University of Strathclyde Business School

Doctoral Thesis

On the Financialisation of Commodity Markets

Author:
Olivier Bauthéac

Supervisors:
Dr. Devraj Basu
Prof. Krishna Paudyal

A thesis submitted in fulfillment of the requirements for the degree of Doctor of Philosophy

in the

Department of Accounting and Finance

June 2021

This thesis is the result of the author's original research. It has been composed by the author and has not been previously submitted for examination which has led to the award of a degree.

An online version of this document is available here for enhanced reading experience.

Signed: 

Date: 2021-06-15

Abstract

As they progressively emerged out of organised forward markets in staple commodities, commodity futures markets came together to address the needs of expert professionals. They are the place where the interests of commercial participants with concerns related to underlying physical commodities meet those of expert speculation; in other words, their essence originally lives in enabling commodity specialists to actively serve their needs. In the early 2000s however, a different type of less informed participation substantially expanded: institutional money entered these markets en masse with abnormally large investments. Participants behind this influx were typically no experts in commodity matters and sought exposures in sharp contrast with those typically assumed by traditional legacy participants. This phenomenon, commonly referred to as "financialisation" had ontological consequences for the commodity futures markets and its impact has been at the centre of heated debates in the policy, legislative, and regulatory spheres as well as in the academic literature. In this collection of studies, we strive to shed new lights on this phenomenon. In the first chapter we explore the issue of co-movement in financialised commodities and our results show that the metals sector was particularly affected. These findings are confirmed in the second chapter where we study the impact of financialisation from a macro viewpoint and our results further put forth the corporate sector as a potential transmission channel to the real economy. The breakdown of the financial crisis of 2008 tempered the commodity investment momentum and was followed by a series of extraordinary accommodative monetary regimes implemented by the US Federal Reserve. In our third chapter we study the financialisation process in this context and our results suggest that the crisis and its unorthodox monetary aftermath seem to have originated a process of definancialisation in the commodity complex.

List of tables

List of figures

Contents

Introduction

The commodity exchange in its modern form finds its origins in the commercial practices and trade customs of European medieval fairs. With the advent of the Late Middle Ages travel and transportation became safer and wandering merchants, in co-operation with local settled counterparts, eventually organised formal trading centres which, in time, developed into periodic fairs.

Trade practices thereat were governed by defined sets of rules and regulations improved and expanded over time that formed the basis of a generally accepted code of international mercantile law: lex mercatoria or "the Law Merchant". Early forms of futurity in transactions could also be observed where "to arrive" contracts (Taylor 1917) were made for delivery of merchandise at a later date with quality matching that of a sample submitted to the buyer at purchase time.

These trading centres developed into more permanent market places as the economic importance of the fairs faded out. In the US for example these local markets sprang up over the various agricultural states and saw the development of market and commodity specific trade associations. Not only these elaborated further tailored trading rules and set up dispute arbitration facilities but also established uniform contracts for general acceptance as well as uniform commodity qualities or "grades" (Baer and Saxon 1949).

With defined and enforced trading rules, some form of time dealing as well as standardisation of contract terms and product quality, the foundations for the development of the modern commodity exchange and futures trading were established.

Futures markets evolved over a long period of time out of surrounding commercial circumstances. Their history is closely related to that of the city of Chicago where they emerged as organised forward markets for grains in the second half of the nineteenth century (H. S. Irwin 1954). Its location made it a strategic spot for the mid-nineteenth century flourishing grain trade and as requirements for reshipment East, as well as processing and feeding the livestock population of the city itself, steadily increased procurement of supplies soon became a problem.

At the time grain was most reliably shipped by road from the fertile plains to the river and canal system for reshipment to the city and beyond during winter whilst weather conditions prevented canal and lake transportation; grain would therefore accumulate in elevators until transportation routes were free of ice. As trade increased so did financing requirements for both the ever-increasing size of crops as well as storage space expansion. With price risk building up, dealers soon developed the practice of finding buyers in Chicago on a forward basis; these firm sale contracts allowed more rational bidding for grain as well as facilitated access to financing for they were judged desirable collateral by bankers.

Forward contracting grew in volume and rapidly came to amount for the majority of transactions. In this context, the Board of Trade of the city of Chicago (CBOT) started business in 1848 by providing facilities for the display of grain and prescribed regular trading hours in contrast with the hectic street curbs and squares trading prevailing until then. Building upon the legacy standardisation work of the trade associations the exchange soon established and enforced grain standards. Receipts designating a given quantity and quality of grain could then be issued in place of lot specific purchase certificates; grain commodities had become fungible assets. The substitution of weight for volume measures and the advent of machinery for inspection and classification further greatly increased efficiency and the receipts themselves soon started to be traded and became widely accepted as collateral in financing transactions.

The emergence of futures markets also rested on the development of the principle of offset whereby a market participant can easily reverse a contractual obligation. First carried out on a bilateral basis with individual participants searching amongst themselves for counterparts holding positions opposite to theirs to settle with, the practice quickly evolved with the formation of groups or "rings" first at the Buffalo Board of Trade (BBOT) and the CBOT (Hoffman 1932) where purchases were "washed" out against corresponding sales amongst ring members. The formation of rings does not eliminate settlement risk however for the failure of a firm in a settlement chain produces consequences to all other participants and difficulties routinely arising in locating some of the contracting parties at settlement time urged exchanges to react. The CBOT endeavoured to tackle the issue as early as 1863 with a rule providing for the suspension of the privileges of membership upon failure of compliance with contract terms and in 1865 a new rule required traders to post performance bonds or margin accounts, held by the exchange, when demanded by either party. The board eventually formalised these methods further in 1883 with the introduction of a third party in the form of a “clearing association” where firms were required to settle net positions daily with all other firms through the payment of price differences to the clearing association laying down the path for “complete” clearing. “Complete” clearing, or true clearing offset, overcomes the shortcomings of the washes and rings with the advent of the clearing house (Moser et al. 1994). Clearing houses have a long history in the banking sector and although the commodity exchange bears the same relationship to the exchange that the financial clearing house bears to the banks it also guarantees contract performance, a function that no other clearing house system undertakes (Edwards 1983).

Complete clearing through a clearing house effectively combines the principles of central clearing with contract registration. The clearing house becomes the buyer on all sales and the seller on all purchases while having no market position of its own as every buyer must have found a seller (and vice versa) and the daily profits of traders always equal the daily losses of other traders. The clearing house thus becomes an intermediary in all futures transactions and guarantees the performance of the parties to each contract. It was first implemented at the Minneapolis Grain Exchange in 1891 and completed the evolution of organised forward markets into futures trading; contracts were now uniform and impersonal with their integrity established by the clearing house.

With that model in place commodity exchanges sprouted beyond Chicago and grains in the late nineteenth and early twentieth centuries across the US with futures markets in common cereals from New-York to San Francisco, markets in cotton in New-York and New-Orleans, in dairy products in both Chicago and New-York with complementary livestock markets in Chicago and soft commodities as well as metals in New-York. Markets were also organised beyond the US borders with prominent wheat futures trading in Winnipeg, Canada and Liverpool, Great Britain as well as extensive commodity futures trading across Europe and Japan (Hieronymus 1977).

In each case futures trading developed from organised forward markets, themselves uniqueis therefore cloly valuable to local producers and merchants for their unique size, quality, timing and location of actual delivery that allow to address specific needs; although their performance continues to rely on the integrity of each party to the contract. Commodity exchanges and futures contracts traded thereat thus developed as a complement rather than a substitute to forward contracting. Unstable in nature, futures trading continued to develop throughout the twentieth century with ups and downs; some exchanges thrived while others declined, trading in some commodity prospered while trading in others languished or never took off.
After a notable slowdown in the 1930s through the Great Depression and sluggish progression afterward and through the second World War with the introduction of a series of price controls, futures trading blossomed in the 1970s with the growth interestingly supported by the introduction of financial futures (Carlton 1984). The period also saw a large percentage of exchanges embrace electronic trading with phones and computer terminal rivalling trading pits although several major exchanges at the time of writing keep using open outcry for trading while offering electronic alternatives. Electronification paved to way for the increasing role of information and technology in exchange success as well as for the more recent developments in the commodity exchange industry including exchange demutualisation, rationalisation and cross-border cooperation.

The history of futures markets is thus closely linked to that of trade in cash commodities. The antique trading centres of Athens and Rome facilitated the emergence of professional money lending and banking which, along with the advent of metallic money, spurred the development of commerce. After an extended period of atonic economic activity over the Dark Ages, inter-city commerce resumed and medieval fairs propagated across Great Britain and Europe. Trade associations soon formed thereat; they promoted self-regulation among members and developed early product grading, laying down the foundations for organised forward trading which soon emerged as a solution to concerns related to the accumulation of inventories as well as ensuing financing and pricing issues that were best addressed by introducing fu-

turity in transactions.
From the late nineteenth century onward commodity exchanges sprang up. Forward contracting developed into standard procedures that were eventually codified and formalised into futures trading; meanwhile the institutional characteristics of the commodity exchange supporting these developments formed along the way. The practice and hosting institution integrated to become the two faces of the same coin: the “exchange” or “futures” contract.

The role of the exchange starts with the design of the contract itself. The terms of a futures contract are a key component to the success of a market and devising them involves numbers of trade-offs and fine tuning to accommodate the needs of all categories of market participants.

In determining a contract’s unit and size for example, the exchange strives to establish terms serviceable to producers, processors and merchants (commercial interests), in other words convenient for hedging, with the many lot sizes dealt with in the course of business calling for small contract units and sizes. For there are per contract, fixed costs, associated with futures trading however, small units and sizes come with high transaction costs making hedging prohibitive.
In establishing price decimals on the other hand, the exchange strives to reach a trade-off between price variations small enough to reflect accurately the information conveyed by participants’ market behaviour but not too small so that trading is not impeded with countless trifling price increments.
Futures contracts are in standard commodity grades crafted to be interchangeable with and as close substitutes as possible for transactions in cash commodities. Grades are made tenderable primarily to permit delivery and since exchange grades are recognised in the physical market, there must be a normal parity between spot and futures markets so that commercial interests may use both. In naming the grade in the contract, commonly referred to as the “contract” or “basis” grade, the exchange must therefore reach a trade-off between hedgers’ plea for granularity and speculators concern for simplicity with the ideal contract grade being narrow, that is, contains commodity of as nearly equal quality as possible but contains enough commodity to

make a market corner unlikely.

Similarly, in contrast with forward contracts that call for delivery at specific dates, delivery on futures contracts can be made over a period during the delivery month which often covers the whole month. A futures contract in a particular commodity is referred to by its delivery month with delivery months varying from contract to contract. Bases for selection by the exchange of contract months include climatic considerations relating to the season of the year as well as concentration of volume of liquidity for example.

Efficient delivery enables arbitrage trading between the futures and the cash market. Should a futures in grains for example trade at a price in excess of the spot price for the quantity of grains called for delivery topped up with the cost of storage up to the delivery month plus the opportunity cost of the capital tied up in the purchase, a trader could open a short position on the contract, in other words sell the contract, while buying the corresponding quantity of grains spot in the cash market. The trader would have an elevator hold the grains to contract maturity at which time delivery would be made on the contract; the trader would thereupon realise a profit equal to the difference between the contract sale price and the expenses engaged in the procurement of the contract quantity of contract grade grains in the cash market and subsequent carrying to the contract delivery month. Settlement risk apart, the operation delivers a risk-free profit seldom overlooked in an active market. Numbers of participants will soon follow suit, pushing the futures price down while bidding the cash price up thereby reducing profit and eventually restoring market equilibrium.

Organised delivery is thus a cornerstone to futures trading for it effectively connects the futures to the underlying cash market and beyond contract terms engineering, the role of the exchange extends to providing for the facilities necessary to facilitate the process. Delivery can only be made in “official” warehouses, approved and licensed by the exchange and intention to deliver must be voiced to the exchange over a certain time window during the contract delivery month with the exchange then matching the positions of the delivering long with short participants willing to take delivery according to a defined set of rules. Owing to the exchange set-up delivery is seamless with the process at the level of participants reduced to a matter of a warehouse receipt transmitted by the long to the exchange designated short participant.

Is the short dependable to take delivery and/or settle with however? Is a particular participant trustworthy to deal with at all? The advent of central clearing through an ad-hoc clearing corporation effectively made the issue obsolete. The clearing house, ground-breaking innovation, both allowed to eliminate the need to search for counterparts that was hindering bilateral settlement through the centralisation of trades as well as addressed the issue of default risk that remained in ring settlement by requiring guarantees from participants.

Exchanges are membership organisations, only a few market participants are exchange members and allowed direct trading; non-member trading orders must therefore be processed by members, often in exchange for a fee. Members are elected by a governing body upon recommendation after thorough investigation. Membership principles extend to the clearing house with membership limited to exchange members and requirements much more difficult to meet than those for exchange membership. Here again, for all trades must clear through the clearing house, non-member clearing must be processed by members. These rigid membership requirements are a first line of defence for the clearing house; they are complemented by several tools designed to decrease the probability of settlement non-performance as well as mitigate loss magnitude in the event of default (Peck 1985a).

The "guaranty fund" allows all members to guarantee the accounts of all other members. Each candidate must contribute before they may become a clearing member and the fund is supplemented by a "surplus fund" that is accumulated from fees charged for clearing. Positions limits are also often enforced; they restrict the size of the total positions that can be carried by each clearing member and are adjusted by the house as warranted by circumstances.

The most effective tool at the clearing house's disposal for performance enforcement however is the right to call for margin deposits. For every futures contract position an "initial" margin must be deposited at initiation with the balance not falling below a certain level ("maintenance" margin) throughout the life of the contract. Margins are present all along the clearing process, from the broker to the clearing house and are at the forefront of loss protection; in the event of default the defaulting member's margin account is depleted first followed by the member's contribution to the guaranty fund, the whole surplus fund and eventually the general guaranty fund.

Central clearing thus shifts control over non-performance from exchange members to the clearing house thereby exempting futures trading from individual counterparty default risk and virtually from default risk altogether[1].

Through the provision of carefully crafted standard contract terms and trading procedures, streamlined delivery as well as elimination of settlement risk, the commodity exchange institution, in its modern form, makes organised commodity markets in staple commodities more efficient and thereby enables futures market to fulfil critical economic functions. It affords physical market operators, producers, processors and dealers, means by which they can, if they so wish, safeguard against the dire consequences of price fluctuations. Prices generated on the exchange also act as a reference for price negotiations between buyers and sellers. The combination of these insurance and price discovery roles of futures markets further provides another service of large economic importance; by supplying simultaneous quotations for multiple subsequent dates and through their use for hedging futures markets tend to promote economically desirable control of stocks (Working 1953a).
The commodity producer and the converter alike are interested in earning a normal "trade profit" as derived from regular business operations involving staple commodities in one way or the other; they are the risk bearers in the physical markets as they voluntarily operate producing or/and transforming facilities. Adverse market price

[1] This is well illustrated by the "Black Monday" crash on October 19th, 1987, when the S&P 500 index plummeted by over 20%, still the most extreme market event in history to date. Although some brokers went bankrupt as they were unable to meet margin calls on contracts entered on their clients' behalf, every single trader who had a short position on S&P 500 futures got paid as the clearing house had sufficient funds to cover the losses. No clearing house default ever occurred in modern history in the US while only three have been documented in the whole world: the "Caisse de Liquidation" (France) defaulted in 1974, the Kuala Lampur Commodity Clearing House failed in 1983, and the Hong Kong Futures Exchange Clearing Corporation failed in the aftermath of the 1987 crash abovementioned (Pirrong 2011; Bignon and Vuillemey 2020).

fluctuations or credit losses are risks that do not belong to their core business and bearing them eventually result in increased production costs.

In life, fire, and marine insurance, owners rid themselves of speculative risks by transferring them to insurance companies. In the commodity distribution system however the first place of risk transfer is the dealership (Baer and Saxon 1949). The dealer makes it possible for a producer to find a buyer at times willing to pay a satisfactory price for specific quantities and specific grades to be delivered in specified periods in the future. There is however never any assurance of such matches and seldom the buyer and seller alike find a befitting counterpart in due course; default by either party also remains possible without protection to the other against losses. Besides, contracting in the trade market involves the buyer and/or seller to disclose themselves when they may not so desire (Emery 1896).

The commodity exchange is not an insurance company, but it establishes a more robust and sophisticated solution for the transfer of risks, commonly referred to as hedging, than accumulation at dealerships in the trade market. In any case, risk can only be transferred if some party stands ready to endorse it and robust commercial hedging therefore requires active speculation.

Speculation intensity is limited in the physical market though as neither are there sufficiently many risk-bearing dealers nor a sufficiently large amount of risk capital among the operating dealers to accommodate commercial needs. The commodity exchange supplements the work of the dealer middlemen in providing a continuous market by gearing into its machinery large capital funds and many professional risk-bearers ready to buy or sell at any particular time.

The existence of a broad (many participants) and deep (intense activity) continuous market gives a commodity the quality of liquidity; large quantities can be obtained or disposed of at any time during the trading session, and at prices varying but slightly between quotations. There is assurance moreover, that if prices tend to fall (rise) to unwarranted levels, the "bull" ("bear") or long (short) interest will resist the movement and vice versa (Huebner 1931), eventually promoting price stability.

Reduced non-operational risk, heightened liquidity and stable price taken together

effectively curb down operational risk for capital providers and consequently encourages more liberal loans by bankers to commercial participants. Softened access to credit also extends to professional speculators; speculation forms the core of their operational risk with that risk similarly reduced by operating on the exchange as opposed to the physical markets.
The advent of a futures market is nevertheless commonly perceived by commercial interests as an intrusion of speculative forces and often accompanied by fierce resistance. Speculation, to a larger extent has forever been the scapegoat of producers and consumers alike with the fires of the two groups generally levelled during drastically different phases of the business cycle. At the trough of every deflationary spiral, when commodity prices are low, the producers are the most vehement critic of speculation; as prices sweep upwards to high levels in inflationary booms, consumers charge the exchanges and speculative operations thereon with the responsibility for high prices. Politicians opportunely fire both ways and often brash measures follow with margins build-ups and/or drops in position limit levels the usuals for peaks and short selling bans the standard for troughs. In most instances however commercial interests eventually come to find futures markets very valuable and adjust their trading in accordance with the opportunities for increased risk management.

Along with robust risk management, exchange markets bring about improved pricing capabilities over the physical market standards. In normal times they gather a range of trade information from government reports, private commercial agencies, other exchanges, as well as exchange members and the various producers, dealers, and manufacturers associations operating in the same fields. This includes production data, imports/exports, supply through certificated inventory in warehouses, demand evidenced by statistics of sales, market activity figures and more. Once processed this information is publicly disseminated globally in the form of periodic market reports and other statistics, daily publication of the record of volume and prices of all exchange transactions as well as continuously broadcasted price quotations and trading data. In contrast, such records and dissemination are unworkable in the physical market where details on prices and quantities traded are seldom advertised.

Cash markets' structure suggests asymmetrical information to the benefit of the demand side where the market is concentrated and dominated by a small number of informed processors.

Exchange markets level the information playing field by affording all participants access to the same information at all times; no buyer has any advantage over any seller, nor no seller over any buyer, and the principle of caveat emptor rests in peace. Throughout the trading day, this information as well as any piece of news having potential direct or indirect effects upon commodity prices is received and processed by all types of expert market participants. Exchange quotations reflecting their average combined judgement are given gratis to all and constitute a real assurance of fair dealing as uninformed participants are therefore protected by a large group of experts whose interpretation of news into current prices furnishes a degree of accuracy much greater than would otherwise prevail (Huebner 1931).

The amount of information reflected in commodity futures prices is greatly improved over that potentially carried in cash prices. Current futures prices hence depend to a lesser extent on past prices and, for they factor in more fundamental, systematic information their unexplained price component is notably reduced (Peck 1985b); the rationality of market prices in enhanced, they become more "efficient".

Exchange markets thus provide an institutional arrangement where efficient commodity prices are warranted outcomes that are "discovered" based on the fundamental market forces of demand and supply. Futures markets price discovery, in turn, feeds back into the cash markets where futures prices are widely used to complement fundamental purchase and sales decisions (Working 1948) eventually strengthening the connection between the two markets. In a virtuous circle, by gathering and widely disseminating trade information, the exchange and intense speculative activity thereon promote market integration that in turn fosters price discovery, improving risk management further and increasing commercial utility derived from exchange participation.

"Efficient" prices on the other hand provide accurate signals for resource allocation

(Fama 1970). With continuous trading over the production period, futures prices not only reflect anticipated production and consumption relations but also the response they create; they are rational forward prices. Besides, commodity exchanges expedite marketing with production swiftly flowing to market under free, competitive conditions; absorbed in orderly fashion, stored, and distributed in accordance with the needs of consumption. Rational decision making and streamlined marketing hence enable the provision of a service of great economic importance that seldom receives the attention it deserves: economically desirable control of stocks (Working 1953a; Tomek and Gray 1970; Sanford J. Grossman 1977; Danthine 1978).

Price quotations applying for successive dates in the future promote rational storage decision making as they are simultaneously supplied on exchanges. The difference in price between two contracts in the same futures series accurately reflects the degree of shortage and thus the market's need for continued storage at a particular time; in that regard futures markets effectively extend the range of the price discovery function to the market price of storage. Besides, the availability of a futures market permits individual storage decisions to be hedged and thereby makes operators sharply aware of losses that must be expected from carrying unnecessary stocks in times of relative shortage of supplies as well as provides assured returns for storage in times of relative surplus. Improved responsiveness of storage decisions to price follows, along with a fine corollary: improved seasonal stability of commodity prices.

The exchange fine-tuned machinery including the clearing house's provision for efficient delivery enables arbitrage trading between a futures and its underlying cash market which enforces price convergence at contract maturity, effectively connecting the two markets.

This strong bond enables effective risk management and excess demand for that service is to a futures market what Keynesian stimulus is to the general economy, a pump priming device. It brings in speculation as well as a prime by-product: liquidity. Like oil in cogs, liquidity greases up the exchange's machinery and enables futures markets to fulfil their economic role more efficiently. Efficiency, in turn, attracts more demand which draws in more speculation that improves efficiency fur-

ther, eventually inviting more demand, etc.
In general exchange markets emerge from physical markets; far from replacing them they supplement their activities and make them more effective and efficient servants of the public interest. They are to cash markets what money is to barter (Lester G. Telser and Higinbotham 1977) with the one important caveat of interdependence. A futures market is not viable without its underlying cash market; the two markets are fundamentally linked and their bond, through the fulfilment of the key economic functions it enables, governs intertemporal relations in the futures series eventually determining the shape of the commodity futures' term structure.

The shape of the term structure is the locus of an almost century long academic debate opposing two main schools of thought. Their respective approaches both relate to the economic role described above albeit to different functions.
The issue was originally addressed by John Maynard Keynes (Keynes 1923, 1930) and John Hicks (Hicks 1939) through the risk management perspective. The Keynes-Hicks hypothesis asserts that hedgers dominate the market and the supply side dominates hedging interest such that hedgers are net sellers. Speculators are assumed risk-neutral and rational such that they'd enter a long position in futures only upon expectation of the realisation of a profit over the investment horizon[2]. With convergence enforced, a futures price that lives below the expected spot price at contract maturity–as proxied by the current spot price–is expected to naturally increase through the life of the contract signalling a profit opportunity from a speculator standpoint, in other words, an incentive to enter the contract on the long side. By selling forward at a discount to the current spot price, short risk-averse commercial hedgers effectively transfer commodity price risk to long speculators along with a premium for the service. A downward slopping term structure with futures trading at a discount to spot prices and decreasing in maturity characterises a market in "backwardation"; the natural configuration in the Keynes-Hicks paradigm: "theory of normal backwardation". The complementary market layout where futures trade at a premium to spot prices and increase in maturity is referred to as "contango". A

[2]Risk hedging model of speculation.

later amendment to the theory allowed to account for the phenomenon by proposing that price should fall whenever hedgers are net long (H. Houthakker 1957; Cootner 1960b).

The Keynes-Hicks approach was soon challenged by Holbrook Working (Working 1949) who, building on previous work (Working 1933, 1934, 1942, 1948; Hoos and Working 1940), addressed the issue from a different perspective, that of inventories: "theory of (the price of) storage". Working emphasises the dominating role that stocks play in determining intertemporal price relationships. For Working, for carrying physical commodities through time accrues storage costs, futures shall trade at a premium to spot prices with the premium covering carrying costs at the least to entice potential holders to carry commodity in inventory and eventually accommodate future demand. Contango as opposed to backwardation is therefore natural. Backwardation is accounted for through Nicolas Kaldor's complement (Kaldor 1939) that introduces the concept of convenience yield. It refers to the sum of all extra advantages, above appreciation of market value, a holder of physical commodity may derive from carrying stock above immediate requirements[3]. Should the value derived by the holder from carrying an extra unit of inventory (marginal convenience yield) rise above the associated costs (marginal carrying cost), in a shortage market for example, the futures price would fall below the spot price and backwardation (or market inversion) would occur.

Both theories were extensively complemented through time with the issue at the centre of academic discussions[4] on how the behaviour and interactions of commercial

[3]For example not having to halt production in case of restocking difficulties in the context of a market shortage.

[4]The quest for a generalised theory of price formation and intertemporal relationship in futures markets, in other words for a theory of the term structure, is still ongoing at the time of writing and gave rise to a number of vigorous academic debates over time starting with a symposium in the Review of Economic Studies that opposed Nicolas Kaldor to Christopher Dow and Ralph Hawtrey (Kaldor 1940; Dow 1940; Hawtrey 1940). A latter discussion opposed Lester Telser to Hendrik Houthakker and Paul Cootner (H. S. Houthakker 1957; Lester G. Telser 1958, 1960; Cootner 1960b, 1960a) and a following contention opposed Richard Heifner to William Tomek and Roger Gray (Tomek and Gray 1970; Heifner 1971; Gray and Tomek 1971). Other notable contributions to the debate include (although are not limited to) Blau (1944), Samuelson (1957), Brennan (1958), Hendrik S. Houthakker (1959), Lester G. Telser (1959), Lester G. Telser and Higinbotham (1977), Lester G. Telser (1981), Gray (1961), Cootner (1961), Cootner (1967), Stein (1961), Weymar (1966),

interest and professional commodity speculation, in other words commodity specialists, set out a commodity market's fundamentals.

From the definition of rules and regulations governing trade practices in medieval fairs to the advent of the exchange and its fine-tuned robust machinery, commodity futures markets throughout their development and maturation have been crafted by informed professionals so that the economic role they fulfil primarily facilitates the conduct of their business operations. A futures market in a particular commodity became the place where the interests of commercial participants with concerns related to the underlying physical commodity meet those of expert speculation; in other words, the essence of commodity futures markets originally lives in enabling commodity specialists to actively serve their needs.

In the early 2000s however, a different type of less informed participation substantially expanded. Institutional money entered the markets en masse with insurance companies, pension as well as hedge funds, foundations, university endowments and even high-net-worth individuals ploughing considerable amounts into commodity index linked products most of which made their way into the commodity futures markets. These investments were abnormally large relative to the size of the markets and their nature orthogonal to that originally prevailing. Participants behind these were typically no experts in commodity matters in general, let alone in individual commodities. They sought broad as opposed to commodity/subsector specific exposures with positions limited to the long side as opposed to long-short and passively as opposed to actively managed.

Non-informed, broad, long only, passive exposures contrast in every aspects with those typically assumed by traditional legacy participants and the phenomenon was only enabled by the unprecedented alignment of a number of favourable contextual factors including a series of financial innovations that enabled financial exposure to commodity markets at large, regulatory changes that facilitated large scale investment in these and a moribund economic context with poor performance on mainstream asset classes that encouraged investors to search for alternatives.

Tomek (1971), Dusak (1973), Rockwell (1976), Danthine (1978) and E. S. Schwartz (1997).

A number of financial innovations enabled large global banks to offer commodity exposure to buy-side institutional and retail investors with these mostly centred around the then incipient concept of commodity index investability.

Although commodity indexes have been around for a long time with The Economist's Commodity Price Index, for example, starting in 1864; the first of the prominent indexes at the time of writing to come to existence was the CRB Index, assembled by the Commodity Research Bureau (CRB), the highly regarded commodities and futures research firm now owned by Barchart.com. Known as the Refinitiv/CoreCommodity CRB Index (RF/CC CRB) at the time of writing, it made its inaugural appearance in 1958 in the firm's Commodity Yearbook and was originally composed of commodity futures traded on exchanges in the US and Canada as well as of two cash markets. Its primary purpose was to provide a dynamic representation of broad trends in overall commodity prices; due to its construction however, its cash market component in particular, it was not useful as an investment index.

The era of investable commodity indexes is much shorter and arguably began with the creation of the Standard & Poor's Goldman Sachs Commodity Index (S&P GSCI; originally known as the Goldman Sachs Commodity Index). Although the index exclusively comprises exchange-traded commodities futures, it was not originally designed to serve as the basis for investable products let alone to provide a balanced, broad exposure to the commodity spectrum. In determining weights for individual commodities and sectors its construction method emphasises global production, liquidity, open interest as well as scalability and as a result the index is heavily weighted toward energy commodities with the energy sector regularly assigned a weight in excess of sixty percent of the overall index. At the other end, the eight smallest of the twenty-four components that comprise the index collectively have an index weighting of less than five percent.

Launched in 1998, the Bloomberg Commodity Index (originally known as the Dow Jones-AIG Commodity Index) was developed with sector constraints that compensate for the energy focus of the S&P GSCI and therefore offers an attractive alternative to investors looking for diversified exposure to the commodities markets.

These indexes eventually became industry-standard benchmarks for commodities investing; they remain mathematically calculated values based upon the relative weights and prices of their components however and investment in them therefore requires ad-hoc vehicles. Although intuitively appealing, purchasing futures contracts for individual commodities in proportions equal to those of an index is reserved to a small minority of institutions for most are bound by conservative investment policies that do not allow direct trading in futures.

The most common alternative was to gain exposure by entering an over-the-counter (OTC) swap contract with the swap paying a return based on the value of a specified index. The purchase price of the swap equals the value of the index on the purchase date and as the value of the commodity index increases (decreases), the value of the swap increases (decreases) by a corresponding amount. The swap dealer in turn typically hedges by purchasing an equivalent amount of the specified individual futures contracts for a net exposure of zero and a benefit amounting to the fee charged (typically around 2%) for the service topped up with the return on funds in excess of futures margins (typically set around 8% to 10%), usually invested in Treasury bills. Goldman Sachs started offering swaps on its own index soon after creation and the process was made even simpler in this case with the introduction of a futures on the S&P GCSI itself in 1992 allowing swap dealers to effectively hedge in a single purchase.

As their name suggest, OTC swaps are not traded on regulated futures exchanges and are sold outside of the statutory and regulatory framework that applies to them. Publicly traded alternatives include Exchange traded funds (ETFs). An ETF issues blocks of shares against the purchase of futures contracts in proportions equal to those of a reference commodity index with the purchase carried out directly or, more commonly, through a commodity index swap. The opportunity of arbitrage that exists between the fund's shares and its components' futures contracts enables a strong bond between the value of the shares and that of the underlying index. This construction allows investors to easily get exposure to a commodity index by buying ETF shares in the same way they would buy shares of stock on a stock exchange and thereby provides a way for smaller investors who are not large enough to deal with a swap dealer directly to invest in commodity indexes. Originally equity focused,

ETFs have matured significantly since the creation of the first of the kind, the Standard & Poor's Depositary Receipt (SPDR), in January 1993. After progressively expanding to commodity related firms, they eventually started offering exposure to commodities themselves in the early 2000s, first through physical holdings.
Exchange traded notes (ETNs) are another notable alternative. Similar to ETFs, blocks of securities are issued against exposure to a specified index; in the case of ETNs however, the securities have a debt type structure where the holder receives the value of the reference index at maturation date. Like ETFs, ETNs had an initial equity centred focus and eventually encompassed commodities with ETNs that offer commodity exposure often referred to as commodity linked notes (CLNs).
Swaps and exchange traded products alike are landmark inventions that greatly facilitated investors access to the commodity complex. By construction they involve taking positions in futures markets however where scalability originally met a regulatory bottleneck.

While organised, lawful speculation enables futures markets to perform valuable economic roles (Williams 1936), disorganised, unlawful speculation, in the form of market manipulation such as corners or squeezes for example, effectively produces the opposite effect. Futures markets and speculators thereat have repeatedly been attacked as "gamblers", "predatory parasites" or even "thieves" (Hardy 1940; Working 1960; Romano 1997; Paesani and Rosselli 2020); perhaps because of confusion between the two concepts.
Over the course of their early developments, in the late eighteenth and early nineteenth centuries, commodity markets were self-regulated and rife with manipulation to the extent that the CBOT became internationally regarded as the epitome of the shortcomings of the American free enterprise: greed, the cycle of riches and ruin, boom and bust, corruption, etc. After a series of unsuccessful attempts in the late eighteenth century including the Butterworth as well as Hatch and Wasburn bills (Emery 1895), agitation from the farmers in the aftermath of the first World War, blaming speculators for collapsing grain prices, urged the introduction of federal regulation.

In 1922 the US Congress passed the Grain Futures Act (GFA) that laid down most of the framework for the regulation of commodity exchanges in effect at the time of writing. The Act established the Grain Futures Administration (GFA) along with the Grain Futures Commission (GFC), its regulatory body; it further prohibited off-exchange transactions for grain futures and required exchanges to foster transparency by making more information public as well as to strive to prevent market manipulation.

The Act was renamed and its scope expanded beyond grains in 1936 with the US Congress enacting the Commodity Exchange Act (CEA). The new Act provided federal regulation for all commodities and futures trading activities, at the time limited to agricultural products; it required all futures and commodity options to be traded on organised exchanges and established the Commodity Exchange Authority (CEA) as the ad-hoc administrative body. It further added more specific anti-speculative clauses, including the empowerment of the GFC to set limits on the number of futures contracts in a single commodity an individual speculator could own, thereby effectively isolating a concern separate from manipulation. A first set was soon introduced in 1938 with limits of 2 million bushels for grains; position limits were born.

By the 1970s commodity markets had extended beyond agricultural products; accordingly the US Congress overhauled the CEA in 1974 and expanded its coverage to include soft commodities and metals[5]. Position limits were extended accordingly and jurisdiction was transferred from the department of agriculture's Commodity Exchange Authority to the a newly created independent federal regulatory agency: the Commodity Futures Trading Commission (CFTC). The 1974 Amendments to the CEA were a complete revision of over fifty years of federal regulation; all exchanges and commodity contracts traded thereat were brought under regulation provided that they were for "future delivery". The exchange of future payments of income or interest, in a swap agreement, on the underlying referenced security or index as a means to transfer price risk constitutes an element of "futurity" that may be suf-

[5]Futures for energy commodities would only start trading later, following extreme price volatility in the sector resulting from the 1970s Arab embargoes, with a first contract for heating oil beginning trading in 1978 on the New York Mercantile Exchange (NYMEX); other energy commodities soon followed including Western Texas Intermediate (WTI) crude oil in 1983.

ficient to characterise a transaction as a futures contract; OTC commodity index swap transactions could therefore be considered illegal under the revised CEA. OTC swap prohibition and position limits clearly did not set the stage for the large influx of index investments that were to come; yet a series of regulatory changes over the following decades eventually opened the gates of the commodity complex for large scale cross-sectional investments.

After a number of exemptions were granted on a case-by-case basis, the US Congress gave the CFTC authority to exempt transactions from the exchange trading requirement and other provisions of the CEA in 1992 through the Futures Trading Practices Act (FTPA). The CFTC proceeded to grant exemption to swap contracts between "sophisticated parties"[6] in 1993–the swap exemption–contending that as "hybrid instruments", along with certain "forward transactions", they were not covered by the CEA. OTC dealing in swaps was set free, although at this stage expansion remained bounded by position limits.

The Commodity Futures Modernisation Act (CFMA) of 2000 would soon alleviate that burden substantially. The Act broadly excluded from regulatory oversight transactions in financial derivatives ("excluded commodities") and extended most of the same exclusions to non-financial commodities that were not agricultural ("exempt commodities") provided contracts were made between "eligible contract participants"[7] and not executed on a trading facility[8]. This provision enabled swap dealers to hedge off-exchange thereby circumventing position limits for these commodities. Under the CFMA however agricultural commodities remain to be traded on a CFTC

[6]Defined as financial institutions, market professionals or individuals meeting certain asset and income thresholds.

[7]Defined similarly to "sophisticated parties", albeit in more liberal terms.

[8]This statutory exemption from regulation for exempt commodities is commonly known as the "Enron loophole" (Senate 2007). Enron was an American energy company based in Houston, Texas. Before its collapse in 2001 the firm utilised energy derivatives to hide losses and debts incurred to finance unprofitable core businesses including natural-gas and electricity transmission. The Act also provisioned for contracts in exempt commodities between "eligible commercial entities" executed on an "electronic trading facility" to also be exempt from most provisions of the CEA. This provision enabled Enron to use its online platform "Enron Online" to ramp up trading in energy derivatives without having to report any details related to these activities to regulatory authorities. The provision also led to the creation of the Intercontinental Exchange (ICE).

regulated exchange and thus liable to the position limits enforced thereat. While position limits apply to speculators, market participants who engage in hedging activities are usually exempt from them provided they are acknowledged as doing so by the CFTC. Exceptions are granted to "bona fide" hedgers with the term first appearing in the Commodity Exchange Act of 1936 with a rather restrictive definition including only participants who owned the underlying commodity, had fixed sales commitments, or produced it. Subsequent revisions iteratively broadened the definition, weakening the link to the trade market, to the extent that several swap dealers, including Goldman Sachs' commodity trading subsidiary, eventually petitioned for waivers claiming they too were using futures for the purpose of hedging. And hedging they were: OTC commodity swaps. The CFTC agreed and exemptions were granted to the "bona fide" swap dealers; the position limits bottleneck was no more.

These provisions applied to a large extent to ETF managers and ETN issuers although for these, investors were required to sign a statement stating they understood the risks of commodity investments; a rather inconvenient procedure for products designed to trade like stocks that was eventually waived by the CFTC in 2005.

With technological and regulatory barriers down, the ground was all set for extensive commodity index investment and a severe economic downturn accompanied by flattering publicity from both the industrial and academic spheres would soon convince institutional players to proceed.

In the early 1990s the advent of the internet and its widespread adoption sparked the establishment of tech-based start-up companies in the US. The success of the few, including Amazon and eBay founded in 1994 and 1995 respectively, inspired the many and stories of people leaving their job to start an internet company rapidly became common. In this tech fad cheap money spurred venture capitalists (VCs), anxious to find the next big score, to freely invest in any company with a ".com" after its name. Companies with dubious business models when there was one, no finished product in some cases and therefore no revenue let alone profits, went to market with initial public offerings (IPOs) that recorded stock prices tripling or quadrupling on the first trading day. These operations multiplied to the extent that they represented most US IPOs in 1999; the "dotcom" bubble was born and swelling fast.

Its expansion was amplified by the unusually high participation of retail investors following the enactment of the Taxpayer Relief Act of 1997 by the US Congress. While leaving dividend tax rates unchanged–at the same levels as regular income–the Act pulled the top marginal tax rate on capital gains from 28% down to 20%. This gave retail investors a strong incentive to favour low-to-no dividend paying growth stocks epitomised by the internet start-ups.

With traditional pricing models not adapted to internet stocks, with new business models and negative earnings and cash flow, investors focused on metrics such as price-to-sales or even website traffic. Many internet firms consequently abandoned fiscal responsibility and spent a fortune on marketing to gain market share through brand building and networking with some start-ups spending as much as ninety percent of their budget on advertising. Some also resorted to aggressive accounting to inflate revenue.

By 1999 a business plan that vowed to "change the world", a "get big fast" strategy, a tendency to operate at a loss with a high cash burning rate as well as a willingness to spend lavishly on brand building were marks of a successful "dotcom". The venture capital funds that backed these companies made little case of whether a business would ever turn a profit because it didn't need to; going public is the exit of choice for a venture investment and investors were therefore aiming for supernova IPOs. Sky-high valuations, divorced from any sort of profitability or rationality, ensued and share prices continued to rise supported by an overwhelming demand spurred by medias companies peddling overly optimistic–albeit well-selling–expectations on future returns. The demand was also fuelled by investment banks which profited significantly from IPOs and therefore strongly encouraged investment in technology. The Nasdaq Composite index, heavily weighted towards the technology sector, increased fivefold from 1995 to its peak in March 2000 at which point it showed a price-to-earnings (P/E) ratio of 200…

Starting the previous year and in an attempt to reiterate the successful soft-landing of 1994, Alan Greenspan's Federal Reserve carried out six consecutive rate hikes, increasing its funds target rate from 4.75% in June 1999 to 6.5% in May 2000. With increased borrowing costs, investment capital started to dry up and so did the lifeblood of the cash-strapped "dotcom" companies. Wall Street analysts took a more conservative stance, letting their clients know that the sector was no longer undervalued, and as insiders cashed in, selling their own stocks at an industrial pace, panic selling sparked amongst investors; the bubble burst.

By the autumn 2002 the Nasdaq had receded by almost 80% relative to its peak in spring 2000, wiping out approximately five trillion dollars in value with the tumble magnified by a loss of investors' confidence following a series of corporate scandals in the sector including the most infamous, Enron and Worldcom[9], as well as the demise of Arthur Andersen[10], auditor to both firms[11]. It would take the index fifteen years to get back to its March 2000 peak level.

In spite of the Federal Reserve attempts to curb the downfall with thirteen consecutive rate cuts, dropping its funds target rate down to 1% in July 2003, the turmoil eventually spread beyond the tech sector to the whole economy with the September 11, 2001 terror attacks catalysing the transmission; and where a soft-landing was expected, a recession occurred followed by a further market downturn in 2002. The S&P 500 and the Dow Jones Industrial Average indexes fell by 46% and 37% from their peaks in January and August 2000 respectively to their troughs in September 2002.

In this moribund context of poor stock market performance and low interest rate

[9] Worldcom was a telecommunications company, for a time the second largest long-distance telephone company in the US. From 1999 to 2002, senior executives at WorldCom orchestrated a scheme to inflate earnings in order to maintain the firm's stock price. The scandal came to light in the summer of 2002 and the subsequent bankruptcy of the company surpassed that of Enron as the biggest bankruptcy in history at the time. It also led to a domino effect of accounting and corporate scandals including one involving Arthur Andersen, auditor company to the firm.

[10] Arthur Andersen was an American large accounting firm that provided auditing, tax and consulting services to large corporations. In 2002 the firm was convicted of obstruction of justice for shredding documents related to its audit of Enron resulting in the infamous eponym scandal. Other big-name accounting scandals were linked to Arthur Andersen including that involving the above-mentionned Worldcom.

[11] This series of corporate scandals in the early 2000s led to the enactment of the Sarbanes-Oxley Act in July 2002 that was meant to restore investors' confidence in the financial markets and close loopholes that allowed public corporations to defraud investors.

environment institutional investors on the lookout for returns and diversification after the recent crash, paid a particular attention to voices from both industry and academia singing the praises of a new investment playing field: the commodity futures markets.

Historically perceived as a heterogeneous collection of idiosyncratic individual markets where any notion of homogeneity typically wouldn't thrive beyond the sector level at best, these were now presented as an asset class with appealing investment characteristics: equity like returns, negative correlations with equities and bonds and positive correlation with the general level of prices (i.e., inflation). Commodity exposure via a passive futures based broad index was branded as a return enhancer, diversifier and inflation hedge with the additional benefit of offering an inherent, natural return that is not conditioned on skills. This was a reference to the "roll return" for backwardated commodities. As a futures contract nears expiration a long position is "rolled" with the position on the current contract closed and a new one opened on the next liquid contract on the term structure; with the next contract trading at a discount to the current, a profit is mechanically realised.

Using these selling points, multiple financial institutions (Goldman Sachs, Prudential Bache Commodities through their consultant Alternative Investment Analytics, Pimco, etc.) that were dealing in products related to commodity indexes, including those who had created an index themselves, began to aggressively market these types of instruments. With the value proposition also echoed in several influential academic papers (Bodie and Rosansky 1980; Bodie 1983; Greer 2000; Jensen, Johnson, and Mercer 2002; Wang and Yu 2004; Claude B. Erb and Harvey 2006) corroborating the main assertions put forward in the marketing frenzy, investors began to consider the commodity complex as a serious candidate for alternative investment. A new investing fad ensued with massive amounts of institutional money poured into commodity index related products; a phenomenon commonly referred to as the "financialisation" of commodity markets.

Uninformed index investors intruded into the realm of commodity specialists as aliens. In contrast with swap dealers and issuers of exchange traded products whose

operations are market neutral in nature, their participation was speculative in the sense that they had no direct concerns in the underlying cash markets and the marketing of physical commodities. They were rather chasing in commodities complementary returns to large mainstream portfolios mostly composed of equity and bond securities.
Their participation was also commercial however for they were hedging risks inherent to regular business operations. They were not hedging physical commodity exposures indeed but hedging they were, more abstract investment risks including portfolio concentration and inflation; in other words, core business risks from a professional investor standpoint.
With exposures in sharp contrast with those of legacy traditional participants and investment inflows large relative to that of the destination markets, the arrival of these “speculhedgers” triggered an ontological drift in the commodity complex, impacting its nature and consequently potentially altering its capacity to perform the valuable economic functions it traditionally fulfils as described above.

The literature on the impact of the financialisation of the commodity markets is vast and we strive to contribute, however modestly, to the comprehension of subjects related to this phenomenon that we believe have not been fully explored.
In particular, in the first chapter we shed new lights on the issue of co-movement in financialised commodities. We use a bespoke asset pricing factors based framework where factors based on the Keynesian and Working’s term structure paradigms seem to best detect the changes brought about by the financialisation influx outlining the alteration of fundamentals in these markets following the arrival of index investors.
In the second chapter we study the impact of the phenomenon from a macro viewpoint where we examine potential spillover effects to the real economy through the corporate sector channel.
Finally, our third chapter examines the behaviour of the commodity complex in the context and aftermath of the unconventional monetary policy implemented by the US Federal Reserve from the trough of the great financial crisis of 2008 through to 2014 and we find, yet again, substantial changes in the nature of these markets.

1 Financialisation of commodities: co-movement behind-the-scenes

1.1 Introduction

The last twenty years have seen major upheavals in the commodity markets with the onset of financialisation[12] as well as the period of the 2008 financial crisis and its aftermath. Financialisation appears to have affected multiple economic sectors, including agriculture and energy, and its impact has been hotly debated in the policy, legislative, regulatory, and academic spheres. A vigorous legislative debate accompanied by an equally intense policy and academic debate across a number of disciplines about the perceived effects on commodity prices of the unprecedented inflow of institutional funds brought into commodity futures markets by new index type investors[13] eventually led to regulatory changes in several individual markets.

In response to immediate policy concerns, the academic debate was initially framed rather narrowly around adequacy of speculation–the burning issue of the day–at the individual commodity market level and the ensuing academic analysis focused on the more mechanical effects of financialisation. With the benefit of hindsight, this approach seems to lack a fundamental understanding of the phenomenon it endeavoured to study and which consequences it attempted to address.

Financialisation was a phenomenon global in nature; through the channel of index investment it affected the whole cross-section of liquid commodities at once, eventually spurring its transition away from a collection of idiosyncratic markets to its emergence as an asset class. Focusing on individual markets in this context thus seems incomprehensive. The mechanical approach similarly seems amiss both in form and substance. Most of the studies underpinning the regulatory response to

[12]Starting around 2004, with a view of commodity markets as an emerging asset class and in an effort to hedge against inflation and seek diversification benefits (Büyükşahin and Robe 2014; Singleton 2013), institutional investors sent forth an unprecedented flow of capital into commodity futures markets. This phenomenon is commonly referred to as the financialisation of commodities (Domanski and Heath 2007).

[13]See section 1.2.1 for a detailed discussion.

financialisation took the form of pairwise correlation, causation and to some extent co-integration analysis, all of which are idiosyncratic in nature for they study single pairs of individual assets. Besides, some of these techniques since proved controversial and seem to produce results the quality of which may fall short of the standards that may reasonably be expected to lay the ground for legislative action. In substance, leaving the idiosyncrasy issue aside, a case could be made for the mechanical approach under the assumption that financialised commodity markets can be described, ceteris paribus, as their prior or legacy state with increased uninformed financial participation. The aforementioned technique(s) could thence be used to observe potential changes in pricing dynamics, for example, which origin could be naturally attributed to the market behaviour of the new comers. Although appealing, for it comes with the promise of prompt "significant" results, this approach misses a critical corollary of the substantial advent of a new category of players in a (set of) market(s): the alteration of market fundamentals it potentially induces, best observed in this context through the lens of commercial hedging pressure (Keynes 1930; Hicks 1939).
While essential to the understanding of the phenomenon, the global nature of financialisation and its impact on market fundamentals therefore appear to have been originally overlooked and another approach, perhaps more refined, seems warranted.

We strive to provide one in this study by taking a fundamentally different empirical perspective that is broader in scope. We consider the entire cross-section of actively traded commodities on futures markets and use a futures-based asset pricing framework that includes factors constructed using both theoretical fundamentals and liquidity considerations.
The global nature of financialisation makes cross-sectional co-movement a cornerstone issue that the direct impact of increased market participation alone might not be able to fully explain for it potentially had deeper effects, for example on market fundamentals as our results suggest. Commodity futures markets have a history of being the classic physical commodity price risk shifting conduit for commodity specialists. Over the financialisation period we observe a decrease in effectiveness

of commercial hedging pressure (CHP) at explaining commodity futures returns at the individual level accompanied by a more pronounced increase at the aggregate level. We further note an overall shift in the nature of hedger's behaviour away from the traditional Keynesian view of risk transfer with higher individual risk premiums over phases of cross-sectional contango as opposed to backwardation. Both patterns suggest that the phenomenon may have altered this long-standing paradigm of commercial risk transfer with the entry of long only commodity index traders (CITs) with very different hedging and volume demands from traditional participants. This change could have altered the hedging ontology in these markets and our asset pricing framework is well suited to detect these more subtle effects driven by changes in the nature of market participation.

Factor model techniques are well suited to isolating common driving factors and detecting co-movement (Fama and French 1993, 2015; Carhart 1997; C. Asness and Frazzini 2013; Hou, Xue, and Zhang 2015; C. Asness et al. 2015; Frazzini and Pedersen 2014; C. S. Asness, Frazzini, and Pedersen 2019) at a broader level, beyond individual pairs of assets, and are commonly used to study commodity market fundamentals (E. Schwartz and Smith 2000; Miffre and Rallis 2007; G. B. Gorton, Hayashi, and Rouwenhorst 2012; Cortazar, Kovacevic, and Schwartz 2013; Yang 2013; Daskalaki, Kostakis, and Skiadopoulos 2014; Szymanowska et al. 2014; Fernandez-Perez et al. 2018; Bakshi, Gao, and Rossi 2019; Boons and Prado 2019; Sakkas and Tessaromatis 2020); they consequently seem well adapted to study these two issues simultaneously. Building on theory we therefore develop a bespoke commodity-based asset pricing framework comprised of factor models based both on fundamentals as well as liquidity considerations.

One of these is based on the Keynes-Hicks (Keynes 1923, 1930; Hicks 1939, 1946) risk transfer approach to the term structure; the corresponding "theory of normal backwardation", complemented for the possibility of contango (H. Houthakker 1957; Cootner 1960b), postulates that futures prices for a given commodity are inversely related to the extent that commercial hedgers are short or long and using commercial hedging pressure (CHP) as a proxy for hedgers net market position we construct factor mimicking portfolios that capture the impact of hedging pressure as a systemic factor (Basu and Miffre 2013). Working's contending approach that relates futures price formation to storage costs in the theory of "the price of storage" (Working 1949) forms the basis of another model that we consider where, following Szymanowska et al. (2014) and Fuertes, Miffre, and Fernandez-Perez (2015) who demonstrate that the term structure factor has explanatory power for the cross-section of commodity returns, we construct factor mimicking portfolios using roll-yield as a proxy for the front end shape of individual commodity term structures. We further consider a liquidity-based model following Hong and Yogo (2012) who find that open interest growth has predictive power for individual commodity returns and again, using the latter measure as a proxy for individual commodity liquidity, we construct long-short factor mimicking portfolios.

We study the performance of these models on a set of twenty-four US traded commodities and six UK traded (London Metal Exchange) base metals over the 1997/2018 period that we divide into four distinct sub-periods: pre-financialisation (1997/2003); financialisation (2004/2008[14]); financial crisis and aftermath, including loose monetary policy regimes that followed (2008/2013); and post-crisis (2014-2018).

Consistent with earlier studies, we observe that mean returns for the US traded commodities are sharply higher over the financialisation period compared to pre-financialisation and this pattern extends to UK traded metals.

The cross-sectional nature of financialisation (Cheng and Xiong 2014; Basak and Pavlova 2016) leads us to extend the Keynesian individual hedging pressure paradigm by incorporating aggregate CHP (**CHP**), a market wide measure of hedging pressure first considered in Hong and Yogo (2012). This paradigm implies that returns for individual commodities should be high in periods where **CHP** is low (**backwardation**) and low in periods where **CHP** is high (**contango**). Over the first period the cross-sectional average returns during phases of **backwardation** for both the US and UK commodities are positive and overall higher than during phases of **contango**,

[14] Starting point based on earlier studies (Steven D. Baker 2014; Christoffersen, Lunde, and Olesen 2014).

providing broad support for an aggregate version of the Keynesian hedging pressure hypothesis. Over the second period this pattern reverses, with both the US and UK commodities having higher returns during phases of **contango** as opposed to **backwardation**. This change in pattern suggests the onset of financialisation altered the traditional risk shifting nature of hedger's behaviour, implied by the Keynesian hypothesis.

This change of paradigm due to the arrival of financial investors, on the other hand, raises the question of whether they functioned as liquidity providers or demanders. Arguments have been put forward in favour of both possibilities with Moskowitz, Ooi, and Pedersen (2012) arguing that financial investors provide liquidity and Kang, Rouwenhorst, and Tang (2020) taking the opposite stance.

Goldstein, Li, and Yang (2014) and Goldstein and Yang (2017) argue that the arrival of financial investors had an impact on the extent of normal backwardation in commodity futures markets. Based on their analysis we would expect our average CHP factor, based on backwardation as measured by hedger's positions (Keynesian perspective, theory of normal backwardation: Keynes (1930), Hicks (1939), H. S. Houthakker (1957), Lester G. Telser (1958)), as well our term structure factor, based on backwardation as measured by roll yield (Working's perspective, theory of storage: Working (1933), Kaldor (1939), Working (1948), Brennan (1958), Cootner (1960b), Weymar (1966), Danthine (1978), Turnovsky (1983), E. S. Schwartz (1997)), to be best suited to measure the impact of financialisation.

We analyse the pricing dynamics over the different periods by first studying the time series explanatory performance of the various factors on all the US traded commodities with the factors constructed using the latter set of commodities. The market-based factor outperforms the other three in the first period and, although its performance increases over the financialisation period, that of the CHP factor shows a greater improvement in a relative sense. The performance of the market factor is driven by agricultural and energy commodities in the first period while metals strongly contribute to the performance improvement observed over the second period. Similarly, the dramatic improvement of the CHP factor in the second

period, is driven by the metals complex, particularly that of the long leg where they predominantly load. Average pairwise correlations amongst individual factors' best performing commodities increase across the board over the financialisation period, far beyond the average for the whole cross-section of US traded commodities. The increase is particularly strong for the long-short factors, in a relative sense, on which the metal complex loads significantly more during financialisation. This increase is due to the dramatic rise in average pairwise correlation amongst the US traded metals all of which exhibited high R^2 with respect to the CHP factor during financialisation which in turn is due to their common low level of CHP over this period. The CHP factor model thus seems able to establish the strengthening link between a non-price attribute and price dynamics in the US metal sub-sector during financialisation.
We explore this issue further by constructing the four factors independently with the top eight commodities for a given factor (factor picks) in each period[15] and evaluating its performance on these selected commodities as well as on all US traded commodities. The results of this exercise provide evidence of convergence of Keynesian and Working's theories of the term structure in detecting price co-movement during financialisation and strongly suggest that the term structure related attributes (hedging pressure/roll) co-movement and price co-movement link was concentrated in the metals sub-sector.

The UK traded base metals provide a useful set of assets to test how widespread were the changes in pricing dynamics brought about by the onset of financialisation. To that end, we examine the performance of the four factors on the six UK metals, when constructed from each set of factor picks. The results show that there was co-movement in global metals returns in the second period and that this co-movement could be detected by our term structure related models, particularly so by our hedging pressure-based model.

The onset of the financial crisis and the monetary policy regimes that followed, on the other hand, also appear to have induced significant changes. Commodity futures returns fell dramatically into the crisis and the pricing results indicate the emergence

[15] See section 1.2.3 for further details.

of a systematic factor across the entire cross-section of the US commodities as well as evidence of cross-market linkages with the UK traded commodity subset. The post-crisis results, in contrast, show a substancial pullback in performance for the market factor across the board as well as evidence of decoupling between the US and UK markets. Besides, starting in the crisis the Keneysian paradigm of returns begins to revert with higher mean returns during low (**backwardation**) relative to high (**contango**) **CHP** phases and this pattern continues, more pronounced, over the post-crisis period. As pointed out in Basu and Bauthéac (2021a), the financial crisis and ensuing accommodative monetary policy therefore seem to have initiated a process of reversion toward pre-financialisation fundamentals in the global commodity futures complex.

Financialisation was an issue of such policy importance that it triggered legislative action. The debate was initially framed around adequacy of speculation, the burning issue of the day, and the ensuing academic analysis focused on the more mechanical effects of financialisation.

With the benefit of hindsight, it appears this approach was perhaps too narrow, and it now seems necessary to address the phenomenon from a broader perspective. Commodity price dynamics appear to have altered substantially in quite different ways over the financialisation and the financial crisis periods and our commodity futures asset pricing factors based approach seems able to provide new insights into the nature of these changes: financialisation was a phenomenon endogenous to the commodity markets transmitted via the commodity futures markets and which effects were particularly strong for the metals sector while the crisis and its aftermath seems to have delivered an exogenous shock across the entire cross-section of liquid commodities and thereby potentially triggered a process of “definancialisaion” in global commodity futures markets.

The initial view of financialisation was that it consisted of speculative flows which had the effect of driving up and creating bubble like conditions in commodity futures prices[16]. However, the fundamental question of the nature of the impact of finan-

[16]M. W. Masters (2008); M. Masters and White (2008); UNCTAD and Cooperation (2009); De

cialisation across the entire cross-section of commodity futures markets has not yet been completely answered. We provide an empirical complement to a new stream of theoretical studies that try to model the impact of financialisation on various aspects of commodity futures markets[17] and demonstrate that the effects of financialisation extend beyond the mechanical effects induced by indexation as outlined in Tang and Xiong (2012) and Basak and Pavlova (2016).

Schutter (2010); Gilbert (2010b); Gilbert (2010a); Herman, Kelly, and Nash (2011); Schumann (2011); Singleton (2013).

[17]Etula (2013), Acharya, Lochstoer, and Ramadorai (2013), Cheng, Kirilenko, and Xiong (2014), Leclercq and Praz (2014), Sockin and Xiong (2015), Goldstein, Li, and Yang (2014), Ekeland, Lautier, and Villeneuve (2016), Goldstein and Yang (2017).

1.2 Data & methods

1.2.1 Background

The period from 1998 to 2008 saw an influx of investment into commodity index linked products most of which made its way into the commodity futures market. Popular commodity indexes whose goal was to track the broad movement of commodity prices became accessible by means of swaps, exchange traded funds and exchange traded notes and attracted at least $100 billion of net super-hoc investment over the 1998-2008 period.

Concerns over the consequences of this financialisation phenomenon eventually led to legislative changes including the approval of Rule 76 FR 4752 issued by the US Commodity Futures Trading Commission (CFTC) on January 26th, 2011. This provision emanates from the Dodd-Frank Wall Street and Consumer Protection Act of 2010 (Title VII, Section 737) that mandates the CFTC to use position limits to restrict the flow of speculative capital into a number of commodity markets. The Rule was approved in a close 3-2 vote and the ensuing rule-making process was extremely contentious with several commissioners (Michael Dunn and Scott D. O'Malia in particular) expressing reservations about the lack of supporting evidence and the Rule also triggering thousands of comment letters as well as a lawsuit against the CFTC spearheaded by two Wall Street trade groups, the International Swaps & Derivatives Association (ISDA) and the Securities Industries & Financial Markets Association (SIFMA)[18].

A world-wide debate ensued about the role of index funds in commodity markets. The first responses to the 2007/2008 crisis of escalating food and energy prices took the form of policy reports, many of which reasoned that the growth of commodity index funds came along with an influx of largely speculative capital that was responsible for driving commodity prices beyond their historic highs (De Schutter 2010; Gilbert 2010a; Herman, Kelly, and Nash 2011; Schumann 2011; UNCTAD and Cooperation 2009).

[18] ISDA & SIFMA v US CFTC; Complaint, 1:11-cv-02146; December 2nd, 2011.

Early US Senate investigations on the matter drew on pricing and trading data supplied by the CFTC as well as interviews with numerous experts including hedge fund manager Michael Masters who linked the growing presence of index investors in US agricultural and energy markets to the observed surges in both futures and cash prices (M. W. Masters 2008; M. Masters and White 2008). This contention has since come to be known as the Masters' hypothesis and was largely endorsed by the final US Senate report on the issue (Senate 2009).

At this stage, the question thrust on the academic sphere was whether "excessive speculation" (understood as the market activity peculiar to index type investors) was linked to escalating energy and agricultural commodity prices. A number of ensuing academic studies, most of which used commodity specific correlation and causality based analysis have since disproved this contention: Scott H. Irwin, Sanders, and Merrin (2009), Sanders, Irwin, and Merrin (2010), Sanders and Irwin (2011a), Sanders and Irwin (2011b), Scott H. Irwin (2013), Brunetti and Reiffen (2014), James D. Hamilton and Wu (2015) and Bruno, Büyükşahin, and Robe (2017) investigated the issue in the context of the agricultural markets; meanwhile, Büyükşahin and Harris (2011), Tokic (2012), Fattouh, Kilian, and Mahadeva (2013), Kilian and Murphy (2014), Knittel and Pindyck (2016) and Manera, Nicolini, and Vignati (2016) examined the energy markets while Bohl and Stephan (2013), Kim (2015) and Boyd et al. (2016) studied both energy and agricultural markets and Scott H. Irwin and Sanders (2011), Scott H. Irwin and Sanders (2012b) as well as Stoll and Whaley (2011) examined the commodity markets in general. Other studies have underlined various alterations in commodity pricing dynamics over the period. Gilbert and Pfuderer (2014) reject the view that financialisation has not had any effects in the grains markets and demonstrate that trades originated by financial market participants, and specifically index investors, can move prices but tend to be typically volatility-reducing. Juvenal and Petrella (2015) contend that the oil price increase between 2004 and 2008 was mainly driven by the strength of global demand but that the financialisation process of commodity markets also played a role. Likewise, Henderson, Pearson, and Wang (2015) show that non-information-based financial investments have important impacts on commodity prices. Cheng and Xiong (2014), on the other hand, show that in the case of index commodities, financialisation has transformed the risk sharing, and information discovery functions of commodity futures markets.

1.2.2 Data

Commodity index swaps, commodity index funds (CIFs), commodity-based exchange traded funds (ETFs) and notes (ETNs) or commodity linked notes (CLNs) were amongst the main investment vehicles that allowed institutional and retail investors to build up commodity exposure in the early 2000s (Boons, De Roon, and Szymanowska 2012; Henderson, Pearson, and Wang 2015; Scott H. Irwin and Sanders 2011; UNCTAD and Cooperation 2009; Schumann 2011). Most of these products were primarily designed to track prominent commodity indexes among which the S&P-GSCI, the most popular.

Most of its constituents at the time of writing form the basis of the broad cross-section of commodities that we consider in this study: corn-#2 yellow (XCBT), oats (XCBT), soybean meal (XCBT), soybean oil (XCBT), soybeans (XCBT), wheat-SRW (XCBT), cattle-feeder (XCME), cattle-live (XCME), lean hogs (XCME), cocoa (IFUS), coffee-C (IFUS), cotton-#2 (IFUS), lumber (XCME), orange juice (IFUS), sugar-#11 (IFUS), natural gas (XNYM), crude oil-WTI (XNYM), gasoline (XNYM), heating oil (XNYM), copper (XCEC), gold (XCEC), palladium (XNYM), platinum (XNYM) and silver (XCEC). Unleaded gasoline, the NYMEX legacy contract for gasoline, stopped trading in 2006 when it was replaced by Reformulated Gasoline Blendstock for Oxygen Blending (RBOB) with the two futures series trading alongside for most of the year. For our NYMEX gasoline data series, we consider unleaded gasoline up to September 1st, 2006 and RBOB gasoline thereafter, date at which liquidity for the latter overtook that for the former.

We also consider the UK metal complex with aluminium (XLME), copper (XLME), lead (XLME), nickel-primary (XLME), tin-refined (XLME) and zinc (XLME).

The commodity futures trading commission (CFTC) operates a comprehensive system of collecting information on market participants known as the large trader reporting program (LTRP) where it records and reports to the public position data on market participants who have position levels in excess of a particular market specific threshold[19]. The commission collects market data and position information daily from clearing members, futures commission merchants (FCMs) and foreign brokers and publishes corresponding summaries weekly in a series of market specific reports. In these reports, individual traders are categorised according to the nature of their trading activity on the basis of self-reported information[20] that is subject to review by CFTC staff for reasonableness. Position information is then aggregated by category and asset type with each report providing an aggregation for a set of report specific categories and, for each category, a breakdown between futures only positions and positions in futures and options combined.

In its legacy report, the commitment of trader report (COT) with data dating back to 1962, the CFTC distinguishes "commercial" and "non-commercial" market participants where a "commercial" participant is defined as one "[...] engaged in business activities hedged by the use of futures and option markets"[21]. A third category, "non-reportable", aggregates positions for participants not meeting the reporting threshold. In response to concerns related to category accuracy[22] the CFTC now refines its classification in the disaggregated commitment of trader report (DCOT) where participant categories include "Producer/Merchant/Processor/User", "Swap dealer", "Money manager" and "Other reportable" as well as in the supplemental commitment of trader report (SCOT) that details commodity index trader aggregate positions for thirteen agricultural commodity futures markets. Data for DCOT and SCOT date back to 2006 and 2007 respectively.

We study the 1997/2018 period where we observe futures only position data from the COT report, the only CFTC report with data available for the whole period of interest; as well as futures term structure price and open interest data from Bloomberg.

[19]Current reporting level thresholds available at: www.ecfr.gov.
[20]CFTC form 40. Available at: www.cftc.gov.
[21]See CFTC regulation 1.3, 17 CFR 1.3(z) for details.
[22]See for example Ederington and Lee (2002).

1.2.3 Methods

On the one hand, futures markets have a long history of serving commodity producers to alleviate their commodity price and output risks. Keynes (1930) and Hicks (1939) emphasise the "normal" behaviour of naturally short hedgers outsourcing their commodity risk to naturally long commodity specialist speculators. This market configuration is referred to as "backwardation" where futures are expected to trade at a discount to spot prices, providing speculators with incentives to take the long side. The opposite market paradigm is referred to as "contango". Working (Working 1933, 1948, 1953b) and Kaldor (Kaldor 1939) somehow relax this "supply-of-speculative-services" (Till 2007) approach by introducing processors and merchants, also commodity experts, on the hedgers side and relating the notions of backwardation and contango more directly to the term structure via the theory of storage where the shape of the front end of the term structure (basis) is directly related to the market price of storage.

Financialisation, on the other hand, refers to the entry of financial investors into the commodity futures markets who, for the most part, are not commodity experts. Besides, these new market participants tend to exhibit herding like behaviour, often taking massive long-only positions on the whole cross-section of indexed commodities in an attempt to enhance returns while hedging against inflation and reaping further diversification benefits for portfolios with, in most cases, existing large positions across various asset classes (Brunetti, Büyükşahin, and Harris 2016; Boyd et al. 2016; Cheng, Kirilenko, and Xiong 2014; Juvenal and Petrella 2015; Singleton 2013; Tang and Xiong 2012). This contrasts with the traditional approaches of Keynes and Working and in this context the issues of co-movement and aggregate market participants behaviour seem particularly relevant.

Asset pricing techniques are well suited to study co-movement. Building on theory we therefore develop an ad-hoc commodity-based asset pricing framework that we believe is well adapted to study these two issues simultaneously and implement it over four periods of interest. The first, the pre-financialisation period, starts in 1997 and is naturally followed by financialisation, spanning the 2004/2008 period, and the financial crisis and its aftermath, spanning the 2008/2013 period. The last period spans the 2014/2018 period starting with the beginning of the tapering/end of the US Quantitative Easing program (QE).

Using the weekly price, open interest and market position data described above we construct market portfolios of individual commodity nearby futures as well as mimicking portfolios for market, commercial hedging pressure, term structure and liquidity risk factors in returns. While our market portfolios are long only, equally weighted portfolios of particular commodity sets, our other mimicking portfolios for risk factors are constructed as combinations of two sub-portfolios (legs), one held long, one held short, which respective constituents are pooled on a weekly basis according to risk factor specific criteria.

For each leg, the position weight for a particular asset for a particular period is contingent on the value of the corresponding sorting variable and its rank relative to the other assets in the pool. The sorting variable values for the asset pool are first rescaled so that the highest (lowest) value becomes 1 (0). Weights are then determined pairwise, starting from the extremes with the highest and lowest figures. A coefficient α is determined by dividing their difference (1 in this case) by the mean of the rescaled values. The high figure is attributed a score of $\frac{1}{n} \times \alpha$ where n is the number of assets in the pool while the score for the low figure is $\frac{1/n}{\alpha}$. The operation is repeated for the pair of assets showing the second highest and second lowest values for the sorting variable and so on until all the assets in the pool are attributed a score. The individual asset weights are then determined by dividing each score by the sum of the scores.

The period return for a particular mimicking portfolio is calculated as the difference between the weighted average return for constituents of the long portfolio and that for the constituents of the short portfolio. i.e, return on the mimicking portfolio for risk factor i (f_i) for period t:

$$r_t^{f_i} = \sum_{j=1}^{x} w_{j,t}^{long} \times r_{j,t} - \sum_{j=n-x}^{n} w_{j,t}^{short} \times r_{j,t}$$

$n \equiv$ number of commodities in the set considered for mimicking portfolio construc-

tion.
$x = n \cdot s$.
$s \equiv$ selection threshold ($\frac{1}{3}$ here).
$w^*_{j,t} \equiv$ period t weight for commodity j on the long or short leg.
$r_{j,t} \equiv$ period t front contract return for commodity j.
$j \equiv$ commodity rank in the ordered set $Y_t^{f_i}$.
$Y_t^{f_i} \equiv$ period t ordered set of the commodities considered for mimicking portfolio construction where the ordering rule is specific to f_i.

For our portfolio CHP (commercial hedging pressure), we sort the set of commodities considered on past twenty-six-week average CHP from lowest to highest. The bottom third constituents (lowest $\overline{CHP}$s) of the corresponding ordered set form the long leg of the portfolio while the top third form the short leg:

$$Y_t^{CHP} \equiv \left\{\left\{\overline{CHP_1}, \overline{CHP_2}, ..., \overline{CHP_n}\right\}, \leq\right\}$$

$\overline{CHP_j} = \frac{1}{26}\sum_{k=0}^{25}\frac{L_{j,t-k}}{L_{j,t-k}+S_{j,t-k}}$
$L_{j,t} \equiv$ number of long positions held by commercial hedgers for period t on the futures series of commodity j.
$S_{j,t} \equiv$ number of short positions held by commercial hedgers for period t on the futures series of commodity j.

For our portfolio TS (term structure), we sort the set of commodities considered on past twenty-six-week average roll-yield from highest to lowest. The bottom third constituents (highest $\overline{RY}$s) of the corresponding ordered set form the long leg of the portfolio while the top third form the short leg:

$$Y_t^{TS} \equiv \left\{\left\{\overline{RY_1}, \overline{RY_2}, ..., \overline{RY_n}\right\}, \geq\right\}$$

$\overline{RY_j} = \frac{1}{26}\sum_{k=0}^{25}(\frac{F^1_{j,t-k}}{F^2_{j,t-k}} - 1)$
$F^1_{j,t} \equiv$ period t close price for commodity j first nearby futures contract.

$F_{j,t}^{2} \equiv$ period t close price for commodity j second nearby futures contract.

For our portfolio OI (open interest), we sort the set of commodities considered on past twenty-six-week average front contract open interest growth from highest to lowest. The bottom third constituents (highest $\overline{OI^{\Delta\%}}$s) of the corresponding ordered set form the long leg of the portfolio while the top third form the short leg.

$$Y_t^{OI} \equiv \left\{ \left\{ \overline{OI_1^{\Delta\%}}, \overline{OI_2^{\Delta\%}}, ..., \overline{OI_n^{\Delta\%}} \right\}, \geq \right\}$$

$\overline{OI_j^{\Delta\%}} = \frac{1}{26}\sum_{k=0}^{25}(\frac{OI_{j,t-k}}{OI_{j,t-k-1}} - 1)$
$OI_{j,t} \equiv$ open interest at close of period t on the front (nearby) contract for commodity j.

We use a time series regression approach where we start with regressions of the US traded individual commodity weekly front contract returns on returns to the mimicking portfolio for a particular risk factor where the portfolio is constructed using the whole cross-section of US traded commodities. The corresponding R^2s are averaged and the process is repeated for each of our four risk factors (market, hedging pressure, term structure and liquidity) and periods (1997/2003, 2004/2008, 2008/2013 and 2014/2018). For the long-short factors the results are reported independently for models where the regressor is the factor itself or one of its legs (long vs. short). The same operation is repeated for the two ($p = 2$) and three ($p = 3$) factor model cases, where regressors include in turn all combinations of any two and three risk factors respectively, as well as for the four ($p = 4$) factor model case where all the risk factor mimicking portfolios are included. Results are reported for the one-factor model case with the other results available upon request.

For each period we also implement the analysis described above over periods of low and high aggregate CHP (**CHP**), a notion that we believe is particularly relevant in the context of financialisation where issues of co-movement and aggregate market behaviour play a central role. We define **CHP** as the cross-sectional average of CHPs for a particular pool of assets. i.e., period t **CHP** for asset pool x:

$$\mathbf{CHP}_t^x = \frac{1}{n}\sum_{j=1}^{n} CHP_{j,t}$$

$n \equiv$ number of commodities in set x.
$CHP_{i,t} \equiv$ period t CHP for commodity i as defined above.

We further define aggregate backwardation (**backwardation**) and contango (**contango**) **CHP** regimes as, for a given period, **CHP** levels below and above the period's median respectively and, in contrast with (Hong and Yogo 2012) who aggregate across sub-sectors, the asset pool we consider for **CHP** construction include the whole cross-section of US traded commodities.

In the next part of the analysis, our mimicking portfolios for risk factors, constructed from the set of all US traded commodities are used as commodity picking devices on the latter commodity set. For each risk factor and period, individual US traded commodity front returns are regressed on returns for the corresponding mimicking portfolio. Individual commodities are sorted by R^2 accordingly from highest to lowest and the top third (highest R^2s) are selected as commodity picks for the risk factor for the period. i.e, set of picks $P_t^{f_i}$ for risk factor i (f_i) over period t:

$$P_t^{f_i} \equiv \{P_1, P_2, ..., P_x\}$$

$x = n \cdot s$.
$n \equiv$ number of commodities in the set considered for the picking exercise (twenty-four here).
$s \equiv$ selection threshold ($\frac{1}{3}$ here).
$P_j \equiv$ commodity pick j for risk factor f_i over period t
$j \equiv$ rank in the ordered set $Y_t^{f_i}$

$$Y_t^{f_i} \equiv \left\{\left\{\tilde{R}_1^2, \tilde{R}_2^2, ..., \tilde{R}_n^2\right\}, \geq\right\}$$

$n \equiv$ number of commodities in the set considered for picking (twenty-four here).
$\tilde{R}_j^2 \equiv$ risk factor f_i returns' explanatory power on commodity j nearby futures returns

over period t as defined above.

For each period we report the proportion of time each pick is held in the long and (/or) short leg of the corresponding risk factor mimicking portfolio as well as the average pairwise correlation amongst every set of picks.

In the last part of the analysis, for each period our mimicking portfolios for risk factors in returns are constructed using each set of commodity picks independently as the asset pool for portfolio construction. A similar time series approach to that described above is then implemented using these newly formed mimicking portfolios. In this case, a first set of dependent variables includes the sets of commodity picks themselves, a second set includes the whole cross-section of US traded commodities while a third set includes the six UK traded metals considered in the study.

1.3 Results & discussion

The descriptive statistics for the commodity series considered in the study displayed in table 1 show a clear pattern of increase in average return during financialisation with an equally weighted portfolio of the US traded assets showing a mean returns of 15.9% significant at the 5% level vs. 6.9% with a 10% significance in the pre-financialisation period. The increase is even more pronounced for an equally weighted portfolio of UK traded assets (metals), 2.47% (not significant) to 21.8% (significant at the 10% level), which sets out the global nature of the phenomenon. Most commodities show a higher mean return while five–Lumber (XCME), Natural gas (XNYM), Palladium (XNYM), Platinum (XNYM) and Nickel-primary (XLME)– show a lower figure with five significant figures–Crude oil-WTI (XNYM), Heating oil (XNYM), Copper (XCEC), Copper (XLME) and Tin-refined (XLME)–against none pre-financialisation. Sugar-#11 wins the race with a mean return increasing from -4.6% to 24.9% followed by copper with sizeable increases for both markets: 1.5% to 28.2% (XCEC) and 0.5% to 28.6% (XLME).
The pattern of results for volatilities is similar although the increase is less pronounced. Both equally weighted portfolios shows an increase, more pronounced for the UK assets, 10% to 13.6% (US) vs. 15.7% to 26.9% (UK), while out of the thirty assets, eleven show a drop in volatility: Oats (XCBT), Lean hogs (XCME), Cocoa (IFUS), Coffee-C (IFUS), Lumber (XCME), Sugar-#11 (IFUS), Natural gas (XNYM), Crude oil-WTI (XNYM), Gasoline (XNYM), Heating oil (XNYM), Palladium (XNYM).

Table 2 shows the average time series R^2 for models where the returns series for the twenty four individual US commodities are regressed against change in their own commercial hedging pressure (CHP) series as well as against change in cross-sectional CHP. The results show an overall decrease in the explanatory power of CHP over the financialisation period with the cross-sectional average R^2 falling from 25.8% pre-financialisation down to 20.8% in the financialisation period.
The pattern of results is strongest for the metals sector both in relative and absolute terms with figures for the pre-financialisation and financialisation periods of 28.1%

and 19.1% respectively. Within the sector the pattern is strongest for the base metals subsector with corresponding figures of 47.4% and 25.9% respectively. The pattern holds for all sectors and subsector apart from livestock with the sector showing the opposite pattern: 6.2% vs. 10.5%.
The cross-sectional nature of financialisation naturally leads us to extend the individual hedging pressure paradigm by incorporating aggregate CHP (**CHP**), a market wide measure of hedging pressure. The results are contrasting with those at the individual markets level; in fact we observe the opposite pattern over the financialisation period with an overall increase relative to the pre-financialisation period: 7.1% vs. 5.4%. The pattern is again strongest for the metals sector, with figures of 8.4% and 15.7% in the pre-financialisation and financialisation periods respectively, and holds for all sectors apart for the agricultural commodities for which the average R^2 remains fairly stable across the pre-financialisation and financialisation periods: 4.9% vs. 4.5%.

The traditional Keynesian hedging pressure paradigm postulates a negative relationship between the return on an individual commodity futures and its hedging pressure. The extended Keynesian hedging pressure paradigm, in the context of financialisation, should also imply that returns for individual commodities should be high in periods where **CHP** is low and vice et versa. In table 3 the mean returns are shown over high (**contango**) and low (**backwardation**) **CHP** regimes for each time period.
Over the first period eighteen of the twenty-four US commodities have higher mean returns during periods of **backwardation** as compared to **contango**, with the difference being statistically significant at the 10% level for two commodities, at the 5% level for one and at the 1% level for another. For the remaining six commodities the higher mean return during **contango** is not statistically significant for any of them. For the six UK commodities, all metals, five of them had higher mean returns during phases of **backwardation** as compared to **contango** in the first period, with one of these differences being statistically significant at the 10% level while for the remaining asset (Zinc) the higher mean return during **contango** is not statistically

significant. An equally weighted portfolio of the twenty-four US commodities had a mean return of 15.4% during **backwardation** phases, statistically significant at the 1% level, and a mean return of -1.1% during **contango**, both in the first period, with the difference between them statistically significant at the 5% level. The corresponding figures for an equally weighted portfolio of the UK metals were 4.4% and 0.3% respectively. These results provide broad support for an aggregate version of the Keynesian hedging pressure hypothesis and suggest that hedgers in the aggregate were engaged in risk transfer during this period.
Over the second period the pattern essentially reverses. For the twenty-four US commodities over this period, fourteen have higher mean returns during phases of **contango** over **backwardation**. Four of the six UK metals achieved higher mean returns over **contango** relative to **backwardation** phases with the difference being statistically significant for one commodity. The equally weighted US portfolio had a mean return of 15.7% over **backwardation** against 16.2% during phases of **contango**, both statistically significant at the 10% level. The difference was considerably more pronounced for the equally weighted UK metals portfolio with a mean return of 8% during **backwardation** rising to 35.6% during **contango**.

The patterns of results in both tables 2 and 3 suggest that the onset of financialisation seems to have engendered a change in the nature of hedger's behaviour, at the aggregate level in particular, taking it away from the traditional Keynesian view of risk shifting. This phenomenon has been noted in earlier theoretical and empirical work (Danthine 1978; Stout 1998) in different contexts from which two competing models of behaviour have emerged.
The information arbitrage model (Sanford J. Grossman and Stiglitz 1980; Danthine 1978; Kyle 1989) implies that hedgers may often be seeking out counterparties to trade with rather than being purely passive. This issue is also raised in both Cheng and Xiong (2014) and Stulz (1996) who point out that hedgers may be taking a view on prices just as speculators do. In fact, by hedging away some of their risk, hedgers are able to speculate more heavily based on their disagreement against speculators regarding futures price movement (Simsek 2013), which fits into a heterogeneous

expectation theory of speculation[23]. As Stout (1998) points out, this disagreement-based theory of trading is one of the main reason the public and the law disapproves speculation as this form of trading is regarded as non-productive[24].
In the second model hedgers are seen as liquidity providers as in Kang, Rouwenhorst, and Tang (2020) with this explanation also consistent with the nature of financialisation which led to the arrival of long term, long only investors who require substantial liquidity to roll-over their positions.

Using our bespoke commodity-based asset pricing framework we strive to shed new lights on the phenomenon by first regressing returns series for the twenty four individual US commodities against our factor mimicking portfolios independently. The average time series explanatory power of the various one factor models on the US traded assets over the four periods is shown in Table 4.
Over the first period the market factor has the best average time series performance with the highest average R^2 with all three futures market factors performing poorly and the overall performance consistent across periods of high and low **CHP** (below period median). The two factor models average R^2s are roughly the sum of the one factor R^2s indicating that the factors are almost orthogonal over this period.
The onset of financialisation leads to a substantial improvement in the performance of the CHP factor with its average R^2 increasing to 8.2% in the second period relative to 1.7% in the first with this improvement coming from the long leg that shows a greater improvement (4.5% to 15.1%) relative to the short (3% to 4%) bringing more evidence of the important role played by long only investors in the change in nature of these markets over that period. The performance of the market factor also improves though not by as much in a relative sense (21.6% from 11.7%) and both the term structure factor and the open interest growth factor show a much smaller improvement in performance with smaller differences between legs. Over all periods, all of our factor models show similar performance across regimes of high and low

[23] J. Hirshleifer (1975); Jack Hirshleifer (1976); Jack Hirshleifer (1977)

[24] Duffie (2014) also discusses some of the challenges faced by a policy treatment of speculative trading motivated by differences in beliefs.

CHP.

We next investigate the top eight of the US traded commodities which achieved the highest time series R^2 for the CHP, market, open interest and term structure factors, in each of the four time periods with the commodity picks shown in Table 5.

For the CHP factor the commodities that achieve high R^2 in a given period are likely to be those with relatively high or low CHP over that period, or those commodities that co-vary with the short or the long side of the factor. The same applies to the open interest and term structure factors with CHP replaced by open interest growth and roll yield respectively; while for the market factor the picks are those that co-vary most strongly with the market factor over that period.

For the CHP factor, we observe a change in the picks between the first and the second period; the picks in the first period included five agricultural commodities and three metals while in the second period they include all the five base and precious metals and only three agricultural commodities. This pattern is also visible for the term structure factor for which there are four metals (copper, silver, gold and platinum) picks in the second period against two in the first (palladium and platinum) as well as for the open interest nearby growth factor for which there are three metals (silver, gold and platinum) picks in the second period against one in the first (platinum). The market factor has three metal picks in the second period (palladium, gold and silver) while all the picks in the first period were agricultural or energy commodities. Over the third period, the average CHP factor shows the same metal picks with the agriculturals replaced by energy commodity; the open interest nearby growth factor still has three metal picks with gold swapped for copper and both the market and term structure factors have one, copper.

The table also shows the proportion of time that these picks were constituents of the corresponding factor. All the picks of the long-short factors (average CHP, open interest nearby growth and term structure factors) were constituents of the corresponding factor for some proportion of time in all of the time periods. In this respect, there is a contrast between the first and second periods with the average CHP and open interest nearby growth factor picks appearing predominantly on the long side of the corresponding factor in the second period, as opposed to both legs in the first. The pattern is particularly strong for the metals and energy commodities respectively, with the exception of copper for the average CHP factor that lives in the short leg a higher proportion of the time over the financialisation period. The pattern is reversed for the term structure factor where the picks appear predominantly on the short leg in the second period, as opposed to both legs in the first with the pattern again strongest for the metals. This behaviour continues over the third period for the average CHP and open interest nearby growth factors and indicates that their picks consistently exhibited low commercial hedging pressure and high front contract open interest growth respectively while indicating that the term structure factor picks showed low roll yield in the first and second period.

In table 6, we show the average pairwise returns correlation between each set of picks in each time period. This exercise gives an indication of the extent to which attribute co-movement reveals price co-movement, which is particularly relevant for the long-short factors for which the corresponding attribute is not directly related to price co-movement.
In the first period the average picks pairwise correlation for the long-short factors ranges from 7.1% (term structure factor picks) to 12.4% (open interest factor picks) while the market factor picks show the highest figure (23.7%). In the second period the figures for the long-short factors rise sharply; up to 22.9% from 8.1% for the average CHP factor picks, up to 32.4% from 12.4% for the open interest factor picks and up to 23.4% from 7.1% for the term structure factor picks. This increase is stronger than that for the market factor picks in a relative sense and is a consequence of the dramatic increase in average pairwise price correlation amongst the US traded metals which dominate the average CHP factor set of picks and which presence is stronger amongst both the open interest and term structure factor sets of picks over the financialisation period. The higher figures for the open interest factor are driven by the strong presence of the energy complex amongst the corresponding picks. The latter exhibits much higher average pairwise correlations than the other sectors in both periods although lower in the second relative to the first which reinforces the role

played by the metals in the sharp increase in average pairwise correlation amongst picks for this factor.
With regards to **CHP** regimes, although not very pronounced, a pattern is noticeable. For the market, open interest and term structure factor picks, average pairwise correlations are stronger over phases of **contango** in the first period and over phases of **backwardation** in the financialisation period, eventually reverting back to being stronger over **contango** phases in the crisis period with the CHP factor sets of picks showing the opposite pattern. Overall, these results suggest an increase in correlation between non-price attributes co-movement and price co-movement over the financialisation period. It is also interesting to note that US traded metals returns were negatively correlated with the rest of US traded commodities in the first period and positively in the second.

To further understand the link between attribute and price co-movement we build all of the factors from every set of factor picks and assess their explanatory performance on these sets of picks over the four periods independently. The results are shown in table 7. The long-short factors for a particular attribute select the top and bottom two of the corresponding picks based on that attribute while the market factor takes an equally weighted combination of the eight corresponding picks. In the absence of price co-movement between the picks, the market factor will achieve an average R^2 of around 12.5%[25], while there is no non-zero R^2 lower bound for the corresponding long-short factors.
A high average R^2 for the market factor is indicative of strong price co-movement. In this respect, the most remarkable change in performance in a relative sense is that of the market factor built from the CHP factor sets of picks with the average R^2 more than doubling, from 18.6% up to 38.1%. For the long-short factors on the other hand it is indicative of simultaneous attribute and price co-movement. For the factors built from the market factor picks the increase is strongest in a relative sense for the CHP factor with the R^2 more than doubling, going from 5.6% in the first period up to 12.4% in the second with the increase stronger for the long leg

[25]Market factor lemma: $\overline{R^2_{r_{mkt},p}} = \frac{1}{n}\sum_j R^2_{r_j,r_{mkt},p} = \frac{1}{n}$; $n \equiv$ size of market portfolio (eight here).

(17.1% vs. 27.9%) relative to the short (16.5% vs. 21.4%). In the case of the factors built from the CHP factor picks, the CHP factor built with its own picks shows a remarkable increase in a relative sense with the R^2 tripling, from 7.2% to 21.4% and the long leg showing a much greater increase relative to the short (10.4% to 31.1% vs. 8.3% to 9.8%). The performance of the term structure factor built from the CHP factor sets of picks also shows a sizable increase in a relative sense, from 3.5% to 5.3% and even more remarkable in this case is the substantial increase in performance of the short leg, from 6.3% to 15.7% relative to the long (7.5% to 9.8%). The pattern is reversed for the CHP factor built from the term structure factor picks where the average R^2 increases from 4.7% to 8% with the performance of the long leg increasing from 11.9% to 28.1% vs. 5.5% to 9.1% for the short. The performance of the term structure factor constructed from its own sets of picks also shows a substantial increase, from 5.1% to 8.4% with, here again the increase in performance relatively stronger for the short leg, from 6% to 16.1% vs. 7.6% to 12.1% for the long.
Taken together with the previous results showing that the metal complex predominantly loads on the long and short legs of the original CHP and term structure factors respectively, these results provide evidence of convergence of Keynesian and Working's theories of the term structure in detecting price co-movement during financialisation perhaps as a result of spillover effects between the corresponding futures and spot markets as suggested in Basak and Pavlova (2016).

In table 8 we assess the performance of the same factors on all the commodities instead of just the picks. While the average R^2s are expectedly lower, the pattern of results mostly holds with the relative performance of the market factors built with different sets of picks as well as that of the CHP and term structure factors built with each other's picks similar to table 7. In contrast, the average CHP factor built with average CHP factor picks shows a smaller absolute increase in average R^2 indicating that the link between CHP co-movement and price co-movement is stronger amongst the picks which are predominantly metals. Taken together, the results in tables 7 and 8 suggest that the onset of financialisation had a major impact on the dynamics of US traded precious and precious-base metals.

To assess whether this phenomenon extended beyond US borders we examine the performance of the factors used in the last two tables above on the six UK metals futures traded on the London Metal Exchange with the results reported in Table 9. In the first period, although all sets of picks, except that of the market factor, included at least one metal, the average R^2s are very low; close to zero in most cases. These figures drastically increase across the board in the financialisation period and show a pattern similar to that observed in the US complex. The market factor built from the CHP and term structure factor sets of picks shows the sharpest increase in performance, relative to using the other sets of factor picks; rising to 20.1% from 1.5% and to 15% from 0.8% respectively. The increase in R^2 for the market factor built with market factor picks is more modest, providing further evidence of concentration of co-movement in the metals sector during financialisation.

Here again the change in performance for the CHP and term structure factor legs stands out where the factors are built with their own as well as each other's sets of picks. The average R^2 for the long leg of the CHP factor built with its own sets of picks increases from 1% to 11% while the short leg shows no significant change. The opposite holds for the term structure factor built from its own set of picks with the short leg performance increasing from 0.1% to 14% while that of the long leg remains below 1%. Building these factors from each other's sets of picks produces a similar pattern with the performance of the long leg of the CHP factor built from the term structure factor picks increasing from 0.7% to 11.4%; a much greater increase relative to the short leg although in this case the latter also shows a sizable increase in performance (0.3% to 6%). The performance of the short leg of the term structure factor built from the CHP factor sets of picks on the other hand increases from 0.3% to 19.2% while the performance for the long leg in the second period remains below 1.5%.

Taken together these results emphasise the global nature of the impact of financialisation on the metals complex and provide further evidence that global metals co-movement could be detected by US based factor models that combine the Keynesian and Working's term structure paradigms. There seems thus to be information in the factor constructed from hedging pressure based on the Keynesian paradigm relevant to the term structure factor built on the Working paradigm and these findings therefore appear to complement the results of Kang, Rouwenhorst, and Tang (2020) who find that hedging pressure both conveys information about liquidity provision in the short term (Working paradigm) and risk transfer in the longer term (Keynesian paradigm).

The crisis period (late 2008 to mid-2013) shows a contrasting pattern of results. Returns fall sharply relative to the financialisation period (table 1) with eighteen US commodities along with all six UK traded metals showing lower mean returns. Returns for equally weighted portfolios of both sets of assets fall down to 9.4% and 5.3% from 15.9% and 21.8% respectively. The explanatory power of CHP and **CHP** further shows converging dynamics (table 2). That of CHP initiates a recovery from its financialisation lows, 22.5% vs. 20.8%, strongest for the metals, 23.3% vs. 19.1%, while the energy sector shows the opposite pattern: 16% vs. 19.5%. That of **CHP** on the other hand shows a stronger increase in the crisis, 14.7% vs. 7.1%, with the pattern strongest for the agricultural sector: 12.4% vs. 4.5%. Returns are mostly higher during phases of **backwardation** relative to **contango** (table 3) with fifteen US assets and five of the UK traded metals showing higher mean returns in **backwardation** and the pattern extending to equally weighted portfolios of the two sets of assets. Volatility is moderately higher for both sets with fifteen US commodities and three UK metals showing higher figures and interestingly eminently higher over phases of **contango**; out of the US complex only Sugar-#11 (IFUS) and none of the UK traded metals show higher volatility figures over **backwardation** phases.
The performance of the market factor dominates the US commodity complex over the period with a 50% increase in mean average R^2 to over 30% (table 4) while that of the CHP factor decreases and, although increasing, remains modest for the open interest growth and term structure factors. The average pairwise correlation amongst the market factor picks increases beyond 50% while there is a leveling in that amongst the picks of the long-short factors as shown in table 6. Notwithstanding, the market factor built from any sets of picks shows a significant rise across the board in performance on the US complex (table 8).

Taken together, these results indicate the presence of a systematic factor across the entire cross-section of the US commodities. Table 9 provides further evidence of systematic linkages, in this case between US and non-US traded commodities with a similar, albeit more pronounced pattern, where the market factor constructed with any sets of picks (US traded commodities) shows a dramatic increase in performance on the UK metals with for example, when constructed from its own sets of picks, the average R^2 increasing to 31.7% from 10.2% in the previous period.

The returns pullback continues into the post-crisis period (table 1) with twenty-two US and four UK traded assets showing lower mean returns relative to the crisis while the same number of US commodities and all UK metals show lower figures relative to the financialisation period; mean returns for equally weighted portfolios of US and UK assets drop down to -0.2% and 2.7% respectively. Interestingly volatility also recedes substantially with twenty US assets and all UK metals showing lower volatility figures relative to both the crisis and financialisation periods suggesting that investment outflows from the commodity futures complex have had a lower impact on volatility than the corresponding inflows witnessed over the financialisation period. The figures for the equally weighted portfolios of US and UK assets drop to 9.9% and 16.2% respectively, very close to pre-financialisation levels.

After showing signs of convergence in the crisis period the dynamics of the explanatory power of CHP and **CHP** seem to part ways (table 2). The recovery initiated in the crisis period for that of CHP is confirmed with a stronger increase in the post-crisis period, 27.2% vs. 22.5%, strongest for the metals sector, 37.3% vs. 23.7%, while the energy sector shows the opposite pattern: 11% vs. 16%. In contrast, after increasing stronger in the crisis, that for **CHP** falls overall in the post-crisis period, 7.5% vs 14.7%, with the decrease strongest for the energy sector in a relative sense: 2.5% vs. 14.8%. The pattern of reversion toward the pre-financialisation Keynesian paradigm initiated during the crisis continues stronger into the post-crisis period (table 3) with mean returns higher during phases of **backwardation** relative to **contango** (table 3), more so than over the crisis period with seventeen US commodities showing higher mean returns over **backwardation** phases. The difference is significant at the 5% level for Lumber (XCME) and at the 10% level for Palladium (XNYM) while no difference is significant for the assets showing higher figures over phases of **contango**. The pattern is more pronounced for the UK traded subset with all six assets showing higher mean returns in **backwardation** with the difference significant at the 1% level for Nickel-primary (XLME), 5% level for Aluminium (XLME) and 10% level for Zinc (XLME). It also extends to equally weighted portfolios of US and UK traded assets that both show higher mean returns during **backwardation** with the difference significant at the 5% level for the UK portfolio and the figure close to the 10% level significance threshold for the portfolio of US assets. Volatilities are overall higher in **contango** although less so than over the previous period with seventeen US commodities showing higher figures over **contango** against twenty-three in the crisis period. The pattern extends to three of the six UK traded metals with the difference significant at the 1% level for Copper (XLME) and Tin (XLME) and at the 5% level for Zinc (XLME) while differences are not significant for Aluminium (XLME), Lead (XLME) and Nickel-primary (XLME) that exhibit higher volatility over **backwardation** phases. Equally weighted portfolios of US and UK traded assets on the other hand both show higher volatility in **contango** with the difference significant at the 1% level for both. Over the financialisation period in contrast volatilities were predominantly higher in **backwardation** for US traded assets with fourteen commodities showing higher volatility figures in these phases; the post-crisis pattern of results for volatilities thus likewise shows signs of reversion to pre-financialisation standards.

Average pairwise correlations amongst factor picks (table 6) fall substantially in the post-crisis period with for example the figure for the market factor picks dropping from 50.1% to 26.1%, almost down to pre-financialisation levels; results are similar for the long-short factor picks with figures below financialisation levels in all cases and very close to pre-financialisation standards for the term structure and liquidity factor picks. The performance of the market factor on the US complex declines below financialisation levels (table 4) with the pattern similar albeit stronger when the factor is built from the sets of factor picks with a decline in performance on the US complex (table 8) to almost pre-financialisation levels when constructed with its own set of picks as well as with those of the long-short factors, in particular the term structure and liquidity factors. Table 9 provides further evidence of decoupling, in this case between US and non-US traded commodities with a sharp decline in performance of the market factor constructed with any set of picks on the UK complex below financialisation, down to almost pre-financialisation levels when constructed with the sets of long-short factors picks.

Taken together the patterns of results over the crisis and post-crisis periods echo those in Basu and Bauthéac (2021a) in suggesting that the exogenous shock delivered by the financial crisis combined with the accommodative monetary policy that ensued seem to have initiated a reversion toward pre-financialisation fundamentals in the commodity futures complex, in other words, a process of "definancialisation".

1.4 Conclusion

In the early 2000s, against a backdrop of a low yield environment and poor stock market performance, a combination of financial innovations[26] and regulatory changes[27] led to large inflows of institutional capital into the commodity futures markets. This process known as "financialisation" spurred a heated public policy debate about whether the ensuing increase in open interest and trading volume in commodity futures exerted upward pressure on prices.
The debate spread to the legislative sphere, with the US senate launching formal investigations, and was thrust onto the academic community as a matter of urgency. Perhaps in response to this, most of the early studies focused on the more mechanical effects of financialisation in individual markets, relying on commodity specific causality and correlation-based analysis. The contention eventually triggered legislative action and new position limits were introduced in a number of grains and energy futures markets.

With the benefit of hindsight, this focus appears to have been too narrow. As our results suggests, financialisation was a phenomenon global in nature, with cross-

[26]Commodity price indexes and the ad-hoc financial instruments enabling investment in them were the main financial innovations which allowed large global banks to offer commodity investment products to institutional and retail investors. In 1991 Goldman Sachs created the S&P-GSCI which provides investors with buy-side exposure to commodities via the OTC swap market and thus without having to participate in the formal futures markets with their position limit restrictions. At this stage, these restrictions still applied to the issuing institutions though, as they hedged the corresponding commodity swap exposure in the futures markets. The first commodity-based ETFs were created through buying physical precious metals with gold and silver ETFs offered as early as 2002/2003. The regulatory hurdle here related to the licensing of commodity trading professionals. Typically, investors had to sign a statement with their broker stating that they understood the risks of commodity investments; a rather inconvenient paperwork for a product designed to trade like a stock, as set forth by a number of industry players at the time.

[27]In 2000, the Commodity Futures Modernization Act (CFMA) granted non-agricultural commodity futures statutory exemption from regulation ("Enron loophole"). It still required agricultural commodity derivatives be traded on a CFTC-regulated exchange however. Eventually, the CFTC classified swap dealers as "bona fide" hedgers, granting them position limits exemption ("swap dealer loophole"). In 2005, the CFTC waived the rule that required commodity investors to sign a statement saying they understood the risks, letting the funds replace it with their prospectus. The regulatory bottleneck that prevented the large-scale expansion of commodity index investment was no more.

sectional effects on market fundamentals and studying the direct effects of increased market participation in single markets thus seems amiss in this context.

The results of our analysis further suggest that financialisation set off an ontological drift in the commodity complex beyond energy and agricultural commodities and in fact strongest for the metals sector at the global level; an aspect largely overlooked in the original approach that we believe the existing literature has not fully analysed. The regulatory changes underpinned by these studies may thus have been unwarranted with potential substantial undesired effects on the functioning of the markets in which they were enforced and thence, to a larger extent on that of the economic system as a whole.

The onset of the financial crisis and the monetary policy regimes that followed, on the other hand, also appear to have induced significant changes in commodity pricing dynamics. In contrast with financialisation, our results suggest that the crisis and its aftermath have delivered an exogenous shock across the entire cross-section of liquid commodities and seem to have triggered a motion of reversion to legacy pre-financialisation fundamentals, in other words, a process of “definancialisation” in global commodity futures markets.

1.5 Tables

Table 1: This table shows mean returns and volatility (sd) for the twenty four individual US commodities and the six LME metals considered in the study as well as for two equally weighted portfolios formed from the US commodities and the LME metals respectively across the four periods of interest (past: 1997-2003; financialisation: 2004-2008; crisis: 2008-2013; post-crisis: 2013-2018). Mean values significant at the 1%, 5% and 10% level are marked with ***, ** and * respectively. The results are discussed in section 1.3.

asset	estimate	past	financialisation	crisis	post-crisis
individual commodities					
Corn-#2 yellow (XCBT)	mean	3.48%	21.37%	6.89%	-4.51%
	sd	23%	29.54%	36.15%	21.8%
Oats (XCBT)	mean	5.49%	21.62%	8.89%	-0.87%
	sd	32.22%	31.04%	34.67%	29.5%
Soybean meal (XCBT)	mean	7.29%	12.06%	8.12%	-0.33%
	sd	26.34%	32.55%	31.78%	25.11%
Soybean oil (XCBT)	mean	6.21%	15.57%	4.04%	-7.39%
	sd	21.43%	28.35%	25.75%	18.95%
Soybeans (XCBT)	mean	6.89%	13.36%	6.19%	-3.82%
	sd	21.47%	30.04%	28%	21.22%
Wheat-SRW (XCBT)	mean	5.07%	17.63%	6.68%	-1.58%
	sd	24.93%	33.03%	37.62%	26.58%
Cattle-feeder (XCME)	mean	0.39%	7.43%	7.13%	1.87%
	sd	13.23%	15.16%	15.24%	18.69%
Cattle-live (XCME)	mean	3.45%	8.77%	4.13%	1.92%
	sd	17.1%	17.43%	16.32%	18.3%
Lean hogs (XCME)	mean	0.73%	8.4%	12.69%	-1.09%
	sd	38.33%	31.89%	30.37%	36.94%
Cocoa (IFUS)	mean	3.66%	16.35%	1.39%	3.65%
	sd	32.66%	29.99%	31.03%	24.69%
Coffee-C (IFUS)	mean	-5.91%	20.38%	2.2%	1.99%
	sd	43.84%	32.3%	30.17%	31.86%
Cotton-#2 (IFUS)	mean	3.24%	0.95%	12.53%	0.5%
	sd	26.38%	29.01%	33.26%	20.61%
Lumber (XCME)	mean	1.9%	-3.58%	11.74%	5.06%
	sd	30.58%	29.39%	36.31%	25.1%
Orange juice (IFUS)	mean	1.67%	13.87%	14.4%	3.8%
	sd	29.5%	33.01%	34.43%	29.37%
Sugar-#11 (IFUS)	mean	-4.56%	24.87%	11.82%	-1.16%
	sd	34.88%	33.25%	37.9%	28.72%

Table 1: *(continued)*

asset	estimate	past	financialisation	crisis	post-crisis
Natural gas (XNYM)	mean	35.38%	16.25%	0.93%	8.33%
	sd	61.55%	54.6%	53.58%	44.58%
Crude oil-WTI (XNYM)	mean	15.43%	*28.74%	9.67%	-5.64%
	sd	39.87%	32.56%	42.84%	34.69%
Gasoline (XNYM)	mean	16.65%	30.95%	10.59%	-5.37%
	sd	42.77%	41.76%	40.07%	37.09%
Heating oil (XNYM)	mean	16.31%	*29.88%	6.83%	-3.44%
	sd	40.75%	35.09%	33.17%	30.56%
Copper (XCEC)	mean	1.45%	*28.15%	6.19%	-0.1%
	sd	21.23%	31.89%	34.91%	19.56%
Gold (XCEC)	mean	4.5%	14.35%	14.01%	0.53%
	sd	15.14%	18.89%	21.46%	14.41%
Palladium (XNYM)	mean	9.12%	9.03%	*29.12%	13.75%
	sd	38.27%	32.71%	36.14%	25.38%
Platinum (XNYM)	mean	12.93%	10.56%	7.29%	-7.92%
	sd	22.62%	22.66%	25.53%	19.48%
Silver (XCEC)	mean	6.19%	17.54%	21.96%	-2.43%
	sd	22%	33.92%	39.87%	24.35%
Aluminium (XLME)	mean	1.13%	13.78%	-3.58%	3.15%
	sd	17.6%	26.41%	26.48%	18.56%
Copper (XLME)	mean	0.45%	**28.59%	5.74%	0.03%
	sd	19.25%	31.09%	34.27%	18.92%
Lead (XLME)	mean	3.83%	28.99%	10.74%	2.07%
	sd	19.64%	41.74%	41.05%	23.26%
Nickel-primary (XLME)	mean	19.31%	12.5%	3.52%	0.31%
	sd	32.26%	44.27%	41.45%	28.98%
Tin-refined (XLME)	mean	4.07%	*29.1%	7.46%	1.68%
	sd	15.38%	31.71%	35.61%	18.79%
Zinc (XLME)	mean	-4.52%	20.13%	7.62%	9.07%
	sd	21.73%	38.77%	36.17%	23.25%
equally weighted portfolios					
US commodities	mean	*6.89%	**15.89%	9.39%	-0.18%
	sd	10%	13.62%	17.58%	9.86%
UK commodities	mean	2.47%	*21.77%	5.25%	2.72%
	sd	15.66%	26.91%	30.24%	16.19%

Table 2: This table shows the average time series R^2 for models where the returns series for the twenty four individual US commodities are independently regressed against relative change in their own commercial hedging pressure (CHP) series as well as against that in aggregate CHP, a market wide measure of CHP which calculation method is discussed in section 1.2.3. Averages are calculated independently across the whole cross-section of US traded commodity assets considered in the study as well as across commodity sectors and subsectors for the four periods of interest (past: 1997-2003; financialisation: 2004-2008; crisis: 2008-2013; post-crisis: 2013-2018). The results are discussed in section 1.3.

regressor	sector	subsector	past	financialisation	crisis	post-crisis
individual CHP	all	all	25.79%	20.72%	22.46%	27.17%
	agriculturals		25.19%	21.6%	23.91%	28.12%
	energy		25.12%	19.45%	16%	10.96%
	metals		28.12%	19.1%	23.27%	37.32%
	agriculturals	grains	33.18%	27.86%	29.15%	36.24%
		livestock	6.23%	10.53%	6.89%	4.34%
		softs	26.68%	20.89%	27.19%	31.88%
	energy	gas	19.69%	15.65%	7.36%	5.29%
		petroleum	26.93%	20.71%	18.87%	12.85%
	metals	base	47.38%	25.86%	18.07%	34.9%
		precious	23.3%	17.41%	24.57%	37.93%
aggregate CHP	all	all	5.37%	7.12%	14.72%	7.49%
	agriculturals		4.91%	4.5%	12.14%	6.23%
	energy		3.35%	6.27%	14.83%	2.45%
	metals		8.36%	15.67%	22.37%	15.33%
	agriculturals	grains	7.25%	5.4%	19.75%	8.45%
		livestock	1.35%	0.41%	0.52%	0.26%
		softs	4.34%	5.64%	10.35%	6.98%
	energy	gas	2.65%	2.58%	2.6%	0.27%
		petroleum	3.59%	7.49%	18.9%	3.17%
	metals	base	10.12%	12.74%	23.94%	7.67%
		precious	7.92%	16.4%	21.98%	17.25%

Table 3: This table shows mean returns and volatility (sd) for the twenty four individual US commodities and the six LME metals considered in the study as well as for two equally weighted portfolios formed from the US commodities and the LME metals respectively across the four periods of interest (past: 1997-2003; financialisation: 2004-2008; crisis: 2008-2013; post-crisis: 2013-2018). Figures are shown independently for phases of aggregate backwardation (aggregate CHP ≤ period median) and aggregate contango (aggregate CHP > period median). Mean values significant at the 1%, 5% and 10% level are marked with ***, ** and * respectively. Aggregate CHP construction and corresponding regime definitions are discussed in section 1.2.3 while the results are discussed in section 1.3.

asset	regime	estimate	past	financialisation	crisis	post-crisis
individual commodities						
Corn-#2 yellow (XCBT)	backwardation	mean	-4.86%	19.26%	20.48%	-8.74%
		sd	23.07%	29.14%	31.59%	21%
	contango	mean	11.3%	23.54%	-4.43%	0.78%
		sd	23%	30.01%	40.14%	22.68%
Oats (XCBT)	backwardation	mean	-5.39%	7.82%	7.85%	2.56%
		sd	29.02%	33.82%	31.43%	31.55%
	contango	mean	16.95%	*35.38%	11.68%	-3.17%
		sd	35.22%	28.1%	37.7%	27.5%
Soybean meal (XCBT)	backwardation	mean	13.15%	8.22%	16.04%	-3.52%
		sd	27.77%	33.06%	25.7%	25.1%
	contango	mean	1.52%	15.91%	2.32%	2.22%
		sd	24.94%	32.13%	36.85%	25.32%
Soybean oil (XCBT)	backwardation	mean	14.79%	14.62%	20.34%	-9.44%
		sd	21.35%	28.94%	22.33%	18.19%
	contango	mean	-2.68%	16.62%	-10.01%	-4.12%
		sd	21.55%	27.91%	28.65%	19.79%
Soybeans (XCBT)	backwardation	mean	13.69%	0.93%	13.42%	-11.45%
		sd	21.93%	34.58%	24.39%	22.04%
	contango	mean	-0.16%	25.71%	0.96%	3.75%
		sd	21.09%	24.74%	31.11%	20.56%
Wheat-SRW (XCBT)	backwardation	mean	-2.7%	19.02%	0.98%	0.44%
		sd	25.79%	36%	37.53%	26.57%
	contango	mean	11.78%	16.29%	14.57%	-2.77%
		sd	24.04%	29.84%	37.73%	26.72%
Cattle-feeder (XCME)	backwardation	mean	2.31%	**20.52%	7.51%	6.58%
		sd	12.79%	14.93%	13.39%	20.14%
	contango	mean	-0.81%	-5.49%	7.28%	-3.12%
		sd	13.67%	15.35%	16.91%	17.23%

Table 3: *(continued)*

asset	regime	estimate	past	financialisation	crisis	post-crisis
Cattle-live (XCME)	backwardation	mean	8.39%	14.2%	5.87%	-2.07%
		sd	16.65%	17.91%	14.97%	19.9%
	contango	mean	-0.34%	3.43%	2.7%	5.82%
		sd	17.49%	16.99%	17.57%	16.66%
Lean hogs (XCME)	backwardation	mean	12.34%	16.3%	18.23%	19.24%
		sd	37.6%	35.73%	27.83%	35.61%
	contango	mean	-10.5%	0.6%	7.5%	-20.66%
		sd	39.22%	27.67%	32.78%	38.28%
Cocoa (IFUS)	backwardation	mean	4.12%	9.25%	-9.56%	-2.98%
		sd	33.57%	31.05%	26.93%	25.86%
	contango	mean	3.67%	23.43%	12.92%	10.29%
		sd	31.81%	28.91%	34.66%	23.57%
Coffee-C (IFUS)	backwardation	mean	4.51%	26.49%	2.66%	14.36%
		sd	48.82%	32.6%	29.92%	31.52%
	contango	mean	-16.87%	14.38%	3.4%	-10.24%
		sd	38.35%	32.06%	30.22%	32.24%
Cotton-#2 (IFUS)	backwardation	mean	22.64%	7.85%	35.53%	10.84%
		sd	26.02%	29.71%	33.94%	21.33%
	contango	mean	-16.46%	-5.92%	-9.36%	-8.91%
		sd	26.77%	28.35%	32.59%	19.95%
Lumber (XCME)	backwardation	mean	-8.48%	-2.37%	29.11%	**26.99%
		sd	30.43%	30.72%	35.45%	21.26%
	contango	mean	11.68%	-4.77%	-5.04%	-17.14%
		sd	30.56%	28.2%	37.23%	28.45%
Orange juice (IFUS)	backwardation	mean	-2.38%	-2.22%	18.24%	18.64%
		sd	28.01%	33.01%	30.09%	28.64%
	contango	mean	5.83%	29.93%	12.29%	-8.64%
		sd	31.05%	33.1%	38.06%	30.11%
Sugar-#11 (IFUS)	backwardation	mean	11.98%	29.51%	2.7%	-8.07%
		sd	33.23%	33.6%	41.29%	27.69%
	contango	mean	-20.49%	20.35%	21.47%	4.7%
		sd	36.48%	32.98%	34.09%	29.83%
Natural gas (XNYM)	backwardation	mean	**85.84%	4.76%	-2.32%	18.33%
		sd	63.46%	47.3%	48.85%	42.59%
	contango	mean	-11.98%	27.84%	4.77%	3.25%
		sd	59.76%	61.3%	58.18%	46.41%
Crude oil-WTI (XNYM)	backwardation	mean	29.17%	*35.61%	11.47%	14.24%
		sd	36.74%	32.09%	28.19%	26.94%
	contango	mean	2.21%	22.04%	9.95%	-24.85%
		sd	42.74%	33.1%	53.7%	41.08%

Table 3: *(continued)*

asset	regime	estimate	past	financialisation	crisis	post-crisis
Gasoline (XNYM)	backwardation	mean	39%	19.82%	23.98%	9.69%
		sd	42.47%	39.38%	31.41%	32.1%
	contango	mean	-5.22%	42.13%	-0.09%	-19.47%
		sd	43.14%	44.13%	47.11%	41.71%
Heating oil (XNYM)	backwardation	mean	36.32%	29.41%	25.56%	15.16%
		sd	41.37%	33.33%	25.95%	24.62%
	contango	mean	-2.74%	30.5%	-10.77%	-21.62%
		sd	40.19%	36.98%	39.16%	35.69%
Copper (XCEC)	backwardation	mean	3.14%	22.17%	16.53%	12.1%
		sd	20.71%	30.05%	25.73%	18.16%
	contango	mean	-0.28%	34.17%	-3.46%	-12.15%
		sd	21.78%	33.69%	42.28%	20.87%
Gold (XCEC)	backwardation	mean	9.19%	13.37%	9.37%	4.21%
		sd	16.89%	19.2%	17.03%	12.36%
	contango	mean	-0.01%	15.37%	19.1%	-3.1%
		sd	13.24%	18.58%	25.21%	16.23%
Palladium (XNYM)	backwardation	mean	**49.79%	24.47%	30.01%	**31.93%
		sd	34.98%	34.23%	33.49%	23.82%
	contango	mean	-30.19%	-6.3%	30.58%	-4.88%
		sd	41.22%	31.2%	38.71%	26.8%
Platinum (XNYM)	backwardation	mean	**29.46%	*25.07%	10.46%	1.17%
		sd	22.1%	22.51%	21.24%	18.04%
	contango	mean	-3.22%	-3.81%	8.04%	-17.28%
		sd	23.12%	22.81%	28.75%	20.8%
Silver (XCEC)	backwardation	mean	5.98%	14.29%	19.66%	3.44%
		sd	21.07%	32.5%	37.17%	20.3%
	contango	mean	6.57%	20.83%	26.77%	-8.09%
		sd	22.93%	35.34%	42.44%	27.77%
Aluminium (XLME)	backwardation	mean	2.56%	14.78%	16.25%	**23.68%
		sd	14.82%	25.57%	24.94%	18.94%
	contango	mean	-0.38%	12.86%	-23.04%	-16.74%
		sd	20.13%	27.29%	28.01%	18.23%
Copper (XLME)	backwardation	mean	1.54%	25.22%	18.66%	11.99%
		sd	17.98%	29.01%	25.53%	17.92%
	contango	mean	-0.95%	32%	-6.78%	-11.89%
		sd	20.41%	32.98%	41.31%	19.86%
Lead (XLME)	backwardation	mean	7.59%	11.21%	9.87%	17.05%
		sd	19.16%	39.91%	35.35%	23.37%
	contango	mean	-0.09%	*46.48%	12.65%	-13.41%
		sd	20.12%	43.16%	46.22%	23.09%

Table 3: *(continued)*

asset	regime	estimate	past	financialisation	crisis	post-crisis
Nickel-primary (XLME)	backwardation	mean	23.25%	-39.24%	16.3%	**35.09%
		sd	30.23%	41.62%	34.48%	29.13%
	contango	mean	15.46%	**63.47%	-7.67%	**-34.64%
		sd	34.28%	46.72%	47.44%	28.6%
Tin-refined (XLME)	backwardation	mean	*15.83%	34.62%	23.7%	4.48%
		sd	14.99%	31.4%	29.09%	15.27%
	contango	mean	-7.78%	23.88%	-6.82%	-1.69%
		sd	15.77%	32.08%	41.13%	21.68%
Zinc (XLME)	backwardation	mean	-9.06%	2.95%	10.05%	**29.42%
		sd	21.15%	36.86%	33.28%	22.12%
	contango	mean	-0.13%	37.11%	5.43%	-11.31%
		sd	22.38%	40.51%	39.03%	24.32%
equally weighted portfolios						
US commodities	backwardation	mean	***15.44%	*15.66%	13.4%	6.82%
		sd	9.88%	14.21%	14.83%	8.59%
	contango	mean	-1.09%	*16.16%	4.9%	-6.33%
		sd	10.09%	13.05%	19.98%	10.95%
UK commodities	backwardation	mean	4.41%	8.01%	15.06%	**19.95%
		sd	14.39%	25.92%	25.94%	15.13%
	contango	mean	0.34%	*35.56%	-5.24%	-14.05%
		sd	16.87%	27.88%	34.06%	17.1%

Table 4: This table shows the average time series R^2 for models where the returns series for the twenty four individual US commodities are regressed against factor mimicking portfolios independently with the resulting R^2 averaged across all the twenty four commodities. The asset pool for the factor mimicking portfolio construction includes the twenty four US commodities. For each long-short factor (average CHP: CHP; open interest nearby growth: open interest; and term structure) the models are constructed with the factor itself (factor) as well as both legs independently (long vs. short). The results are reported in order for the market, CHP, open interest and term structure factors, for the four periods of interest (past: 1997-2003; financialisation: 2004-2008; crisis: 2008-2013; post-crisis: 2013-2018) and shown independently for phases of aggregate backwardation (aggregate CHP $\leq$ period median) and aggregate contango (aggregate CHP $>$ period median). Factors as well as aggregate CHP construction and corresponding regime definitions are discussed in section 1.2.3 while the results are discussed in section 1.3.

factor	leg	regime	past	financialisation	crisis	post-crisis
market	factor	all	11.68%	21.6%	30.72%	15.57%
		backwardation	11.28%	23.51%	28.95%	13.12%
		contango	12.23%	19.96%	32.47%	17.66%
CHP		all	1.67%	8.24%	5.67%	4.07%
		backwardation	1.84%	8.81%	5.01%	5.74%
		contango	2.05%	8.25%	6.81%	3.58%
	long	all	4.53%	15.14%	21.88%	9.31%
		backwardation	4.77%	17.25%	21.46%	8.07%
		contango	4.85%	13.8%	22.56%	10.53%
	short	all	3.02%	4%	9.1%	4.36%
		backwardation	2.51%	4.03%	7.14%	6.24%
		contango	4%	4.81%	12.42%	3.88%
open interest	factor	all	2.91%	3.84%	6.21%	5.12%
		backwardation	3.61%	2.93%	4.99%	5.04%
		contango	2.5%	5.21%	7.39%	5.41%
	long	all	5.94%	13.15%	21.23%	8.72%
		backwardation	6.78%	14.01%	18.83%	8.01%
		contango	5.47%	12.78%	23.07%	9.34%
	short	all	3.55%	7.41%	12.39%	4.25%
		backwardation	3.32%	9.77%	10.61%	3.97%
		contango	3.98%	5.16%	13.83%	4.86%
term structure	factor	all	1.12%	1.46%	2.93%	0.94%
		backwardation	1.16%	2.17%	2.53%	1.28%
		contango	1.55%	2.02%	3.6%	1.22%
	long	all	4.15%	6.36%	8.39%	5.07%
		backwardation	4.38%	8.41%	9.91%	4.98%
		contango	4.28%	5.73%	7.99%	5.5%
	short	all	2.59%	8.79%	14.46%	4%
		backwardation	2.78%	10.16%	10.18%	2.69%
		contango	2.9%	7.9%	18.16%	6.25%

Table 5: This table shows the factor 'picks' for the market as well as the long-short factors for the four periods of interest (past: 1997-2003; financialisation: 2004-2008; crisis: 2008-2013; post-crisis: 2013-2018). For each factor and period the twenty four US commodities are regressed against the corresponding factor mimicking portfolio and ranked by R^2. The top eight commodities are selected as 'picks' for the corresponding factor and period. The table also shows the proportion of time, for each period, each individual pick lives on both legs (long vs. short) of its picking factor. The results are reported in order for the market, CHP, open interest and term structure factors used as the picking factor. Factors construction details are discussed in section 1.2.3 while the results are discussed in section 1.3.

picking factor	period	pick	long	short
market	past	Corn-#2 yellow (XCBT)	100%	0%
		Soybean meal (XCBT)	100%	0%
		Soybeans (XCBT)	100%	0%
		Wheat-SRW (XCBT)	100%	0%
		Natural gas (XNYM)	100%	0%
		Crude oil-WTI (XNYM)	100%	0%
		Gasoline (XNYM)	100%	0%
		Heating oil (XNYM)	100%	0%
	financialization	Corn-#2 yellow (XCBT)	100%	0%
		Soybean oil (XCBT)	100%	0%
		Soybeans (XCBT)	100%	0%
		Crude oil-WTI (XNYM)	100%	0%
		Heating oil (XNYM)	100%	0%
		Gold (XCEC)	100%	0%
		Palladium (XNYM)	100%	0%
		Silver (XCEC)	100%	0%
	crisis	Corn-#2 yellow (XCBT)	100%	0%
		Soybean oil (XCBT)	100%	0%
		Soybeans (XCBT)	100%	0%
		Wheat-SRW (XCBT)	100%	0%
		Crude oil-WTI (XNYM)	100%	0%
		Gasoline (XNYM)	100%	0%
		Heating oil (XNYM)	100%	0%
		Copper (XCEC)	100%	0%
	post-crisis	Corn-#2 yellow (XCBT)	100%	0%
		Soybean oil (XCBT)	100%	0%
		Soybeans (XCBT)	100%	0%
		Crude oil-WTI (XNYM)	100%	0%
		Gasoline (XNYM)	100%	0%
		Heating oil (XNYM)	100%	0%
		Copper (XCEC)	100%	0%
		Silver (XCEC)	100%	0%

Table 5: *(continued)*

picking factor	period	pick	long	short
CHP	past	Cattle-feeder (XCME)	12.28%	67.96%
		Cattle-live (XCME)	16.47%	50.3%
		Lean hogs (XCME)	13.77%	58.98%
		Cotton-#2 (IFUS)	18.56%	46.11%
		Orange juice (IFUS)	55.39%	18.56%
		Gold (XCEC)	36.83%	61.68%
		Platinum (XNYM)	91.92%	2.1%
		Silver (XCEC)	100%	0%
	financialization	Oats (XCBT)	97.91%	0%
		Cattle-feeder (XCME)	0%	97.49%
		Lean hogs (XCME)	0%	72.38%
		Copper (XCEC)	28.45%	46.44%
		Gold (XCEC)	100%	0%
		Palladium (XNYM)	100%	0%
		Platinum (XNYM)	100%	0%
		Silver (XCEC)	100%	0%
	crisis	Natural gas (XNYM)	0%	100%
		Crude oil-WTI (XNYM)	5.76%	46.09%
		Gasoline (XNYM)	52.67%	0%
		Copper (XCEC)	0%	81.48%
		Gold (XCEC)	100%	0%
		Palladium (XNYM)	100%	0%
		Platinum (XNYM)	100%	0%
		Silver (XCEC)	99.59%	0%
	post-crisis	Corn-#2 yellow (XCBT)	0%	62.77%
		Soybean meal (XCBT)	34.04%	0%
		Wheat-SRW (XCBT)	0%	97.52%
		Natural gas (XNYM)	0%	100%
		Gold (XCEC)	80.14%	0%
		Palladium (XNYM)	100%	0%
		Platinum (XNYM)	96.81%	0%
		Silver (XCEC)	57.45%	0%

Table 5: *(continued)*

picking factor	period	pick	long	short
open interest	past	Oats (XCBT)	17.1%	50.3%
		Soybean meal (XCBT)	19.71%	49.1%
		Cattle-live (XCME)	12.46%	58.68%
		Natural gas (XNYM)	82.61%	1.2%
		Crude oil-WTI (XNYM)	99.71%	0%
		Gasoline (XNYM)	99.71%	0%
		Heating oil (XNYM)	99.71%	0%
		Palladium (XNYM)	10.14%	52.69%
	financialization	Soybean meal (XCBT)	0.75%	80.09%
		Natural gas (XNYM)	87.97%	0%
		Crude oil-WTI (XNYM)	92.48%	0%
		Gasoline (XNYM)	92.11%	0%
		Heating oil (XNYM)	92.11%	0%
		Gold (XCEC)	16.54%	37.04%
		Platinum (XNYM)	19.55%	31.02%
		Silver (XCEC)	49.25%	17.13%
	crisis	Soybean oil (XCBT)	10.61%	58.38%
		Natural gas (XNYM)	95.45%	0%
		Crude oil-WTI (XNYM)	95.45%	0%
		Gasoline (XNYM)	92.05%	0%
		Heating oil (XNYM)	94.7%	0%
		Copper (XCEC)	23.11%	35.14%
		Platinum (XNYM)	51.14%	17.84%
		Silver (XCEC)	25.76%	34.05%
	post-crisis	Corn-#2 yellow (XCBT)	14.97%	48.33%
		Oats (XCBT)	19.73%	53.53%
		Wheat-SRW (XCBT)	10.54%	43.49%
		Cattle-feeder (XCME)	26.53%	54.65%
		Natural gas (XNYM)	98.64%	0%
		Crude oil-WTI (XNYM)	98.64%	0%
		Gasoline (XNYM)	97.28%	0%
		Heating oil (XNYM)	97.28%	0%

Table 5: *(continued)*

picking factor	period	pick	long	short
term structure	past	Corn-#2 yellow (XCBT)	94.52%	1.15%
		Lean hogs (XCME)	43.8%	36.68%
		Cotton-#2 (IFUS)	77.81%	13.18%
		Sugar-#11 (IFUS)	25.07%	55.87%
		Gasoline (XNYM)	16.43%	60.17%
		Heating oil (XNYM)	15.56%	33.24%
		Palladium (XNYM)	0%	59.03%
		Platinum (XNYM)	0%	89.68%
	financialization	Soybean meal (XCBT)	17.27%	48.18%
		Soybeans (XCBT)	20.45%	31.98%
		Cattle-live (XCME)	19.09%	48.18%
		Natural gas (XNYM)	78.18%	0%
		Copper (XCEC)	0%	89.88%
		Gold (XCEC)	0%	17%
		Platinum (XNYM)	0%	92.71%
		Silver (XCEC)	0%	30.77%
	crisis	Soybean meal (XCBT)	0%	82.54%
		Soybeans (XCBT)	0%	58.33%
		Lean hogs (XCME)	69.84%	21.83%
		Cotton-#2 (IFUS)	38.1%	48.02%
		Sugar-#11 (IFUS)	34.52%	50.79%
		Natural gas (XNYM)	76.59%	0%
		Gasoline (XNYM)	8.33%	60.32%
		Copper (XCEC)	0%	40.87%
	post-crisis	Corn-#2 yellow (XCBT)	89.69%	6.77%
		Wheat-SRW (XCBT)	96.91%	0%
		Cattle-feeder (XCME)	17.87%	69.55%
		Cattle-live (XCME)	27.84%	60.9%
		Coffee-C (IFUS)	100%	0%
		Lumber (XCME)	40.89%	39.85%
		Sugar-#11 (IFUS)	69.07%	20.68%
		Natural gas (XNYM)	71.48%	17.29%

Table 6: This table shows the average pairwise correlation amongst factor picks for each factor and period independently. The figures are shown independently for phases of aggregate backwardation (aggregate CHP $\leq$ period median) and aggregate contango (aggregate CHP $>$ period median). The results are reported in order for the market, CHP, open interest and term structure factors used as the picking factor. Factors as well as aggregate CHP construction and corresponding regime definitions along with details on the picking process are discussed in section 1.2.3 while the results are discussed in section 1.3.

picking factor	regime	past	financialisation	crisis	post-crisis
market	all	23.68%	34.2%	50.07%	26.13%
	backwardation	22.21%	36.28%	45.4%	22.53%
	contango	25.31%	32.6%	52.73%	29.07%
CHP	all	8.05%	22.94%	40.1%	19.84%
	backwardation	8.4%	22.48%	43.5%	16.63%
	contango	7.64%	23.6%	38.72%	22.32%
open interest	all	12.42%	32.35%	41.96%	16.13%
	backwardation	11.62%	35.44%	41.9%	14.44%
	contango	12.99%	29.69%	42.18%	17.75%
term structure	all	7.07%	23.41%	23.15%	8.86%
	backwardation	5.63%	24.56%	18.99%	8.37%
	contango	8.3%	22.66%	26.34%	9.15%

Table 7: This table shows the average time series R^2 for models where the returns series for the various sets of factor picks are regressed against factor mimicking portfolios independently with the resulting R^2 averaged across the picks. For each picking factor and period, the market as well as the long-short factor mimicking portfolios are constructed from the corresponding set of factor picks. For each long-short factor (average CHP: CHP; open interest nearby growth: open interest; and term structure) the models are constructed with the factor itself (factor) as well as both legs independently (long vs. short). The results are reported in order for the market, CHP, open interest and term structure factors used as the picking factor, for the four periods of interest (past: 1997-2003; financialisation: 2004-2008; crisis: 2008-2013; post-crisis: 2013-2018) and shown independently for phases of aggregate backwardation (aggregate CHP $\leq$ period median) and aggregate contango (aggregate CHP $>$ period median). Factors as well as aggregate CHP construction and corresponding regime definitions along with details on the picking process are discussed in section 1.2.3 while the results are discussed in section 1.3.

picking factor	factor	leg	regime	past	financialisation	crisis	post-crisis
market	market	factor	all	32.72%	42.33%	56.22%	36.48%
			backwardation	31.67%	43.85%	52.22%	34.13%
			contango	33.87%	41.14%	58.62%	38.39%
	CHP		all	5.61%	12.44%	6.89%	6.83%
			backwardation	5.02%	11.4%	7.33%	5.58%
			contango	7.73%	15.34%	8.2%	9.49%
		long	all	17.09%	27.87%	40.38%	17.61%
			backwardation	17.36%	26.97%	33.21%	13.37%
			contango	17.39%	29.12%	44.06%	21.69%
		short	all	16.49%	21.39%	35.95%	16.37%
			backwardation	13.19%	25.78%	32.18%	12.42%
			contango	20.53%	18.68%	39.1%	20.49%
	open interest	factor	all	23.2%	7.78%	11.68%	19.69%
			backwardation	24.03%	8.65%	8.56%	19.29%
			contango	22.67%	7.38%	14.32%	20.15%
		long	all	25.03%	26.41%	39.29%	27.68%
			backwardation	26.05%	28.34%	34.39%	27.3%
			contango	24.42%	24.86%	41.79%	28.25%
		short	all	23.67%	22.99%	34.48%	17.13%
			backwardation	21.81%	26.13%	33.14%	14.96%
			contango	26.47%	20.67%	35.71%	19.57%
	term structure	factor	all	5.92%	7.26%	4.29%	1.98%
			backwardation	6.44%	7.24%	9.11%	1.51%
			contango	5.52%	9.23%	3.01%	2.81%
		long	all	11.61%	24.74%	35.76%	17.54%
			backwardation	10.72%	27.25%	33.61%	18.51%
			contango	12.92%	23.08%	37.43%	17.53%
		short	all	16.22%	24.13%	35.98%	20.6%
			backwardation	17.07%	25.62%	30.3%	16.38%
			contango	16.15%	24.36%	39.28%	23.56%

Table 7: *(continued)*

picking factor	factor	leg	regime	past	financialisation	crisis	post-crisis
CHP	market	factor	all	18.62%	38.1%	47.61%	28.42%
			backwardation	19.04%	36.9%	50.48%	25.17%
			contango	18.39%	39.54%	46.48%	30.9%
	CHP		all	7.19%	21.38%	13%	14.34%
			backwardation	6.78%	19.58%	12.57%	18.44%
			contango	8.32%	23.66%	13.51%	14.5%
		long	all	10.45%	31.09%	38.06%	24.09%
			backwardation	11.18%	30.55%	41.19%	22.78%
			contango	10.21%	31.88%	36.81%	25.3%
		short	all	8.27%	9.84%	15.7%	10.44%
			backwardation	8.12%	9.87%	16.25%	15.17%
			contango	9.33%	9.98%	15.57%	11.21%
	open interest	factor	all	1.47%	4.76%	9.16%	11.59%
			backwardation	2.34%	4.23%	7.98%	11.57%
			contango	1%	5.64%	10.58%	11.9%
		long	all	6.27%	24.94%	25.22%	12.58%
			backwardation	6.82%	26.16%	19.14%	12.47%
			contango	6.42%	24.13%	28.34%	12.75%
		short	all	5.59%	13.44%	35.65%	14.08%
			backwardation	6.49%	16.16%	39.06%	12.01%
			contango	5.2%	11.43%	34.37%	16.51%
	term structure	factor	all	3.5%	5.28%	8.11%	5.96%
			backwardation	3.79%	8.13%	9.48%	6.88%
			contango	4.9%	4.01%	7.64%	5.86%
		long	all	7.45%	9.78%	15.63%	12.48%
			backwardation	7.12%	9.85%	15.97%	11.94%
			contango	8.85%	10.75%	15.59%	13.31%
		short	all	6.26%	15.74%	28.56%	13.03%
			backwardation	6.51%	19.46%	28.59%	10.21%
			contango	6.58%	13.22%	28.76%	17.2%

Table 7: *(continued)*

picking factor	factor	leg	regime	past	financialisation	crisis	post-crisis
open interest	market	factor	all	28.43%	41.66%	49.79%	29.2%
			backwardation	28%	44.29%	49.09%	27.73%
			contango	28.84%	39.55%	50.49%	30.43%
	CHP		all	9.58%	14.48%	11.28%	9.83%
			backwardation	9.81%	13.64%	11.15%	10.3%
			contango	9.47%	16.17%	11.62%	11.76%
		long	all	12.63%	27.21%	32.29%	18.56%
			backwardation	12.41%	28.26%	35.25%	15.67%
			contango	13.06%	26.85%	31.22%	20.78%
		short	all	10.71%	23.23%	16.94%	8.09%
			backwardation	9.72%	24.06%	16.56%	13.98%
			contango	11.79%	23.43%	17.35%	9.21%
	open interest	factor	all	18.25%	15.83%	9.45%	11.79%
			backwardation	19.96%	14.24%	6.39%	12.24%
			contango	16.97%	17.33%	11.49%	11.87%
		long	all	24.83%	30.24%	33.8%	13.61%
			backwardation	25.07%	31.83%	26.7%	13.11%
			contango	24.77%	29.24%	37.38%	14.3%
		short	all	8.32%	17.57%	31.68%	11.76%
			backwardation	7.65%	17.99%	32.14%	11.62%
			contango	9.17%	17.62%	31.72%	12.44%
	term structure	factor	all	2.3%	6.95%	7.93%	3.63%
			backwardation	3.56%	5.35%	10.01%	5.48%
			contango	2.61%	8.26%	7.22%	3.24%
		long	all	7.54%	20.81%	17.64%	12.3%
			backwardation	7.45%	22.37%	16.44%	14.08%
			contango	7.84%	19.88%	18.58%	11.56%
		short	all	8.85%	19.61%	32.42%	11.02%
			backwardation	12.38%	24.66%	32.66%	7.46%
			contango	7.69%	16.26%	32.72%	14.76%

Table 7: *(continued)*

picking factor	factor	leg	regime	past	financialisation	crisis	post-crisis
term structure	market	factor	all	20%	33.71%	33.64%	19.37%
			backwardation	18.65%	35.1%	29.47%	19.58%
			contango	21.25%	32.72%	36.91%	19.29%
	CHP		all	4.68%	7.97%	8.75%	3.74%
			backwardation	4.7%	7.11%	10.38%	8.99%
			contango	5.19%	9.3%	8.01%	3.69%
		long	all	11.93%	28.13%	22.6%	7.81%
			backwardation	14.34%	27.9%	21.19%	8.65%
			contango	10.77%	28.61%	24.63%	8.45%
		short	all	5.54%	9.15%	13.2%	5.52%
			backwardation	4.6%	8.86%	12.38%	11.89%
			contango	7.11%	10.4%	14.58%	5.3%
	open interest	factor	all	8.62%	8.02%	5.96%	10.47%
			backwardation	9.54%	7.27%	6.5%	10.93%
			contango	7.77%	8.87%	6.99%	10.46%
		long	all	13.53%	15.51%	16.65%	12.44%
			backwardation	13.3%	16.33%	12.47%	12.45%
			contango	13.92%	15.23%	20.05%	12.48%
		short	all	5.94%	14.55%	14.78%	7.79%
			backwardation	5.61%	16.34%	13.08%	8.88%
			contango	6.29%	13.09%	17.1%	7.81%
	term structure	factor	all	5.1%	8.38%	8.8%	6.83%
			backwardation	7.27%	6.31%	8.91%	9.15%
			contango	5.15%	10.07%	9.39%	5.96%
		long	all	7.6%	12.13%	11.03%	7.86%
			backwardation	7.13%	12.38%	10.13%	9.57%
			contango	8.38%	12.17%	12.68%	7.96%
		short	all	6.03%	16.11%	20.26%	9.96%
			backwardation	9.07%	15.15%	15.34%	10.19%
			contango	6.06%	17.5%	24.31%	10.3%

Table 8: This table shows the average time series R^2 for models where the returns series for the twenty four US commodities are regressed against factor mimicking portfolios independently with the resulting R^2 averaged across all the twenty four commodities. For each picking factor and period, the market as well as the long-short factor mimicking portfolios are constructed from the corresponding set of factor picks. For each long-short factor (average CHP: CHP; open interest nearby growth: open interest; and term structure) the models are constructed with the factor itself (factor) as well as both legs independently (long vs. short). The results are reported in order for the market, CHP, open interest and term structure factors used as the picking factor, for the four periods of interest (past: 1997-2003; financialisation: 2004-2008; crisis: 2008-2013; post-crisis: 2013-2018) and shown independently for phases of aggregate backwardation (aggregate CHP $\leq$ period median) and aggregate contango (aggregate CHP $>$ period median). Factors as well as aggregate CHP construction and corresponding regime definitions along with details on the picking process are discussed in section 1.2.3 while the results are discussed in section 1.3.

picking factor	factor	leg	regime	past	financialisation	crisis	post-crisis
market	market	factor	all	11.67%	21.24%	28.16%	14.85%
			backwardation	11.34%	22.98%	26.68%	13.36%
			contango	12.09%	19.79%	29.81%	16.31%
	CHP		all	1.96%	5.44%	2.52%	3.24%
			backwardation	1.83%	4.93%	3.16%	4.06%
			contango	2.85%	6.82%	2.83%	3.73%
		long	all	6.64%	13.42%	18.81%	7.99%
			backwardation	6.99%	13.31%	16.43%	7.93%
			contango	6.6%	13.78%	20.61%	9.08%
		short	all	6.12%	10.75%	18.35%	7.61%
			backwardation	4.75%	13.22%	16.28%	5.87%
			contango	7.85%	9.05%	20.59%	9.7%
	open interest	factor	all	8.25%	3.72%	4.49%	6.9%
			backwardation	8.64%	4.35%	3.3%	6.81%
			contango	8.08%	3.44%	5.7%	7.11%
		long	all	8.51%	12.69%	18.26%	9.71%
			backwardation	8.85%	13.94%	17.03%	9.45%
			contango	8.4%	11.82%	19.42%	10.13%
		short	all	9.47%	11.69%	17.99%	8.18%
			backwardation	8.98%	14.42%	17.72%	6.81%
			contango	10.39%	9.76%	18.66%	9.79%
	term structure	factor	all	2.1%	3.26%	1.76%	0.79%
			backwardation	2.31%	3.4%	4.15%	0.77%
			contango	2.06%	4.12%	1.21%	1.05%
		long	all	4.51%	13.46%	17.75%	7.25%
			backwardation	4.26%	15.48%	17.21%	7.69%
			contango	5.01%	12.06%	18.8%	7.44%
		short	all	5.69%	11.42%	17.51%	7.68%
			backwardation	5.91%	12.62%	15.24%	6.11%
			contango	5.87%	11.09%	19.48%	8.94%

Table 8: *(continued)*

picking factor	factor	leg	regime	past	financialisation	crisis	post-crisis
CHP	market	factor	all	6.77%	16.67%	25.41%	12.77%
			backwardation	6.85%	17.81%	24.61%	10.81%
			contango	6.84%	15.98%	26.51%	14.52%
	CHP		all	2.54%	8.73%	4.39%	5.06%
			backwardation	2.46%	8.28%	4.36%	6.61%
			contango	3.04%	9.5%	4.67%	5.16%
		long	all	3.9%	12.72%	17.36%	9.4%
			backwardation	4.13%	13.64%	19.11%	8.14%
			contango	4%	12.3%	16.6%	10.8%
		short	all	2.83%	3.82%	7.51%	4.17%
			backwardation	2.82%	3.72%	7.27%	6.11%
			contango	3.31%	4.19%	7.95%	4.3%
	open interest	factor	all	0.54%	1.68%	4.1%	4.1%
			backwardation	0.9%	1.54%	2.96%	4.14%
			contango	0.38%	2.27%	5.48%	4.26%
		long	all	2.36%	10.1%	15.23%	4.56%
			backwardation	2.57%	10.72%	10.19%	4.46%
			contango	2.45%	9.77%	18.64%	4.71%
		short	all	1.94%	6.35%	17.65%	6.96%
			backwardation	2.25%	8.71%	17.99%	5.62%
			contango	1.88%	4.71%	17.98%	8.46%
	term structure	factor	all	1.31%	1.97%	2.83%	2.2%
			backwardation	1.59%	2.9%	3.32%	2.55%
			contango	1.85%	1.65%	2.74%	2.37%
		long	all	2.62%	4.52%	8.05%	5.5%
			backwardation	2.65%	5.03%	7.26%	5.11%
			contango	3.08%	4.51%	8.86%	6.15%
		short	all	2.43%	7%	15.51%	6.71%
			backwardation	2.49%	9.01%	13.83%	4.78%
			contango	2.94%	5.61%	16.98%	9.57%

Table 8: *(continued)*

picking factor	factor	leg	regime	past	financialisation	crisis	post-crisis
open interest	market	factor	all	10.6%	18.43%	26.36%	12.03%
			backwardation	10.25%	20.18%	25.13%	10.91%
			contango	11.05%	17.11%	27.83%	13.17%
	CHP		all	4%	5.34%	4.54%	3.71%
			backwardation	4.1%	4.98%	4.37%	3.61%
			contango	4.02%	6.14%	4.86%	4.74%
		long	all	6.78%	13.48%	18.66%	7.42%
			backwardation	6.63%	14.34%	20.18%	5.9%
			contango	7.12%	13.11%	18.16%	8.77%
		short	all	3.94%	9.11%	7.49%	3.11%
			backwardation	3.56%	9.31%	7.08%	5.61%
			contango	4.45%	9.44%	8.05%	3.32%
	open interest	factor	all	6.4%	5.64%	3.37%	4.11%
			backwardation	6.93%	5.3%	2.53%	4.35%
			contango	6.07%	6.09%	4.25%	4.1%
		long	all	8.48%	12.35%	15.81%	4.76%
			backwardation	8.5%	13.24%	11.7%	4.54%
			contango	8.63%	11.82%	18.57%	5.08%
		short	all	4.07%	12.5%	19.46%	4.99%
			backwardation	3.64%	13.52%	18.93%	4.95%
			contango	4.64%	11.82%	20.29%	5.39%
	term structure	factor	all	0.83%	2.54%	3.13%	1.45%
			backwardation	1.3%	2.22%	3.71%	2.52%
			contango	1.13%	2.95%	3.02%	1.16%
		long	all	3.09%	7.65%	8.04%	5.26%
			backwardation	2.8%	8.53%	7.11%	5.96%
			contango	3.73%	7.22%	9%	5.21%
		short	all	3.55%	9.48%	16.63%	4.56%
			backwardation	4.8%	12.03%	15.62%	3.13%
			contango	3.21%	7.83%	17.77%	6.32%

Table 8: *(continued)*

picking factor	factor	leg	regime	past	financialisation	crisis	post-crisis
term structure	market	factor	all	9.13%	18.37%	25.17%	8.95%
			backwardation	8.79%	20.14%	22.77%	8.19%
			contango	9.55%	16.99%	27.12%	10.02%
	CHP		all	1.98%	3.42%	3.3%	1.38%
			backwardation	1.89%	3.08%	3.79%	3.4%
			contango	2.33%	4.07%	3.17%	1.32%
		long	all	4.8%	13.48%	15.65%	3.14%
			backwardation	5.63%	14.34%	13.9%	3.23%
			contango	4.55%	13.11%	17.32%	3.58%
		short	all	2.58%	5.81%	7.05%	2.51%
			backwardation	1.91%	5.91%	5.92%	5.04%
			contango	3.55%	6.2%	8.3%	2.29%
	open interest	factor	all	3.93%	3.97%	2.83%	3.6%
			backwardation	4.31%	3.56%	2.88%	3.87%
			contango	3.67%	4.63%	3.53%	3.57%
		long	all	6.42%	8.62%	12.51%	4.45%
			backwardation	6.24%	9.01%	9.32%	4.44%
			contango	6.73%	8.59%	14.98%	4.53%
		short	all	2.49%	8.49%	10.4%	3.46%
			backwardation	2.6%	10.34%	8.32%	3.83%
			contango	2.58%	6.84%	12.73%	3.64%
	term structure	factor	all	2.17%	3.38%	3.69%	2.53%
			backwardation	3.39%	2.69%	3.48%	3.52%
			contango	2.06%	4.03%	4.16%	2.16%
		long	all	3.91%	5.88%	5.59%	3.55%
			backwardation	3.65%	6.37%	4.61%	3.98%
			contango	4.38%	5.7%	6.74%	3.94%
		short	all	2.44%	7.8%	12.81%	3.63%
			backwardation	4.14%	8.02%	9.12%	3.54%
			contango	2.27%	8.05%	15.82%	4.21%

Table 9: This table shows the average time series R^2 for models where the returns series for the six UK metals are regressed against factor mimicking portfolios independently with the resulting R^2 averaged across the six UK metals. For each picking factor and period, the market as well as the long-short factor mimicking portfolios are constructed from the corresponding set of factor picks. For each long-short factor (average CHP: CHP; open interest nearby growth: open interest; and term structure) the models are constructed with the factor itself (factor) as well as both legs independently (long vs. short). The results are reported in order for the market, CHP, open interest and term structure factors used as the picking factor, for the four periods of interest (past: 1997-2003; financialisation: 2004-2008; crisis: 2008-2013; post-crisis: 2013-2018) and shown independently for phases of aggregate backwardation (aggregate CHP $\leq$ period median) and aggregate contango (aggregate CHP $>$ period median). Factors as well as aggregate CHP construction and corresponding regime definitions along with details on the picking process are discussed in section 1.2.3 while the results are discussed in section 1.3.

picking factor	factor	leg	regime	past	financialisation	crisis	post-crisis
market	market	factor	all	0.25%	10.17%	31.69%	11.52%
			backwardation	0.32%	11.66%	31.95%	8.64%
			contango	0.3%	9.16%	31.72%	14.26%
	CHP		all	0.06%	3.39%	0.42%	0.38%
			backwardation	0.36%	1.84%	0.26%	0.25%
			contango	0.05%	5.36%	0.66%	0.82%
		long	all	0.15%	13.12%	18.65%	5.45%
			backwardation	0.58%	12.24%	18.24%	5.07%
			contango	0.1%	14.17%	19.06%	5.98%
		short	all	0.05%	3%	24.38%	16.07%
			backwardation	0.11%	4.23%	14.79%	6.56%
			contango	0.06%	2.24%	32.21%	26.59%
	open interest	factor	all	0.04%	0.83%	1.45%	0.07%
			backwardation	0.05%	1.4%	0.07%	0.03%
			contango	0.2%	0.55%	3.21%	0.15%
		long	all	0.11%	6.59%	17.68%	2.57%
			backwardation	0.17%	7.76%	17.27%	1.58%
			contango	0.17%	5.85%	18.2%	3.57%
		short	all	0.05%	3.99%	17.16%	6.86%
			backwardation	0.39%	4.23%	19.91%	3.79%
			contango	0.09%	3.85%	15.74%	10.3%
	term structure	factor	all	0.1%	1.82%	0.98%	0.17%
			backwardation	0.42%	1.22%	0.04%	0.35%
			contango	0.06%	2.64%	2.2%	0.11%
		long	all	0.26%	1.85%	11.63%	2.82%
			backwardation	1.06%	2.98%	11.17%	1.53%
			contango	0.03%	1.24%	12.09%	4.32%
		short	all	0.03%	5.78%	20.53%	3.27%
			backwardation	0.1%	5.75%	18.66%	2.59%
			contango	0.12%	6.04%	21.67%	4.01%

Table 9: *(continued)*

picking factor	factor	leg	regime	past	financialisation	crisis	post-crisis
CHP	market	factor	all	1.55%	20.13%	34.54%	7.43%
			backwardation	1.53%	20.93%	35.18%	5.21%
			contango	1.75%	19.83%	34.3%	9.41%
	CHP		all	0.07%	5.5%	0.47%	2.12%
			backwardation	0.12%	4.05%	1.15%	1.4%
			contango	0.09%	7.36%	0.25%	2.78%
		long	all	1.02%	10.98%	21.81%	8.99%
			backwardation	0.77%	10.77%	25.33%	5.57%
			contango	1.36%	11.39%	19.89%	12.11%
		short	all	0.41%	0.25%	6.19%	0.19%
			backwardation	0.21%	0.47%	5.55%	0.24%
			contango	0.61%	0.22%	6.67%	0.2%
	open interest	factor	all	0.03%	0.64%	0.06%	0.27%
			backwardation	0.21%	0.06%	1.07%	0.12%
			contango	0.08%	1.68%	0.18%	1.33%
		long	all	0.28%	10.41%	15.26%	0.52%
			backwardation	0.39%	10.56%	10.18%	0.82%
			contango	0.34%	10.47%	18.21%	0.38%
		short	all	0.31%	8.77%	29.79%	4.53%
			backwardation	0.25%	12.85%	30.49%	1.57%
			contango	0.49%	5.85%	29.59%	8.33%
	term structure	factor	all	0.05%	4.73%	0.83%	0.6%
			backwardation	0.1%	4.5%	0.6%	1.11%
			contango	0.27%	5.11%	0.95%	0.31%
		long	all	0.32%	1.38%	5.13%	0.65%
			backwardation	0.2%	1.98%	4.85%	0.44%
			contango	0.58%	1.03%	5.35%	0.86%
		short	all	0.26%	19.23%	18.98%	3.91%
			backwardation	0.48%	21.81%	17.8%	4.62%
			contango	0.22%	17.21%	19.65%	3.4%

Table 9: *(continued)*

picking factor	factor	leg	regime	past	financialisation	crisis	post-crisis
open interest	market	factor	all	0.31%	8.13%	34.43%	3.37%
			backwardation	0.35%	9.97%	35.43%	1.72%
			contango	0.39%	6.8%	34.06%	5.08%
	CHP		all	0.02%	1.39%	0.15%	1.38%
			backwardation	0.06%	0.83%	0.45%	0.45%
			contango	0.07%	2.07%	0.11%	2.46%
		long	all	0.11%	11.35%	19.64%	2.84%
			backwardation	0.29%	11.19%	23.58%	1.06%
			contango	0.07%	11.68%	17.62%	4.84%
		short	all	0.15%	1.41%	5.91%	0.21%
			backwardation	0.17%	1.89%	5.05%	0.25%
			contango	0.24%	1.11%	6.54%	0.2%
	open interest	factor	all	0.04%	0.37%	0.03%	0.16%
			backwardation	0.05%	0.3%	0.33%	0.46%
			contango	0.15%	0.46%	0.13%	0.09%
		long	all	0.2%	5.54%	15.97%	0.62%
			backwardation	0.14%	6.38%	12.59%	0.89%
			contango	0.38%	5.01%	17.83%	0.53%
		short	all	0.14%	7.03%	30.65%	0.26%
			backwardation	0.35%	7.6%	30.31%	0.07%
			contango	0.08%	6.65%	30.96%	0.9%
	term structure	factor	all	0.06%	0.1%	1.96%	0.05%
			backwardation	0.31%	0.2%	1.75%	0.12%
			contango	0.07%	0.15%	2.05%	0.06%
		long	all	0.19%	1.2%	4.58%	1.01%
			backwardation	0.7%	2.21%	4.31%	0.29%
			contango	0.06%	0.69%	4.78%	2.14%
		short	all	0.07%	3.46%	22.01%	0.93%
			backwardation	0.14%	4.11%	21.24%	0.08%
			contango	0.08%	3.05%	22.44%	2.18%

Table 9: *(continued)*

picking factor	factor	leg	regime	past	financialisation	crisis	post-crisis
term structure	market	factor	all	0.75%	15.9%	28.49%	1.27%
			backwardation	0.59%	17.08%	27.92%	0.43%
			contango	0.94%	15.1%	28.9%	2.52%
	CHP		all	0.04%	0.34%	0.03%	0.03%
			backwardation	0.09%	0.33%	0.06%	0.11%
			contango	0.03%	0.46%	0.05%	0.11%
		long	all	0.68%	11.35%	10.54%	0.44%
			backwardation	0.4%	11.19%	8.88%	0.57%
			contango	1%	11.68%	11.43%	0.34%
		short	all	0.34%	6.03%	5.82%	0.25%
			backwardation	0.18%	6.06%	3.33%	0.13%
			contango	0.53%	6.1%	7.87%	0.4%
	open interest	factor	all	0.05%	0.08%	0.27%	0.07%
			backwardation	0.03%	0.13%	0.05%	0.51%
			contango	0.26%	0.33%	0.67%	0.25%
		long	all	0.38%	3.41%	11.21%	0.29%
			backwardation	0.16%	3.72%	7.67%	0.6%
			contango	0.75%	3.24%	13.44%	0.18%
		short	all	0.19%	7.89%	11.78%	0.3%
			backwardation	0.34%	10.15%	8.1%	0.07%
			contango	0.13%	6.06%	15.31%	1.33%
	term structure	factor	all	0.05%	2.34%	1.67%	0.3%
			backwardation	0.09%	1.07%	0.86%	0.35%
			contango	0.04%	3.61%	2.43%	0.31%
		long	all	0.29%	0.88%	2.66%	0.92%
			backwardation	0.44%	1.81%	1.5%	0.44%
			contango	0.22%	0.44%	3.64%	1.65%
		short	all	0.09%	13.93%	11.04%	0.17%
			backwardation	0.08%	10.91%	6.36%	0.06%
			contango	0.11%	16.59%	14.67%	0.6%

2 On the economic impact of commodity market financialisation

2.1 Introduction

While most of the debate on the effects of commodity financialisation has centred on futures price levels and sweeping increases in pairwise correlations (Tang and Xiong 2012; Singleton 2013; Basak and Pavlova 2016; Henderson, Pearson, and Wang 2015; Scott H. Irwin and Sanders 2012b; James D. Hamilton and Wu 2015; Büyükşahin and Robe 2009; Korniotis et al. 2009), we take a more global view of commodity price risk in contrast to these more local or commodity specific traditional approaches. We investigate the effects of this fundamental change in the nature of commodity investing on futures price dynamics at large, across a broad cross-section of thirty US and UK traded commodities and examine potential transmission channels between these markets and the real economy through the corporate sector.

To that end we first examine the distributional dynamics of these commodities where we conduct a distributional stability analysis at the univariate level, looking for distributional breaks at the individual commodity level. The results, once averaged, provide proxy periods for financialisation as well as the financial crisis and unorthodox monetary policy that ensued with the first period end point, May 2003, close to the onset of financialisation as dated in the literature (Steven D. Baker and Routledge 2012; Cheng and Xiong 2014) and that for the second, June 2007, close to the dating of the financial crisis using bond spreads to August 2007 by Contessi, De Pace, and Guidolin (2014) indicating that the advent of the financial crisis may have contributed to reining in the financialisation momentum. In response to the financial crisis the Federal Reserve significantly expanded its balance sheet by carrying a series of open market operations with large scale purchases of mortgage-backed and treasury securities. The end point for the third period, May 2011, is close to the announced tapering of the second round of this program, commonly referred to as “Quantitative Easing” and suggests that the gradual winding down of this unorthodox monetary policy seems to have had an effect on commodity futures return distributions.

Individual commodity mean returns overall rise from the first to the second period with the agricultural and the metals sectors showing the most substantial increases mostly supported by the soft and base metals subsectors respectively. The overall mean returns increase is accompanied by an across-the-board increase in volatility with the metals sector showing the most substantial progress driven by the base metals subsector with the precious showing a more moderate progression. The univariate statistical analysis of these changes in the context of the overall distribution indicates that financialisation does not seem have altered commodity futures return dynamics across the full cross-section and further suggests that the metals sector was particularly affected. This pattern of results is confirmed at the multivariate level, particularly so for the UK traded assets, in other words, for the base metals subsector.

These results therefore suggest that the onset of financialisation had a major impact on the dynamics of the metals futures markets that appear to have been affected by the arrival of index traders to a larger extent than the energy and agricultural sectors and thereby seem to back the conclusions of earlier studies on the effects of financialisation on energy and agricultural commodities (Büyükşahin and Harris (2011), Tokic (2012), Fattouh, Kilian, and Mahadeva (2013), Kilian and Murphy (2014), Knittel and Pindyck (2016) and Manera, Nicolini, and Vignati (2016) for the energy sector; Scott H. Irwin, Sanders, and Merrin (2009), Sanders, Irwin, and Merrin (2010), Sanders and Irwin (2011a), Sanders and Irwin (2011b), Scott H. Irwin (2013), Brunetti and Reiffen (2014), James D. Hamilton and Wu (2015) and Bruno, Büyükşahin, and Robe (2017) for agriculturals and Bohl and Stephan (2013), Kim (2015) as well as Boyd et al. (2016) for both).
The results for the third period on the other hand indicate that commodity futures returns dynamics do not seem to have altered significantly over the period of the financial crisis and ensuing loose monetary policy from the previous period and therefore suggest that the impact of the onset of financialisation was stronger.

Financialisation spurred the transition of the commodity complex away from a collection of idiosyncratic markets ruled by individual/sectorial commercial commodity specialists to its emergence as an asset class (Claude B. Erb and Harvey 2006; G. Gorton and Rouwenhorst 2006; Adams and Glück 2015; Levine et al. 2018; Adams, Collot, and Kartsakli 2020) with the influx of uniformed non-commercial cross-sectional traders.

Challenged with the strategic issue of adapting to this new paradigm, large legacy commercial participants may have updated their perspective of the commodity complex by adopting an investment view in an attempt to see through the lens of the new overlooking participants for upgraded market cues. We attempt to examine this approach by ascertaining the impact of the distributional changes that we observe on the investment opportunity set of a mean variance investor by simulating Sharpe ratio distributions for the global minimum variance (GMV) and tangency portfolios for various groups of assets and compare them across periods and asset universes.

The financialisation period shows an across-the-board increase in Sharpe ratios with the metals sector at large recording the strongest progression mostly driven by the base metals subsector while in the agricultural sector, where the progression is also sizeable, substantial variation across the three agricultural subsectors suggests differing behaviours. Portfolio volatilities further suggest the increase seems driven by the means of the corresponding portfolios. Over the financialisation period therefore, the rise in mean returns which naturally expands the investment opportunity set seems to have outweighed the increase in standard deviations which naturally produces the opposite effect. The results for the third period show a converse pattern, most pronounced for the metals, suggesting a contraction of the investment opportunity set driven by the second moment component.

Financialisation thus seems to have affected the global base metals subsector where its effects seem to have produced an expansion of the corresponding investment opportunity set while the financial crisis and ensuing loose monetary policy seem to have engendered the opposite effect.

The analysis of the curvature dynamics of the corresponding efficient frontiers shows a similar pattern of results both across investment universes with the metals sector the most affected, particularly its UK traded subset comprised of base metals exclusively; as well as periods with opposite effects across the financialisation and the crisis periods.

Taken together these results suggest financialisation may have caused global metal futures, base metals in particular, to signal better growth prospects over the period relative to the previous one as well as to the other sectors possibly influencing financial and investment policies in the corporate sector and thus impacting the real economy.

We analyse this issue further by examining changes in growth opportunities of the mining sector which are important determinants of corporate financial and investment policies. Futures prices have informational effects on commodity demand as well as the spot price as illustrated in Sockin and Xiong (2015) and therefore play a role determining growth opportunities with the issue fitting into the larger context of feedback effects from financial markets to real economic activity, via firm investment for example (Ozdenoren and Yuan 2008). Following Cao, Simin, and Zhao (2006) we estimate five growth opportunity proxies for the top five global mining companies by market capitalisation listed in the US including two price-based measures, the market value to book value of assets (price/book) and the debt to equity ratio (debt/equity); two non-price-based measures, the ratio of capital expenditures to fixed assets (CAPEX/fixed assets) and the Tobin's Q ratio; as well as a direct measure, the present value of growth opportunities (PVGO).

For each proxy we examine the average pairwise correlations amongst the mining companies across the periods of interest and find mixed results. Moving into the financialisation period price-based proxies show opposite dynamics with the average pairwise correlation for the price/book ratio decreasing indicating greater signal dispersion amongst the firms while that for the debt/equity ratio shows the opposite pattern indicating greater signal convergence. The dynamics of the average pairwise correlation amongst proxies by firm are similarly mixed, further suggesting an heterogenuous information set. The lag-one autocorrelations dynamics for the non-price-based proxies are more consistent than those for their price-based counterparts however and seem to result from the clear increasing trend in levels exhibited by these proxies relative to the non-price counterparts and the PVGO.

Taken together the results suggest strong price signals emanated from the metals futures markets over the financialisation period with these tampered by the effects of financialisation.

These signals may have been perceived as reflecting legacy fundamentals and were perhaps confirmed by non-price feedback effects through the corporate sector thereby misleading senior management in the mining sector in forming beliefs regarding growth prospects and eventually triggering a coordinated surge in capital investment throughout the period as suggested in the model of Goldstein, Ozdenoren, and Yuan (2013) where the arrival of long-only investors led to market actors trading in the same direction eventually leading to shifts in firms' investment decisions. As Sockin and Xiong (2015) points out, the large investment flows due to financialisation might have confused producers into believing emerging economies were stronger than they actually were, implying growing investment opportunity sets and prompting swift expansion.

The ensuing upsurge in capital expenses might therefore not have been warranted and would later bring dire consequences with the sector facing unprecedented value destruction starting shortly after the winding down of the second round of quantitative easing in 2011.

2.2 Data & methods

2.2.1 Data

The broad cross-section of commodity that we consider covers the agricultural, energy and metal sectors of the commodity futures complex with assets traded on all four exchanges of the CME Group including the Chicago Board of Trade (XCBT), the Chicago Mercantile Exchange (XCME), the New York Mercantile Exchange (XNYM), and the Commodity Exchange Inc (XCEC); as well as on the US division of the Intercontinental Exchange (IFUS) and the London Metal Exchange (XLME). Within the agricultural sector are considered grain assets including corn-#2 yellow (XCBT), oats (XCBT), soybean meal (XCBT), soybean oil (XCBT), soybeans (XCBT) and wheat-SRW (XCBT); livestock including live and feeder cattle (XCME) as well as lean hogs (XCME); and soft commodities including cocoa (IFUS), coffee-C (IFUS), cotton-#2 (IFUS), lumber (XCME), orange juice (IFUS) and sugar-#11 (IFUS). Within the energy sector are considered natural gas (XNYM) as well as petroleum products including crude oil-WTI (XNYM), gasoline (XNYM) and heating oil (XNYM). The metal futures series considered on the other hand include US and UK traded assets with the US complex including both base and precious metals: copper (XCEC), gold (XCEC), palladium (XNYM), platinum (XNYM) and silver (XCEC); while the UK cross-section only includes base metals: aluminium (XLME), copper (XLME), lead (XLME), nickel-primary (XLME), tin-refined (XLME) and zinc (XLME).
Also considered in the study are the top five mining companies by market capitalisation at the time of writing listed in the US, namely, Barrick Gold, BHP Billinton, Newmont, Nucor and Rio Tinto; as well as commodity and equity indexes including the S&P Goldman Sachs Commodity index and both the Morgan Stanley Capital International (MSCI) China and emerging markets indexes.

The sample period spans the 1997-2018 time frame and the data for the commodity futures series, corporations and indexes are from Bloomberg where the quote prices for the corresponding futures and stocks as well as index levels are observed at the daily frequency while firm book data are observed quarterly. The return data for our market and risk free asset proxies on the other hand are from Kenneth R. French data library[28].

2.2.2 Methods

We conduct a distributional stability analysis over the whole sample period at the univariate level where for each individual commodity series we assess deviation from stability in the classical linear regression model:

$$y_i = x_i^T \beta + \mu_i$$

Where:
y_i: rolling moment vector for commodity i.
x_i: vector of ones.

We assume that there are three break points during the period considered where the coefficients shift from one stable regression relationship to a different one. There are therefore four segments in which the regression coefficients are constant, and the model can be rewritten as:

$$y_i = x_i^T \beta + \mu_i \qquad (i = i_{j-1} + 1, \ldots, i_j,\ j = 1, \ldots, 4)$$

Where:
j: segment index.

The break points i_j are then estimated by minimising the residual sum of squares of the equation above. Individual commodity daily observations are used to estimate the first four moments of the corresponding distributions where the latter are observed over a one-year (252 observations) rolling window.
We estimate boundary dates for the pre-financialisation, financialisation, crisis and accompanying loose monetary policy as well as post-crisis proxy periods by averaging

[28]The data are made available for convenient consumption in the R programming language in the FFresearch package developed by the author.

the corresponding break dates across moments at the individual commodity level with the resulting figures averaged across the range of commodities considered.

We assess distributional dynamics across the periods defined above at the individual commodity level as well as for various commodity groups in which assets are pooled by country, sector and/or subsector. We carry out Mann-Whitney tests (Gibbons 2010) of difference in distributions both at the univariate and multivariate levels. While in the univariate set up distributions from two different proxy periods for the same asset are directly tested for difference, the multivariate approach involves preliminary accommodations where the multivariate returns matrices for the corresponding two periods are represented in the principal components space. A univariate Mann-Whitney test is then performed on the corresponding first components. We complement this approach in the multivariate case with multivariate analysis of variance (MANOVA) (Krzanowski 1988; Tabachnick and Fidell 2013) tests over up to five dimensions, corresponding to the first five components which together explain most of the variance. For groups comprised of less than five assets the tests are carried out using all principal components.

Our enquiry into the investment opportunity set is Markowitzian in nature; we observe and compare various investment universes across commodity groups and periods. For each group of assets and period we observe the global minimum variance and tangency portfolios and estimate their respective Sharpe ratios. The minimum variance portfolio represents the minimum risk point on the efficient frontier with weights,

$$\mathbf{w} = \frac{\mathbf{\Sigma}^{-1}\mathbf{1}}{1^t\mathbf{\Sigma}^{-1}\mathbf{1}}$$

where, $\mathbf{\Sigma}$ is the n assets' variance-covariance matrix ($n \times n$) and $\mathbf{1}$ is a size n vector of ones. The tangency portfolio on the other hand lives at the point where the capital market line touches the efficient frontier. The line represents the reward/risk profiles of different combinations of a risky portfolio with a riskless asset with return r_f and the point where it touches the efficient frontier corresponds to the optimal risky portfolio; in other words, the portfolio on the frontier that maximises the Sharpe ratio with weights w:

$$\mathbf{w} = \frac{\mathbf{\Sigma}^{-1}(\mu - r_f \cdot \mathbf{1})}{1^t\mathbf{\Sigma}^{-1}(\mu - r_f \cdot \mathbf{1})}$$

Where μ is the size n vector of asset means and r_f the risk free rate of return.
For each universe we construct distributions for the global minimum variance and tangency portfolio Sharpe ratios respectively via bootstrapping where the corresponding return series and sampled ten thousand times.

For our analysis of changes in the growth opportunity set we construct five proxies using book data for the five mining companies considered. These include the price to book (price/book) ratio, where the market capitalisation for the firm is scaled by the corresponding book value; the debt to equity (debt/equity) ratio that relates total debt to total equity; the capital expenditures to fixed assets that relates investment expenses to long term assets; the Tobin's Q ratio that relates the value of the firm (market value of equity + liabilities book value) to the assets' replacement cost (as proxied by equity book value + liabilities book value); and the present value of growth opportunities (PVGO), a direct estimate, calculated as the difference between the value of the firm and the present value of its earnings assuming zero growth (next earnings as a perpetuity at the current cost of equity):

$$PVGO = \text{current market value} - \frac{\text{next earnings}}{\text{cost of equity}}$$

Where the next earnings figure is estimated using the return on equity smoothed over the previous five years applied to the current equity value. The cost of equity on the other hand is estimated using the capital asset pricing model.

2.3 Results & discussion

2.3.1 Distributional dynamics

Table 10 shows the mean return break dates for the set of commodities considered. We define the four periods based on the average break points across the whole set of commodities along the first four moments of their respective futures returns distributions where the start of the first period is July 1997 and the end is the first average break point; the end points for periods 2 and 3 are the second and third average break points respectively.

The first set of break points are mainly clustered in the 2001-2003 period and the first period end point, May 2003, is close to the onset of financialisation as dated in many studies (Steven D. Baker and Routledge 2012; Cheng and Xiong 2014). The endpoint for the second period is June 2007, and most of the individual mean break points are in the late 2005 to end 2008 region although those for crude oil and heating oil are in 2013 with the first break point for these commodities being 2007. The average date of June 2007 is quite close to the dating of the financial crisis using bond spreads to August 2007 by Contessi, De Pace, and Guidolin (2014). It therefore seems that the onset of the financial crisis may have played a role in holding back the period of financialisation. The third period endpoint on the other hand, May 2011, is close to the end of the second round of quantitative easing (June 2011).

The initiation of the first round of the unorthodox monetary policy by the Federal Reserve from the end of 2008, in response to the financial crisis, led to a revival in both stock markets and commodity futures markets, both of which had sustained sharp losses during 2008. The gradual winding down of this policy thus seems to have had an effect on commodity futures mean returns.

Table 11 shows individual mean returns and volatilities for the set of commodities considered across the periods defined above. Mean returns progress overall over the second period with the agricultural commodities showing the most important advance. The average mean return for the sector increases sharply (13.2% vs. -8.3%) with most commodities–except soybean meal, live & feeder cattle–showing an increase in mean return, substantial in most cases; and two significant mean returns at the 10% level (soft red winter wheat and orange juice) in the second period against none in the first. The metals sector follows closely with a substantial increase in average mean return (2% vs. 13%) where four assets show a significant mean return at the 1% level (copper (XCEC), copper (XLME), gold and zinc), one at the 5% level (lead), and two at the 10% level (palladium and tin) in the second period against only one significant at the 10% level (palladium) in the first. The increase is mostly driven by the base metal subsector with the corresponding average mean return increasing from -3.8% to 21.3% against an overall decrease for the precious. The energy sector on the other hand also shows an overall decrease mostly driven by petroleum products while the mean return for natural gas shows a sizeable increase. The overall advance in mean returns is accompanied by an across-the-board increase in volatility with the metals sector showing the most substantial progress. The average volatility for the sector increases to 29.9% in the second period against 23.1% in the first with, here again, the progression driven by the base metals subsector where average volatility rises up to 30.7% in the second period against 21.8% in the first while the increase for the precious is more moderate. Volatility in the grains sector also increases markedly (30.1% vs. 26.8%) with the progression mostly driven by the grains subsector (31.4% vs. 24.2%) and greater than that for the energy subsector. Volatility in the latter, although higher in both periods than that for both previous sectors, shows a milder increase (45.8% vs. 42.5%) interestingly driven by natural gas which mean return progresses substantially across the two periods in contrast with the other assets in the sector.

These changes are further explored in the context of the overall distribution in Table 12 where p-values are reported for univariate Mann-Whitney-Wilcoxon tests–a non-parametric test of difference in distributions–across periods 1 and 2 as well as periods 2 and 3. The results suggest that the onset of financialisation and the financial crisis does not seem have altered commodity futures return dynamics across the full cross-section.

At the individual commodity level however the advent of financialisation seems to have had a significant distributional effect on most of the metals sector with p-values for distributional difference between periods 1 and 2 significant at the 1% level for all the base metals except nickel (significant at the 10% level) as well as for gold and silver, although platinum and palladium remained unaffected. The only other commodity with a p-value close to 5% is feeder cattle and the other agricultural commodities (excluding softs) as well as energy commodities, all of whose price and return behaviour over financialisation was the object of intensive scrutiny, have p-values higher than 15%.

We extend the test to an equally weighted portfolio of all the commodities considered and find insignificant p-values suggesting that financialisation did not have a significant effect across the entire cross-section of the commodity complex.

In order to analyse this issue further we perform similar–albeit multivariate–tests on various different groups of commodities including various sub-sectors of the US commodity complex. For each group, the Mann-Whitney-Wilcoxon test is applied to the first principal component of the corresponding commodity group returns distribution. A multivariate analysis of variance test along up to five dimensions is also applied on the latter. While the first series of tests attempt to isolate the strongest common component across each group and test for changes in its distribution, the second checks for changes in the corresponding multivariate distribution across more dimensions by considering all principal components for groups consisting of five or less assets and the five first principal components for larger groups. The results are reported in table 13 for tests between the first and the second period on the one hand and between second and the third on the other hand.

For the entire set of commodities as well as the US complex the results indicate that these distributions did not significantly change from the first to the second period; the lower p-value for the second test however suggest that some components across the entire as well as the US cross-section may have been affected more strongly than others. For all of the other groups the p-values for the second test for change between the first and the second periods are lower than those for the first test, substantially so in some cases, and therefore suggest that the effects of financialisation were strongest on the common component. Significant p-values for these tests all belong to the metals complex with the results for the UK base metals and US metals sectors significant at the 1% level for the first test and 5% for the second test for the former group. The results for the precious metals subsector on the other hand, although not significant for the second test are significant at the 5% level for the first.

Consequently, while mean returns increased sharply over the financialisation period for both agricultural commodities as well as metals, the univariate and multivariate distributional tests indicate that financialisation affected the distribution of metals, particularly base metals, more substantially. The overall sharp increases in mean returns for agricultural commodities were not accompanied by a change in the overall dynamics of futures returns for these commodities suggesting that these increases might have been due to responses to demand and supply dynamics rather than to the expansion of index trading. Our findings thus seem to back the conclusions of early studies of financialisation which found that the arrival of index traders had little overall effect on the prices and returns on energy and agricultural commodities[29]. Our findings however suggest that the onset of financialisation had a major impact on the dynamics of the metals future markets that appear to have been affected by the arrival of index traders, particularly the base metals; and complement the analysis of Basu and Bauthéac (2021b) who found that co-movement between metals increased sharply during financialisation.
Over the financial crisis period only the returns distributions for nickel and zinc appear to be significantly different from the ones in the previous period in the metals complex with univariate distributional difference tests significant at the 5% level; the multivariate tests on the other hand show no significant difference although the p-value for UK base metals is close to the 10% threshold. Soybean meal and lumber

[29]Büyükşahin and Harris (2011), Tokic (2012), Fattouh, Kilian, and Mahadeva (2013), Kilian and Murphy (2014), Knittel and Pindyck (2016) and Manera, Nicolini, and Vignati (2016) study the energy markets while Scott H. Irwin, Sanders, and Merrin (2009), Sanders, Irwin, and Merrin (2010), Sanders and Irwin (2011a), Sanders and Irwin (2011b), Scott H. Irwin (2013), Brunetti and Reiffen (2014), James D. Hamilton and Wu (2015) and Bruno, Büyükşahin, and Robe (2017) examine the agricultural markets and Bohl and Stephan (2013), Kim (2015) as well as Boyd et al. (2016) investigate both.

are the only two other commodities showing significant results for univariate distributional difference tests, albeit at the 10%. The multivariate test results are also contrasting with those comparing the past to the financialisation periods with only the softs showing significant results at the 10% level.
The commodity futures return dynamics over the period of the financial crisis and unorthodox monetary policy that followed therefore do not seem to have altered significantly from the previous period and overall, these findings suggest that the impact of the onset of financialisation was more significant for the commodity complex.

2.3.2 Investment opportunity set analysis

Faced with the strategic issue of adapting to the new asset class paradigm (Claude B. Erb and Harvey 2006; G. Gorton and Rouwenhorst 2006; Adams and Glück 2015; Levine et al. 2018; Adams, Collot, and Kartsakli 2020) brought about by financialisation in the commodity complex, legacy commercial participants may have adapted their perspective by adopting an investment view in an attempt to understand that of the new players and thereby get upgraded cues on the complex. In an attempt to examine this approach we therefore endeavour to ascertain the impact of the distributional changes we observe on the investment opportunity set of a mean variance investor. To that end we simulate Sharpe ratio distributions from the realised return series of various groups of assets and examine changes across the periods defined above. The results are shown in table 14 where the averages of bootstrapped global minimum variance (GMV) as well as tangency portfolios for the various groups are reported for the first period while for the second and third periods the difference with respect to the previous period is shown.
Apart from that for the energy sector and the precious metals subsector, all GMV sector Sharpe ratios are negative in the first period with the metals complex showing the lowest figure at the sector level followed by agricultural commodities. The low figure for the former is driven by the base metals subsector while that for the latter is driven by soft commodities. Conversely these two subsectors experience the largest increases over the second period. The period shows a substantial, across-the-board,

increase in Sharpe ratios where the metals sector at large records the strongest progression mostly driven by the base metals subsector. While the overall sector shows a 1.15 increase against 1 for the entire cross-section, the base metals sector which comprises the UK traded metals–all base–as well as US traded copper records a 1.40 increase against 1.47 for the UK traded assets alone indicating that the progression was weaker for US copper relative to the UK traded metals. The soft commodities show the strongest advance (0.81) in the agricultural complex where there is substantial variation in increases across the three agricultural subsectors suggesting differing behaviour. The energy sector on the other hand shows the lowest increase. The corresponding tangency portfolios show a similar pattern in increase over the two periods with the metals complex showing the greatest progression, driven by the base metals, the UK traded assets in particular.

In order to ascertain the significance of these increases we construct confidence intervals around the Sharpe ratio means from their respective standard errors. For the GMV portfolios, at the 1% level the second period increase is significant only for the UK traded base metals with all of the first period group Sharpe ratios falling within the confidence interval around the corresponding second period figure apart for the latter group. At the 5% level on the other hand the figures for agricultural commodities and the metals complex at large show significance. The results are similar for the tangency portfolios although less pronounced for agricultural commodities that only show significance the 10% level. This pattern of results therefore suggests that financialisation had a significant effect on both the agricultural and metal commodity sectors, stronger for the latter within which the effect seems to have been more pronounced for the base metals.

The standard deviations of the GMV, reported in table 15, also mostly increase over the second period. One exception at the sector level is the energy complex that shows a small decrease while at the subsector level, excluding energy, the figure for the soft commodities does not progress markedly. The metals complex shows the strongest advance, by far in a relative sense; here again driven by the base metals subsector with very close figures in that case for the subsector at large and its subset of UK traded assets. The increase for agricultural commodities on the other hand

seems driven by the grains.
The broad increase in Sharpe ratios observed above consequently seems driven by an increase in the means of the corresponding portfolios, even in the case of the energy sector and the soft subsector where the respective relative increase in Sharpe ratio is much greater than the decrease in standard deviation. Over the second period therefore, the rise in mean returns which naturally expands the investment opportunity set seems to have outweighed the increase in standard deviations which naturally produces the opposite effect.
Over the third period the standard deviations progress across-the-board with the exception of the livestock subsector of the agricultural commodity complex with the strongest relative increases observed at the sector level for the metals followed by agricultural commodities driven by the base metals and grains subsectors respectively. Although not significantly, the GMV Sharpe ratios for the agricultural complex and its grain subsector increase over the period indicating an expansion of the investment opportunity set driven by the first moment component. In contrast, the corresponding figures for the base metals subsector and its UK traded subset sharply decrease–although not significantly so–indicating a contraction of the investment opportunity set driven by the second moment component with a similar situation observed for the energy sector.
Taken together these results suggest that the global base metals subsector was the most affected by financialisation which effects seem to have produced an expansion of the corresponding investment opportunity set while the financial crisis and the unorthodox monetary policy that followed seem to have engendered the opposite effect.

The curvature of the efficient frontier on the other hand appraises the non-linear compensation for taking on extra risk in investing in an efficient portfolio above the global minimum variance reference. In our commodity setting, an increase in the curvature parameter for a given set of commodities could be perceived by a commodity producer as the realisation of a growth option arising from higher investment in the corresponding assets and consequently suggest opportunities for further in-

vestment in the form of capital expenditure or acquisitions. We therefore calculate curvature parameters for the asset groups and periods considered above and examine the changes across periods. The results are shown in table 16 where the curvature parameters are calculated as the difference between the squared Sharpe ratio for the tangency and the global minimum variance portfolios. In the case of negative Sharpe ratios the sum is calculated in place of the difference.
Over the financialisation period the curvature parameter for the full cross-section shows a substantial 70% increase mostly driven by the metals complex with an almost four-fold increase where the advance is most pronounced for the base metals subsector, particularly so for its UK traded subset of assets that shows a more than five-fold increase. While the agricultural sector also shows an increase with respect to the pre-financialisation period it is not nearly as large as that for the metals; in the meantime, the progression in the energy sector is marginal. The crisis period on the other hand sees a sharp decline for the metals sector (-40%), particularly so for the base subsector, strongest for its UK traded subset. The energy sector shows a similar albeit less pronounced pattern (-35%) while the agricultural sector shows a 30% increase despite the grains subsector showing a slight decline.

These results indicate that global metal futures, base metals in particular, seemed to signal better growth prospects over the financialisation period relative to the previous one as well as to the other sectors and subsequently sustained the strongest impact over the financial crisis and ensuing loose monetary policy regimes.

2.3.3 Growth opportunity set analysis

For each proxy we examine the average pairwise correlations amongst the mining companies and across the periods of interest. The results, reported in table 17, are mixed. Going from the first to the second period the price-based proxies show opposite dynamics with the average pairwise correlation for the price/book ratio decreasing, from positive in the first period (0.28) to negative in the second (-0.28), indicating greater signal dispersion amongst the firms; while that for the debt/equity ratio shows the opposite pattern although lower in magnitude (-0.1 vs. 0.05), indicating greater signal convergence. Moving to the third period the dynamics invert again with a positive (0.33) and negative (-0.16) figure for the price/book and debt/equity ratios respectively. The non-price-based proxies show similar dynamics moving from the first to the second period although of overall lower magnitude with small negative (-0.02) and positive (0.03) figures in the first period for the CAPEX/fixed assets and Tobin's Q ratios respectively moving to positive for the former (0.13) and negative for the latter (-0.03) in the second period. The figures for the two proxies increase in the third period however more substantially so for the Tobin's Q ratio (-0.03 to 0.56 vs. 0.13 to 0.16). The dynamics for the PVGO are similar to those for the price/book ratio although overall lower in magnitude with a decrease in average pairwise correlation from a small positive figure (0.03) in the first period to negative (-0.33) in the second followed by an increase to a positive figure over the third period (0.09).

The table also reports the lag-one autocorrelation for each proxy averaged amongst the five mining companies across the periods of interest with the results also mixed. Similar to the previous case, the price-based proxies show opposite dynamics with the figure for the price/book ratio increasing from the first period to the next (0.61 vs 0.46), indicating greater signal stability, while that for the debt/equity ratio decreases (0.38 vs 0.70) indicating greater signal variability while both figures decrease over the third period. The dynamics for the non-price-based proxy are more consistent however with both proxies showing increasing figures from the first to the second period, with the increase greater in both absolute and relative terms for the CAPEX/fixed assets ratio (0.15 to 0.38 vs. 0.47 to 0.58); and both figures decreasing over the third period, more so for the CAPEX/fixed assets ratio. The pattern for the PVGO is similar to that for the price/book and the non-price-based proxies with an increase over the second period (0.19 vs. -0.05) followed by a decrease in the third (-0.01).

These results depict a heterogeneous information set and, although they seem to indicate some degree of superiority for the non-price over the price-based proxies in terms of consistency for signalling changes in the growth opportunity set, they overall suggest conflicting signals.

We also examine, for each company, the average pairwise correlation amongst the

growth opportunity proxies with the results reported in table 18. Similarly, they show a mixed pattern with positive and increasing figures from the first to the second period for Barrick Gold and Nucor, indicating greater signal convergence amongst the proxies; and the increase stronger, both in absolute and relative sense, for the former (0.04 to 0.48 vs. 0.02 to 0.08). In contrast, the figures for Newmont and Rio Tinto decrease, indicating greater signal variability; from positive for both in the first period to negative in the second for Rio tinto, with the decrease much more substantial for the latter. BHP Billiton on the other hand shows increasing but negative figures in both periods.
These results echo the previous ones from table 17 in suggesting heterogeneous signalling amongst the proxies. The dynamics in the proxy level averages further suggest superior consistency for the non-price-based proxies with both the CAPEX/fixed assets and Tobin's Q ratios showing an increasing trend over the second period while neither of the price/book and debt/equity ratios nor the PVGO consistently progresses up or down over the period.

Taken together these results suggest senior management in the mining sector, attuned to the futures markets, might have been led to believe that price signals emanating from the metals sector over the financialisation period, perhaps confirmed or at least reinforced by non-price feedback effects through the corporate sector, justified triggering growth options through capital expenditure or acquisitions. An immediate consequence was a coordinated surge in investment throughout the period as shown in figure 1 below with the average quarterly capital expenditures across the top five mining companies considered here quadrupling from around $300 million at the start of the financialisation period to over $1.2 billion at their peak into the crisis.

This very likely contributed to the market integration phenomenon observed over the period (Boons, De Roon, and Szymanowska 2012; Brooks et al. 2016; Hu and Xiong 2013) that figure 2 below illustrates where the return correlation between an equally weighted portfolio of the top five mining companies and the S&P Goldman Sachs Commodity Index progresses markedly over the financailisation period; rising from around 0.05 in the third quarter of 2003 to around 0.35 in the second quarter

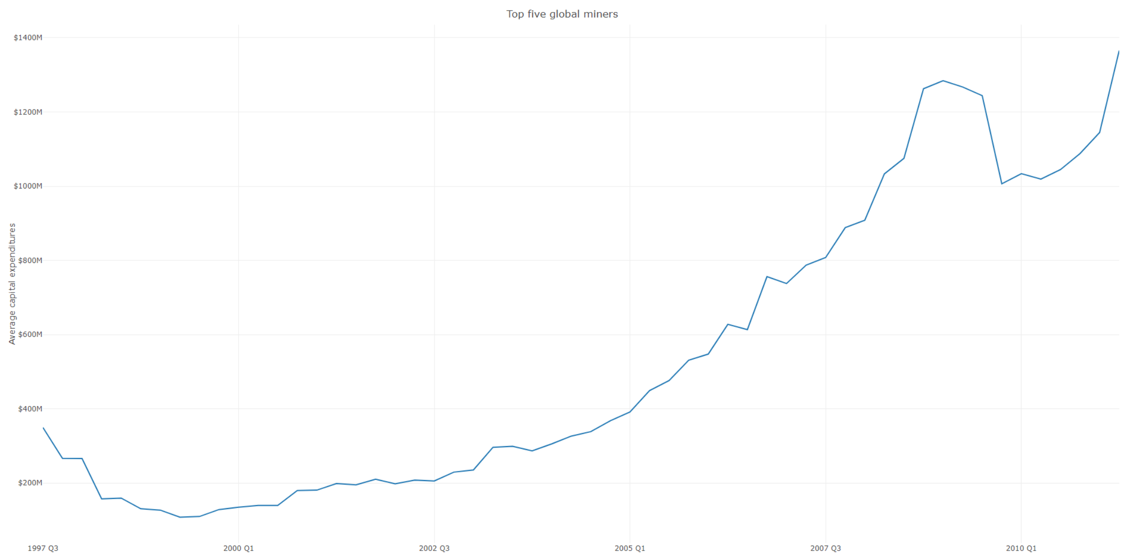

Figure 1: This figure shows quarterly capital expenditure figures averaged across the five global mining companies considered in the study. The series is smoothed for better readability with the trailing four quarters averaged with equal weighting.

of 2007[30].

As the previous sets of results in sections 2.3.1 and 2.3.2 suggest however, the metals futures complex seems to have been substantially affected by financialisation and may have consequently diffused misleading price signals potentially misinterpreted by senior management in the corporate mining sector as favourable demand and supply dynamics emanating from emerging economies–the driving engine at the time– and therefore prompting swift expansion. A similar phenomenon in the oil markets is described in James D. Hamilton (2009) and Juvenal and Petrella (2015) where possibly false signals from the energy futures markets induced major oil companies to postpone production. The ensuing large scale coordinated capital investments of the major players in the mining industry may therefore not have been warranted with the

[30]Interestingly the correlation with the equity market itself also increase for the five top miners with the 1-year rolling correlation between an equally weighted portfolio of these stocks and the S&P 500 increasing from around 0.35 in the second quarter of 2003 to around 0.55 for the second quarter 2007.

Figure 2: This figure shows the 1-year daily return rolling correlation between an equally weighted portfolio of the top five mining companies considered and the S&P Goldman Sachs Commodity Index.

emergings may be perceived as stronger as they actually were and dire consequences for the sector eventually ensued. In their post-crisis run-up the emerging economies did not recover back to their pre-crisis level; particularly China, the driving force, as illustrated in figure 3 below.

In fact, starting around the end of the second round of quantitative easing in the second quarter of 2011 up to the first quarter of 2016 the figure shows a downtrend with the two indexes receding by about 40%. Over the same period the corporate mining sector experienced unprecedented value destruction as depicted in figure 4 below where an equally weighted portfolio of the top five mining companies considered shows a 60% loss.

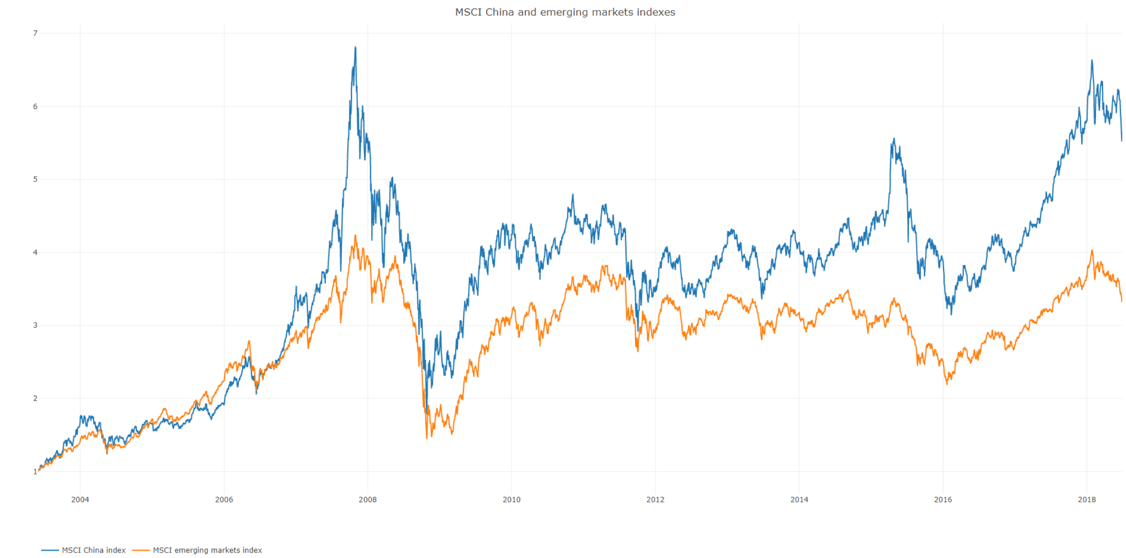

Figure 3: This figure shows the MSCI China (blue) and emerging market (orange) indexes rebased to 1 at the start of our proxy period for financialisation.

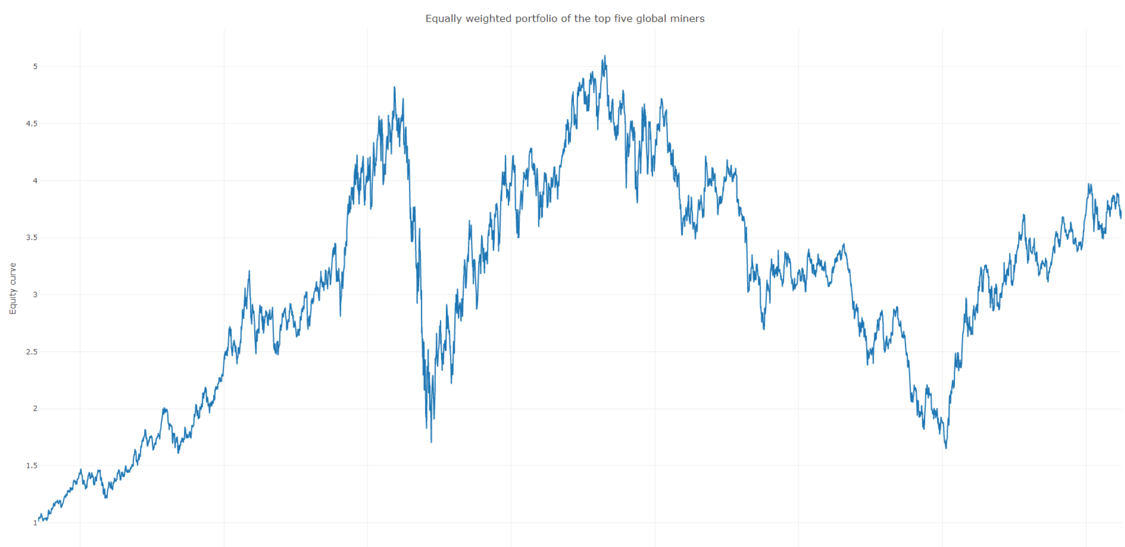

Figure 4: This figure shows the equity curve for an equally weighted portfolio of the top five mining companies considered in the study.

2.4 Conclusion

Financialisation has led to fundamental changes in the nature of commodity investing and its impact on commodity return dynamics has been widely debated and investigated, particularly at the individual commodity level. Conversely, we study the impact of the phenomenon from a macro viewpoint where we examine potential spillover effects to the real economy in particular through the corporate sector channel.

Our results suggest that the onset of financialisation seems to have had stronger effects on the metals sector, particularly on its base metals subset, than on the full cross-section of the commodity futures complex, with return distributions more significantly affected both at the univariate and multivariate levels relative to other sectors; and its effects on the commodity spectrum seem to have been stronger than those of the subsequent financial crisis and ensuing loose monetary policy regimes.

Challenged with the strategic issue of adapting to the new asset class paradigm prevailing in the commodity complex in the wake of the influx of cross-sectional traders brought about by financialisation, large legacy commercial participants may have adopted an investment perspective aiming to understand that of these new players and thereby form an upgraded view on the complex. We examine this approach by attempting to ascertain the impact of financialisation that we observe at the distributional level in the metals sector from a mean-variance view point and find that financialisation seems to have produced an expansion of the investment opportunity set eventually signalling better growth prospects over the period relative to the previous one as well as to the other sectors while the financial crisis seems to have engendered the opposite effects. In contrast, corporate level growth prospect proxies provided conflicting cues over the period.

Presented with these, senior management in top mining companies might have relied upon the futures market for price signals in forming beliefs regarding growth prospects, perceiving these as reflecting legacy fundamentals. With the latter implying growing investment opportunity sets and thus prompting investment, an expansion spree followed with top global miners quadrupling their capital expenditures.

Our results suggest however that these signals were tampered by financialisation, depicting an inaccurate picture of market fundamentals; this surge therefore appears to have been unwarranted as further suggested by the unprecedented value destruction the sector subsequently suffered. By altering the capital allocation decision process at the corporate level financialisation seems to eventually have channeled its way down to the real economy. With the benefit of hindsight it consequently seems worthwhile to study its impact beyond mechanical effects in individual markets–the focus of the original academic approach to the phenomenon.

2.5 Tables

Table 10: This table shows the results of a univariate distributional stability analysis carried out over the entire sample period, spanning the 1997-2018 time frame. For each individual commodity, the table shows the dates corresponding to three break points in mean returns over the period. Implementation details are discussed in section 2.2.2 while the results are discussed in section 2.3.1.

asset	break point 1	break point 2	break point 3
Corn-#2 yellow (XCBT)	2005-09-21	2007-10-05	2012-06-29
Oats (XCBT)	2000-05-30	2005-04-28	2007-09-28
Soybean meal (XCBT)	2003-08-12	2005-10-14	2007-10-03
Soybean oil (XCBT)	2000-06-30	2005-10-19	2007-10-08
Soybeans (XCBT)	2001-02-12	2005-10-18	2007-10-05
Wheat-SRW (XCBT)	2005-08-15	2007-08-03	2009-07-29
Cattle-feeder (XCME)	2005-09-27	2009-01-16	2014-07-22
Cattle-live (XCME)	2007-01-16	2009-01-14	2014-06-26
Lean hogs (XCME)	2002-04-05	2004-03-30	2013-12-09
Cocoa (IFUS)	2000-01-14	2002-05-10	2015-04-06
Coffee-C (IFUS)	2001-08-03	2011-01-28	2013-01-31
Cotton-#2 (IFUS)	2001-05-25	2008-10-02	2010-09-20
Lumber (XCME)	2002-05-01	2004-04-26	2008-10-22
Orange juice (IFUS)	2003-12-11	2006-05-25	2008-07-24
Sugar-#11 (IFUS)	2003-06-24	2005-08-11	2010-10-20
Natural gas (XNYM)	2001-08-24	2005-02-23	2011-10-03
Crude oil-WTI (XNYM)	2007-10-10	2013-04-01	2015-03-25
Gasoline (XNYM)	1999-11-11	2001-11-14	2007-10-04
Heating oil (XNYM)	2007-10-10	2013-04-01	2015-03-25
Copper (XCEC)	2002-09-18	2006-04-25	2008-09-29
Gold (XCEC)	2001-01-26	2011-07-08	2015-02-12
Palladium (XNYM)	2000-06-08	2002-12-04	2008-09-08
Platinum (XNYM)	2006-10-05	2008-09-30	2010-09-23
Silver (XCEC)	2002-07-26	2008-09-08	2010-11-29
Aluminium (XLME)	2006-10-25	2008-10-20	2010-10-12
Copper (XLME)	2002-07-30	2006-04-25	2008-09-30
Lead (XLME)	2002-09-16	2007-05-08	2015-03-13
Nickel-primary (XLME)	2006-08-10	2008-08-04	2010-08-03
Tin-refined (XLME)	2001-09-18	2010-09-14	2015-03-23
Zinc (XLME)	2002-10-07	2006-08-04	2008-07-29

Table 11: This table shows mean returns and volatility (sd) for each individual commodity across three periods which boundary dates correspond to break points in mean returns as show in table 10 above. Mean values significant at the 1%, 5% and 10% level are marked with ***, ** and * respectively. Results are discussed in section 2.3.1.

asset	estimate	period 1	period 2	period 3
Corn-#2 yellow (XCBT)	mean	-1.33%	24.39%	13.05%
	sd	23.64%	30.35%	36.29%
Oats (XCBT)	mean	-7.58%	4.95%	27.61%
	sd	26.52%	36.12%	28.62%
Soybean meal (XCBT)	mean	-2.79%	-3.71%	23.41%
	sd	26.61%	38.35%	24.58%
Soybean oil (XCBT)	mean	-9.5%	8.68%	23.82%
	sd	21.65%	25.81%	21.36%
Soybeans (XCBT)	mean	-6.99%	5.73%	24.39%
	sd	21.28%	28.57%	21.85%
Wheat-SRW (XCBT)	mean	-0.48%	*35.4%	-13.53%
	sd	25.6%	29.13%	44.19%
Cattle-feeder (XCME)	mean	3.96%	-6.11%	**14.82%
	sd	14.02%	15.56%	13.63%
Cattle-live (XCME)	mean	3.76%	-4.27%	10.26%
	sd	17.46%	17.97%	14.64%
Lean hogs (XCME)	mean	-7.53%	13.73%	1.68%
	sd	36.04%	41.6%	29.99%
Cocoa (IFUS)	mean	-27.17%	23.48%	6.1%
	sd	26.91%	34.92%	29.91%
Coffee-C (IFUS)	mean	-33.71%	15.7%	-25.46%
	sd	46.36%	33.45%	30.29%
Cotton-#2 (IFUS)	mean	-15.75%	5.46%	27.08%
	sd	21.68%	29.99%	32.09%
Lumber (XCME)	mean	-5.16%	16.53%	-17.3%
	sd	30.11%	31.38%	29.85%
Orange juice (IFUS)	mean	-1.83%	*34.82%	-15.3%
	sd	29.07%	30.55%	34.05%
Sugar-#11 (IFUS)	mean	-12.57%	22.6%	20.85%
	sd	35.57%	28.07%	38.34%
Natural gas (XNYM)	mean	6.03%	28.99%	-7.52%
	sd	57.71%	62.78%	54.87%
Crude oil-WTI (XNYM)	mean	14.44%	3.4%	*-34.24%
	sd	37.13%	42.26%	28.27%

Table 11: *(continued)*

asset	estimate	period 1	period 2	period 3
Gasoline (XNYM)	mean	9.87%	-13%	25.07%
	sd	35.99%	44.35%	44.67%
Heating oil (XNYM)	mean	15.24%	6.08%	-28.94%
	sd	38.99%	33.71%	27.65%
Copper (XCEC)	mean	-9.3%	***42.14%	-4.88%
	sd	21.54%	25.56%	35.3%
Gold (XCEC)	mean	-6.59%	***17.03%	-6.73%
	sd	15.15%	18.86%	19.46%
Palladium (XNYM)	mean	*44.93%	*-37.85%	0.61%
	sd	41.36%	34.76%	33.7%
Platinum (XNYM)	mean	9.89%	-2.37%	23.88%
	sd	21.81%	28.76%	29.43%
Silver (XCEC)	mean	0.39%	15.42%	36.5%
	sd	22.65%	31.35%	42.37%
Aluminium (XLME)	mean	5.32%	-14.38%	7.09%
	sd	21.07%	25.98%	31.28%
Copper (XLME)	mean	-10.35%	***41.58%	-5.54%
	sd	19.94%	23.04%	35.16%
Lead (XLME)	mean	-6.57%	**34.37%	-2.01%
	sd	18.77%	35.07%	38.65%
Nickel-primary (XLME)	mean	17.19%	-22.29%	9.33%
	sd	35.27%	46.66%	54.56%
Tin-refined (XLME)	mean	-8.94%	*20.65%	-5.53%
	sd	13.53%	31.95%	25.43%
Zinc (XLME)	mean	-14.05%	***47.19%	-28.37%
	sd	22.65%	26.86%	45.59%

Table 12: For each individual commodity, this table shows the p-values for Mann-Whitney-Wilcoxon univariate tests of difference in distributions across pairs of periods. Results are reported on the one hand for tests between the first and second periods and, on the other hand, between the second and third periods. The periods' boundary dates correspond to average break points amongst all commodities considered in the study across the first four moments of their respective distributions. Implementation details are discussed in section 2.2.2 while results are discussed in section 2.3.1.

	period	
asset	1 vs. 2	2 vs. 3
Corn-#2 yellow (XCBT)	0.7431	0.3949
Oats (XCBT)	0.3482	0.6150
Soybean meal (XCBT)	0.5231	0.0958
Soybean oil (XCBT)	0.6260	0.4938
Soybeans (XCBT)	0.3639	0.2276
Wheat-SRW (XCBT)	0.6445	0.9869
Cattle-feeder (XCME)	0.0562	0.5603
Cattle-live (XCME)	0.3566	0.4108
Lean hogs (XCME)	0.4642	0.2454
Cocoa (IFUS)	0.5933	0.1835
Coffee-C (IFUS)	0.1026	0.2418
Cotton-#2 (IFUS)	0.1995	0.1466
Lumber (XCME)	0.6436	0.0612
Orange juice (IFUS)	0.2025	0.8436
Sugar-#11 (IFUS)	0.3641	0.2895
Natural gas (XNYM)	0.1553	0.6772
Crude oil-WTI (XNYM)	0.9386	0.7824
Gasoline (XNYM)	0.5840	0.7117
Heating oil (XNYM)	0.7790	0.8944
Copper (XCEC)	0.0001	0.1104
Gold (XCEC)	0.0023	0.5293
Palladium (XNYM)	0.3116	0.8331
Platinum (XNYM)	0.3388	0.6584
Silver (XCEC)	0.0004	0.4142
Aluminium (XLME)	0.0054	0.2951
Copper (XLME)	0.0001	0.1639
Lead (XLME)	0.0000	0.1684
Nickel-primary (XLME)	0.0686	0.0347
Tin-refined (XLME)	0.0005	0.6416
Zinc (XLME)	0.0000	0.0238

Table 13: This table shows p-values for tests of difference in multivariate distributions for various commodity groups across pairs of periods. Results are reported for Mann-Whitney-Wilcoxon tests applied to the first principal component of the corresponding commodity group as well as for multivariate analysis of variance tests along up to five dimensions. For commodity groups that include less than five assets, results are reported for tests along the corresponding number of dimensions. Results are reported on the one hand for tests across the first and second period and, on the other hand, between the second and third period. The periods' boundary dates correspond to average break points amongst all commodities considered in the study across the first four moments of their respective distributions. Implementation details are discussed in section 2.2.2 while results are discussed in section 2.3.1.

				period	
test	country	sector	subsector	1 vs. 2	2 vs. 3
Mann-Whitney	all	all	all	0.7796	0.8082
	US			0.8632	0.5775
	UK			0.0006	0.1072
	US	agriculturals		0.2783	0.2077
		energy		0.7351	0.8011
		metals		0.0025	0.9513
		agriculturals	grains	0.3393	0.4923
			livestock	0.5547	0.1348
			softs	0.2404	0.0706
		metals	precious	0.0149	0.6788
MANOVA	all	all	all	0.1393	0.6027
	US			0.4672	0.9344
	UK			0.0422	0.5028
	US	agriculturals		0.7890	0.9570
		energy		0.9089	0.9622
		metals		0.2341	0.6337
		agriculturals	grains	0.9554	0.9802
			livestock	0.9656	0.9966
			softs	0.7466	0.9547
		metals	precious	0.6942	0.8569

Table 14: This table shows the Sharpe ratio averages for the bootstrapped global minimum variance (gmv) as well as tangency portfolios for various commodity groups across the different periods defined above. The figures are reported for the first period while for second and third periods the differences with respect to the previous period are reported. Methods related to the analysis of the investment opportunity set are discussed in section 2.2.2 while results are discussed in section 2.3.2.

				period		
country	sector	subsector	portfolio	1	2 - 1	3 - 2
all	all	all	gmv	-0.5629	1.0336	0.5892
			tangency	2.3034	0.7967	0.2088
	agriculturals		gmv	-0.3247	0.9089	0.2378
			tangency	1.1315	0.8168	0.3056
		grains	gmv	-0.1049	0.6199	0.0582
			tangency	0.4111	0.6122	-0.0075
		livestock	gmv	-0.1598	0.3821	0.1574
			tangency	0.2552	0.3035	0.1656
		softs	gmv	-0.3727	0.8143	0.5529
			tangency	0.5215	0.6915	0.4301
	energy	all	gmv	0.5216	0.2603	-0.4572
			tangency	0.8788	0.2224	-0.4038
		petroleum	gmv	0.5165	0.2633	-0.4615
			tangency	0.8750	0.2302	-0.4158
	metals	all	gmv	-0.4100	1.1452	0.0572
			tangency	1.0132	1.1915	-0.4181
		base	gmv	-0.5282	1.3975	-0.4321
			tangency	0.5874	1.2372	-0.7983
		precious	gmv	0.0377	0.6594	0.1075
			tangency	0.5289	0.7348	0.0173
US	all	all	gmv	-0.2504	0.8733	0.4240
			tangency	2.0236	0.7332	0.1766
UK			gmv	-0.5467	1.4679	-0.5921
			tangency	0.4406	1.4290	-0.9545

Table 15: This table shows the standard deviations for the average bootstrapped global minimum variance portfolios for various commodity groups across the different periods defined above. The figures are reported for the first period while for second and third periods the differences with respect to the previous period are reported. Methods related to the analysis of the investment opportunity set are discussed in section 2.2.2 while results are discussed in section 2.3.2.

			period		
country	sector	subsector	1	2 - 1	3 - 2
all	all	all	0.0642	0.0155	0.0134
	agriculturals		0.0830	0.0107	0.0234
		grains	0.1737	0.0305	0.0619
		livestock	0.1201	0.0271	-0.0132
		softs	0.1439	-0.0004	0.0526
	energy	all	0.3462	-0.0316	0.0308
		petroleum	0.3463	-0.0316	0.0307
	metals	all	0.0960	0.0389	0.0328
		base	0.1205	0.0828	0.0611
		precious	0.1391	0.0100	0.0441
US	all	all	0.0698	0.0122	0.0136
UK			0.1205	0.0821	0.0610

Table 16: This table shows estimates of the curvature of the efficient frontier calculated from average bootstrapped global minimum variance and tangency portfolios for various commodity groups across the different periods defined above. The figures are reported for the first period while for second and third periods the differences with respect to the previous period are reported. Methods related to the analysis of the investment opportunity set are discussed in section 2.2.2 while results are discussed in section 2.3.2.

			period		
country	sector	subsector	1	2 - 1	3 - 2
all	all	all	5.6225	3.7668	0.4365
	agriculturals		1.3858	2.0688	0.9495
		grains	0.1800	0.6020	-0.0787
		livestock	0.0906	0.1720	0.1177
		softs	0.4108	0.8655	0.4344
	energy	all	0.5003	0.1009	-0.2203
		petroleum	0.4988	0.1146	-0.2395
	metals	all	1.1947	3.1255	-1.7560
		base	0.6241	1.9495	-1.7115
		precious	0.2783	0.8326	-0.1174
US	all	all	4.1577	3.0542	0.2969
UK			0.4930	2.1537	-1.9177

Table 17: This table shows the average pairwise correlations in growth opportunity proxies amongst the five mining companies considered. The results are reported for the five growth opportunity proxies used in the study as well as the three periods of interest where the first, second and third periods are proxies for the pre-financailisation, financialisation, as well as crisis and following loose monetary policy periods respectively. The table also reports the lag-one autocorrelation for each growth opportunity proxy and period, averaged across the five mining companies. Growth option proxies construction methods are discussed in section 2.2.2 while results are discussed in section 2.3.3.

proxy	estimate	period 1	period 2	period 3
price/book	average pairwise correlation	0.2790	-0.2833	0.3274
	average auto-correlation	0.4556	0.6106	0.5271
debt/equity	average pairwise correlation	-0.1152	0.0451	-0.1557
	average auto-correlation	0.7000	0.3766	0.2961
CAPEX/fixed assets	average pairwise correlation	-0.0209	0.1334	0.1584
	average auto-correlation	0.1524	0.3781	0.2103
Tobin's Q	average pairwise correlation	0.0344	-0.0316	0.5616
	average auto-correlation	0.4653	0.5786	0.5166
PVGO	average pairwise correlation	0.0265	-0.3302	0.0850
	average auto-correlation	-0.0537	0.1936	-0.0095

Table 18: This table shows the average pairwise correlations amongst the five growth opportunity proxies used in the study for each mining company considered. The results are reported for the three periods of interest where the first, second and third periods are proxies for the pre-financailisation, financialisation, as well as crisis and following loose monetary policy periods respectively. Growth option proxies construction methods are discussed in section 2.2.2 while results are discussed in section 2.3.3.

firm	period 1	period 2	period 3
Barrick Gold	0.0440	0.4788	0.1039
BHP Billiton	-0.7447	-0.2388	-0.1997
Newmont	0.0497	0.0273	0.3190
Nucor	0.0154	0.0828	0.1574
Rio Tinto	0.0156	-0.7728	0.2963

3 Commodity markets definancialisation

3.1 Introduction

The last twenty years have seen major upheavals in the commodity markets with the onset of financialisation as well as the period of the 2008 financial crisis and its aftermath. Financialisation appears to have affected a number of economic sectors, including agriculture[31] and energy[32], and its impact has been hotly debated in the policy, legislative, regulatory, and academic spheres[33]. The broad consensus in the academic literature is that the onset of financialisation was in the early 2000s, perhaps around 2003, and that the process continued until the financial crisis with, over the period, commodity indexes showing a nearly fourfold increase in levels.

The financial crisis curbed that trend with commodity indexes sharply declining before recovering substantially through the period of quantitative easing (QE) carried out by the US Federal Reserve (Fed). Although excluded from the core Consumer Price Index (CPI)[34] inflation rate, the commodity complex and monetary policy are tightly coupled through a number of channels with monetary policy actions having direct effects on commodity prices and corollarely making them a fine barometer of the current monetary stance (Frankel 2008). There is limited academic work, theoretical or empirical that studies the effects of this unorthodox monetary regime, with little equivalent in at least the last fifty years, on prices of risky assets such as commodities. In this study we attempt to provide a complement to the few studies that do so (Hammoudeh, Nguyen, and Sousa 2015; Amatov and Dorfman 2017)

[31] See for instance Scott H. Irwin, Sanders, and Merrin (2009), Sanders, Irwin, and Merrin (2010), Sanders and Irwin (2011a), Sanders and Irwin (2011b), Scott H. Irwin (2013), Brunetti and Reiffen (2014), James D. Hamilton and Wu (2015), Bruno, Büyükşahin, and Robe (2017).

[32] Büyükşahin and Harris (2011); Tokic (2012); Fattouh, Kilian, and Mahadeva (2013); Kilian and Murphy (2014); Knittel and Pindyck (2016); Manera, Nicolini, and Vignati (2016).

[33] See for example De Schutter (2010), Gilbert (2010b), Gilbert (2010a), M. W. Masters (2008), M. Masters and White (2008), Herman, Kelly, and Nash (2011), Schumann (2011), Singleton (2013) and UNCTAD and Cooperation (2009).

[34] The broad consensus amongst policy makers at the macroeconomic level is that monetary policy needs focus only on the core as opposed to headline CPI for the price volatility of the food and energy component embedded in the latter makes it difficult to discern trends from the overall inflation rate.

where, using an event-study type framework, we examine its impact on commodity prices by examining changes in the behaviour of commodity futures returns during and after its implementation.
The US Fed announced early 2014 that it would taper its asset purchases with the end of the program leading to a decline in commodity index levels. The heavily energy influenced S&P GSCI for example had fallen back to pre-financialisation levels by 2016 declining by over 50%, in stark contrast to the S&P 500 which remained well above its pre-financial crisis peak and did not suffer a major drawdown over the 2014-2018 period. There has thus been a substantial divergence in the behaviour of commodity and equity indexes since about 2014 which contrasts with their previous highly correlated dynamics. Correlations between commodities and equity were higher following the financialisation of the commodity markets (Silvennoinen and Thorp 2013) and continued to increase over the 2008-2012 period with levels as high during the first period of quantitative easing as over the actual crisis period; they remained high through the second round, including operation twist which ended in 2012, and began to decline from then[35].
The end of quantitative easing therefore seems to have had very different implications for commodity and equity markets and we explore the dynamics of the commodity futures complex from 2014 onward in an attempt to understand how its behaviour was different from that over the preceding ten years. While this divergence in commodity market behaviour has been observed in specific contexts our analysis is broader in scope as we examine the entire cross-section of liquid commodities rather than a subsector (Zhang, Chevallier, and Guesmi 2017) or linkages with the equity market (Bianchi, Fan, and Todorova 2019).

We observe twenty-four liquid commodity futures series traded on both US and non-US exchanges and find that average pairwise correlations over the 2014-2018 period dropped across the board as well as within different commodity sectors and subsectors (agriculture: grains, livestock and softs; energy: gas and petroleums; metals: base and precious) from those over the 2008-2013 period, indicating lower levels of co-

[35]See Reuters article here.

movement among related commodities. The decline was sharpest for the agricultural commodities in which grains have traditionally behaved differently from the softs and which have generally had the lowest average pairwise correlations among the three subsectors. The average pairwise correlations among all commodities dropped even more sharply indicating that the increased co-movement that characterised the financialisation period (Tang and Xiong 2012; Basak and Pavlova 2016) and continued into the crisis was dropping back to past, legacy levels.
We investigate this matter further from a systematic risk perspective–an approach that seems particularly relevant in this context–by carrying out a dynamic conditional correlation analysis where we fit DCC-GARCH models independently over the crisis/QE (2007-2013), post-QE (2014-2018) and more recent past (2016-2018) periods across different sectors and subsectors. The univariate conditional volatility modeling results suggest that the nature of time variation has changed, with lower persistence and volatility shocks having a bigger effect. Recent commodity volatility therefore appears to be more responsive to news than it was over the crisis and quantitative easing period. The results are particularly pronounced for the energy commodities, grains and base metals and over the proxy period for the recent past. The multivariate conditional correlation modeling results on the other hand indicate a change in the nature of commodity correlations over the two periods. Levels of time variation and shocks persistence in correlations are high over the crisis/QE period, confirming the findings of Creti, Joëts, and Mignon (2013), while there is evidence of overall lower time variation and persistence levels over the post-QE period suggesting a convergence of correlations to a stable level.
Taken together with the declining trend in correlations this suggests that the end of quantitative easing seems to have initiated a trend of lower co-movement among commodities, potentially reversing the trend seen from the beginning of the century.

The performance of the commodity and the equity markets diverged markedly after the withdrawal of quantitative easing was announced and in fact had exhibited substantial divergence from around 2012. Another key characteristic of the financialisation period was the strong build-up of cross-market linkages with other asset classes including equities (Chong and Miffre 2010; Tang and Xiong 2012; Silvennoinen and Thorp 2013; Büyükşahin and Robe 2014; Cheng and Xiong 2014; Goldstein and Yang 2019). Correlations with the commodity complex as a whole as well as with commodity sectors and subsectors fell sharply post-QE relative to the crisis/QE period however. The phenomenon seemed to apply globally as we observe the same pattern of sharply declining correlations between various equally weighted portfolios of US and non-US traded commodities and S&P 500 as well as MSCI Emergings index futures.

We analyse the issue further by examining the commodity-equity structural relationship stability over the period encompassing both the crisis/QE and post-QE sub-periods. We find evidence of structural breaks in futures returns relationship between broad commodity indexes and the stock market after the end of the second round of quantitative easing and ensuing operation twist in June 2012.

These results suggest that the end of the unorthodox monetary policy together with the decline in index investing seemingly altered the nature of the equity-commodity relationship and did so earlier than the end of the final period of quantitative easing with the phenomenon also observed in Bianchi, Fan, and Todorova (2019).

An additional crucial aspect of commodity financialisation was in the inflow of commodity index linked investment (James D. Hamilton and Wu 2015; Henderson, Pearson, and Wang 2015) which grew from less than \$15bn in 2000 to \$200bn in 2008. The post financial crisis period in contrast saw a substantial decline in this type of investment with the value of commodity assets under management falling down to \$67bn in 2014[36]. The monthly index investment data collected by the CFTC until November 2015 confirms this general pattern with the notional value of index trader investments averaging over \$200bn in 2011/2012 before engaging in a declining trend all the way down to around \$140bn in October 2015 when the CFTC terminated the reporting of this type of data. Despite the decline in index investment via the futures market, open interest and volume in the futures markets continued to rise over the post-QE period continuing the trend dating back to 1997.

[36]See Financial Times articles here

Meanwhile, the post financial crisis period saw the rise of Exchange Traded Funds (ETFs) as an investment vehicle providing exposure to broad asset classes as well as sub-sectors and even individual stocks and commodities. Individual commodity-based ETFs in particular saw a big increase in assets under management since 2008. As of August 2018, the largest commodity ETFs by assets under management were gold and silver based with sizes about ten times that of ETFs tracking with, interestingly, the largest gold and silver ETFs physically backed rather than through investment in corresponding futures. The assets under management of the top five single commodity ETFs were around \$50bn in May 2019 compared to around \$5bn for the largest commodity index tracking ETFs. Investor interest in commodity ETFs therefore appears to have moved toward tracking single commodities either actively or passively, or sectors such as energy or metals. This new paradigm resembles, albeit in a modern form, the original, pre-financialisation, commodity specialist approach to these markets. Using Granger causality we examine the effect of this rise in ETF market capitalisation on the gold and silver futures markets. We find evidence of an impact on the silver futures market, particularly on short, medium and longer-term futures price volatility over the 2008-2013 period. The gold market appears to have been also affected over the same period, although to a lesser extent, with a noticeable short term impact of the rise of gold ETF market capitalisation on gold future prices. A longer-term impact on volatility is also observed, opposite to that for silver, perhaps illustrating the risk on-risk off nature (RoRo) of the period that encompasses both the crisis as well as the accommodative monetary policy then ensued. The gold and silver ETFs rose from a very low base to constitute a significant fraction of the investment market for gold and silver and it appears that the rise in market capitalisation had a bigger effect on the smaller silver market.

The main transmission channels of monetary policy to the commodity complex include both a direct, the short interest rate, as well as an indirect route, that of inventories (Frankel 2008). The short interest rate is a direct component of the determination of futures prices relative to the corresponding spot markets which in turn feed back into the cash markets through the price discovery function (Working 1948).

It further indirectly contributes to price formation via the inventory channel where a higher (lower) interest rate increases (reduces) the cost of carrying commodity assets either in trad-able or raw (e.g. in the ground) form through increased (reduced) cost of financing, thereby reducing (increasing) the demand &/or increasing (reducing) the supply of storable commodities. Both the short interest rate and cost of storage are primary factors in the determination of commodity spot premiums[37] which consequently reflect the effects of monetary policy dynamics. We therefore examine their evolution for the US traded subset of the commodity cross-section considered in the study as the changes in monetary policy emanating from the US Fed are likely to have had the strongest impact on these.

We find evidence that the nature of commodity spot premiums has altered with both a narrowing of the premiums as well as an overall reduction in their volatility–although relatively less pronounced–post-QE relative to the crisis/QE period. The monetary policy changes combined with increased ETF investment therefore appear to have altered the whole cross-section of liquid US traded commodities, particularly the average spot premium levels perhaps through the interest rate channel where higher borrowing costs post-QE could have made carry trades less profitable.

Overall, our results suggest that the behaviour of the commodity futures markets in the 2014-2018 period is markedly different from that over the previous period with the joint dynamics of commodity prices as well as links to the equity market and investor preferences seemingly altered. While commodity financialisation was characterised by heightened intra commodity co-movement, strong market integration–including with but not limited to equities–and massive, long only, passive exposures to broad indexes, the post-QE period shows substantially lower co-movement within the commodity complex, weakened linkages to the equity market and a shift in investor preferences toward single commodity exposures and active investment. Definancialisation seems en route and the post crisis unconventional monetary policy regimes as well as the rise of single assets and subsectors ETFs, among others, may be significant contributing factors.

[37]futures - spot = interest rate - convenience yield + cost of storage = spot premium.

3.2 Data & methods

3.2.1 Background

The period from 1998 to 2008 saw an influx of investment into commodity index linked products most of which made its way into the commodity futures market. At least $100bn of net super-hoc investment influx flowed into these products whose goal was to track the broad movement of commodity prices with this "financialisation" phenomenon leading to world-wide debates around the role of index funds in commodity markets as well as consequential legislative changes.

The post financial crisis period as well as the ensuing period of accommodative monetary policy saw a major shift in the type and nature of commodity investing, notably with the rise of ETFs in all sectors, including the commodity complex with passive vehicles based on single commodities or commodity indexes as well as active strategies such as leveraged short or long positions. And while most of these are backed by futures contracts, some major ETFs are based on physical holdings, most notably for gold. The period saw an inflow of investment into these products particularly directed towards single commodity ETFs including actively managed ones outlining a substantial change in the type of commodity investments preferred by investors.

3.2.2 Data

We consider futures series for twenty-four liquid commodities traded both in and outside the US. The agricultural subset of these includes grain commodities with CBOT (XCBT) traded corn-#2 yellow, soybeans as well as hard red winter and soft red winter wheat; livestock with CME (XCME) traded feeder and live cattle as well as lean hogs; and soft commodities with ICE US (IFUS) traded cocoa, coffee-c, cotton-#2 and sugar-#11. The commodities considered in the energy sector include NYMEX (XNYM) traded natural gas and petroleum products with crude-oil WTI, gasoline-RBOB, and heating oil as well as ICE EU (IFEU) traded crude-oil brent and gasoil. In the metals sector we consider COMEX (XCEC) traded precious metals with gold and silver as well as LME (XLME) traded base metals with aluminium, copper, lead, nickel-primary and zinc. Futures returns are calculated on the nearby contract while spot premiums are estimated as the return on the second to front month contract, following Szymanowska et al. (2014), so that liquidity issues related to the spot price are avoided.

Our data sample further includes a number of indexes. Commodity indexes include the S&P Goldman Sachs Commodity Index, the Bloomberg Commodity Index as well as a cross-section proxy. While the S&P Goldman Sachs Commodity Index is heavily weighted towards energy, the construction method for the Bloomberg Commodity Index emphasises economic significance with liquidity and production based weights and strives for diversification: no single commodity constituting more than 15% of the index (25% including its derivatives; i.e. ULS diesel or gasoline for crude oil) or less than 2% and no sector/subsector with weight superior to 33%. Our cross-section proxy on the other hand is constructed as an equally weighted portfolio of the commodity series observed in the study. Equity indexes sample data includes the S&P 500 and the MSCI Emergings.

We further consider the two largest exchange traded funds (ETFs) for gold and silver; at the time of writing these were SPDR Gold Shares and iShares Gold Trust as well as iShares Silver Trust and ETFs Physical Silver Shares respectively.

The data are observed over the 1997-2018 period with the analysis carried out independently over several sub-periods including the 1997-2003 period, a proxy for the past or legacy market environment for the commodity complex; the 2007-2013 period, encompassing both the financial crisis as well as the ensuing unorthodox monetary policy; the 2014-2018 period, a proxy for the post quantitative easing program market environment; as well as the 2016-2018 period in some cases, a proxy for the more recent past.

3.2.3 Methods

After examining the correlations dynamics of commodity futures returns returns both within asset groups as well as with the two equity indexes considered, we carry out a dynamic conditional correlation analysis on these futures returns where we fit DCC-GARCH models (Engle 2002, 2009) independently across the individual periods outlined above as well as a number of commodity groups including sectors and subsectors for both the US and non-US subsets of the commodity cross-section considered.

This class of models is widely used in financial time–series analysis for it is able to capture well the stylized facts of the data (Brownlees and Engle 2016). Besides, a notable advantage of GARCH estimation is that it captures the dynamic evolution of systematic risk explicitly (Adrian and Brunnermeier 2016) which seems particularly relevant in this context where we strive to understand the effects of macroeconomic factors on the broad cross-section of the commodity complex.

Conditional correlation models are founded on a decomposition of the conditional covariance matrix into conditional standard deviations and correlations. The dynamic conditional correlation (DCC) model (Engle 2002; Tse and Tsui 2002) in particular decomposes the multivariate volatility problem into one of first modeling univariate volatility series and then modeling correlations in contrast to the constant conditional correlation model (Bollerslev 1990) that the DCC builds upon in which correlations are unrealistically assumed constant. In the univariate step of the estimation process we model individual commodity futures returns volatility using first order generalised auto-regressive conditional heteroskedasticity (GARCH(1, 1)) models (Bollerslev 1986) with mean equation:

$$\begin{aligned} r_t &= \mu + u_t, \\ u_t &= \sigma_t \epsilon_t, \\ \epsilon_t &\sim N(0, 1) \end{aligned}$$

r_t : commodity nearby futures return for day t,
μ : constant,
u_t : time t innovation.

and variance equation:

$$h_t = \omega + \alpha u_{t-1}^2 + \beta h_{t-1}$$

h_t: commodity nearby futures returns conditional variance at time t,

u^2_{t-1}: residuals from the mean filtration process described above,
h_{t-1}: previously fitted value.

The commodity futures returns conditional variance at a particular point in time can therefore be interpreted as weighted function of a long-term average value (unconditional variance $\hat{h} = \frac{\hat{\omega}}{1-\hat{\alpha}-\hat{\beta}}$), previous period shock (μ^2_{t-1}) and previous period fitted variance from the model (h_{t-1}).

Similarly, in the multivariate step, we model the conditional variance-covariance matrix as a function of time varying individual conditional variances and correlations as follows:

$$\mathbf{H}_t = \mathbf{D}_t \mathbf{R}_t \mathbf{D}_t$$

$\mathbf{H}_t$: commodity nearby futures returns conditional variance-covariance matrix at time t,
$\mathbf{D}_t = diag(\sqrt{h_{1,1;t}}, \ \ldots, \sqrt{h_{n,n;t}})$: the diagonal matrix of the conditional standard deviations,
$\mathbf{R}_t = diag(\mathbf{Q}_t)^{-1/2} \mathbf{Q}_t diag(\mathbf{Q}_t)^{-1/2}$ the conditional correlations matrix with $\mathbf{Q}_t$ a proxy process modeled after the logic above as a weighted function of a long term average, previous period shock and previous period fitted value as follows:

$$\mathbf{Q}_t = (1 - a - b)\bar{\mathbf{Q}} + a\mathbf{z}_{t-1}\mathbf{z}'_{t-1} + b\mathbf{Q}_{t-1}$$

a and b positive scalars with $a+b < 1$ to ensure stationarity and positive definiteness of $\mathbf{Q}_t$, $\mathbf{z}_t$ the standardised innovation vector, and $\bar{\mathbf{Q}}$ the unconditional covariance matrix of $\mathbf{z}_t$.

We further examine the futures returns relationship between the commodity and equity indexes detailed in section 3.2.2 above where following Zeileis et al. (2003)'s implementation of the algorithm described in Bai and Perron (2003) we assess deviation from stability in the classical linear regression model:

$$c_{i,j} = e_{i,k}^T \beta + \mu_i$$

Assuming two breakpoints over the 2007-2018 period where the coefficients shift from one stable regression relationship to a different one, there are three segments in which the regression coefficients are constant, and the model can be rewritten as:

$$c_{i,j} = e_{i,k}^T \beta + \mu_i \qquad (i = i_{l-1} + 1, \ldots, i_l,\ l = 1, \ldots, 3)$$

$c_{i,j}$: vector of daily futures returns for commodity index j over segment i, $e_{i,k}$: vector of daily futures returns for equity index k over segment i, l: segment index.

The breakpoints i_l are then estimated by minimising the residual sum of squares in the equation above.

We finally examine the relation between the cumulated market capitalisation of the two largest ETFs at the time of writing for gold and silver and the price and return volatility of the corresponding futures series using Granger causality analysis. Out of concerns for stationarity we observe the cumulated market capitalisation and price series in the first differences rather than levels. We further carry out this analysis at the daily, weekly and monthly frequencies by implementing classic Wald tests comparing the unrestricted model—in which y is explained by the lags of y and x—and the restricted model—in which y is only explained by the lags of y where the maximum number of lags corresponds to the number of time units in a year for the given frequency (daily: 252, weekly: 52, monthly: 12) and the models are compared using F-statistics.

3.3 Results & discussion

3.3.1 Correlation and volatility dynamics across periods

Table 19 shows average pairwise front contract daily futures return correlations amongst commodities futures series grouped by sector, subsector and country calculated over three distinct periods: 1997/2003 (past), 2007/2013 (crisis/QE) and 2014/2018 (post-QE).
A clear declining trend can be observed post-QE, particularly pronounced in relative terms for the agricultural commodities, less so for the energy sector. The figure for the agriculture sector as a whole declines to 0.13 post-QE against 0.25 over the crisis/QE period with the decrease most pronounced for the soft subsector (0.27 vs. 0.11), while the decline for the global energy sector is milder, 0.52 vs. 0.56, mostly driven by US traded petroleum assets, and that for the global metals sector is comparable in magnitude to the agriculturals with the average pairwise correlation declining from 0.53 to 0.37.
Co-movement among related commodities therefore declines in the post-QE period, quite sharply in the case of agricultural commodities, almost reverting to levels observed over the pre-financialisation period: 0.10, 0.51 and 0.30 for the agriculture, energy and metals sector respectively. The average pairwise correlations across all commodities considered dropped by over 50% between the 2008-2013 and 2014-2018 periods, from 0.28 to 0.14, with the average over the post-QE period again comparable to the 0.09 figure observed over the 1997-2003 pre-financialisation period. Although the yearly average correlations vary widely over the post-QE period, in 2017 the figures for the agricultural, energy and metal commodities as well as for the entire cross-section were 0.14, 0.48, 0.32 and 0.12 respectively suggesting a stable to declining trend in pairwise correlations from 2014 onward.

We further analyse both volatility and correlation dynamics using DCC-GARCH models that we fit over the entire cross-section of the commodities considered as well as over the agricultural, energy and metals sectors and their respective subsectors separately. The results for the crisis/QE, post-QE and 2016/2018 (more recent past) periods are shown in tables 20 and 21.

As detailed in section 3.2.3 the estimation process first involves modeling univariate conditional volatilities. The corresponding results are reported in table 20 and show strong evidence for time-varying volatility, with the alpha coefficient (response to shocks) and the beta coefficient (persistence) significant for the vast majority of commodities in all periods. The magnitude of the coefficients changes across the periods, and there is a clear rising trend in the alpha coefficient across all sets of commodities, particularly pronounced for the energy commodities, grains and base metals and over the proxy period for the recent past. The beta coefficients on the other hand show the opposite pattern with a broad declining trend, particularly pronounced for the same commodity groups and period. These findings suggest that the nature of time variation has changed, with lower persistence and volatility shocks having a bigger effect; recent commodity volatility therefore appears to be more responsive to news than it was over the crisis and quantitative easing period.

The results of the second, multivariate estimation stage shown in table 21 indicate that the nature of commodity correlations has also changed over the two periods. Over the first period there is a higher level of time variation in correlations, confirming the findings of Creti, Joëts, and Mignon (2013) as well as high persistence in correlation shocks across the entire cross-section as well as all of the sectors and subsectors, with all jointly estimated persistence coefficients greater than 0.9. The jointly estimated alpha parameters show more variation across sectors; while the coefficients at the level of sector are all significant at the 1% level over the first period, energy commodities show the highest figures followed by the precious metals. In the post-QE period however, while increasing and decreasing respectively, the coefficients for the agricultural and metals sectors show a decrease in significance. This is accompanied by a generalised decline in shock persistence coefficients across the full set of commodities as well as all sectors and subsectors with fairly steep drops for the agriculture and energy sectors. This pattern is more pronounced over the recent past proxy period with less significant alpha for the agriculture sector and more pronounced (or comparable in the case of the livestock subsector) drops in persistence coefficient for the whole cross-section as well as all sectors and subsectors.

Taken together these results suggest that correlations in the agriculture and the metals sector are exhibiting less time variation with a declining trend. For the full cross section there is evidence of time variation in both periods, but there is a declining trend in both coefficients in the second period suggesting that commodity correlations may be becoming less time varying, converging to a level lower than in the first period. Thus, the end of quantitative easing seems to have initiated a trend of lower co-movement among commodities, potentially reversing the trend seen from the beginning of the century and documented in a number of studies (Tang and Xiong 2012; Basak and Pavlova 2016).

3.3.2 Evolution of commodity equity-correlations

We next examine the behaviour of commodity and equity correlations over our sample period. Table 19 shows average front futures return correlations between equally weighted commodity futures portfolios and individual equity index futures. All of the sectors and subsectors see a sharp rise in correlations with the US equity index from the past to the crisis/QE period with the increase strongest for the energy sector (0.41 vs. -0.01) followed by global metals (0.33 vs. 0.07). Correlations then substantially declined over the post-QE period with the fall sharpest for the agricultural (0.15 vs. 0.33) and metals sectors, particularly so for their respective soft (0.10 vs. 0.32) and US traded subsets (-0.05 vs. 0.12).

We investigate the connection between the two asset classes further by assessing the stability of the structural relationship between commodity and equity indexes daily returns where we consider three commodity indexes including the S&P GSCI, the Bloomberg commodity index and a cross-sectional proxy index, in the form of a equally weighted portfolio of the twenty four commodities considered in the study, against two equity indexes: the S&P 500 and the MSCI Emergings index. While testing for a single structural break identifies the period around the financial crisis, similar to earlier findings (Creti, Joëts, and Mignon 2013; Silvennoinen and Thorp 2013; Delatte and Lopez 2013), the two-break test results shown in table 22 identify the 2012-2013 period in a number of cases including the Bloomberg index and

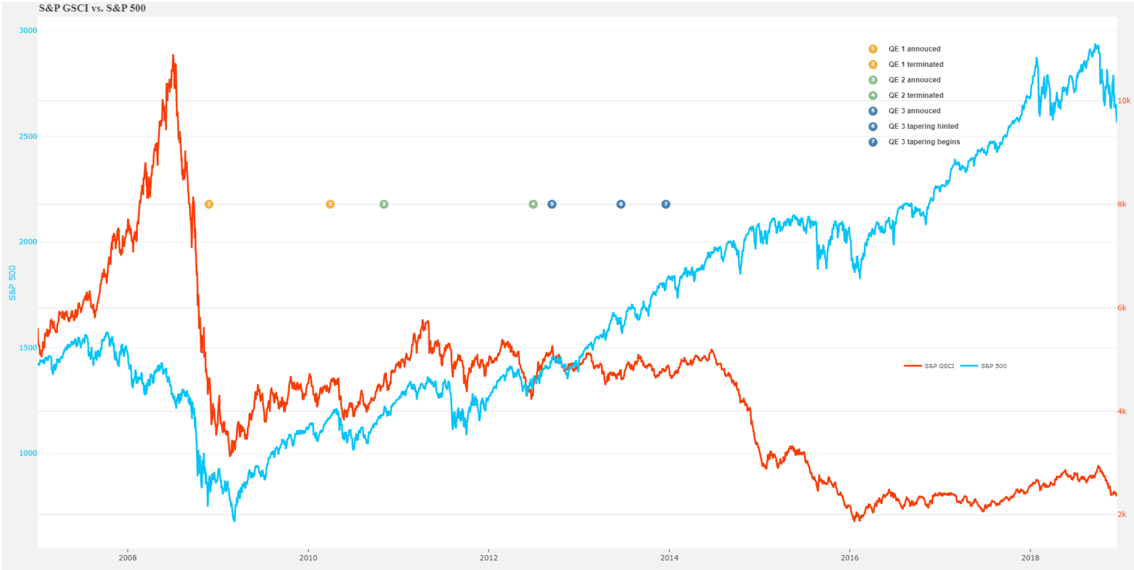

Figure 5: This figure shows level curves for both the S&P GSCI (right-hand side y-axis) and the S&P 500 (left-hand side y-axis) superposed with key announcement and action dates of the US quantitative easing program.

equally weighted portfolio with the S&P 500 where breaks are observed in November and August 2012 respectively as well as the Bloomberg and S&P GSCI with the MSCI Emerging Markets index with breaks for both in August 2012. Consistent with Bianchi, Fan, and Todorova (2019), our results therefore show evidence of a structural break in the relationship between the commodity and equity complexes after the end of the second round of quantitative easing, including operation twist, around June 2012 suggesting that the divergence in the broad equity and commodity markets likely began before the end of the final period of quantitative easing and had continued through to the current period. The pattern is further illustrated in figure 5 below that shows a clear divergence in the dynamics of the S&P GSCI and S&P 500 in the wake of the phasing-out of Fed's QE program.

The change in the nature of commodity equity relationship outlined above coincides with a decline in the volume of investment in commodity index products. This has been documented in the financial press with the Financial Times reporting a $36bn decline in index related investments in 2013 followed by an $18bn dollar decline in 2014 in contrast to inflows of $28bn in 2012[38], reducing the value of commodity assets under management to $67bn[39]. This also coincides with institutional investors pulling back from commodity investments with the $36.4bn Harvard University endowment cutting its target portfolio allocation for commodities to zero in 2014 from a high of 8% in 2008. As the Financial Times article from June 2015 puts it: "Institutional investors [...] big commodity experiment has so far been a disaster [...] Commodity prices crashed with equities following the financial crisis and traded tightly in line with the stock market over the nervous years that followed, providing no diversification. When they finally parted company, they inflicted more pain as commodities tumbled while stocks roared ahead. The Bloomberg Commodity Index has lost 37% on a total return basis since early 2011". The monthly index investment data collected by the CFTC until November 2015 confirms this general pattern as illustrated in the figure 6 below, with index investment starting a recovery after the announcement of the first round of quantitative easing and rising sharply over the 2009-2012 period with the notional value of index trader investments reaching a peak of over $250bn in April 2011 before a declining trend set in from late 2012/early 2013, in the aftermath of the announcement of the third round of quantitative easing, all the way to October 2015 date at which the CFTC ended collecting this type of data, taking the figure down to around $140bn.

3.3.3 Evolution of the commodity market

Table 23 shows the average futures series open interest and volume for commodities futures series grouped by sector and subsector where the figures are aggregated over individual futures series term structures (i.e. each observation represents the sum of the values over all contracts on the term structure) and the averages are calculated over the 2007/2013 (crisis/QE) and 2014/2018 (post-QE) periods.

A clear trend of increasing open interest can be observed through the entire period

[38] See Financial Times articles here and here.

[39] See Financial Times article here.

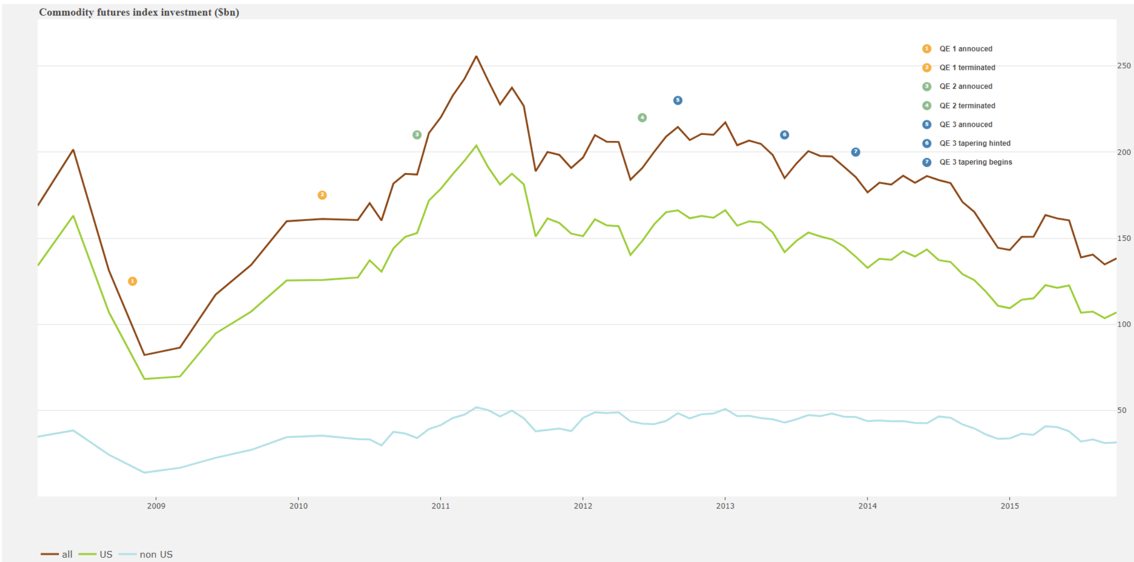

Figure 6: This figure shows the amount of net index investment (long minus short) in global commodity futures markets (in billions of dollars) over the 2007-2015 period as reported in the CFTC's special reports on swap dealers and index traders market activity. The special reports of index investment data are an outgrowth of Recommendation 2 of the September 2008 Staff Report on Commodity Swap Dealers & Index Traders (Futures Trading Commission 2008) with the data reporting the gross long, gross short and net notional values and equivalent number of futures contracts for each market. This report was published on a quarterly basis through June 30, 2010, when it began to be published on a monthly basis and the CFTC eventually discontinued the collection of data and release of the report as of October 30, 2015. The figure superposes the report data with key announcement and action dates of the US quantitative easing program.

across the market as well as sectors and subsectors with all groups showing rising open interest. Open interest over the entire complex progressed by over 30% post-QE while volume increased by nearly 50% with the overall increase for both liquidity measures seemingly driven by the energy sector. Indeed, not only does the latter show the largest market activity figures but it also records the strongest progression for both indicators with increases of 53% and 57% in open interest and volume respectively.

The post financial crisis period also saw the rise of Exchange Traded Funds (ETFs) as an investment vehicle providing exposure not only to broad asset classes and subsectors but also to individual stocks and commodities. The phenomenon for the case of single commodity ETFs is illustrated in figure 7 that shows the rapid growth in the number of these instruments as well as their assets under management over the 2007-2018 period.
Individual commodity based ETFs saw a sharp rise in numbers and managed assets since 2008-albeit, for the latter, a substantial pullback over the third round of quantitative easing period followed by a rebound resuming the increasing trend-and as of August 2018 the largest commodity ETFs by assets under management were gold and silver based ETFs with assets managed about ten times those of ETFs tracking commodity indexes. Interestingly these are backed by investments in physical commodities rather than in corresponding futures. The assets under management of oil-based ETFs as well as sector based ETFs which tend to invest in futures were also substantially higher than those of commodity index tracking ETFs. Investor interest therefore appears to have substantially increased in tracking single commodities either actively or passively, or sectors such as metals or energy.

A comparison of the market capitalisation of the ETFs with the corresponding futures market value size provides some more context. As of early 2019 the two largest gold ETFs had a combined market capitalisation of around \$46bn while the US gold futures value size (measured as contract value multiplied by open interest) was around \$55bn while the corresponding figures for silver were \$5.2bn and \$14bn respectively with both sets of ETFs physically backed. This contrasts with other sectors including

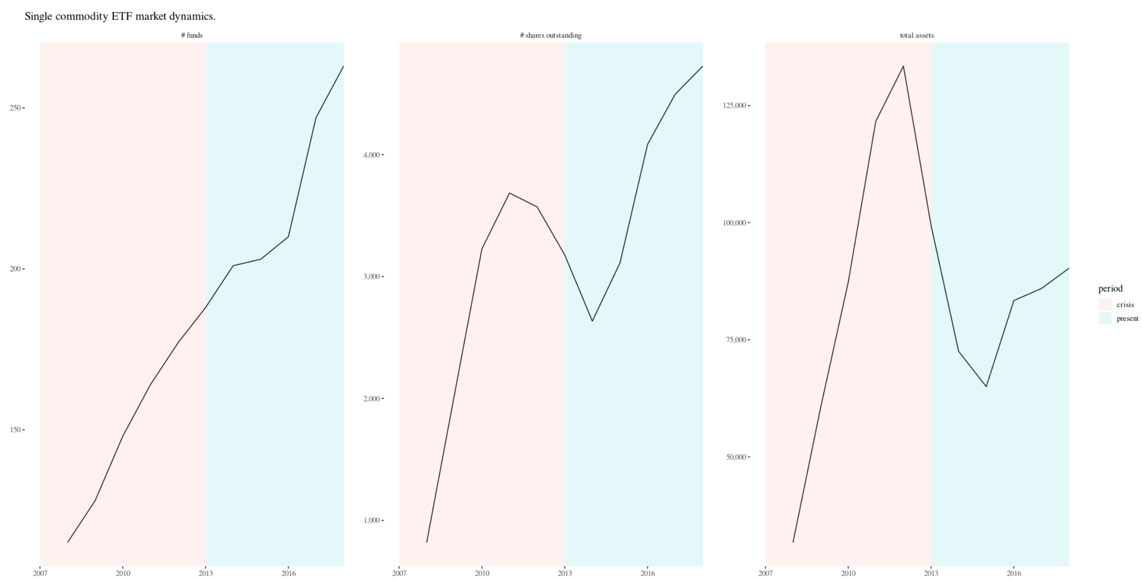

Figure 7: This figure shows the evolution of the number of single commodity Exchange Traded Funds (ETFs) traded in US dollars as well as their cumulated number of shares outstanding (in millions) and corresponding asset under management figures (in million US dollars). The line plots span the 2007-2018 time frame thereby covering both our crisis/QE and post-QE proxy periods.

energy where the largest ETFs in crude oil and natural gas for example are futures backed and as of early 2019 show substantially lower market capitalisation figures relative to the value size of the corresponding futures market.

We examine the potential effect, if any, the rise in market capitalisation in the largest commodity ETFs had on the corresponding commodity price and volatility for gold and silver. We perform this analysis by carrying out Granger causality tests with closing price, volatility and market capitalisation of the two largest ETFs for these assets where we consider daily, weekly and monthly frequencies for the crisis/QE and post-QE periods separately which allows to assess the shorter and longer-term impacts of the rise in market capitalisation during and after the period of unorthodox monetary policy.

The results reported in table 24 show that at the daily frequency, over the first period, there is clear evidence that market capitalisation Granger causes closing price for both commodities. For silver, the causality also goes the other way suggesting the existence of an underlying variable driving the joint dynamics with the results also significant–albeit to a lower level–at the weekly and monthly frequencies. For gold however, at the daily frequency, the causality is only significant in one direction indicating that the increase in ETF market capitalisation over the first period did appear to have a short-term impact on futures prices. Similarly, over the first period, market capitalisation appears to Granger cause volatility in a unidirectional manner for silver indicating that the rise of ETF investing seemed to have short term risk implications as well. The pattern extends to the weekly and monthly frequency for silver over the period–albeit with a significance level of 5% for both the weekly and monthly frequencies against 1% at the daily frequency. For gold, on the other hand, there is evidence of risk related causality in the opposite direction with volatility seemingly Granger causing market capitalisation at the monthly frequency at the 10% significance level with this pattern perhaps reflecting risk on-risk off trading behaviour over the crisis period and following monetary accommodating regimes.

The gold futures market, commodity safe haven, is a natural recipient of net investment inflows in turbulent market times although return volatility thereat remains closely related to that in the commodity complex and beyond as illustrated by the average pairwise return volatility correlation between gold and the twenty-three other commodity series considered of over 0.6 and that with S&P 500 return volatility over 0.8 for the period. The risk-on crisis environment with high global volatility levels would thus naturally have channelled investment flows to the gold market thereby driving up the market capitalisation for the corresponding ETFs, while the ensuing accommodative monetary policy possibly brought forth a risk-off environment with the opposite effect. These effects did not persist in the post quantitative easing period where only silver seemed impacted with futures price Granger causing ETFs market capitalisation at the 10% significance level.

Taken together these results suggest that the rise in ETF market capitalisation had the largest impact on the silver market, particularly on futures price volatility, in the short, medium as well as the longer term, while there appears to have been short term effects on futures prices as well as longer term effects on volatility for gold. ETFs rose from a very low base to constitute a significant fraction of the investment market for these assets and it appears that the rise in market capitalisation had a bigger effect on the smaller silver market.

3.3.4 Analysis of spot premiums

Spot premiums reflect commodity basis in relative terms and, as Bailey and Chan (1993) points out, are likely to be influenced by macroeconomic factors. Changes in monetary policy could been seen as such and we therefore analyse the difference in commodity daily spot premiums over the crisis/QE and the post-QE periods where we follow Szymanowska et al. (2014) in computing the spot premium as the return on the second to front month contract thereby avoiding liquidity issues related to the spot price.

The results shown in table 25 are restrained to the US cross-section of the commodity set considered in the study for the changes in monetary policy emanating from the US Fed are likely to have had the strongest impact on US traded assets. Apart from soybeans and gasoline all the average spot premiums are negative over the

crisis/QE period while five of them are positive post-QE with soybeans and gasoline still showing positive figures and live cattle, feeder cattle as well as cotton now exhibiting backwardation on average.
An overall narrowing of the spreads can be observed between the two periods with a decrease in average spot premiums for eleven commodities out of seventeen in absolute terms and the difference between the two periods significant at the 1% level for most except for soybeans (significant at the 10% level), as well as crude oil and gasoline (both significant at the 5% level). The differences for commodities showing increasing figures are also mostly significant at the 1% level except for soft red winter wheat (significant at the 5% level).
Spot premiums volatility seems to be decreasing overall although the dynamics are less pronounced than those for the spot premium averages with nine commodities showing decreasing figures and volatility dropping by 38% on average for these while the rest of the cross-section shows increasing figures, by 32% on average.

The changes in monetary policy and perhaps increased ETF investment therefore appear to have had an impact on the whole cross-section of liquid US traded commodities, stronger on average spot premium levels with the observed overall decline in spot premiums may be related to the increase in interest rates following the end of quantitative easing which makes the carry trade in commodity futures less profitable as a result of higher borrowing costs.

3.4 Conclusion

The upheavals of the past twenty years or so have had a profound impact on commodity futures markets and there is now a substantial body of literature documenting the effects of these structural shifts. These changes matter not only for investors in these markets but also for the global macroeconomy where commodity prices play an important role and futures markets fulfil key economic functions.

In this study we examine the behaviour of commodity futures markets in the context as well as in the aftermath of the unconventional financial stimulus known as quantitative easing implemented by the US Federal Reserve in the trough of the great financial crisis in an attempt to curb the economic downturn. The effects on price levels in the commodity complex are clear with an overall increase through the QE period followed by a substantial fall back in the wake of the tapering of the program; our results further suggest however that the impact reached beyond these mechanical effects with potential ontological consequences similar in magnitude to those brought about by financialisation; perhaps spelling the end of the commodity "asset class".

In particular, we find substantial changes in the nature of these markets with dynamics in contrast with those underlying the financialisation period; dynamics of commodity prices, both individual and joint, seem to have altered and so do connections to the equity market as well as investor preferences. Heightened inner commodity complex co-movement, strong market integration, particularly with the equity market, and massive long only passive investment inflows into broad commodity index type vehicles were all crucial aspects of commodity financialisation. Conversely, starting in the financial crisis period, we observe a change in the nature of correlations across the cross-section of liquid commodities with a strong declining trend and more stable dynamics; linkages to the equity market are weakened and a more commodity specialist approach to commodity investment seems to prevail with investor preferences moving toward subsector to single asset exposure and active management. In other words, market dynamics appear to be reverting back to legacy, pre-financialisation fundamentals.

Definancialisation seems underway and the post crisis unconventional monetary policy regimes as well as the rise of single assets and subsectors exchange traded funds may be significant contributing factors.

3.5 Tables

Table 19: This table shows average pairwise front contract daily futures return correlations amongst commodities futures series grouped by country, sector & subsector (pairwise) as well as the correlations between equally weighted portfolios of the commodity members of a group and two equity index futures, the S&P 500 and the MSCI Emerging Markets index. The correlations are calculated over entire periods: past (1997/2003), crisis (2007/2013) and post-QE (2014/2018). Limited data availability for the latter index only enables results reporting for the crisis and post-QE periods. The results are reported in order for US and UK traded commodities. The results are discussed in sections 3.3.1 and 3.3.2.

country	sector	subsector	period	pairwise	S&P 500	MSCI Emergings
US	agriculturals	all	past	0.096	0.0433	
			financialization	0.1072	0.0757	
			crisis	0.2507	0.3267	0.3777
			post-QE	0.1297	0.1513	0.2132
		grains	past	0.5348	0.0366	
			financialization	0.5231	0.0592	
			crisis	0.6487	0.2289	0.2404
			post-QE	0.5514	0.0773	0.1283
		livestock	past	0.3376	0.0246	
			financialization	0.3107	0.0208	
			crisis	0.3377	0.1739	0.1468
			post-QE	0.3413	0.1178	0.061
		softs	past	0.0519	0.0179	
			financialization	0.0899	0.0546	
			crisis	0.2778	0.3173	0.3906
			post-QE	0.1098	0.1048	0.2163
	energy	petroleum	past	0.7578	-0.0129	
			financialization	0.7739	-0.0202	
			crisis	0.7752	0.4131	0.5043
			post-QE	0.7125	0.2875	0.3649
	metals	precious	past	0.5363	-0.0841	
			financialization	0.7955	0.0922	
			crisis	0.8097	0.1194	0.3336
			post-QE	0.7908	-0.048	0.1074
UK	energy	petroleum	past	0.6007	-0.0199	
			financialization	0.5738	-0.0571	
			crisis	0.6744	0.3769	0.4939
			post-QE	0.7066	0.2833	0.3552
	metals	base	past	0.4673	0.1133	
			financialization	0.5089	0.1575	
			crisis	0.6779	0.3581	0.5427
			post-QE	0.5115	0.226	0.3325

Table 19: *(continued)*

country	sector	subsector	period	pairwise	S&P 500	MSCI Emergings
all	energy	all	past	0.5088	-0.0175	
			financialization	0.5636	-0.0238	
			crisis	0.5636	0.3939	0.4797
			post-QE	0.5213	0.2706	0.3459
		petroleum	past	0.6879	-0.0155	
			financialization	0.6814	-0.0323	
			crisis	0.7465	0.4104	0.5135
			post-QE	0.7201	0.2942	0.3691
	metals	all	past	0.3006	0.0694	
			financialization	0.447	0.1546	
			crisis	0.5264	0.331	0.5376
			post-QE	0.3745	0.1706	0.3151
		base	past	0.4673	0.1133	
			financialization	0.5089	0.1575	
			crisis	0.6779	0.3581	0.5427
			post-QE	0.5115	0.226	0.3325
		precious	past	0.5363	-0.0841	
			financialization	0.7955	0.0922	
			crisis	0.8097	0.1194	0.3336
			post-QE	0.7908	-0.048	0.1074

Table 20: This table shows the coefficient estimates for the mean (mu) and volatility (omega, alpha, beta) equations for univariate GARCH(1, 1) models fitted to indidividual commodity daily futures series with the estimation done over the 2007-2013 (crisis), 2014-2018 (post-QE) and 2016-2018 (recent-past) periods. This is the first part of the two-step DCC-GARCH(1, 1) estimation process which results are shown in table 21 below. The results are reported in order for US and UK traded commodities. The details of the model are discussed in section 3.2.3 while the results are discussed in section 3.3.1.

country	sector	subsector	asset	coefficient	crisis	post-QE	recent past
US	agriculturals	grains	Corn-#2 yellow (XCBT)	mu	0.0004	0.0001	0.0004
				omega	***0	***0	***0
				alpha	***0.0538	***0.0785	***0.1005
				beta	***0.9281	***0.8852	***0.8574
			Soybeans (XCBT)	mu	0.0003	-0.0003	0.0002
				omega	0	0	0
				alpha	***0.0404	***0.0608	***0.0673
				beta	***0.9432	***0.9272	***0.915
			Wheat-HRW (XCBT)	mu	-0.0002	0.0001	0.0004
				omega	0	***0	***0
				alpha	0.0485	***0.0353	***0.0423
				beta	***0.9505	***0.946	***0.9352
			Wheat-SRW (XCBT)	mu	-0.0001	0	0.0003
				omega	0	***0	***0
				alpha	***0.0383	***0.0444	***0.0527
				beta	***0.9607	***0.9309	***0.9227
		livestock	Cattle-feeder (XCME)	mu	**0.0005	0.0003	0
				omega	0	0	***0
				alpha	***0.0333	*0.0503	***0.0272
				beta	***0.9565	***0.9428	***0.9229
			Cattle-live (XCME)	mu	0.0004	-0.0001	-0.0003
				omega	0	**0	0
				alpha	***0.0077	***0.0072	0
				beta	***0.9913	***0.9907	***0.999
			Lean hogs (XCME)	mu	0.0005	-0.0002	0.0001
				omega	0	0	***0
				alpha	***0.0017	0	0
				beta	***0.9973	***0.999	***0.999
		softs	Cocoa (IFUS)	mu	0.0004	0.0002	-0.0004
				omega	0	0	***0
				alpha	***0.0273	*0.0401	***0.0212
				beta	***0.9683	***0.9572	***0.9633
			Coffee-C (IFUS)	mu	0	-0.0002	-0.0004
				omega	***0	0	***0
				alpha	***0.0243	***0.0253	***0.016
				beta	***0.9437	***0.9708	***0.9755
			Cotton-#2 (IFUS)	mu	0.0006	0	0.0004
				omega	0	0	***0.0001
				alpha	*0.0655	***0.0013	***0.256
				beta	***0.9224	***0.997	0.2526
			Sugar-#11 (IFUS)	mu	0	-0.0002	-0.0006
				omega	0	***0	0
				alpha	0.0295	***0.0004	***0.0008

Table 20: *(continued)*

country	sector	subsector	asset	coefficient	crisis	post-QE	recent past
UK	energy	petroleum	Crude oil-brent (IFEU)	mu	0.0008	0	0.0011
				omega	0	0	***0
				alpha	0.0592	**0.0789	***0.0751
				beta	***0.9326	***0.9188	***0.8975
			Gasoil (IFEU)	mu	*0.0006	-0.0003	0.0009
				omega	0	0	0
				alpha	***0.0339	0.056	0.042
				beta	***0.9636	***0.943	***0.9491
	metals	base	Aluminium (XLME)	mu	0	0.0001	0.0002
				omega	*0	***0	***0
				alpha	***0.0372	***0.1116	***0.1172
				beta	***0.9513	***0.7293	***0.7514
			Copper (XLME)	mu	0.0005	-0.0001	0.0004
				omega	0	0	***0
				alpha	**0.0705	***0.0304	***0.0162
				beta	***0.9224	***0.95	***0.9527
			Lead (XLME)	mu	0.0005	0.0001	0.0003
				omega	0	0	***0.0002
				alpha	***0.0333	***0.0399	***0.1615
				beta	***0.9657	***0.9462	0
			Nickel-primary (XLME)	mu	0	0.0001	0.0007
				omega	0	**0.0001	***0
				alpha	0.0682	***0.0701	0
				beta	***0.9272	***0.7078	***0.999
			Zinc (XLME)	mu	0.0001	0.0004	0.0008
				omega	0	0	***0
				alpha	***0.0241	*0.0416	***0.0534
				beta	***0.9749	***0.9476	***0.9151

Table 21: This table shows the joint coefficient estimates for DCC-GARCH(1, 1) models fitted to various commodity groups where commodities are gathered by sectors and subsectors with the estimation done over the 2007-2013 (crisis), 2014-2018 (post-QE) and 2016-2018 (recent-past) periods. These models are fitted in two steps where univariate conditional volatilities are first modeled using GARCH(1, 1) models, with the results shown in table 20 above; the multivariate stage then involves the modeling of the conditional variance-covariance matrix as a function of time varying individual conditional variances and correlations. The details of the model are discussed in section 3.2.3 while the results are discussed in section 3.3.1.

country	sector	subsector	period	pairwise	S&P 500	MSCI Emergings
US	agriculturals	all	past	0.096	0.0433	
		all	financialization	0.1072	0.0757	
		all	crisis	0.2507	0.3267	0.3777
		all	post-QE	0.1297	0.1513	0.2132
		grains	past	0.5348	0.0366	
		grains	financialization	0.5231	0.0592	
		grains	crisis	0.6487	0.2289	0.2404
		grains	post-QE	0.5514	0.0773	0.1283
		livestock	past	0.3376	0.0246	
		livestock	financialization	0.3107	0.0208	
		livestock	crisis	0.3377	0.1739	0.1468
		livestock	post-QE	0.3413	0.1178	0.061
		softs	past	0.0519	0.0179	
		softs	financialization	0.0899	0.0546	
		softs	crisis	0.2778	0.3173	0.3906
		softs	post-QE	0.1098	0.1048	0.2163
	energy	petroleum	past	0.7578	-0.0129	
		petroleum	financialization	0.7739	-0.0202	
		petroleum	crisis	0.7752	0.4131	0.5043
		petroleum	post-QE	0.7125	0.2875	0.3649
	metals	precious	past	0.5363	-0.0841	
		precious	financialization	0.7955	0.0922	
		precious	crisis	0.8097	0.1194	0.3336
		precious	post-QE	0.7908	-0.048	0.1074
UK	energy	petroleum	past	0.6007	-0.0199	
		petroleum	financialization	0.5738	-0.0571	
		petroleum	crisis	0.6744	0.3769	0.4939
		petroleum	post-QE	0.7066	0.2833	0.3552
	metals	base	past	0.4673	0.1133	
		base	financialization	0.5089	0.1575	
		base	crisis	0.6779	0.3581	0.5427
		base	post-QE	0.5115	0.226	0.3325

Table 21: *(continued)*

country	sector	subsector	period	pairwise	S&P 500	MSCI Emergings
all	energy	all	past	0.5088	-0.0175	
		all	financialization	0.5636	-0.0238	
		all	crisis	0.5636	0.3939	0.4797
		all	post-QE	0.5213	0.2706	0.3459
		petroleum	past	0.6879	-0.0155	
		petroleum	financialization	0.6814	-0.0323	
		petroleum	crisis	0.7465	0.4104	0.5135
		petroleum	post-QE	0.7201	0.2942	0.3691
	metals	all	past	0.3006	0.0694	
		all	financialization	0.447	0.1546	
		all	crisis	0.5264	0.331	0.5376
		all	post-QE	0.3745	0.1706	0.3151
		base	past	0.4673	0.1133	
		base	financialization	0.5089	0.1575	
		base	crisis	0.6779	0.3581	0.5427
		base	post-QE	0.5115	0.226	0.3325
		precious	past	0.5363	-0.0841	
		precious	financialization	0.7955	0.0922	
		precious	crisis	0.8097	0.1194	0.3336
		precious	post-QE	0.7908	-0.048	0.1074

Table 22: This table shows the results of stability tests where the stability of the regression relationship of daily return series is tested for two break points between commodity and equity indexes. Tests are carried out for two commodity indexes including the S&P GSCI and the Bloomberg commodity index as well as an equally weighted portfolio of the whole cross-section of commodities considered in the study against two equity indexes, the S&P 500 and the MSCI Emergings. The details of the testing procedure are discussed in section 3.2.3 while the results are discussed in section 3.3.2.

commodity	equity	breakpoint	date
S&P GSCI	S&P 500	1	2009-04-29
		2	no significant break
	MSCI Emergings	1	2010-09-22
		2	2012-08-31
Bloomberg commodity index	S&P 500	1	2009-04-28
		2	2012-11-01
	MSCI Emergings	1	2010-10-12
		2	2012-08-10
Equally weighted portfolio	S&P 500	1	2009-04-09
		2	2012-08-03
	MSCI Emergings	1	2008-10-30
		2	no significant break

Table 23: This table shows the average futures series open interest and volume levels where the figures are aggregated over individual futures series term structures (i.e., for each observation: sum of the values over all contracts on the term structure) and the averages are calculated over entire periods: 2007/2013 (crisis) and 2014/2018 (post-QE) as well as across commodity futures series grouped by country, sector and subsector. Relative changes are calculated with respect to the previous proxy period; the figures displayed for the crisis proxy period therefore show the evolution from the financialisation period (2004/2007). The results are discussed in section 3.3.3.

country	sector	subsector	period	OI	OI change	volume	volume change
US	agriculturals	grains	crisis	572346	33.26%	135250	74.97%
			post-QE	696283	21.65%	182004	34.57%
		livestock	crisis	184379	62.25%	29632	77.11%
			post-QE	196212	6.42%	36858	24.39%
		softs	crisis	302515	41.87%	41167	69.32%
			post-QE	371934	22.95%	56304	36.77%
	energy	gas	crisis	975580	59.38%	268772	198.3%
			post-QE	1170144	19.94%	367246	36.64%
		petroleum	crisis	657241	33.06%	273845	78.62%
			post-QE	900177	36.96%	434902	58.81%
	metals	precious	crisis	288663	30.93%	111034	106.17%
			post-QE	319749	10.77%	151011	36%
UK	energy	petroleum	crisis	730072	114.21%	310352	188.27%
			post-QE	1409035	93%	502751	61.99%
	metals	base	crisis	183279	37.23%	49373	82.37%
			post-QE	224704	22.6%	66257	34.2%
all	energy	all	crisis	733744	61.62%	282311	130.58%
			post-QE	1121198	52.8%	442936	56.9%
		petroleum	crisis	686548	62.74%	285864	120.11%
			post-QE	1110341	61.73%	458829	60.51%
	metals	all	crisis	214832	21.72%	67117	76.1%
			post-QE	252423	17.5%	90410	34.71%
	all		crisis	415154	44.03%	122960	105.02%
			post-QE	559872	34.86%	181120	47.3%

Table 24: This table shows the results for Granger Causality tests between the market capitalisations (first differences) of Exchange Traded Funds (ETFs) for gold, silver, crude oil and natural gas and the volatility and close price (first differences) of the front month futures on these commodities. For gold, silver ad crude oil the two largest ETFs are used with cumulated figures while the single largest ETF is used for natural gas. The results are shown in order for tests carried out at the daily, weekly and monthly frequency as well as across the 2007/2013 (crisis) and 2014/2018 (post-QE) periods. Dependent variables are shown in the Y column while independent variables are displayed in column X. Results are shown in the last two columns where the F-statistics as well as corresponding p-values are displayed. The details of the testing procedure are discussed in section 3.2.3 while the results are discussed in section 3.3.3.

frequency	asset	period	Y	X	F-statistic	p.value
daily	Gold (XCEC)	crisis	close price	market capitalization	1.5224	0
			market capitalization	close price	1.0937	0.1772
			volatility	market capitalization	0.9853	0.5509
			market capitalization	volatility	0.868	0.9162
		post-QE	close price	market capitalization	1.0921	0.2151
			market capitalization	close price	0.8847	0.8569
			volatility	market capitalization	1.0839	0.2345
			market capitalization	volatility	1.0801	0.2443
	Silver (XCEC)	crisis	close price	market capitalization	2.8394	0
			market capitalization	close price	1.6929	0
			volatility	market capitalization	1.3193	0.002
			market capitalization	volatility	0.9163	0.802
		post-QE	close price	market capitalization	1.1711	0.0793
			market capitalization	close price	1.0112	0.4574
			volatility	market capitalization	0.8071	0.9691
			market capitalization	volatility	1.0348	0.3776
weekly	Gold (XCEC)	crisis	close price	market capitalization	0.7921	0.8396
			market capitalization	close price	0.8882	0.6878
			volatility	market capitalization	0.9549	0.5657
			market capitalization	volatility	1.1223	0.2822
		post-QE	close price	market capitalization	0.6341	0.9613
			market capitalization	close price	0.6877	0.9271
			volatility	market capitalization	0.7561	0.8621
			market capitalization	volatility	1.2009	0.2225
	Silver (XCEC)	crisis	close price	market capitalization	1.9794	4e-04
			market capitalization	close price	1.4379	0.0393
			volatility	market capitalization	1.5203	0.021
			market capitalization	volatility	0.6601	0.9616
		post-QE	close price	market capitalization	0.7055	0.9124
			market capitalization	close price	0.7251	0.8942
			volatility	market capitalization	1.234	0.1908
			market capitalization	volatility	1.0614	0.3968

Table 24: *(continued)*

frequency	asset	period	Y	X	F-statistic	p.value
monthly	Gold (XCEC)	crisis	close price	market capitalization	0.5338	0.8813
			market capitalization	close price	0.6894	0.7528
			volatility	market capitalization	0.6636	0.7762
			market capitalization	volatility	1.7446	0.0879
		post-QE	close price	market capitalization	0.7223	0.7129
			market capitalization	close price	0.3293	0.972
			volatility	market capitalization	0.5587	0.8469
			market capitalization	volatility	0.6908	0.7404
	Silver (XCEC)	crisis	close price	market capitalization	1.7634	0.0839
			market capitalization	close price	1.6984	0.0985
			volatility	market capitalization	2.1545	0.0312
			market capitalization	volatility	0.9328	0.5235
		post-QE	close price	market capitalization	0.5803	0.8293
			market capitalization	close price	0.7044	0.728
			volatility	market capitalization	1.5895	0.1815
			market capitalization	volatility	1.1193	0.4027

Table 25: This table shows the spot premium averages for the US traded cross-section of the set of commodities considered in the study over the 2007/2013 (crisis) and 2014/2018 (post-QE) periods as well as the spot premium volatilities over the two periods. The calculation of the spot premiums is outlined in section 3.2.3 while the results are discussed in section 3.3.4.

	average		volatility	
asset	crisis	post-QE	crisis	post-QE
Corn-#2 yellow (XCBT)	-1.2%	-2.24%	4.53%	1.06%
Soybeans (XCBT)	0.42%	0.19%	3.53%	3.61%
Wheat-HRW (XCBT)	-1.61%	-2.6%	1.22%	1.53%
Wheat-SRW (XCBT)	-2.46%	-2.59%	1.93%	1.38%
Cattle-feeder (XCME)	-1.07%	0.52%	1.15%	1.26%
Cattle-live (XCME)	-1.6%	0.74%	2.38%	3.41%
Lean hogs (XCME)	-3.39%	-1.32%	6.55%	9.15%
Cocoa (IFUS)	-0.56%	-0.13%	0.61%	0.67%
Coffee-C (IFUS)	-1.8%	-2.01%	0.79%	0.56%
Cotton-#2 (IFUS)	-0.83%	0.37%	5.37%	2.57%
Sugar-#11 (IFUS)	-0.46%	-2.08%	4.57%	3.36%
Natural gas (XNYM)	-2.72%	-1.37%	3.71%	3.23%
Crude oil-WTI (XNYM)	-0.92%	-0.78%	1.97%	1.49%
Gasoline-RBOB (XNYM)	0.36%	0.02%	2.69%	4.44%
Heating oil (XNYM)	-0.47%	-0.18%	0.84%	1.37%
Gold (XCEC)	-0.33%	-0.25%	0.37%	0.21%
Silver (XCEC)	-0.36%	-0.39%	0.35%	0.18%

Conclusion

Commodity futures markets came together over a long period of time as they emerged out of commanding commercial circumstances. Their development can be traced back to the European medieval fairs where widely accepted formal regulation of trading practices and futurity in transactions, two founding building blocks, were introduced. They respectively took the form of the "Law Merchant", a generally accepted code of international mercantile law, and "to arrive" contracts with spot transactions based on samples and merchandise delivered at later dates. These trading centres eventually developed into more permanent marketplaces including in the US where market and commodity specific trade associations formed and soon devised dispute arbitration facilities and established uniform contracts for general acceptance as well as uniform commodity grades. With well-defined and enforced trading rules, time dealing as well as standardisation of contracts and merchandises the ground was set for the advent of the commodity exchange.

The first of the kind, the CBOT, started business in 1848 as an organised forward market for grains. Building upon the legacy standardisation work of the trade associations it established and enforced grain standards which enabled fungibility. Trading could henceforth take place in quantities and grades rather than in specific lots through the issuance of warehouse receipts that quickly became themselves tradable instruments.

Similar institutions sprang up across the US over the late nineteenth and early twentieth centuries among which formed the principle of offset as an alternative to delivery for the settlement of transactions. Contractual obligations became easily reversible by settling with parties with opposite commitments, directly in the first place on a bilateral basis and eventually in groups with the formation of "rings" where members' purchases were "washed out" against corresponding sales, then indirectly with the advent of clearing associations that enabled daily settlement with a unique third party.

The role of the association progressively expanded to record every trade and become counterpart to every transaction; complete clearing was born and clearing associa-

tions had become clearing houses. With trading in standard contracts in standard grades of fungible commodities centrally cleared though an ad-hoc third party in the form of a clearing house the commodity exchange had reached maturity in its development as a trading institution.
Technology has brought change in the way operations are carried out; starting in the 1970s, electronification and digitalisation spurred dematerialisation for example. To date however, commodity exchanges in their modern form continue to function on these very same century old principles for they are sound for the purpose and robust for the task. They are the outcome of over half a century of iterative trials and errors, tweaks and fine tuning of commodity specialists striving to devise a facility that would address their needs as best as possible.
The role of the exchange is vast and starts with the design of bespoke contract terms. Unit, size, grade, month; the terms of a futures contract are a key component to the success of the corresponding market and choosing them involves numbers of trade-offs and calibration to accommodate the needs of all categories of participants. The role of the exchange extends to organising delivery with rules designed to streamline the process, as well as the provision of facilities, for example in the form of "official" warehouses, approved and licensed by the exchange where delivery can take place. Being by delivery or offset the exchange further virtually eliminates settlement risk with central clearing though the clearing house which drastically decreases the probability of settlement non-performance as well as mitigates loss magnitude in the event of default. This sophisticated machinery enables exchange or futures markets to perform a number of valuable economic functions including risk management, price discovery and rational allocation of resources.
Commercial participants are typically interested in earning a normal "trade profit" as derived from regular business operations involving staple commodities and futures markets allow for the transfer to speculative participants of commodity price risk that does not belong to their typical core business activities. Exchange markets also bring improved pricing capabilities over the physical markets. By publicly disseminating market data they level the information playing field with all participants having access to the same information. At all times, this information is processed an acted

upon by all types of expert market participants with the resulting prices carrying a degree of accuracy much greater than would otherwise prevail. These more efficient prices in turn feed back into the trade markets where they guide purchase and sales decisions and thereby strengthen the connection between the two markets. Exchange price quotations, by applying to successive dates in the future, also promote rational storage decisions. The difference in price between two contracts in the same futures series accurately reflects the supply availability of the underlying commodity; in shortage markets this figure would typically fall below the cost of storage enticing holders to release inventory while the opposite would happen in surplus markets.
Through the fulfilment of these functions commodity futures markets serve a prime economic role of considerable value to the commodity specialist and to a larger extent to the greater economic system.

This prime vocation was challenged over the period from the early 2000s to the great financial crisis of 2008 that saw an unprecedented influx of institutional funds into the commodity futures complex mostly in the form of investments into commodity index linked products. The phenomenon was facilitated by the exceptional convergence of technological, regulatory and economic contextual factors.
Advances in financial technology in the form of landmark innovations enabled large global banks to offer commodity markets exposure to buy-side institutional and retail investors. The advent of commodity indexes–including the Standard & Poor's Goldman Sachs commodity index (S&P GSCI) as well as the Bloomberg commodity index that eventually became industry-standard benchmarks for commodities investing–opened the door for commodity wide exposures. Yet, indexes are not investible per se for they are only mathematically calculated values based upon the relative weights and prices of their components. Starting in the 1990s however several large financial institutions developed new ad-hoc financial vehicles that enabled investibility in commodity indexes. The commodity index swap for example has a purchase price equal to that of a specified index and pays the holder a return based on the value of that index. Popularised by Goldman Sachs, it quickly became the baseline for commodity index investment. Swaps are customised contracts that are

traded "over-the-counter" between private parties however, with access restrained to investors large enough to open a line of business with a swap dealer. More accessible exchange traded alternatives were soon put together with the most common including the exchange traded fund (ETF) that issues shares against exposure to a commodity index thereby enabling investors to "trade" the index like a share of stock, or the exchange traded note (ETN), debt-type equivalent to the ETF share, that pays the value of the underlying index at maturity.
All these products involve, in one way or another, taking offsetting positions in commodity futures markets where regulation held back growth in the first place with position limits applicable to speculative participation holding back the expansion of investment in these products. In time, a number of regulatory changes, including the enactment of the Commodity Futures Modernisation Act of 2000 as well as multiple CFTC issued exemptions, overturned the applicability of these limits for commodity index investment and set the ground up for large scale inflows.
The internet or "dotcom" bubble that had been growing vigorously over the past few years soon collapsed; stock markets tumbled and a recessionary, low interest environment ensued. In this context multiple financial institutions started to aggressively promote commodities as an appealing alternative asset class making the case that a broad, futures based long only passive exposure to the liquid commodity complex generates good, equity-like returns while being negatively correlated with stock markets and positively correlated with the general level of prices. The contention found echo in the academic sphere with several studies confirming that index-type exposures to the commodity markets had historically delivered positive returns while providing diversification benefits as well as an efficient hedge against inflation. Aggressive marketing vetted by academic rigour was more than enough for investors, on the lookout for returns and diversification after the recent crash, to seize the opportunity and institutional money started to pour into commodity futures at an industrial pace.

This phenomenon, commonly referred to as the "financialisation" of the commodity markets, appears to have affected the commodity complex at large and have been at the centre of a number of debates starting with questions related to the nature of some of the investment motives behind it.

In particular, the advertised eye-catching returns, as pointed out by some of the publicising academic studies (Greer 2000; G. Gorton and Rouwenhorst 2004), seem not to have originated from a secular value appreciation of the commodity assets comprising the popular indexes (Claude B. Erb and Harvey 2005); it rather seems that the term structure at the individual commodity futures series level had been the dominant driver (B. E. Feldman and Till 2006; B. Feldman and Till 2006; Till 2006) in the pre-financialisation era with returns generated by rolling positions forward in backwardated markets. This argument was perhaps initially overlooked for serious sustainability concerns ensue from it. It was notably argued that index investments, because of their size relative to legacy commodity specialist markets as well as their long only nature, put upward pressure on futures prices, potentially driving historically backwardated markets into contango; such was the case for the oil market, for example, with a structural switch in regime from backwardation to contango starting in 2004 (Senate 2009). Sustained equity like returns were thus perhaps not guaranteed in financialised commodity markets and commodity index investment, rather than a diversificating, inflation-proof additional source of return, was maybe a bet on term structure dynamics at the aggregate commodity complex level.

In response to these concerns a number of financial institutions, including Deutsche Bank, Goldman Sachs and Prudential Bache amongst others, developed second generation indexes that, in contrast with their first-generation predecessors, invest beyond the very short end of the term structure, in longer dated maturities, so that positions have to be rolled less frequently and roll related losses in contangoed markets are reduced. With the benefit of hindsight and following the logic of the argument above however, these strategies appear to have been fighting a losing battle. With investment demand growing large relative to commercial participation, had the great financial crisis not tamed the investing ardour, buying pressure beyond the short end would arguably have supported regime moves toward contango at whatever maturity(ies) positions lived, over larger portions of the corresponding term structures.

Despite this caveat index investments flowed, financialisation advanced and its im-

pact was soon at the centre of heated debates in the policy, legislative, regulatory, and academic spheres. In particular, starting around late 2005, early 2006, prices of energy and agricultural commodities rose substantially, eventually reaching record highs in 2008 before receding sharply into the crisis. A global food crisis ensued, with widespread discontent and riots breaking out in over thirty countries (Mittal 2009) particularly amongst developing nations. An extensive press coverage[40] triggered a worldwide public debate on the perceived effects of financialisation on energy and food prices. Complaints were also being voiced from within the commodity complex itself with commercial interest raising concerns regarding increased costs of hedging due the rising prices triggering margin calls as well as prices in the trade markets being pulled away from sector fundamentals by inflated futures prices through the price discovery function. Complaints also linked index investors to repeated occurrences of spot-futures non-convergence (Scott H. Irwin et al. 2009, 2011; Aulerich, Fishe, and Harris 2011; Adjemian et al. 2013; Garcia, Irwin, and Smith 2015) at maturity in the grains markets which mechanically made hedging even less effective and ultimately lead to resources misallocation while sending confusing signals to the markets and potentially threatening the viability of the corresponding contracts.
With all three, risk management, pricing and resources allocation functions affected, the ability of the commodity futures markets to fulfil their fundamental economic role seemed impaired; fingers pointed at index investors designated as culprits and authorities were urged to react. The first responses took the form of policy reports many of which supported the claims, reasoning that the index related influx of capital was largely speculative in nature and was thus responsible for inflated commodity prices (Mittal 2009; UNCTAD and Cooperation 2009; De Schutter 2010; Gilbert 2010a; Herman, Kelly, and Nash 2011; Schumann 2011). The debate spread to the legislative sphere with the US Senate launching formal investigations with these drawing on market data provided by the CFTC as well as on testimonies of various experts including hedge fund managers Georges Soros (Soros 2008) and Michael Masters[41] (M. W. Masters 2008). The latter directly linked the surge in index in-

[40]See Senate (2009), footnote 37 for an extensive list of related articles.
[41]The full video recording of Michael Masters hearing before the oversight & investigations sub-

vestment to escalating prices in both futures and cash markets for energy and grain commodities (M. Masters and White 2008) with the contention, commonly referred to as the "Masters hypothesis", largely endorsed by the Senate in its report on the issue (Senate 2009).

At this stage the matter was thrust onto the academic sphere as the burning issue of the day and a vigorous debate ensued that opposed the advocates of the "yes" who directly or indirectly endorsed the Masters hypothesis (Gilbert 2010a, 2010b; Einloth 2009; Tang and Xiong 2012, etc.) to the advocates of the "no", in larger numbers, who rejected it or at least argued that no firm conclusions could be reasonably drawn on the matter (Harris and Buyuksahin 2009; Brunetti and Buyuksahin 2009; Stoll and Whaley 2010; Sanders and Irwin 2010, 2011b, 2011a; Scott H. Irwin and Sanders 2012a; Büyükşahin and Robe 2014, etc.). In spite of a majority a studies disproving the Masters hypothesis legislative action was taken to curtail index investments that were deemed to bring "excessive speculation" in commodity futures markets and market regulation was eventually amended with the introduction of new position limits[42] in a number of markets in 2011.

Legislative action, let alone of this particular nature, was perhaps not warranted however for much of the research was "quick and dirty" as it was carried out in haste in response to the pressing needs of policymakers. In particular, the academic debate was initially framed rather narrowly with most of the focus on individual markets in the energy and grain sectors as well as research often limited to correlation and causality analysis using data and methods subject to important criticisms that limit the degree of confidence that can be placed in their results (Scott H. Irwin and Sanders 2011).

In this collection of studies, we take a broader approach and consider the commodity complex as a whole as suggested by the nature of financialisation that affected the entire cross-section of liquid commodities at once and our results concur to suggest that beyond energy and agricultural commodities, the metals sector seems to have

committee of the House Energy & Commerce Committee is available for online watching here.

[42]CFTC Rule 76 FR 4752.

been particularly affected by the phenomenon.
In our first study we address the issue of co-movement, central to the financialisation literature. Asset pricing factors are particularly well suited for the task and building on theory we thus carry out our analysis using a range of bespoke factors that we believe are well adapted to the commodity futures markets context. Our results suggest that the metals sector was the most affected with heightened co-movement over the financialisation period and the increase in co-movement large relative to that in other sectors. An interesting stylised fact of our results is that the factors based on the Keynes-Hicks paradigm as well as those based on Working's approach of the commodity futures term structure are best able to detect these changes outlining the impact of financialisation on the fundamentals in these markets.
The results in our second study confirm the effects of financialisation were particularly strong in the metals sector and further suggest a transmission to the real economy through the corporate sector channel. Financialisation signals in the metals sector seem to have triggered a coordinated surge in capital expenditures in the mining industry that was perhaps unwarranted with subsequent considerable value destruction in the sector. The great financial crisis on the other hand delivered an exogenous shock to the commodity complex and put a halt to the index investment craze. This was followed by an extraordinary accommodative monetary regime that was implemented over several phases.
In our third study we shed new lights on the consequences of this sudden slowdown and ensuing unorthodox monetary policy on the commodity financialisation process. Our results suggest that the commodity complex was substantially affected with dynamics seemingly reverting back to pre-financialisation standards. In particular we observe a decrease in the degree of inner-complex co-movement, a decoupling from the equity markets as well as a rise of commodity/sector specific investment and active management. These new dynamics are orthogonal in many aspects to those prevailing over the financialisation period; the crisis and its monetary accommodative aftermath seem therefore to have originated a process of definancialisation in the commodity complex and the rise of actively managed, single asset/sector ETFs seems to have been a strong contributing factor.

A Mathematical appendix

A.1 Market factor lemma

For a series of ordinary least square regressions where returns on market portfolios of nearby futures for a set of n individual commodities are independently regressed on the returns on a mimicking portfolio for market risk in returns composed of nearby futures for the whole set of the n commodities with equal individual commodity weights, in the absence of returns co-movement between the individual commodity portfolios, the average R^2 equals $1/n$:

$$\overline{R^2_{r_{mkt}}} = \frac{1}{n}\sum_j R^2_{r_j,r_{mkt}} = \frac{1}{n}$$

$\overline{R^2_{mkt}} \equiv$ average R^2 for mimicking portfolio for market factor,
$R^2_{j,mkt} \equiv R^2$ for the regression where the response variable is the vector of returns on a portfolio of commodity j nearby contracts and the regressor is the vector of returns on the market portfolio,
$j \in Y^{mkt}$ with $Y^{mkt} \equiv$ commodity set considered for the mimicking portfolio for market risk factor,
$n \equiv$ number of commodities in Y^{mkt},
$r_j \equiv$ return on portfolio of nearby futures for commodity j,
$r_{mkt} \equiv$ return on mimicking portfolio for market risk factor; $r_{mkt} = \sum_j w_j \cdot r_j$ with $w_j \equiv$ weight for commodity j in the portfolio.

A.1.1 Assumpions

$$\begin{aligned} w_j &= w_k = \tfrac{1}{n} \,\forall\, \{j,\ k\}\,;\ j,\ k\ \in Y^{mkt}, \\ \sigma_{r_j} &= \sigma_{r_k} \,\forall\, \{j,\ k\}\,;\ j,\ k\ \in Y^{mkt}, \\ cov\left(r_j, r_k\right) &= 0\,\forall \{j,\ k\}\,;\ j,\ k\ \in Y^{mkt}. \end{aligned}$$

$w_j \equiv$ weight for commodity j in the mimicking portfolio for market risk in returns,
$\sigma_{r_j} \equiv$ week t return volatility for commodity j,
$cov\left(r_j, r_k\right) \equiv$ return covariance for commodity j and k.

A.1.2 Proof

$$
\begin{aligned}
\sigma^2_{r_j} &= \beta^2_{r_j,r_{mkt}} \cdot \sigma^2_{r_{mkt}} + \sigma^2_\epsilon \\
\beta^2_{r_j,r_{mkt}} \cdot \sigma^2_{r_{mkt}} &= \sigma^2_{r_j} - \sigma^2_\epsilon \\
\frac{\beta^2_{r_j,r_{mkt}} \cdot \sigma^2_{r_{mkt}}}{\sigma^2_{r_j}} &= \frac{\sigma^2_{r_j} - \sigma^2_\epsilon}{\sigma^2_{r_j}} \\
\frac{\beta^2_{r_j,r_{mkt}} \cdot \sigma^2_{r_{mkt}}}{\sigma^2_{r_j}} &= R^2_{r_j,r_{mkt}}
\end{aligned}
$$

$$
\begin{aligned}
\sigma^2_{r_{mkt}} &= \sum_j w_j^2 \cdot \sigma_j^2 + 2 \cdot \sum_j \sum_{k \neq j} w_j \cdot w_k \cdot cov\left(r_j, r_k\right) \\
&= \sum_j \left(\frac{1}{n}\right)^2 \cdot \sigma_j^2 \\
&= \frac{\sum_j \sigma_j^2}{n^2}
\end{aligned}
$$

$$
\begin{aligned}
cov\left(r_j, r_{mkt}\right) &= cov\left(r_j, \frac{1}{n} \sum_k r_k\right) \\
&= \frac{1}{n} \sum_k cov\left(r_j, r_k\right) \\
&= \frac{1}{n} cov\left(r_j, r_j\right) \\
&= \frac{\sigma^2_{r_j}}{n}
\end{aligned}
$$

$$
\begin{aligned}
\beta^2_{j,mkt} &= \left[\frac{cov(r_j, r_{mkt})}{\sigma^2_{r_{mkt}}}\right]^2 \\
&= \frac{cov(r_j, r_{mkt})^2}{\sigma^4_{r_{mkt}}}
\end{aligned}
$$

$$
\begin{aligned}
\beta^2_{j,mkt} \cdot \sigma^2_{r_{mkt}} &= \frac{cov(r_j, r_{mkt})^2}{\sigma^2_{r_{mkt}}} \\
&= \left(\frac{\sigma^2_{r_j}}{n}\right)^2 \cdot \frac{1}{\sigma^2_{r_{mkt}}} \\
&= \frac{\sigma^4_{r_j}}{n^2 \cdot \sigma^2_{r_{mkt}}}
\end{aligned}
$$

$$
\begin{aligned}
R^2_{r_j,r_{mkt}} &= \frac{\sigma^4_{r_j}}{n^2 \cdot \sigma^2_{r_{mkt}}} \cdot \frac{1}{\sigma^2_{r_j}} \\
&= \frac{\sigma^2_{r_j}}{n^2 \cdot \sigma^2_{r_{mkt}}}
\end{aligned}
$$

$$\therefore$$

$$
\begin{aligned}
\overline{R^2_{r_{mkt}}} &= \frac{1}{n} \sum_j \frac{\sigma^2_{r_j}}{n^2 \cdot \sigma^2_{r_{mkt}}} \\
&= \frac{1}{n} \cdot \frac{1}{n^2 \cdot \sigma^2_{r_{mkt}}} \cdot \sum_j \sigma^2_{r_j} \\
&= \frac{1}{n} \cdot \frac{\sum_j \sigma^2_{r_j}}{n^2 \cdot \frac{1}{n^2} \cdot \sum_j \sigma^2_{r_j}} \\
&= \frac{1}{n}
\end{aligned}
$$

B Technological appendix

The financial data consumed in this collection of studies is from Bloomberg while the empirical analysis is carried out using the R programming language with a number of software programs and packages developed by the author providing assistance.

B.1 Excel tools for Bloomberg data extraction

Bloomberg delivers extensive coverage of markets and securities with information across all asset classes including commodities, the focus of the present collection of studies, as well as equities, also considered in various parts of the analysis. Working with Bloomberg can be daunting for it not only comes with a rather steep learning curve but working knowledge of the system is also sometimes not enough. The native Bloomberg Office Excel query tools for example seem designed for single queries with immediate ibidem data consumption. Research in finance however often requires systematic data retrieval and further processing using a programming language (R, python, etc.) or a data processing software (Stata, Eviews, etc.); the author thus developed programs that are meant to facilitate this process. They are available for download here in the form of two VBA augmented Excel workbooks that enable systematic querying from Bloomberg for commodity futures as well as equity market and corporate data.

B.2 The finRes suite

Only so much can be done in Excel; serious data munging and further statistical processing require flexibility and computational power. Programming languages make these accessible and within that realm, the R programming language stands out for statistical analysis, the workhorse of research in finance and financial economics. Fetching data involves making API (Application Programming Interface) calls; once retrieved the data must be stored somewhere which requires setting up and working with databases; statistical processing and financial modeling as well as visualisation for analysis or results communication can further require quite involved coding work.

The author developed a suite of packages in the R programming language that is meant to abstract complexity away and facilitate the work of the researcher/analyst at all these stages. The suite is available for download here in the form of a collection of packages that can be downloaded/installed from github individually or all at once using the main wrapper finRes package.

References

Acharya, Viral V., Lars A. Lochstoer, and Tarun Ramadorai. 2013. "Limits to Arbitrage and Hedging: Evidence from Commodity Markets." *Journal of Financial Economics* 109 (2): 441–65. https://doi.org/10.1016/j.jfineco.2013.03.003.

Adams, Zeno, Solène Collot, and Maria Kartsakli. 2020. "Have Commodities Become a Financial Asset? Evidence from Ten Years of Financialization." *Energy Economics* 89: 104769. https://doi.org/10.1016/j.eneco.2020.104769.

Adams, Zeno, and Thorsten Glück. 2015. "Financialization in Commodity Markets: A Passing Trend or the New Normal?" *Journal of Banking & Finance* 60: 93–111. https://doi.org/10.1016/j.jbankfin.2015.07.008.

Adjemian, Michael, Philip Garcia, Scott H Irwin, and Aaron Smith. 2013. "Non-Convergence in Domestic Commodity Futures Markets: Causes, Consequences, and Remedies." *USDA-ERS Economic Information Bulletin*, no. 115.

Adrian, Tobias, and Markus K. Brunnermeier. 2016. "CoVaR." *The American Economic Review* 106 (7): 1705–41. http://www.jstor.org/stable/43861110.

Amatov, Aitbek, and Jeffrey H Dorfman. 2017. "The Effects on Commodity Prices of Extraordinary Monetary Policy." *Journal of Agricultural and Applied Economics* 49 (1): 83–96. https://doi.org/10.1017/aae.2016.34.

Asness, Clifford S, Andrea Frazzini, and Lasse Heje Pedersen. 2019. "Quality Minus Junk." *Review of Accounting Studies* 24 (1): 34–112. https://doi.org/10.1007/s11142-018-9470-2.

Asness, Clifford, and Andrea Frazzini. 2013. "The Devil in HML's Details." *The Journal of Portfolio Management* 39 (4): 49–68. https://doi.org/10.3905/jpm.2013.39.4.049.

Asness, Clifford, Andrea Frazzini, Ronen Israel, and Tobias Moskowitz. 2015. "Fact, Fiction, and Value Investing." *The Journal of Portfolio Management* 42 (1): 34–52. https://doi.org/10.3905/jpm.2015.42.1.034.

Aulerich, Nicole M, Raymond PH Fishe, and Jeffrey H Harris. 2011. "Why Do Expiring Futures and Cash Prices Diverge for Grain Markets?" *Journal of Futures Markets* 31 (6): 503–33. https://doi.org/10.1002/fut.20483.

Baer, Julius B., and Olin Glenn Saxon. 1949. *Commodity Exchanges and Fu-*

tures Trading. Harper And Brothers Publishers. http://archive.org/details/commodityexchang031279mbp.

Bai, Jushan, and Pierre Perron. 2003. "Computation and Analysis of Multiple Structural Change Models." *Journal of Applied Econometrics* 18 (1): 1–22. https://doi.org/10.1002/jae.659.

Bailey, Warren, and Kalok C Chan. 1993. "Macroeconomic Influences and the Variability of the Commodity Futures Basis." *The Journal of Finance* 48 (2): 555–73. https://doi.org/10.1111/j.1540-6261.1993.tb04727.x.

Baker, Steven D. 2014. "The Financialization of Storable Commodities." SSRN Scholarly Paper ID 2348333. Rochester, NY: Social Science Research Network. https://doi.org/10.2139/ssrn.2348333.

Baker, Steven D, and Bryan R Routledge. 2012. "The Price of Oil Risk." *Unpublished Working Paper, Carnegie Mellon University.* https://faculty.comm.virginia.edu/sdb7e/papers/BR-oilshare-latest.pdf.

Bakshi, Gurdip, Xiaohui Gao, and Alberto G Rossi. 2019. "Understanding the Sources of Risk Underlying the Cross Section of Commodity Returns." *Management Science* 65 (2): 619–41. https://doi.org/10.1287/mnsc.2017.2840.

Basak, Suleyman, and Anna Pavlova. 2016. "A Model of Financialization of Commodities." *The Journal of Finance* 71 (4): 1511–56. https://doi.org/10.1111/jofi.12408.

Basu, Devraj, and Olivier Bauthéac. 2021a. "Commodity Definancialisation." *Working Paper.*

———. 2021b. "Financialisation of Commodities: Co-Movement Behind-the-Scenes." *Working Paper.*

Basu, Devraj, and Joëlle Miffre. 2013. "Capturing the Risk Premium of Commodity Futures: The Role of Hedging Pressure." *Journal of Banking & Finance* 37 (7): 2652–64. https://doi.org/10.1016/j.jbankfin.2013.02.031.

Bianchi, Robert J, John Hua Fan, and Neda Todorova. 2019. "Financialization and de-Financialization of Commodity Futures: A Quantile Regression Approach." *Working Paper.* https://doi.org/10.2139/ssrn.3267879.

Bignon, Vincent, and Guillaume Vuillemey. 2020. "The Failure of a Clearinghouse:

Empirical Evidence." *Review of Finance* 24 (1): 99–128. https://doi.org/10.1093/rof/rfy039.

Blau, Gerda. 1944. "Some Aspects of the Theory of Futures Trading." *The Review of Economic Studies* 12 (1): 1–30. https://doi.org/10.2307/2296011.

Bodie, Zvi. 1983. "Commodity Futures as a Hedge Against Inflation." *The Journal of Portfolio Management* 9 (3): 12–17. https://doi.org/10.3905/jpm.9.3.12.

Bodie, Zvi, and Victor I Rosansky. 1980. "Risk and Return in Commodity Futures." *Financial Analysts Journal* 36 (3): 27–39. https://doi.org/10.2469/faj.v36.n3.27.

Bohl, Martin T., and Patrick M. Stephan. 2013. "Does Futures Speculation Destabilize Spot Prices? New Evidence for Commodity Markets." *Journal of Agricultural and Applied Economics* 45 (4): 595–616. https://doi.org/10.1017/S1074070800005150.

Bollerslev, Tim. 1986. "Generalized Autoregressive Conditional Heteroskedasticity." *Journal of Econometrics* 31 (3): 307–27. https://doi.org/10.1016/0304-4076(86)90063-1.

———. 1990. "Modelling the Coherence in Short-Run Nominal Exchange Rates: A Multivariate Generalized Arch Model." *The Review of Economics and Statistics* 72 (3): 498–505. https://doi.org/10.2307/2109358.

Boons, Martijn, Frans De Roon, and Marta Szymanowska. 2012. "The Stock Market Price of Commodity Risk." In *AFA 2012 Chicago Meetings Paper*. https://doi.org/10.2139/ssrn.1785728.

Boons, Martijn, and Melissa Porras Prado. 2019. "Basis-Momentum." *The Journal of Finance* 74 (1): 239–79. https://doi.org/10.1111/jofi.12738.

Boyd, Naomi E., Bahattin Büyükşahin, Michael S. Haigh, and Jeffrey H. Harris. 2016. "The Prevalence, Sources, and Effects of Herding." *Journal of Futures Markets* 36 (7): 671–94. https://doi.org/10.1002/fut.21756.

Brennan, Michael J. 1958. "The Supply of Storage." *The American Economic Review* 48 (1): 50–72. https://www.jstor.org/stable/1812340.

Brooks, Chris, Adrian Fernandez-Perez, Joëlle Miffre, and Ogonna Nneji. 2016. "Commodity Risks and the Cross-Section of Equity Returns." *The British Accounting Review* 48 (2): 134–50. https://doi.org/10.1016/j.bar.2016.03.001.

Brownlees, Christian, and Robert F. Engle. 2016. "SRISK: A Conditional Capital Shortfall Measure of Systemic Risk." *The Review of Financial Studies* 30 (1): 48–79. https://doi.org/10.1093/rfs/hhw060.

Brunetti, Celso, and Bahattin Buyuksahin. 2009. "Is Speculation Destabilizing?" *Working Paper*. https://doi.org/10.2139/ssrn.1393524.

Brunetti, Celso, Bahattin Büyükşahin, and Jeffrey H. Harris. 2016. "Speculators, Prices, and Market Volatility." *Journal of Financial and Quantitative Analysis* 51 (5): 1545–74. https://doi.org/10.1017/S0022109016000569.

Brunetti, Celso, and David Reiffen. 2014. "Commodity Index Trading and Hedging Costs." *Journal of Financial Markets* 21: 153–80. https://doi.org/10.1016/j.finmar.2014.08.001.

Bruno, Valentina G., Bahattin Büyükşahin, and Michel A. Robe. 2017. "The Financialization of Food?" *American Journal of Agricultural Economics* 99 (1): 243–64. https://doi.org/10.1093/ajae/aaw059.

Büyükşahin, Bahattin, and Jeffrey H. Harris. 2011. "Do Speculators Drive Crude Oil Futures Prices?" *The Energy Journal*, 167–202. https://www.jstor.org/stable/41323326.

Büyükşahin, Bahattin, and Michel A Robe. 2009. "Commodity Traders' Positions and Energy Prices: Evidence from the Recent Boom-Bust Cycle." Working paper, US Commodity Futures Trading Commission.

Büyükşahin, Bahattin, and Michel A. Robe. 2014. "Speculators, Commodities and Cross-Market Linkages." *Journal of International Money and Finance*, Understanding international commodity price fluctuations, 42 (April): 38–70. https://doi.org/10.1016/j.jimonfin.2013.08.004.

Cao, Charles, Timothy Simin, and Jing Zhao. 2006. "Can Growth Options Explain the Trend in Idiosyncratic Risk?" *The Review of Financial Studies* 21 (6): 2599–2633. https://doi.org/10.1093/rfs/hhl039.

Carhart, Mark M. 1997. "On Persistence in Mutual Fund Performance." *The Journal of Finance* 52 (1): 57–82. https://doi.org/10.2307/2329556.

Carlton, Dennis W. 1984. "Futures Markets: Their Purpose, Their History, Their Growth, Their Successes and Failures." *The Journal of Futures Markets* 4 (3):

237. https://doi.org/10.1002/fut.3990040302.

Cheng, Ing-Haw, Andrei Kirilenko, and Wei Xiong. 2014. “Convective Risk Flows in Commodity Futures Markets.” *Review of Finance* 19 (5): 1733–81. https://doi.org/10.1093/rof/rfu043.

Cheng, Ing-Haw, and Wei Xiong. 2014. “Financialization of Commodity Markets.” *Annual Review of Financial Economics* 6 (1): 419–41. https://doi.org/10.1146/annurev-financial-110613-034432.

Chong, James, and Joelle Miffre. 2010. “Conditional Return Correlations Between Commodity Futures and Traditional Assets.” *Journal of Alternative Investments* 12 (3): 61–75. https://doi.org/10.3905/JAI.2010.12.3.061.

Christoffersen, Peter, Asger Lunde, and Kasper V. Olesen. 2014. “Factor Structure in Commodity Futures Return and Volatility.” *Journal of Financial and Quantitative Analysis*, 1–74. https://doi.org/10.1017/S0022109018000765.

Contessi, Silvio, Pierangelo De Pace, and Massimo Guidolin. 2014. “How Did the Financial Crisis Alter the Correlations of US Yield Spreads?” *Journal of Empirical Finance* 28: 362–85. https://doi.org/10.1016/j.jempfin.2014.04.005.

Cootner, Paul H. 1960a. “Returns to Speculators: Rejoinder.” *Journal of Political Economy* 68 (4): 415–18. https://doi.org/10.1086/258349.

———. 1960b. “Returns to Speculators: Telser Versus Keynes.” *Journal of Political Economy* 68 (4): 396–404. https://doi.org/10.1086/258347.

———. 1961. “Common Elements in Futures Markets for Commodities and Bonds.” *The American Economic Review* 51 (2): 173–83. http://www.jstor.org/stable/1914482.

———. 1967. “Speculation and Hedging.” *Food Research Institute Studies* 7 (1387-2016-116227): 65. https://ageconsearch.umn.edu/record/134944/files/fris-1967-07-supplement-336.pdf.

Cortazar, Gonzalo, Ivo Kovacevic, and Eduardo S. Schwartz. 2013. “Commodity and Asset Pricing Models: An Integration.” NBER Working Papers 19167. National Bureau of Economic Research, Inc. https://ssrn.com/abstract=2287027.

Creti, Anna, Marc Joëts, and Valérie Mignon. 2013. “On the Links Between Stock and Commodity Markets’ Volatility.” *Energy Economics* 37: 16–28. https://doi.

org/10.1016/j.eneco.2013.01.005.

Danthine, Jean-Pierre. 1978. "Information, Futures Prices, and Stabilizing Speculation." *Journal of Economic Theory* 17 (1): 79–98. https://doi.org/10.1016/0022-0531(78)90124-2.

Daskalaki, Charoula, Alexandros Kostakis, and George Skiadopoulos. 2014. "Are There Common Factors in Individual Commodity Futures Returns?" *Journal of Banking & Finance* 40 (March): 346–63. https://doi.org/10.1016/j.jbankfin.2013.11.034.

De Schutter, Olivier. 2010. "Food Commodities Speculation and Food Price Crises: Regulation to Reduce the Risks of Price Volatility." *United Nations Special Rapporteur on the Right to Food Briefing Note* 2: 1–14. https://www2.ohchr.org/english/issues/food/docs/briefing_note_02_september_2010_en.pdf.

Delatte, Anne-Laure, and Claude Lopez. 2013. "Commodity and Equity Markets: Some Stylized Facts from a Copula Approach." *Journal of Banking & Finance* 37 (12): 5346–56. https://doi.org/10.1016/j.jbankfin.2013.06.012.

Domanski, Dietrich, and Alexandra Heath. 2007. "Financial Investors and Commodity Markets." *Working Paper*. https://www.bis.org/publ/qtrpdf/r_qt0703g.pdf.

Dow, J. C. R. 1940. "A Theoretical Account of Futures Markets." *The Review of Economic Studies* 7 (3): 185–95. https://doi.org/10.2307/2967406.

Duffie, Darrell. 2014. "Challenges to a Policy Treatment of sSpeculative Trading Motivated by Differences in Beliefs." *The Journal of Legal Studies* 43 (S2): S173–82. https://doi.org/10.1086/677836.

Dusak, Katherine. 1973. "Futures Trading and Investor Returns: An Investigation of Commodity Market Risk Premiums." *Journal of Political Economy* 81 (6): 1387–1406. https://doi.org/10.1086/260133.

Ederington, Louis, and Jae Ha Lee. 2002. "Who Trades Futures and How: Evidence from the Heating Oil Futures Market." *The Journal of Business* 75 (2): 353–73. https://doi.org/10.1086/338706.

Edwards, Franklin R. 1983. "The Clearing Association in Futures Markets: Guarantor and Regulator." *The Journal of Futures Markets* 3 (4): 369. https://doi.org/10.1002/fut.3990030404.

Einloth, James Thomas. 2009. “Speculation and Recent Volatility in the Price of Oil.” *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.1488792.

Ekeland, Ivar, Delphine Lautier, and Bertrand Villeneuve. 2016. “Speculation in Commodity Futures Markets: A Simple Equilibrium Model.” https://hal.archives-ouvertes.fr/hal-01655848.

Emery, Henry Crosby. 1895. “Legislation Against Futures.” *Political Science Quarterly* 10 (1): 62–86.

———. 1896. “Speculation on the Stock and Produce Exchange of the United States.” In *Studies in History, Economics and Public Law*. Vol. 7. 2. Columbia University.

Engle, Robert. 2002. “Dynamic Conditional Correlation.” *Journal of Business & Economic Statistics* 20 (3): 339–50. https://doi.org/10.1198/073500102288618487.

———. 2009. *Anticipating Correlations: A New Paradigm for Risk Management*. Princeton University Press. https://doi.org/doi:10.1515/9781400830190.

Erb, Claude B., and Campbell R. Harvey. 2005. “The Tactical and Strategic Value of Commodity Futures.” National Bureau of Economic Research. https://doi.org/10.3386/w11222.

Erb, Claude B, and Campbell R Harvey. 2006. “The Strategic and Tactical Value of Commodity Futures.” *Financial Analysts Journal* 62 (2): 69–97.

Etula, Erkko. 2013. “Broker-Dealer Risk Appetite and Commodity Returns.” *Journal of Financial Econometrics* 11 (3): 486–521. https://doi.org/10.1093/jjfinec/nbs024.

Fama, Eugene F. 1970. “Efficient Capital Markets: A Review of Theory and Empirical Work.” *The Journal of Finance* 25 (2): 383–417. https://doi.org/10.2307/2325486.

Fama, Eugene F., and Kenneth R. French. 1993. “Common Risk Factors in the Returns on Stocks and Bonds.” *Journal of Financial Economics* 33 (1): 3–56. https://doi.org/10.1016/0304-405X(93)90023-5.

———. 2015. “A Five-Factor Asset Pricing Model.” *Journal of Financial Economics* 116 (1): 1–22. https://doi.org/10.1016/j.jfineco.2014.10.010.

Fattouh, Bassam, Lutz Kilian, and Lavan Mahadeva. 2013. "The Role of Speculation in Oil Markets: What Have We Learnt so Far?" *The Energy Journal* 34 (3): 7–33. https://www.jstor.org/stable/41970495.

Feldman, Barry E, and Hilary Till. 2006. "Separating the Wheat from the Chaff: Backwardation as the Long-Term Driver of Commodity Futures Performance: Evidence from Soy, Corn and Wheat Futures from 1950 to 2004." *Working Paper*. https://doi.org/10.2139/ssrn.892387.

Feldman, Barry, and Hilary Till. 2006. "Backwardation and Commodity Futures Performance: Evidence from Evolving Agricultural Markets." *Journal of Alternative Investments* 9 (3): 24. https://doi.org/10.3905/jai.2006.670098.

Fernandez-Perez, Adrian, Bart Frijns, Ana-Maria Fuertes, and Joelle Miffre. 2018. "The Skewness of Commodity Futures Returns." *Journal of Banking & Finance* 86: 143–58. https://doi.org/10.1016/j.jbankfin.2017.06.015.

Frankel, Jeffrey A. 2008. "7. The Effect of Monetary Policy on Real Commodity Prices." In *Asset Prices and Monetary Policy*, edited by John Y. Campbell, 291–334. University of Chicago Press. https://doi.org/doi:10.7208/9780226092126-010.

Frazzini, Andrea, and Lasse Heje Pedersen. 2014. "Betting Against Beta." *Journal of Financial Economics* 111 (1): 1–25. https://doi.org/10.1016/j.jfineco.2013.10.005.

Fuertes, Ana-Maria, Joëlle Miffre, and Adrian Fernandez-Perez. 2015. "Commodity Strategies Based on Momentum, Term Structure, and Idiosyncratic Volatility." *Journal of Futures Markets* 35 (3): 274–97. https://doi.org/10.1002/fut.21656.

Futures Trading Commission, Commodity. 2008. "Staff Report on Commodity Swap Dealers & Index Traders with Commission Recommendations." *Commodity Futures Trading Commission*. https://www.cftc.gov/sites/default/files/idc/groups/public/@newsroom/documents/file/cftcstaffreportonswapdealers09.pdf.

Garcia, Philip, Scott H Irwin, and Aaron Smith. 2015. "Futures Market Failure?" *American Journal of Agricultural Economics* 97 (1): 40–64. https://doi.org/10.1093/ajae/aau067.

Gibbons, Subhabrata, Jean Dickinson; Chakraborti. 2010. *Nonparametric Statistical*

Inference. 5th ed. CRC Press. https://doi.org/10.1201/9781439896129.

Gilbert, Christopher L. 2010a. "Speculative Influences on Commodity Futures Prices 2006-2008." *UNCTAD, Geneva*. https://www.cftc.gov/sites/default/files/idc/groups/public/@swaps/documents/file/plstudy_14_cifrem.pdf.

———. 2010b. "How to Understand High Food Prices." *Journal of Agricultural Economics* 61 (2): 398–425. https://doi.org/10.1111/j.1477-9552.2010.00248.x.

Gilbert, Christopher L., and Simone Pfuderer. 2014. "The Role of Index Trading in Price Formation in the Grains and Oilseeds Markets." *Journal of Agricultural Economics* 65 (2): 303–22. https://doi.org/10.1111/1477-9552.12068.

Goldstein, Itay, Yan Li, and Liyan Yang. 2014. "Speculation and Hedging in Segmented Markets." *The Review of Financial Studies* 27 (3): 881–922. https://doi.org/10.1093/rfs/hht059.

Goldstein, Itay, Emre Ozdenoren, and Kathy Yuan. 2013. "Trading Frenzies and Their Impact on Real Investment." *Journal of Financial Economics* 109 (2): 566–82. https://doi.org/10.1016/j.jfineco.2013.03.011.

Goldstein, Itay, and Liyan Yang. 2017. "Commodity Financialization and Information Transmission." SSRN Scholarly Paper ID 2555996. Rochester, NY: Social Science Research Network. https://doi.org/10.2139/ssrn.2555996.

———. 2019. "Commodity Financialization and Information Transmission." In *AFA 2016 Annual Meeting*. https://doi.org/10.2139/ssrn.2555996.

Gorton, Gary B, Fumio Hayashi, and K Geert Rouwenhorst. 2012. "The Fundamentals of Commodity Futures Returns." *Review of Finance* 17 (1): 35–105. https://doi.org/10.1093/rof/rfs019.

Gorton, Gary, and K Geert Rouwenhorst. 2004. "Facts and Fantasies about Commodity Futures." National Bureau of Economic Research. https://doi.org/10.3386/w10595.

Gorton, Gary, and K. Geert Rouwenhorst. 2006. "Facts and Fantasies about Commodity Futures." *Financial Analysts Journal* 62 (2): 47–68. https://doi.org/10.2469/faj.v62.n2.4083.

Gray, Roger W. 1961. "The Search for a Risk Premium." *Journal of Political Economy* 69 (3): 250–60. https://doi.org/10.1086/258467.

Gray, Roger W., and William G. Tomek. 1971. "Temporal Relationships Among Futures Prices: Reply." *American Journal of Agricultural Economics* 53 (2): 362–66. http://www.jstor.org/stable/1237465.

Greer, Robert J. 2000. "The Nature of Commodity Index Returns." *Journal of Alternative Investments* 3 (1): 45–52. https://doi.org/10.3905/jai.2000.318924.

Grossman, Sanford J. 1977. "The Existence of Futures Markets, Noisy Rational Expectations and Informational Externalities." *The Review of Economic Studies* 44 (3): 431–49. https://doi.org/10.2307/2296900.

Grossman, Sanford J, and Joseph E Stiglitz. 1980. "On the Impossibility of Informationally Efficient Markets." *The American Economic Review* 70 (3): 393–408. https://doi.org/10.7916/D8765R99.

Hamilton, James D. 2009. "Causes and Consequences of the Oil Shock of 2007-08." 1. *Brookings Papers on Economic Activity*. Vol. 2009. https://doi.org/10.1353/eca.0.0047.

Hamilton, James D., and Jing Cynthia Wu. 2015. "Effects of Index-Fund Investing on Commodity Futures Prices." *International Economic Review* 56 (1): 187–205. https://doi.org/10.1111/iere.12099.

Hammoudeh, Shawkat, Duc Khuong Nguyen, and Ricardo M. Sousa. 2015. "US Monetary Policy and Sectoral Commodity Prices." *Journal of International Money and Finance* 57: 61–85. https://doi.org/https://doi.org/10.1016/j.jimonfin.2015.06.003.

Hardy, Charles. 1940. *Risk and Risk-Bearing*. Revised. Chicago University Press.

Harris, Jeffrey H., and Bahattin Buyuksahin. 2009. "The Role of Speculators in the Crude Oil Futures Market." *Working Paper*, CFTC,. https://doi.org/10.2139/ssrn.1435042.

Hawtrey, R. G. 1940. "A Symposium on the theory of the forward market: III. Mr. Kaldor on the forward market." *The Review of Economic Studies* 7 (3): 202–5. https://doi.org/10.2307/2967409.

Heifner, Richard G. 1971. "Temporal Relationships Among Futures Prices: Comment." *American Journal of Agricultural Economics* 53 (2): 361–62. https://doi.org/10.2307/1237465.

Henderson, Brian J., Neil D. Pearson, and Li Wang. 2015. “New Evidence on the Financialization of Commodity Markets.” *The Review of Financial Studies* 28 (5): 1285–1311. https://doi.org/10.1093/rfs/hhu091.

Herman, Marc-Olivier, Ruth Kelly, and Robert Nash. 2011. “Not a Game, Speculation v. Food Security: Regulating Financial Markets to Grow a Better Future.” *Oxfam Policy and Practice: Agriculture, Food and Land* 11 (7): 127–38. https://www.ingentaconnect.com/content/oxpp/oppafl/2011/00000011/00000007/art00005.

Hicks, John Richard. 1939. *Value and Capital*. 1st ed. Oxford University Press, Cambridge.

———. 1946. *Value and Capital*. 2nd ed. Oxford University Press, Cambridge.

Hieronymus, Thomas Applegate. 1977. *Economics of Futures Trading for Commercial and Personal Profit*. Commodity Research Bureau New York.

Hirshleifer, J. 1975. “Speculation and Equilibrium: Information, Risk, and Markets.” *The Quarterly Journal of Economics* 89 (4): 519–42. https://doi.org/10.2307/1884690.

Hirshleifer, Jack. 1976. “Reply to Comments on" Speculation and Equilibrium: Information, Risk, and Markets".” *The Quarterly Journal of Economics*, 689–96. https://doi.org/10.2307/1885330.

———. 1977. “The Theory of Speculation Under Alternative Regimes of Markets.” *The Journal of Finance* 32 (4): 975–99. https://doi.org/10.2307/2326507.

Hoffman, G. Wright. 1932. *Future Trading Upon Organized Commodity Markets in the United States*. University of Pennsylvania Press. http://www.jstor.org/stable/j.ctv51318w.

Hong, Harrison, and Motohiro Yogo. 2012. “What Does Futures Market Interest Tell Us about the Macroeconomy and Asset Prices?” *Journal of Financial Economics* 105 (3): 473–90. https://doi.org/10.1016/j.jfineco.2012.04.005.

Hoos, Sidney, and Holbrook Working. 1940. “Price Relations of Liverpool Wheat Futures: With Special Reference to the December-March Spreads.” *Wheat Studies* 17 (1388-2016-116845): 101–43.

Hou, Kewei, Chen Xue, and Lu Zhang. 2015. “Digesting Anomalies: An Investment

Approach." *The Review of Financial Studies* 28 (3): 650–705. https://doi.org/10.1093/rfs/hhu068.

Houthakker, H. S. 1957. "Can Speculators Forecast Prices?" *The Review of Economics and Statistics* 39 (2): 143–51. https://doi.org/10.2307/1928531.

Houthakker, Hendrik. 1957. "Restatement of the Theory of Normal Backwardation." Cowles Foundation Discussion Papers 44. Cowles Foundation for Research in Economics, Yale University. https://EconPapers.repec.org/RePEc:cwl:cwldpp:44.

Houthakker, Hendrik S. 1959. *The Scope and Limits of Futures Trading*. Cowles Foundation for Research in Economics at Yale University.

Hu, Conghui, and Wei Xiong. 2013. "The Informational Role of Commodity Futures Prices." *Apres Le Deluge: Finance and the Common Good After the Crisis, University of Chicago Press*. https://www.eia.gov/finance/markets/reports_presentations/WXInformationCommodity.pdf.

Huebner, S. S. 1931. "The Insurance Service of Commodity Exchanges." *The ANNALS of the American Academy of Political and Social Science* 155 (1): 1–6. https://doi.org/10.1177/000271623115500102.

Irwin, Harold Speer. 1954. "Evolution of Futures Trading." http://www.farmdoc.illinois.edu/irwin/archive/books/Ev-of-Futrs-Tradng/Ev-of-Futrs-Tradng_contents.pdf.

Irwin, Scott H. 2013. "Commodity Index Investment and Food Prices: Does the "Masters Hypothesis" Explain Recent Price Spikes?" *Agricultural Economics* 44 (s1): 29–41. https://doi.org/10.1111/agec.12048.

Irwin, Scott H, Philip Garcia, Darrel L Good, and Eugene Kunda. 2009. "Poor Convergence Performance of CBOT Corn, Soybean and Wheat Futures Contracts: Causes and Solutions." *Marketing and Outlook Research Report* 2. https://doi.org/10.2139/ssrn.1392380.

Irwin, Scott H, Philip Garcia, Darrel L Good, and Eugene L Kunda. 2011. "Spreads and Non-Convergence in Chicago Board of Trade Corn, Soybean, and Wheat Futures: Are Index Funds to Blame?" *Applied Economic Perspectives and Policy* 33 (1): 116–42. https://www.jstor.org/stable/41237211.

Irwin, Scott H., and Dwight R. Sanders. 2011. "Index Funds, Financialization, and Commodity Futures Markets." *Applied Economic Perspectives and Policy* 33 (1): 1–31. https://doi.org/10.1093/aepp/ppq032.

———. 2012a. "Testing the Masters' Hypothesis in Commodity Futures Markets." *Energy Economics* 34 (1): 256–69. https://doi.org/10.1016/j.eneco.2011.10.008.

———. 2012b. "Financialization and Structural Change in Commodity Futures Markets." *Journal of Agricultural and Applied Economics* 44 (3): 371–96. https://doi.org/10.1017/S1074070800000481.

Irwin, Scott H., Dwight R. Sanders, and Robert P. Merrin. 2009. "Devil or Angel? The Role of Speculation in the Recent Commodity Price Boom (and Bust)." *Journal of Agricultural and Applied Economics* 41 (2): 377–91. https://doi.org/10.1017/S1074070800002856.

Jensen, Gerald R, Robert R Johnson, and Jeffrey M Mercer. 2002. "Tactical Asset Allocation and Commodity Futures." *The Journal of Portfolio Management* 28 (4): 100–111. https://doi.org/10.3905/jpm.2002.319859.

Juvenal, Luciana, and Ivan Petrella. 2015. "Speculation in the Oil Market." *Journal of Applied Econometrics* 30 (4): 621–49. https://doi.org/10.1002/jae.2388.

Kaldor, Nicholas. 1939. "Speculation and economic stability." *The Review of Economic Studies* 7 (1): 1–27. https://doi.org/10.2307/2967593.

———. 1940. "A Note on the Theory of the Forward Market." *The Review of Economic Studies* 7 (3): 196–201. https://doi.org/10.2307/2967407.

Kang, Wenjin, K Geert Rouwenhorst, and Ke Tang. 2020. "A Tale of Two Premiums: The Role of Hedgers and Speculators in Commodity Futures Markets." *The Journal of Finance* 75 (1): 377–417. https://doi.org/10.1111/jofi.12845.

Keynes, John Maynard. 1923. "Some Aspects of Commodity Markets." *Manchester Guardian Commercial: European Reconstruction Series* 13: 784–86.

———. 1930. *Treatise on Money.* Macmillan, London.

Kilian, Lutz, and Daniel P. Murphy. 2014. "The Role of Inventories and Speculative Trading in the Global Market for Crude Oil." *Journal of Applied Econometrics* 29 (3): 454–78. https://doi.org/10.1002/jae.2322.

Kim, Abby. 2015. "Does Futures Speculation Destabilize Commodity Markets?"

Journal of Futures Markets 35 (8): 696–714. https://doi.org/10.1002/fut.21716.

Knittel, Christopher R., and Robert S. Pindyck. 2016. "The Simple Economics of Commodity Price Speculation." *American Economic Journal: Macroeconomics* 8 (2): 85–110. https://doi.org/10.1257/mac.20140033.

Korniotis, George M et al. 2009. *Does Speculation Affect Spot Price Levels?: The Case of Metals with and Without Futures Markets.* Division of Research & Statistics; Monetary Affairs, Federal Reserve Board. https://www.federalreserve.gov/Pubs/feds/2009/200929/200929pap.pdf.

Krzanowski, W. J. 1988. *Principles of Multivariate Analysis: A User's Perspective.* Oxford Statistical Science Series. Oxford University Press, Inc.

Kyle, Albert S. 1989. "Informed Speculation with Imperfect Competition." *The Review of Economic Studies* 56 (3): 317–55. https://doi.org/10.2307/2297551.

Leclercq, Emmanuel, and Remy Praz. 2014. "Equilibrium Commodity Trading." SSRN Scholarly Paper ID 2464400. Rochester, NY: Social Science Research Network. https://doi.org/10.2139/ssrn.2464400.

Levine, Ari, Yao Hua Ooi, Matthew Richardson, and Caroline Sasseville. 2018. "Commodities for the Long Run." *Financial Analysts Journal* 74 (2): 55–68. https://doi.org/10.2469/faj.v74.n2.4.

Manera, Matteo, Marcella Nicolini, and Ilaria Vignati. 2016. "Modeling Futures Price Volatility in Energy Markets: Is There a Role for Financial Speculation?" *Energy Economics*, Energy markets, 53 (January): 220–29. https://doi.org/10.1016/j.eneco.2014.07.001.

Masters, Michael W. 2008. "Testimony Before the Committee on Homeland Security and Governmental Affairs." *U.S. Senate* 20 (May).

Masters, MW, and AK White. 2008. "The Accidental Hunt Brothers: How Institutional Investors Are Driving up Food and Energy Prices." *Working Paper*.

Miffre, Joelle, and Georgios Rallis. 2007. "Momentum Strategies in Commodity Futures Markets." *Journal of Banking & Finance* 31 (6): 1863–86. https://doi.org/10.1016/j.jbankfin.2006.12.005.

Mittal, Anuradha. 2009. "The 2008 Food Price Crisis: Rethinking Food Security Policies." *United Nations Conference on Trade and Development, G-24 Discus-*

sion Papers, January.

Moser, James T. et al. 1994. "Origins of the Modern Exchange Clearinghouse: A History of Early Clearing and Settlement Methods at Futures Exchanges." Federal Reserve Bank of Chicago.

Moskowitz, Tobias J., Yao Hua Ooi, and Lasse Heje Pedersen. 2012. "Time Series Momentum." *Journal of Financial Economics*, Special issue on investor sentiment, 104 (2): 228–50. https://doi.org/10.1016/j.jfineco.2011.11.003.

Ozdenoren, Emre, and Kathy Yuan. 2008. "Feedback Effects and Asset Prices." *The Journal of Finance* 63 (4): 1939–75. https://doi.org/10.1111/j.1540-6261.2008.01378.x.

Paesani, Paolo, and Annalisa Rosselli. 2020. "How Speculation Became Respectable: Early Theories on Financial and Commodity Markets." *The European Journal of the History of Economic Thought*, 1–19. https://doi.org/10.1080/09672567.2020.1817117.

Peck, Anne E. 1985a. *Futures Markets: Regulatory Issues*. Vol. 435. Aei Press. https://legacy.farmdoc.illinois.edu/irwin/archive/books/Futures-Regulatory/Futures-Regulatory.pdf.

———. 1985b. "The Economic Role of Traditional Commodity Futures Markets." *Futures Markets: Their Economic Role. Washington, DC: American Enterprise Institute for Public Policy Research*, 1–81. http://farmdoc.illinois.edu/irwin/archive/books/Futures-Economic/Futures-Economic_chapter1.pdf.

Pirrong, Craig. 2011. "The Economics of Central Clearing: Theory and Practice."

Rockwell, Charles S. 1976. "Normal Backwardation, Forecasting, and the Returns to Commodity Futures Traders." In *The Economics of Futures Trading*, 153–67. Springer.

Romano, Roberta. 1997. "The Political Dynamics of Derivative Securities Regulation." *Yale Journal on Regulation* 14: 279. https://openyls.law.yale.edu/bitstream/handle/20.500.13051/1185/Political_Dynamics_of_Derivative_Securities_Regulation.pdf?sequence=2.

Sakkas, Athanasios, and Nikolaos Tessaromatis. 2020. "Factor Based Commodity Investing." *Journal of Banking & Finance* 115: 105807. https://doi.org/10.1016/

j.jbankfin.2020.105807.

Samuelson, Paul A. 1957. “Intertemporal Price Equilibrium: A Prologue to the Theory of Speculation.” *Weltwirtschaftliches Archiv* 79: 181–221. http://www.jstor.org/stable/40434184.

Sanders, Dwight R., and Scott H. Irwin. 2010. “A Speculative Bubble in Commodity Futures Prices? Cross-Sectional Evidence.” *Agricultural Economics* 41 (1): 25–32. https://doi.org/10.1111/j.1574-0862.2009.00422.x.

———. 2011a. “The Impact of Index Funds in Commodity Futures Markets: A Systems Approach.” *The Journal of Alternative Investments* 14 (1): 40–49. https://doi.org/10.3905/jai.2011.14.1.040.

———. 2011b. “New Evidence on the Impact of Index Funds in u.s. Grain Futures Markets.” *Canadian Journal of Agricultural Economics/Revue Canadienne d'agroeconomie* 59 (4): 519–32. https://doi.org/10.1111/j.1744-7976.2011.01226.x.

Sanders, Dwight R., Scott H. Irwin, and Robert P. Merrin. 2010. “The Adequacy of Speculation in Agricultural Futures Markets: Too Much of a Good Thing?” *Applied Economic Perspectives and Policy* 32 (1): 77–94. https://doi.org/10.1093/aepp/ppp006.

Schumann, Harald. 2011. “The Hunger-Makers: How Deutsche Bank, Goldman Sachs and Other Financial Institutions Are Speculating with Food at the Expense of the Poorest.” *Foodwatch, Berlin*. https://www.foodwatch.org/uploads/media/foodwatchreport_TheHungerMakers_observationsandcallsforaction_ger_03.pdf.

Schwartz, Eduardo S. 1997. “The Stochastic Behavior of Commodity Prices: Implications for Valuation and Hedging.” *The Journal of Finance* 52 (3): 923–73. https://doi.org/10.1111/j.1540-6261.1997.tb02721.x.

Schwartz, Eduardo, and James E Smith. 2000. “Short-Term Variations and Long-Term Dynamics in Commodity Prices.” *Management Science* 46 (7): 893–911. https://www.jstor.org/stable/2661607.

Senate, U. S. 2007. “Excessive Speculation in the Natural Gas Market.” *Permanent Subcommittee on Investigations*. https://www.hsgac.senate.gov/imo/media/doc/

REPORTExcessiveSpeculationintheNaturalGasMarket.pdf.

———. 2009. "Excessive Speculation in the Wheat Market." *Majority and Minority Staff Report. Permanent Subcommittee on Investigations* 24: 107–8. https://www.hsgac.senate.gov/imo/media/doc/REPORTExcessiveSpecullationintheWheatMarketwoexhib pdf?attempt=2.

Silvennoinen, Annastiina, and Susan Thorp. 2013. "Financialization, Crisis and Commodity Correlation Dynamics." *Journal of International Financial Markets, Institutions and Money* 24: 42--65. https://doi.org/10.1016/j.intfin.2012.11.007.

Simsek, Alp. 2013. "Speculation and Risk Sharing with New Financial Assets." *The Quarterly Journal of Economics* 128 (3): 1365–96. https://doi.org/10.1093/qje/qjt007.

Singleton, Kenneth J. 2013. "Investor Flows and the 2008 Boom/Bust in Oil Prices." *Management Science* 60 (2): 300–318. https://doi.org/10.1287/mnsc.2013.1756.

Sockin, Michael, and Wei Xiong. 2015. "Informational Frictions and Commodity Markets." *The Journal of Finance* 70 (5): 2063–98. https://doi.org/10.1111/jofi.12261.

Soros, G. 2008. "Testimony Before the United States Senate Commerce Committee Oversight Hearing on FTC Advanced Rulemaking on Oil Market Manipulation." *Washington, DC* 3 June. https://www.govinfo.gov/content/pkg/CHRG-110shrg80428/html/CHRG-110shrg80428.htm.

Stein, Jerome L. 1961. "The Simultaneous Determination of Spot and Futures Prices." *The American Economic Review* 51 (5): 1012–25. https://doi.org/10.2307/1885530.

Stoll, Hans R., and Robert E. Whaley. 2010. "Commodity Index Investing and Commodity Futures Prices." *Journal of Applied Finance* 20 (1). https://doi.org/10.2139/ssrn.1478195.

———. 2011. "Commodity Index Investing: Speculation or Diversification?" *The Journal of Alternative Investments* 14 (1): 50–60. https://doi.org/10.2139/ssrn.1633908.

Stout, Lynn A. 1998. "Why the Law Hates Speculators: Regulation and Private Ordering in the Market for OTC Derivatives." *Duke Law Journal* 48: 701–86.

https://doi.org/10.2307/1373070.

Stulz, René M. 1996. "Rethinking Risk Management." *Journal of Applied Corporate Finance* 9 (3): 8–25. https://doi.org/10.1111/j.1745-6622.1996.tb00295.x.

Szymanowska, Marta, Frans De Roon, Theo Nijman, and Rob Van Den Goorbergh. 2014. "An Anatomy of Commodity Futures Risk Premia." *The Journal of Finance* 69 (1): 453–82. https://doi.org/10.1111/jofi.12096.

Tabachnick, Barbara G, and Linda S Fidell. 2013. *Using Multivariate Statistics*. Pearson Education.

Tang, Ke, and Wei Xiong. 2012. "Index Investment and the Financialization of Commodities." *Financial Analysts Journal* 68 (5): 54–74. https://doi.org/10.2469/faj.v68.n6.5.

Taylor, Charles Henry. 1917. *History of the Board of Trade of the City of Chicago*. Vol. 2. RO Law. https://archive.org/details/historyofboardof03tayl/page/n6.

Telser, Lester G. 1958. "Futures Trading and the Storage of Cotton and Wheat." *Journal of Political Economy* 66 (3): 233–55. https://doi.org/10.1086/258036.

———. 1959. "A Theory of Speculation Relating Profitability and Stability." *The Review of Economics and Statistics* 41 (3): 295–301. https://doi.org/10.2307/1927455.

———. 1960. "Returns to Speculators: Reply." *Journal of Political Economy* 68 (4): 404–15. http://www.jstor.org/stable/1830014.

———. 1981. "Why There Are Organized Futures Markets." *The Journal of Law & Economics* 24 (1): 1–22. http://www.jstor.org/stable/725200.

Telser, Lester G, and Harlow N. Higinbotham. 1977. "Organized Futures Markets: Costs and Benefits." *Journal of Political Economy* 85 (5): 969–1000. https://doi.org/10.1086/260617.

Till, Hilary. 2006. "Structural Sources of Return and Risk in Commodity Futures Investments." *Commodities Now* 10 (2): 57–65. https://risk.edhec.edu/sites/risk/files/pdf/RISKArticle.2007-11-16.4731/attachments/Structural/%20Sources/%20Return/%20Risk/%20Commodity/%20Futures/%20Investments.pdf.

———. 2007. "A Long-Term Perspective on Commodity Futures Returns." In *Intelligent Commodity Investing*. London: Risk books.

Tokic, Damir. 2012. “Speculation and the 2008 Oil Bubble: The DCOT Report Analysis.” *Energy Policy* 45 (June): 541–50. https://doi.org/10.1016/j.enpol.2012.02.069.

Tomek, William G. 1971. “A Note on Historical Wheat Prices and Futures Trading.” *Food Research Institute Studies* 10 (1387-2016-116105): 109. https://doi.org/10.22004/ag.econ.135016.

Tomek, William G., and Roger W. Gray. 1970. “Temporal Relationships Among Prices on Commodity Futures Markets: Their Allocative and Stabilizing Roles.” *American Journal of Agricultural Economics* 52 (3): 372–80. https://doi.org/10.2307/1237388.

Tse, Y. K, and Albert K. C Tsui. 2002. “A Multivariate Generalized Autoregressive Conditional Heteroscedasticity Model with Time-Varying Correlations.” *Journal of Business & Economic Statistics* 20 (3): 351–62. https://doi.org/10.1198/073500102288618496.

Turnovsky, Stephen J. 1983. “The Determination of Spot and Futures Prices with Storable Commodities.” *Econometrica* 51 (5): 1363–87. https://doi.org/10.2307/1912279.

UNCTAD, Secretariat Task Force on Systemic Issues, and Economic Cooperation. 2009. “The Global Economic Crisis: Systemic Failures and Multilateral Remedies.” *UNCTAD, Geneva*. https://unctad.org/system/files/official-document/gds20091_en.pdf.

Wang, Changyun, and Min Yu. 2004. “Trading Activity and Price Reversals in Futures Markets.” *Journal of Banking & Finance* 28 (6): 1337–61. https://doi.org/10.1016/S0378-4266(03)00120-1.

Weymar, F. Helmut. 1966. “The Supply of Storage Revisited.” *The American Economic Review* 56 (5): 1226–34. http://www.jstor.org/stable/1815306.

Williams, John Burr. 1936. “Speculation and the Carryover.” *The Quarterly Journal of Economics* 50 (3): 436–55. http://www.jstor.org/stable/1882611.

Working, Holbrook. 1933. “Price Relations Between July and September Wheat Futures at Chicago Since 1885.” *Wheat Studies* 9 (1388-2016-116727): 187. https://doi.org/10.22004/ag.econ.142876.

———. 1934. "Price Relations Between May and New-Crop Wheat Futures at Chicago Since 1885." *Food Research Institute Wheat Studies* 10: 183–228. https://ageconsearch.umn.edu/record/139816.

———. 1942. "Quotations on Commodity Futures as Price Forecasts." *Econometrica: Journal of the Econometric Society*, 39–52. https://doi.org/10.2307/1907020.

———. 1948. "Theory of the Inverse Carrying Charge in Futures Markets." *Journal of Farm Economics* 30 (1): 1–28. https://doi.org/10.2307/1232678.

———. 1949. "The Theory of Price of Storage." *The American Economic Review*, 1254–62. https://www.jstor.org/stable/1816601.

———. 1953a. "Futures Trading and Hedging." *The American Economic Review* 43 (3): 314–43. https://www.jstor.org/stable/1811346.

———. 1953b. "Hedging Reconsidered." *Journal of Farm Economics* 35 (4): 544–61. https://doi.org/10.2307/1233368.

———. 1960. "Speculation on Hedging Markets." *Food Research Institute Studies*, no. 02. https://doi.org/10.22004/ag.econ.136578.

Yang, Fan. 2013. "Investment Shocks and the Commodity Basis Spread." *Journal of Financial Economics* 110 (1): 164–84. https://doi.org/10.1016/j.jfineco.2013.04.012.

Zeileis, Achim, Christian Kleiber, Walter Krämer, and Kurt Hornik. 2003. "Testing and Dating of Structural Changes in Practice." *Computational Statistics & Data Analysis* 44 (1-2): 109–23. https://doi.org/10.1016/S0167-9473(03)00030-6.

Zhang, Yue-Jun, Julien Chevallier, and Khaled Guesmi. 2017. ""De-Financialization" of Commodities? Evidence from Stock, Crude Oil and Natural Gas Markets." *Energy Economics* 68: 228–39. https://doi.org/10.1016/j.eneco.2017.09.024.