Financialisation of Commodity Markets
Co-movement Behind-the-Scenes

Devraj Basu[a,*], Olivier Bauthéac[a]

[a] *University of Strathclyde Business School, Accounting & Finance, 199 Cathedral Street, Glasgow, G4 0QU*

Abstract

In the early 2000s institutional investors entered the commodity futures markets en masse with passive, long only, index type positions in sharp contrast with those typically assumed by traditional expert participants. A heated public debate soon erupted over the perceived consequences of the phenomenon–commonly referred to as "financialisation"—and, in response to immediate policy concerns, the matter was thrust onto the academic sphere as a burning issue. With the benefit of hindsight it now seems that the academic debate was framed rather narrowly, used contentious research methods, and eventually led to regulatory changes that were therefore perhaps unwarranted. In contrast, we take a broader approach where we consider a large cross-section of liquid commodities as suggested by the nature of financialisation that comprehends commodity futures as an asset class. Using a bespoke asset pricing factors based framework we study the issue through the lens of co-movement and find that the phenomenon had ontological consequences for the commodity complex with its impact extending beyond the mechanical effects induced by indexation. The onset of the financial crisis and the monetary policy regimes that followed, on the other hand, seem to have set off a motion of reversion to legacy pre-financialisation fundamentals.

Keywords: Commodity markets, Financialisation, Asset pricing

*Corresponding author
Email addresses: devraj.basu@strath.ac.uk (Devraj Basu), olivier.bautheac@strath.ac.uk (Olivier Bauthéac)

1. Introduction

The last twenty years have seen major upheavals in the commodity markets with the onset of financialisation[1] 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[2] 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 limited. Most of the studies underpinning the regulatory response to 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. 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 tailored to detect

[1]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).

[2]See section Section 2.1 for a detailed discussion.

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; Carhart, 1997; Asness and Frazzini, 2013; Fama and French, 2015; Hou et al., 2015; Asness et al., 2015; Frazzini and Pedersen, 2014; Asness et al., 2019) at a broader level, beyond individual pairs of assets, and are commonly used to study commodity market fundamentals (Schwartz and Smith, 2000; Miffre and Rallis, 2007; Gorton et al., 2012; Cortazar et al., 2013; Yang, 2013; Daskalaki et al., 2014; Szymanowska et al., 2014; Fernandez-Perez et al., 2018; Bakshi et al., 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 (Houthakker, 1957a; Cootner, 1960), 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). The cross-sectional nature of financialisation (Cheng and Xiong, 2014; Basak and Pavlova, 2016) further leads us to extend this paradigm by incorporating aggregate CHP (**CHP**), a market wide measure of hedging pressure first considered in Hong and Yogo (2012). In this context, returns for individual commodities should be high in periods where **CHP** is low (**backwardation**) and low in periods where **CHP** is high (**contango**). 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 et al. (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[3]); 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.

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**, 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 et al. (2012) arguing that financial investors provide liquidity and Kang et al. (2020) taking the opposite stance. Our analysis of individual commodity returns' relation with both

[3]Starting point based on earlier studies (Baker, 2021; Christoffersen et al., 2014).

CHP and **CHP** before and during financialisation sheds a new light on this issue with our results suggesting that financial investors may have been liquidity demanders leading hedgers to become liquidity providers.

Goldstein et al. (2014) and Goldstein and Yang (2022) 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), Houthakker (1957b), 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 (1960), Weymar (1966), Danthine (1978), Turnovsky (1983), 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[4] 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 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 substantial pull-back 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 (2024), the financial crisis and ensuing accommodative mon-

[4]See section Section 2.3 for further details.

etary 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 triggering a reversion to pre-financialisation dynamics.

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[5]. However, the fundamental question of the nature of the impact of financialisation 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[6] 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).

[5] Masters (2008); Masters and White (2008); UNCTAD and Cooperation (2009); De Schutter (2010); Gilbert (2010a); Gilbert (2010b); Herman et al. (2011); Schumann (2011); Singleton (2013).

[6] Etula (2013), Acharya et al. (2013), Cheng et al. (2014), Leclercq and Praz (2014), Sockin and Xiong (2015), Goldstein et al. (2014), Ekeland et al. (2016), Goldstein and Yang (2022), Ekeland et al. (2019), Isleimeyyeh (2020).

2. Data & methods

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)[7].

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, 2010b; Herman et al., 2011; Schumann, 2011; UNCTAD and Cooperation, 2009).
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 (Masters, 2008; 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: Irwin et al. (2009), Sanders et al. (2010), Sanders and Irwin (2011a), Sanders and Irwin (2011b), Irwin (2013), Brunetti and Reiffen (2014), Hamilton and Wu (2015) and Bruno et al. (2017) investigated the issue in the context of the agricultural markets; meanwhile, Büyükşahin and Harris (2011), Tokic (2012), Fattouh et al. (2013), Kilian and Murphy (2014), Knittel and Pindyck (2016) and Manera et al. (2016) examined the energy markets while Bohl and Stephan (2013), Kim (2015) and Boyd et al. (2016) studied both energy and agricultural markets and Irwin and Sanders (2011), Irwin and Sanders (2012) 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 et al. (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.

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

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 et al., 2012; Henderson et al., 2015; 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 1$^{\text{st}}$, 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). This sample cross-section of assets is further divided into groups for the purpose of the analysis by country (US, GB), sector (agriculturals, energy, metals) and by sub-sector (agriculturals: grains, livestock, softs; energy: gas, petroleum; metals: base, precious).

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[8]. 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[9] 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"[10]. A third category, "non-reportable", aggregates positions for participants not meeting the reporting threshold. In response to concerns related to category accuracy[11] 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 examine the period from 1997 to 2018, during which we utilize futures-only position data from the COT report—the only CFTC report providing data for the entire duration of interest—as well as futures term structure price and open interest data sourced from Bloomberg. The sample period is further divided into

[8] Current reporting level thresholds available at: www.ecfr.gov.

[9] CFTC form 40. Available at: www.cftc.gov.

[10] See CFTC regulation 1.3, 17 CFR 1.3(z) for details.

[11] See for example Ederington and Lee (2002).

four distinct intervals. The pre-financialisation era spans the 1997-2003 period and is naturally followed by the financialisation phase running from 2004 to 2008 which in turn leads into the financial crisis and its aftermath, covering 2008 to 2013. The final interval starts in 2013 with the onset of tapering and the conclusion of the US Quantitative Easing (QE) program.

2.3. Methods

For each commodity asset we compute the weekly front futures return and commercial hedging pressure (CHP) time series with the CHP calculated as the ratio of the number of long commercial positions to the total number of commercial positions for the considered asset-week combination. For each asset-period combination we compute the average return and corresponding volatility over the entire period as well as over phases of cross-sectional low and high CHP[12]. These statistics are also computed for equally weighted portfolios of the US and GB traded commodity assets independently.

For each period, the return series for the individual US-traded assets are regressed on both the relative change on their respective CHP series and that on the cross-sectional CHP independently. The resulting R^2 values are then averaged by sector and subsector. Additionally, pairwise correlations are computed for each combination of assets across the periods of interest and for each individual year within the full sample period. These correlation coefficients are subsequently averaged across the entire cross-section of assets, as well as by country, sector, and subsector. For each period, the coefficients are also calculated and averaged across phases of low and high cross-sectional CHP.

This approach sheds light on the evolving interconnectedness among commodity assets as the complex transitions from traditional market dynamics—where commodity producers and speculators had distinct roles—to a more intricate landscape shaped by the influx of financial investors.

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, 1953) 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 et al., 2016; Boyd et al., 2016; Cheng et al., 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.

By grouping together assets by shared attribute dynamics in common portfolios, asset pricing techniques–and factor models in particular–are well suited to study co-movement (Fama and French, 1993; Carhart, 1997; Asness and Frazzini, 2013; Fama and French, 2015; Hou et al., 2015; Asness et al., 2015; Frazzini and

[12] Aggregate CHP or **CHP**: see below for a formal definition and description of the phase construction process.

Pedersen, 2014; Asness et al., 2019). Careful, theory-based, attribute selection further enables a refined analysis of market fundamentals (Schwartz and Smith, 2000; Miffre and Rallis, 2007; Gorton et al., 2012; Cortazar et al., 2013; Yang, 2013; Daskalaki et al., 2014; Szymanowska et al., 2014; Fernandez-Perez et al., 2018; Bakshi et al., 2019; Boons and Prado, 2019; Sakkas and Tessaromatis, 2020). We therefore develop a futures-based asset pricing framework that includes factors constructed using both theoretical and liquidity considerations. Using the weekly returns, 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 combinations 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.

All portfolios are equally weighted and returns for the two-legged factors are calculated as the difference between the average return for constituents of the long leg and that for the constituents of the short. i.e, return on the mimicking portfolio for risk factor i (f_i) for period t:

$$r_t^{f_i} = \frac{1}{x}\left(\sum_{j=1}^{x} r_{j,t} - \sum_{j=n-x}^{n} r_{j,t}\right)$$

$n \equiv$ number of commodities in the set considered for mimicking portfolio construction.
$x = n \cdot s$.
$s \equiv$ selection threshold ($\frac{1}{3}$ here).
$r_{j,t} \equiv$ 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.
$F^2_{j,t} \equiv$ 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 individual commodity weekly front futures contract returns are regressed on returns to the mimicking portfolio for a particular risk factor with the corresponding βs and R^2s averaged. For the long-short factors the βs and R^2s are computed for models where the regressor is the factor itself as well as both its long and short legs independently (results available upon request).

For each time period considered in the study, being one of the four multi-year periods described above or any individual year over the entire sample time period, we carry out our analysis over the entire period as well as over phases of low and high aggregate CHP (**CHP**) over the period; 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 individual 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, sub-periods with **CHP** levels below and above the period's median respectively and, in contrast with (Hong and Yogo, 2012) who aggregate across sub-sectors, our **CHP** construction draws on the full cross-section of US-traded assets considered in the study.

By relating returns on attribute based risk factor mimicking portfolios to returns on individual as well as group of assets, our time series approach therefore draws the link between attribute and pricing dynamics over different, theory-based market regimes, and thereby enables us to study market fundamentals and co-movement simultaneously, two key issues in the financialisation phenomenon.

3. Results & discussion

Table 1 displays descriptive statistics for the commodity series considered in the study; the results 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 GB 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 GB assets, 10% to 13.6% (US) vs. 15.7% to 26.9% (GB), 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). Financialisation seems however to have impacted the commodity complex beyond these mechanical effects of increased long participation ensuing from the entry on index type investments as our results suggest next.

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 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. Table 1 further shows the mean returns and volatilities for 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 GB 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 (XLME)) 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 GB 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 GB 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 GB metals portfolio with a mean return of 8% during **backwardation** rising to 35.6% during **contango**.

The onset of financialisation thus 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 (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[13]. 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[14].
In the second model hedgers are seen as liquidity providers as in Kang et al. (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. Table 2 supports this view. We regress commodity futures front returns on individual commercial hedging pressure (CHP) as well as aggregate CHP (**CHP**), our market wide measure of CHP, in separate models and find that the explanatory power of CHP at the individual commodity level decreases over the financialisation period with the US cross-sectional average R^2 falling down to 20.8% from 25.8% in the previous period while that of **CHP** increases (7.1% vs 5.4%). Financialisation therefore seems to have had the effect of loosening the extent to which futures risk premiums relate to commodity specific commercial hedging motives while strengthening that to which they relate to broader dynamics such as cross-sectional liquidity provision. The pattern is strongest for the metals sector where the average R^2 drops down to 19.1% from 28.1% between the two periods at the individual level while it rises from 8.4% to 15.7% at the aggregate level. The symmetry breaks in the crisis period, with the US cross-sectional average R^2 at the individual level bouncing back up (22.5% vs 20.8%) while that at the aggregate level rises further (14.7% vs 7.1%), before eventually resuming post-crisis with a further rise at the individual level (27.2% vs 22.5%) and a drop at the aggregate level (7.5% vs 14.7%) suggesting a return to legacy commodity specific dynamics.

Financialisation was a global phenomenon, through the channel of index investment it simultaneously influenced the entire spectrum of liquid commodities; this sweeping impact spurred the transformation of commodity markets from a collection of idiosyncratic markets into a unified asset class with interconnectedness emerging as a crucial aspect that warrants thorough examination.
We strive to address this issue by first examining the average of weekly returns pairwise correlations between commodities across the entire cross-section of the commodity assets considered in the study as well as by country, sector and sub-sector. Table 3 shows the results for the four periods of interest with the results reported for the entire period as well as for periods of **backwardation** and **contango**. For the entire sample the average pairwise correlation jumps from 0.07 in the first period to 0.16 over financialisation. This finding indicate higher interdependence within the full cross-section of commodities starting with the financialisation period, consistent with the empirical findings in Fry-McKibbin and McKinnon (2023) and Mayer et al. (2017) as well as with the theoretical model of Basak and Pavlova (2016). The sector analysis sheds light on the driving force behind these changes. The US metals see the sharpest increase in pairwise correlations going from 0.22 over the past period to 0.56 over financialisation while the three other sectors see a much smaller percentage increase during financialisation relative to the past period. These results thus suggest that the US metals sector was the driving force behind increased average pairwise correlations during financialisation, a new observation to the best of our knowledge. The pattern of correlations is very similar across phases of **backwardation** and **contango** for all the sectors and sub-sectors over the past and financialisation periods which indicates that increased commodity interdependence over financialisation was not a phase driven phenomenon in the same way that individual commodity returns are, as demonstrated in Table 1.
We further examine these correlations by year in Table 4 to uncover any distinct breakpoints. For the full

[13] Hirshleifer (1975); Hirshleifer (1976); Hirshleifer (1977)
[14] Duffie (2014) also discusses some of the challenges faced by a policy treatment of speculative trading motivated by differences in beliefs.

sample of assets, the average pairwise correlations increase from 0.08 to 0.12 from 2003 to 2004 seemingly driven by US metals average pairwise correlations, more than doubling from 0.22 to 0.49, suggesting 2004 as the onset of financialization as noted in several studies (Baker, 2021; Tang and Xiong, 2012) and our contribution is to observe that the US metals sub-sector seems to have played a major role in this.

We investigate further the issue of co-movement from an asset pricing perspective using a bespoke asset pricing framework starting with a market factor mimicking portfolio constituted of the twenty-four US traded commodities considered in the study with equal weighting. This portfolio enables a refined examination of cross correlations across sectors as the numerator of the beta of the regression of the returns for an individual commodity against those for the market factor is driven by covariances while the denominator is driven by the individual commodity variance. Thus, an increase in a commodity's correlation with other commodities should lead to an increase in its beta relative to the market factor portfolio. We accordingly regress the weekly individual commodity front futures returns against those for our market factor portfolio and average the resulting betas across the entire set of commodity assets considered as well as by country, sector and sub-sector for each of the four periods of interest with the results shown in Table 5. The average beta for the US metals sector jumps sharply to 1.12 over financialisation from 0.63 over the previous period; the increase is even more dramatic for the base metals sub-sector (GB traded assets) in a relative sense. The group had a much lower beta of 0.27 over the past period, suggesting a low level of correlation with US commodities; this figure increases to 0.85 over the financialisation period, even beyond that for the US agricultural sector of 0.80. In contrast, the corresponding figure for the energy sector show a substantial decrease, down to 1.61 during financialisation from 2.33 over the past period.
The corresponding pricing performance displays a similar pattern as shown in Table 6 where for each period the corresponding R^2 values are independently averaged over the entire period as well as over periods of **contango** and **backwardation**. The average R^2 for the market factor across the entire cross-section of commodity assets considered in the study, including the GB traded base metals, increases to around 20% during financialisation compared to around 10% over the previous period with the rise driven by the metals sector at large. The sector average for the US traded assets jumps to 31% during financialisation from 7.5% over the past period while for the GB traded assets the corresponding figure increases from less than 2%, or virtually no explanatory power for the (US based) market factor, to almost 12% over the financialisation period. The results for our other risk factor mimicking portfolios show a similar pattern and provide a deeper insights into co-movement dynamics in this context. All three factors—CHP, open interest and term structure—performed poorly in the first period, indicating that the commodities with extreme factor attributes (high or low CHP for example) were uncorrelated with the rest of the commodity cross-section, and the overall performance consistent across periods of **contango** and **backwardation**. The onset of financialisation leads to a substantial improvement in the performance of the CHP factor with its average R^2, albeit still small at 5.4%, almost tripling from the past to the financialisation period in contrast to the other factors that show weaker dynamics with a slight decrease and a much smaller increase for the open interest and term structure factors respectively. Here again the increase in pricing performance for the CHP factor is driven by the metals sector, particularly the precious sub-sector with the average R^2 for the group jumping to almost 26% during financialisation from 1.2% over the past period. The corresponding figures of 22% and 1.1% for the entire US metals sector stand in sharp contrast with the agricultural sector, which exhibits no notable change, and the energy sector, where pricing performance drops substantially from 9.2% down to 1.6%. The improvement in the CHP factor's pricing performance remarkably comes predominantly from the long leg (low CHP assets: Keynesian "normal backwardation") of the factor^{Results available from the authors upon request.} with the corresponding mimicking portfolio's performance itself driven by the metals, the precious sub-sector in particular. The average R^2 for the group jumps to 55% during financialisation from less than 12% over the past period while the short leg sees a far smaller increase, up to 8.9% from 3.3% over the past period. Interestingly, although the term structure factor itself only sees a very modest increase, its short leg (low roll-yield assets: Working's backwardation) shows a sizeable rise in pricing performance, yet again driven the metals sector, with the average R^2 for the group's US traded assets jumping to 28.2% during financialisation from 6.2% over the past period. The pattern of results for both factors extends to the GB trade assets and suggest a convergence of Keneysian and Working's term

structure perspective over the financialisation period.
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 et al. (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 GB 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. Returns are mostly higher during phases of **backwardation** relative to **contango** with fifteen US assets and five of the GB 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 GB 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 GB traded metals show higher volatility figures over **backwardation** phases. The symmetry between the dynamics of CHP and **CHP**'s explanatory power on individual commodity returns breaks in the crisis period (Table 2) with both now seemingly converging; the US cross-sectional average R^2 at the individual level bouncing back up (22.5% vs 20.8%) while that at the aggregate level rises further (14.7% vs 7.1%).

The average pairwise correlation for the entire cross-section of commodities considered in the study (Table 3) increases further into the crisis to 0.28 indicating an intensification of the higher interdependence within the full cross-section of commodities prompted by financialisation. The result is consistent with the greater interdependence between equity and commodity markets over this period documented in Silvennoinen and Thorp (2013). The figure for the US traded section of the metals sector only progresses modestly to 0.59 after peaking at 0.63 in 2006 (Table 4). In contrast, the GB traded assets see a sharp increase to over 0.65 in the crisis starting in 2007 up to a peak of 0.69 in 2010. The agricultural sector on the other hand shows a substantial rise in the crisis period with the sharpest increase in 2008 when the average pairwise correlation for the sector jumps to 0.30. Meanwhile, the energy sector also shows a notable progression starting in 2007 and peaking at 0.63 in 2008 before levelling back down over the rest of the period. The onset of the financial crisis seems therefore to have had an across the board impact on the interdependence of commodities in contrast with financialisation, much more closely related to the metals sector.

The entire cross-section sees an increase in average regression coefficient relative to the market factor over the crisis period with the strongest progression for the GB traded metals followed by the agricultural sector (Table 5). The pricing performance of the factor dominates the US commodity complex over the period (Table 6), showing a 50% increase in mean average R^2 to over 31%, while that for both the CHP and open interest factor decreases and, although increasing, remains modest for the term structure factors; the increase is strongest for the GB traded metal assets with an average R^2 of almost 34% for the period. Taken together, these results indicate the presence of a systematic factor across the entire cross-section of the US commodities. For both the CHP and term structure factors, both legs show an increase in average R^2 and while substantially diverging over the preceding financialisation period the pricing performance for both legs seems to converge back to a pattern closer to that observed pre-financialisation.

The returns pull-back 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.
The pattern of reversion toward the pre-financialisation Keynesian paradigm initiated during the crisis continues stronger into the post-crisis period with mean returns higher during phases of **backwardation** relative to **contango**, 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. After showing signs of convergence in the crisis period the dynamics of the explanatory power of CHP and **CHP** part ways (Table 2), seemingly reverting to the Keynesian paradigm observed pre-financialisation, further suggesting a return to legacy commodity specific dynamics. 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 average pairwise correlations fall across the board in the post-crisis period, below the levels observed during financialisation, with the figure for the entire cross-section (Table 3) dropping down to 0.12 from 0.28 over the crisis. This substantial decline, that does not appear to have been widely noted, appears to begin in the latter part of the crisis period, around 2012 (Table 4), before levelling down over the whole post-crisis period.

In a similar vein, the average market factor beta for the entire cross-section drops down to 0.94 (Table 5), below the level observed during financialization. The decline seems driven by the metals sector, particularly the GB traded segment, with the figures for the US and GB traded assets at 0.91 and 0.72, down from 1.12 and 1.18, respectively. Meanwhile, the pricing performance of the market factor also retreats to below financialisation levels with the average R^2 for the entire cross-section dropping down to 14.7% (Table 6). All sectors seem affected with agriculturals, energy and metals all seeing their average R^2 decline below the levels observed during the financialisation period albeit remaining above 10% for the GB traded metals against less than 2% pre-financialisation. Similarly, the performance for both the CHP and term structure factors falls back to levels below those attained over financialisation while the gap between their long and short legs remains narrower than observed during that period. These results, along with those from the crisis period,

suggest that the exogenous shock of the financial crisis, combined with the subsequent accommodative monetary policy, may have triggered a reversion toward pre-financialization fundamentals in the commodity futures complex; an issue that, to our knowledge, has not been widely discussed in the existing literature.
The phases analysis further documents the emerging role/dominance of the **contango** regime post-crisis with average correlations higher during those phases and the pattern stronger for the metal assets both US and GB traded. Similarly, for the latter the pricing performance of the market factor is considerably better during phase of **contango** in contrast with the previous periods that showed no substantial difference between phase of **contango** and **backwardation**. The figures for the US and GB traded segments of the sector are 23% (**contango**) vs 11.5% (**backwardation**) against 36.2% vs 43% during financialisation and 14.4% (**contango**) vs 6.6% (**backwardation**) against 33.5% vs 34.4% during financialisation respectively. Taken together, these results indicate some recent changes in the correlation structure within the sector and along with the decline in interdependence in the commodity sector at large documented above, this observation could form a valuable basis for future research.
These findings further providence additional evidence that the interdependence effects of financialization seems to have been strongest for the entire cross-section of the metals sector with a lesser impact for the other sectors.

4. Conclusion

In the early 2000s, against a backdrop of a low yield environment and poor stock market performance, a combination of financial innovations[15] and regulatory changes[16] 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 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 had cross-sectional effects on market fundamentals across 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 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.

[15] 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.

[16] 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.

5. Tables

Table 1: This table shows mean returns and volatility for the twenty four individual US commodities and the six GB metals considered in the study as well as for two equally weighted portfolios formed from the US commodities and the GB metals respectively across the four periods of interest (past: 1997-2003; financialisation: 2004-2008; crisis: 2008-2013; post-crisis: 2013-2018). for each period the figures are shown independently for the entire period as well as for phases of aggregate backwardation (aggregate CHP $\leq$ 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 2.3 while the results are discussed in Section 3.

asset	regime	estimate	past	financialisation	crisis	post-crisis
Corn-#2 yellow (XCBT)	whole period	mean	3.48%	21.37%	6.89%	-4.51%
Corn-#2 yellow (XCBT)	whole period	volatility	23%	29.54%	36.15%	21.8%
Corn-#2 yellow (XCBT)	backwardation	mean	-4.86%	19.26%	20.48%	-8.74%
Corn-#2 yellow (XCBT)	backwardation	volatility	23.07%	29.14%	31.59%	21%
Corn-#2 yellow (XCBT)	contango	mean	11.3%	23.54%	-4.43%	0.78%
Corn-#2 yellow (XCBT)	contango	volatility	23%	30.01%	40.14%	22.68%
Oats (XCBT)	whole period	mean	5.49%	21.62%	8.89%	-0.87%
Oats (XCBT)	whole period	volatility	32.22%	31.04%	34.67%	29.5%
Oats (XCBT)	backwardation	mean	-5.39%	7.82%	7.85%	2.56%
Oats (XCBT)	backwardation	volatility	29.02%	33.82%	31.43%	31.55%
Oats (XCBT)	contango	mean	16.95%	*35.38%	11.68%	-3.17%
Oats (XCBT)	contango	volatility	35.22%	28.1%	37.7%	27.5%
Soybean meal (XCBT)	whole period	mean	7.29%	12.06%	8.12%	-0.33%
Soybean meal (XCBT)	whole period	volatility	26.34%	32.55%	31.78%	25.11%
Soybean meal (XCBT)	backwardation	mean	13.15%	8.22%	16.04%	-3.52%
Soybean meal (XCBT)	backwardation	volatility	27.77%	33.06%	25.7%	25.1%
Soybean meal (XCBT)	contango	mean	1.52%	15.91%	2.32%	2.22%
Soybean meal (XCBT)	contango	volatility	24.94%	32.13%	36.85%	25.32%
Soybean oil (XCBT)	whole period	mean	6.21%	15.57%	4.04%	-7.39%
Soybean oil (XCBT)	whole period	volatility	21.43%	28.35%	25.75%	18.95%
Soybean oil (XCBT)	backwardation	mean	14.79%	14.62%	20.34%	-9.44%
Soybean oil (XCBT)	backwardation	volatility	21.35%	28.94%	22.33%	18.19%
Soybean oil (XCBT)	contango	mean	-2.68%	16.62%	-10.01%	-4.12%
Soybean oil (XCBT)	contango	volatility	21.55%	27.91%	28.65%	19.79%
Soybeans (XCBT)	whole period	mean	6.89%	13.36%	6.19%	-3.82%
Soybeans (XCBT)	whole period	volatility	21.47%	30.04%	28%	21.22%
Soybeans (XCBT)	backwardation	mean	13.69%	0.93%	13.42%	-11.45%
Soybeans (XCBT)	backwardation	volatility	21.93%	34.58%	24.39%	22.04%
Soybeans (XCBT)	contango	mean	-0.16%	25.71%	0.96%	3.75%
Soybeans (XCBT)	contango	volatility	21.09%	24.74%	31.11%	20.56%
Wheat-SRW (XCBT)	whole period	mean	5.07%	17.63%	6.68%	-1.58%
Wheat-SRW (XCBT)	whole period	volatility	24.93%	33.03%	37.62%	26.58%
Wheat-SRW (XCBT)	backwardation	mean	-2.7%	19.02%	0.98%	0.44%
Wheat-SRW (XCBT)	backwardation	volatility	25.79%	36%	37.53%	26.57%
Wheat-SRW (XCBT)	contango	mean	11.78%	16.29%	14.57%	-2.77%
Wheat-SRW (XCBT)	contango	volatility	24.04%	29.84%	37.73%	26.72%
Cattle-feeder (XCME)	whole period	mean	0.39%	7.43%	7.13%	1.87%
Cattle-feeder (XCME)	whole period	volatility	13.23%	15.16%	15.24%	18.69%
Cattle-feeder (XCME)	backwardation	mean	2.31%	**20.52%	7.51%	6.58%
Cattle-feeder (XCME)	backwardation	volatility	12.79%	14.93%	13.39%	20.14%
Cattle-feeder (XCME)	contango	mean	-0.81%	-5.49%	7.28%	-3.12%
Cattle-feeder (XCME)	contango	volatility	13.67%	15.35%	16.91%	17.23%
Cattle-live (XCME)	whole period	mean	3.45%	8.77%	4.13%	1.92%
Cattle-live (XCME)	whole period	volatility	17.1%	17.43%	16.32%	18.3%
Cattle-live (XCME)	backwardation	mean	8.39%	14.2%	5.87%	-2.07%
Cattle-live (XCME)	backwardation	volatility	16.65%	17.91%	14.97%	19.9%
Cattle-live (XCME)	contango	mean	-0.34%	3.43%	2.7%	5.82%
Cattle-live (XCME)	contango	volatility	17.49%	16.99%	17.57%	16.66%
Lean hogs (XCME)	whole period	mean	0.73%	8.4%	12.69%	-1.09%
Lean hogs (XCME)	whole period	volatility	38.33%	31.89%	30.37%	36.94%

Lean hogs (XCME)	backwardation	mean	12.34%	16.3%	18.23%	19.24%
Lean hogs (XCME)	backwardation	volatility	37.6%	35.73%	27.83%	35.61%
Lean hogs (XCME)	contango	mean	-10.5%	0.6%	7.5%	-20.66%
Lean hogs (XCME)	contango	volatility	39.22%	27.67%	32.78%	38.28%
Cocoa (IFUS)	whole period	mean	3.66%	16.35%	1.39%	3.65%
Cocoa (IFUS)	whole period	volatility	32.66%	29.99%	31.03%	24.69%
Cocoa (IFUS)	backwardation	mean	4.12%	9.25%	-9.56%	-2.98%
Cocoa (IFUS)	backwardation	volatility	33.57%	31.05%	26.93%	25.86%
Cocoa (IFUS)	contango	mean	3.67%	23.43%	12.92%	10.29%
Cocoa (IFUS)	contango	volatility	31.81%	28.91%	34.66%	23.57%
Coffee-C (IFUS)	whole period	mean	-5.91%	20.38%	2.2%	1.99%
Coffee-C (IFUS)	whole period	volatility	43.84%	32.3%	30.17%	31.86%
Coffee-C (IFUS)	backwardation	mean	4.51%	26.49%	2.66%	14.36%
Coffee-C (IFUS)	backwardation	volatility	48.82%	32.6%	29.92%	31.52%
Coffee-C (IFUS)	contango	mean	-16.87%	14.38%	3.4%	-10.24%
Coffee-C (IFUS)	contango	volatility	38.35%	32.06%	30.22%	32.24%
Cotton-#2 (IFUS)	whole period	mean	3.24%	0.95%	12.53%	0.5%
Cotton-#2 (IFUS)	whole period	volatility	26.38%	29.01%	33.26%	20.61%
Cotton-#2 (IFUS)	backwardation	mean	22.64%	7.85%	35.53%	10.84%
Cotton-#2 (IFUS)	backwardation	volatility	26.02%	29.71%	33.94%	21.33%
Cotton-#2 (IFUS)	contango	mean	-16.46%	-5.92%	-9.36%	-8.91%
Cotton-#2 (IFUS)	contango	volatility	26.77%	28.35%	32.59%	19.95%
Lumber (XCME)	whole period	mean	1.9%	-3.58%	11.74%	5.06%
Lumber (XCME)	whole period	volatility	30.58%	29.39%	36.31%	25.1%
Lumber (XCME)	backwardation	mean	-8.48%	-2.37%	29.11%	**26.99%
Lumber (XCME)	backwardation	volatility	30.43%	30.72%	35.45%	21.26%
Lumber (XCME)	contango	mean	11.68%	-4.77%	-5.04%	-17.14%
Lumber (XCME)	contango	volatility	30.56%	28.2%	37.23%	28.45%
Orange juice (IFUS)	whole period	mean	1.67%	13.87%	14.4%	3.8%
Orange juice (IFUS)	whole period	volatility	29.5%	33.01%	34.43%	29.37%
Orange juice (IFUS)	backwardation	mean	-2.38%	-2.22%	18.24%	18.64%
Orange juice (IFUS)	backwardation	volatility	28.01%	33.01%	30.09%	28.64%
Orange juice (IFUS)	contango	mean	5.83%	29.93%	12.29%	-8.64%
Orange juice (IFUS)	contango	volatility	31.05%	33.1%	38.06%	30.11%
Sugar-#11 (IFUS)	whole period	mean	-4.56%	24.87%	11.82%	-1.16%
Sugar-#11 (IFUS)	whole period	volatility	34.88%	33.25%	37.9%	28.72%
Sugar-#11 (IFUS)	backwardation	mean	11.98%	29.51%	2.7%	-8.07%
Sugar-#11 (IFUS)	backwardation	volatility	33.23%	33.6%	41.29%	27.69%
Sugar-#11 (IFUS)	contango	mean	-20.49%	20.35%	21.47%	4.7%
Sugar-#11 (IFUS)	contango	volatility	36.48%	32.98%	34.09%	29.83%
Natural gas (XNYM)	whole period	mean	35.38%	16.25%	0.93%	8.33%
Natural gas (XNYM)	whole period	volatility	61.55%	54.6%	53.58%	44.58%
Natural gas (XNYM)	backwardation	mean	**85.84%	4.76%	-2.32%	18.33%
Natural gas (XNYM)	backwardation	volatility	63.46%	47.3%	48.85%	42.59%
Natural gas (XNYM)	contango	mean	-11.98%	27.84%	4.77%	3.25%
Natural gas (XNYM)	contango	volatility	59.76%	61.3%	58.18%	46.41%
Crude oil-WTI (XNYM)	whole period	mean	15.43%	*28.74%	9.67%	-5.64%
Crude oil-WTI (XNYM)	whole period	volatility	39.87%	32.56%	42.84%	34.69%
Crude oil-WTI (XNYM)	backwardation	mean	29.17%	*35.61%	11.47%	14.24%
Crude oil-WTI (XNYM)	backwardation	volatility	36.74%	32.09%	28.19%	26.94%
Crude oil-WTI (XNYM)	contango	mean	2.21%	22.04%	9.95%	-24.85%
Crude oil-WTI (XNYM)	contango	volatility	42.74%	33.1%	53.7%	41.08%
Gasoline (XNYM)	whole period	mean	16.65%	30.95%	10.59%	-5.37%
Gasoline (XNYM)	whole period	volatility	42.77%	41.76%	40.07%	37.09%
Gasoline (XNYM)	backwardation	mean	39%	19.82%	23.98%	9.69%
Gasoline (XNYM)	backwardation	volatility	42.47%	39.38%	31.41%	32.1%
Gasoline (XNYM)	contango	mean	-5.22%	42.13%	-0.09%	-19.47%
Gasoline (XNYM)	contango	volatility	43.14%	44.13%	47.11%	41.71%
Heating oil (XNYM)	whole period	mean	16.31%	*29.88%	6.83%	-3.44%
Heating oil (XNYM)	whole period	volatility	40.75%	35.09%	33.17%	30.56%
Heating oil (XNYM)	backwardation	mean	36.32%	29.41%	25.56%	15.16%
Heating oil (XNYM)	backwardation	volatility	41.37%	33.33%	25.95%	24.62%

Heating oil (XNYM)	contango	mean	-2.74%	30.5%	-10.77%	-21.62%
Heating oil (XNYM)	contango	volatility	40.19%	36.98%	39.16%	35.69%
Copper (XCEC)	whole period	mean	1.45%	*28.15%	6.19%	-0.1%
Copper (XCEC)	whole period	volatility	21.23%	31.89%	34.91%	19.56%
Copper (XCEC)	backwardation	mean	3.14%	22.17%	16.53%	12.1%
Copper (XCEC)	backwardation	volatility	20.71%	30.05%	25.73%	18.16%
Copper (XCEC)	contango	mean	-0.28%	34.17%	-3.46%	-12.15%
Copper (XCEC)	contango	volatility	21.78%	33.69%	42.28%	20.87%
Gold (XCEC)	whole period	mean	4.5%	14.35%	14.01%	0.53%
Gold (XCEC)	whole period	volatility	15.14%	18.89%	21.46%	14.41%
Gold (XCEC)	backwardation	mean	9.19%	13.37%	9.37%	4.21%
Gold (XCEC)	backwardation	volatility	16.89%	19.2%	17.03%	12.36%
Gold (XCEC)	contango	mean	-0.01%	15.37%	19.1%	-3.1%
Gold (XCEC)	contango	volatility	13.24%	18.58%	25.21%	16.23%
Palladium (XNYM)	whole period	mean	9.12%	9.03%	*29.12%	13.75%
Palladium (XNYM)	whole period	volatility	38.27%	32.71%	36.14%	25.38%
Palladium (XNYM)	backwardation	mean	**49.79%	24.47%	30.01%	**31.93%
Palladium (XNYM)	backwardation	volatility	34.98%	34.23%	33.49%	23.82%
Palladium (XNYM)	contango	mean	-30.19%	-6.3%	30.58%	-4.88%
Palladium (XNYM)	contango	volatility	41.22%	31.2%	38.71%	26.8%
Platinum (XNYM)	whole period	mean	12.93%	10.56%	7.29%	-7.92%
Platinum (XNYM)	whole period	volatility	22.62%	22.66%	25.53%	19.48%
Platinum (XNYM)	backwardation	mean	**29.46%	*25.07%	10.46%	1.17%
Platinum (XNYM)	backwardation	volatility	22.1%	22.51%	21.24%	18.04%
Platinum (XNYM)	contango	mean	-3.22%	-3.81%	8.04%	-17.28%
Platinum (XNYM)	contango	volatility	23.12%	22.81%	28.75%	20.8%
Silver (XCEC)	whole period	mean	6.19%	17.54%	21.96%	-2.43%
Silver (XCEC)	whole period	volatility	22%	33.92%	39.87%	24.35%
Silver (XCEC)	backwardation	mean	5.98%	14.29%	19.66%	3.44%
Silver (XCEC)	backwardation	volatility	21.07%	32.5%	37.17%	20.3%
Silver (XCEC)	contango	mean	6.57%	20.83%	26.77%	-8.09%
Silver (XCEC)	contango	volatility	22.93%	35.34%	42.44%	27.77%
Aluminium (XLME)	whole period	mean	1.13%	13.78%	-3.58%	3.15%
Aluminium (XLME)	whole period	volatility	17.6%	26.41%	26.48%	18.56%
Aluminium (XLME)	backwardation	mean	2.56%	14.78%	16.25%	**23.68%
Aluminium (XLME)	backwardation	volatility	14.82%	25.57%	24.94%	18.94%
Aluminium (XLME)	contango	mean	-0.38%	12.86%	-23.04%	-16.74%
Aluminium (XLME)	contango	volatility	20.13%	27.29%	28.01%	18.23%
Copper (XLME)	whole period	mean	0.45%	**28.59%	5.74%	0.03%
Copper (XLME)	whole period	volatility	19.25%	31.09%	34.27%	18.92%
Copper (XLME)	backwardation	mean	1.54%	25.22%	18.66%	11.99%
Copper (XLME)	backwardation	volatility	17.98%	29.01%	25.53%	17.92%
Copper (XLME)	contango	mean	-0.95%	32%	-6.78%	-11.89%
Copper (XLME)	contango	volatility	20.41%	32.98%	41.31%	19.86%
Lead (XLME)	whole period	mean	3.83%	28.99%	10.74%	2.07%
Lead (XLME)	whole period	volatility	19.64%	41.74%	41.05%	23.26%
Lead (XLME)	backwardation	mean	7.59%	11.21%	9.87%	17.05%
Lead (XLME)	backwardation	volatility	19.16%	39.91%	35.35%	23.37%
Lead (XLME)	contango	mean	-0.09%	*46.48%	12.65%	-13.41%
Lead (XLME)	contango	volatility	20.12%	43.16%	46.22%	23.09%
Nickel-primary (XLME)	whole period	mean	19.31%	12.5%	3.52%	0.31%
Nickel-primary (XLME)	whole period	volatility	32.26%	44.27%	41.45%	28.98%
Nickel-primary (XLME)	backwardation	mean	23.25%	-39.24%	16.3%	**35.09%
Nickel-primary (XLME)	backwardation	volatility	30.23%	41.62%	34.48%	29.13%
Nickel-primary (XLME)	contango	mean	15.46%	**63.47%	-7.67%	**-34.64%
Nickel-primary (XLME)	contango	volatility	34.28%	46.72%	47.44%	28.6%
Tin-refined (XLME)	whole period	mean	4.07%	*29.1%	7.46%	1.68%
Tin-refined (XLME)	whole period	volatility	15.38%	31.71%	35.61%	18.79%
Tin-refined (XLME)	backwardation	mean	*15.83%	34.62%	23.7%	4.48%
Tin-refined (XLME)	backwardation	volatility	14.99%	31.4%	29.09%	15.27%
Tin-refined (XLME)	contango	mean	-7.78%	23.88%	-6.82%	-1.69%
Tin-refined (XLME)	contango	volatility	15.77%	32.08%	41.13%	21.68%

Zinc (XLME)	whole period	mean	-4.52%	20.13%	7.62%	9.07%
Zinc (XLME)	whole period	volatility	21.73%	38.77%	36.17%	23.25%
Zinc (XLME)	backwardation	mean	-9.06%	2.95%	10.05%	**29.42%
Zinc (XLME)	backwardation	volatility	21.15%	36.86%	33.28%	22.12%
Zinc (XLME)	contango	mean	-0.13%	37.11%	5.43%	-11.31%
Zinc (XLME)	contango	volatility	22.38%	40.51%	39.03%	24.32%
US commodities	whole period	mean	*6.89%	**15.89%	9.39%	-0.18%
US commodities	whole period	volatility	10%	13.62%	17.58%	9.86%
US commodities	backwardation	mean	***15.44%	*15.66%	13.4%	6.82%
US commodities	backwardation	volatility	9.88%	14.21%	14.83%	8.59%
US commodities	contango	mean	-1.09%	*16.16%	4.9%	-6.33%
US commodities	contango	volatility	10.09%	13.05%	19.98%	10.95%
GB commodities	whole period	mean	2.47%	*21.77%	5.25%	2.72%
GB commodities	whole period	volatility	15.66%	26.91%	30.24%	16.19%
GB commodities	backwardation	mean	4.41%	8.01%	15.06%	**19.95%
GB commodities	backwardation	volatility	14.39%	25.92%	25.94%	15.13%
GB commodities	contango	mean	0.34%	*35.56%	-5.24%	-14.05%
GB commodities	contango	volatility	16.87%	27.88%	34.06%	17.1%

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 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 3.

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

Table 3: This table shows the average pairwise correlation coefficients calculated independently across the whole cross-section of commodity assets considered in the study as well as across countries and commodity sectors and subsectors for the four periods of interest (past: 1997-2003; financialisation: 2004-2008; crisis: 2008-2013; post-crisis: 2013-2018). For each period, the results are calculated independently over the entire period as well as over phases of aggregate backwardation and contango. Aggregate CHP construction and corresponding regime definitions are discussed in Section 2.3 while the results are discussed in Section 3.

country	sector	subsector	regime	past	financialisation	crisis	post-crisis
all	all	all	whole period	0.0737	0.1638	0.2849	0.1282
all	all	all	backwardation	0.0724	0.1790	0.2709	0.1001
all	all	all	contango	0.0748	0.1501	0.2985	0.1495
US	all	all	whole period	0.0684	0.1545	0.2526	0.1096
US	all	all	backwardation	0.0642	0.1697	0.2323	0.0859
US	all	all	contango	0.0720	0.1402	0.2706	0.1268
US	agriculturals	all	whole period	0.0910	0.1305	0.2322	0.1075
US	agriculturals	all	backwardation	0.0799	0.1421	0.1975	0.0955
US	agriculturals	all	contango	0.1018	0.1184	0.2611	0.1186
US	agriculturals	grains	whole period	0.4421	0.4898	0.5673	0.3728
US	agriculturals	grains	backwardation	0.4312	0.5283	0.5749	0.3289
US	agriculturals	grains	contango	0.4570	0.4510	0.5675	0.4161
US	agriculturals	livestock	whole period	0.3340	0.2868	0.3707	0.3333
US	agriculturals	livestock	backwardation	0.3053	0.2652	0.3906	0.3220
US	agriculturals	livestock	contango	0.3605	0.3150	0.3557	0.3483
US	agriculturals	softs	whole period	0.0391	0.0853	0.1584	0.0764
US	agriculturals	softs	backwardation	0.0437	0.0845	0.1210	0.0685
US	agriculturals	softs	contango	0.0334	0.0874	0.1937	0.0833
US	energy	all	whole period	0.4908	0.5892	0.4687	0.4203
US	energy	all	backwardation	0.4844	0.5949	0.4601	0.4179
US	energy	all	contango	0.4957	0.5869	0.4779	0.4210
US	energy	petroleum	whole period	0.7278	0.7846	0.7692	0.7175
US	energy	petroleum	backwardation	0.6962	0.7854	0.7727	0.7282
US	energy	petroleum	contango	0.7606	0.7856	0.7716	0.7134
US	metals	all	whole period	0.2167	0.5553	0.5877	0.4721
US	metals	all	backwardation	0.2201	0.5418	0.6353	0.4155
US	metals	all	contango	0.2145	0.5727	0.5709	0.5035
US	metals	precious	whole period	0.2883	0.6305	0.6704	0.5762
US	metals	precious	backwardation	0.3070	0.6061	0.6991	0.5386
US	metals	precious	contango	0.2713	0.6591	0.6615	0.5949
GB	all	all	whole period	0.4047	0.4691	0.6536	0.4412
GB	all	all	backwardation	0.3987	0.4753	0.6729	0.3954
GB	all	all	contango	0.4108	0.4652	0.6456	0.4797

Table 4: This table shows the average pairwise correlation coefficients calculated independently across the whole cross-section of commodity assets considered in the study as well as across countries and commodity sectors and subsectors by year for the whole period of interest (1997-2018). The results are discussed in Section 3.

country	sector	subsector	decade	0	1	2	3	4	5	6	7	8	9
all	all	all	1990								0.0401	0.0812	0.0822
all	all	all	2000	0.0652	0.0719	0.0796	0.0848	0.1242	0.1247	0.1650	0.1541	0.3334	0.2913
all	all	all	2010	0.2743	0.2837	0.2235	0.1432	0.1139	0.1547	0.1339	0.0963	0.1374	
US	all	all	1990								0.0536	0.0811	0.0803
US	all	all	2000	0.0597	0.0652	0.0600	0.0723	0.1073	0.1164	0.1502	0.1479	0.3284	0.2621
US	all	all	2010	0.2275	0.2541	0.1850	0.1018	0.0986	0.1371	0.1064	0.0905	0.1197	
US	agriculturals	all	1990								0.0827	0.0916	0.1121
US	agriculturals	all	2000	0.0918	0.0967	0.0734	0.0827	0.1111	0.1090	0.1125	0.1131	0.3034	0.2507
US	agriculturals	all	2010	0.2038	0.2304	0.1583	0.0716	0.0846	0.1360	0.1121	0.1148	0.1181	
US	agriculturals	grains	1990								0.5243	0.4882	0.5650
US	agriculturals	grains	2000	0.4870	0.4337	0.3851	0.3402	0.4473	0.5335	0.4594	0.5040	0.6325	0.5681
US	agriculturals	grains	2010	0.5389	0.6424	0.5592	0.3199	0.3134	0.4390	0.3872	0.4123	0.3618	
US	agriculturals	livestock	1990								0.2192	0.3724	0.3453
US	agriculturals	livestock	2000	0.2762	0.3315	0.3243	0.3497	0.2937	0.4170	0.2784	0.2744	0.2822	0.3365
US	agriculturals	livestock	2010	0.3568	0.4772	0.3585	0.1783	0.3532	0.4246	0.3445	0.2948	0.2994	
US	agriculturals	softs	1990								-0.0042	-0.0001	0.0128
US	agriculturals	softs	2000	0.0603	0.0289	0.0470	0.0807	0.0577	0.0624	0.0765	0.0485	0.2484	0.1710
US	agriculturals	softs	2010	0.1273	0.1400	0.1038	0.0568	0.0413	0.0983	0.1280	0.0825	0.0565	
US	energy	all	1990								0.4060	0.4552	0.5256
US	energy	all	2000	0.4362	0.5186	0.5682	0.5248	0.6212	0.6402	0.5082	0.5530	0.6278	0.4840
US	energy	all	2010	0.4549	0.4752	0.3796	0.2889	0.4103	0.4282	0.4442	0.3890	0.4270	
US	energy	petroleum	1990								0.7207	0.7946	0.8527
US	energy	petroleum	2000	0.6122	0.7632	0.8072	0.6948	0.8321	0.7377	0.7703	0.7895	0.8184	0.7460
US	energy	petroleum	2010	0.8835	0.7867	0.6692	0.6075	0.6710	0.7069	0.7547	0.6672	0.7786	
US	metals	all	1990								0.2296	0.2877	0.2449
US	metals	all	2000	0.1860	0.1832	0.1992	0.2290	0.4923	0.4480	0.6328	0.5426	0.5664	0.5547
US	metals	all	2010	0.6297	0.6458	0.6649	0.6160	0.4531	0.4850	0.4269	0.3584	0.5259	
US	metals	precious	1990								0.3063	0.3451	0.3308
US	metals	precious	2000	0.2934	0.2337	0.3053	0.2959	0.5688	0.5674	0.6969	0.6143	0.6428	0.6713
US	metals	precious	2010	0.7004	0.7107	0.7089	0.6988	0.5620	0.6088	0.5652	0.4746	0.5716	
GB	all	all	1990								0.2289	0.3601	0.4487
GB	all	all	2000	0.3550	0.4082	0.4775	0.5526	0.5068	0.4792	0.4340	0.4653	0.5795	0.6647
GB	all	all	2010	0.6886	0.6742	0.6122	0.6606	0.4700	0.5003	0.4636	0.3810	0.3598	

Table 5: This table shows the average time series regression coefficients for models where the returns series for all the commodity assets considered in the study are independently regressed against the return series for our market factor, an equally weighted portfolio of the 24 US commodities considered in the study. The results are calculated independently across countries as well as commodity sectors and subsectors for the four periods of interest (past: 1997-2003; financialisation: 2004-2008; crisis: 2008-2013; post-crisis: 2013-2018). The market factor construction is discussed in Section 2.3 while the results are discussed in Section 3.

country	sector	subsector	past	financialisation	crisis	post-crisis
all	all	all	0.8556	0.9709	1.0352	0.9438
US	agriculturals	all	0.7706	0.7965	0.8535	0.8252
US	agriculturals	grains	0.9891	1.1982	1.1727	1.0301
US	agriculturals	livestock	0.4320	0.2059	0.3317	0.5484
US	agriculturals	softs	0.7213	0.6900	0.7953	0.7589
US	energy	all	2.3308	1.6106	1.3977	1.7639
US	energy	gas	2.6992	1.7090	1.0044	1.2585
US	energy	petroleum	2.2080	1.5778	1.5288	1.9324
US	metals	all	0.6320	1.1252	1.1212	0.9131
US	metals	base	0.4902	1.1178	1.4140	0.8780
US	metals	precious	0.6674	1.1271	1.0480	0.9219
GB	all	all	0.2713	0.8520	1.1761	0.7192

Table 6: This table shows the average time series regression R^2 for models where the returns series for all the commodity assets considered in the study are independently regressed against the return series for our mimicking portfolios for risk factors in returns, including the market, CHP, open interest and term structure factors. The results are calculated independently across countries and commodity sectors and subsectors for the four periods of interest (past: 1997-2003; financialisation: 2004-2008; crisis: 2008-2013; post-crisis: 2013-2018); for each period the results are calculated independently over the entire period as well as over phases of aggregate backwardation and contango. Factors as well as aggregate CHP construction and corresponding regime definitions are discussed in Section 2.3 while the results are discussed in Section 3.

country	sector	subsector	factor	regime	past	financialisation	crisis	post-crisis
all	all	all	market	whole period	9.69%	19.7%	31.3%	14.73%
all	all	all	market	backwardation	9.44%	21.55%	30.04%	11.82%
all	all	all	market	contango	10.07%	18.15%	32.67%	16.99%
all	all	all	CHP	whole period	1.93%	5.39%	4.43%	3.78%
all	all	all	CHP	backwardation	2.6%	5.61%	4%	4.57%
all	all	all	CHP	contango	1.54%	5.55%	4.99%	4.09%
all	all	all	open interest	whole period	5.98%	5.63%	4.09%	4.32%
all	all	all	open interest	backwardation	5.69%	5.47%	3.89%	4.12%
all	all	all	open interest	contango	6.41%	6.21%	4.73%	4.74%
all	all	all	term structure	whole period	1.52%	2.95%	5.2%	1.39%
all	all	all	term structure	backwardation	1.87%	2.7%	4.56%	2.3%
all	all	all	term structure	contango	1.62%	3.59%	5.93%	1.12%
US	all	all	market	whole period	11.67%	21.7%	30.69%	15.73%
US	all	all	market	backwardation	11.26%	23.68%	28.95%	13.12%
US	all	all	market	contango	12.22%	19.97%	32.48%	17.66%
US	all	all	CHP	whole period	2.4%	5.8%	5.39%	4.47%
US	all	all	CHP	backwardation	3.19%	5.94%	4.72%	5.54%
US	all	all	CHP	contango	1.91%	6.1%	6.14%	4.79%
US	all	all	open interest	whole period	7.45%	6.95%	4.57%	5.29%
US	all	all	open interest	backwardation	7.1%	6.79%	4.5%	5%
US	all	all	open interest	contango	7.95%	7.61%	5.24%	5.82%
US	all	all	term structure	whole period	1.89%	2.87%	5.12%	1.71%
US	all	all	term structure	backwardation	2.3%	2.78%	4.79%	2.85%
US	all	all	term structure	contango	2.01%	3.41%	5.73%	1.34%
US	agriculturals	all	market	whole period	9.08%	16.04%	25.99%	12.07%
US	agriculturals	all	market	backwardation	8.57%	18.68%	23.01%	11.56%
US	agriculturals	all	market	contango	9.85%	13.5%	28.67%	12.91%
US	agriculturals	all	CHP	whole period	1.03%	1.6%	1.47%	1.61%
US	agriculturals	all	CHP	backwardation	1.14%	2.47%	1.72%	3.11%
US	agriculturals	all	CHP	contango	1.21%	1.31%	1.56%	1.1%
US	agriculturals	all	open interest	whole period	1.09%	1.9%	0.45%	1%
US	agriculturals	all	open interest	backwardation	0.85%	3.74%	1.57%	2.01%
US	agriculturals	all	open interest	contango	1.58%	0.97%	0.58%	0.67%
US	agriculturals	all	term structure	whole period	1.28%	1.36%	1.73%	2.16%
US	agriculturals	all	term structure	backwardation	1.2%	1.27%	1.93%	3.55%
US	agriculturals	all	term structure	contango	1.72%	1.91%	2.15%	1.69%
US	agriculturals	grains	market	whole period	16.44%	29.28%	42.09%	19.27%
US	agriculturals	grains	market	backwardation	14.54%	34.68%	38.84%	18.3%
US	agriculturals	grains	market	contango	18.73%	23.95%	44.4%	20.71%

US	agriculturals	grains	CHP	whole period	0.64%	1.37%	0.78%	2.98%
US	agriculturals	grains	CHP	backwardation	0.77%	2.63%	1.04%	5.46%
US	agriculturals	grains	CHP	contango	0.74%	1.06%	0.7%	1.36%
US	agriculturals	grains	open interest	whole period	2.22%	4.18%	0.67%	2.04%
US	agriculturals	grains	open interest	backwardation	1.38%	7.87%	2.5%	3.8%
US	agriculturals	grains	open interest	contango	3.3%	1.92%	0.69%	1.24%
US	agriculturals	grains	term structure	whole period	1.78%	1.37%	2.04%	2.08%
US	agriculturals	grains	term structure	backwardation	1.47%	1.19%	1.87%	3.56%
US	agriculturals	grains	term structure	contango	2.25%	2.18%	3.3%	1.72%
US	agriculturals	livestock	market	whole period	2.96%	1.83%	8.99%	4.84%
US	agriculturals	livestock	market	backwardation	2.14%	2.15%	6.2%	4.32%
US	agriculturals	livestock	market	contango	4.03%	1.52%	11.26%	5.94%
US	agriculturals	livestock	CHP	whole period	1.62%	2.06%	3.36%	1.23%
US	agriculturals	livestock	CHP	backwardation	1.95%	2.94%	3.54%	1.94%
US	agriculturals	livestock	CHP	contango	1.35%	1.29%	3.71%	0.89%
US	agriculturals	livestock	open interest	whole period	0.43%	0.55%	0.18%	0.34%
US	agriculturals	livestock	open interest	backwardation	0.44%	0.88%	0.39%	0.66%
US	agriculturals	livestock	open interest	contango	0.5%	0.3%	0.19%	0.28%
US	agriculturals	livestock	term structure	whole period	0.38%	1.25%	1.15%	1.79%
US	agriculturals	livestock	term structure	backwardation	0.59%	1.09%	1.43%	4.47%
US	agriculturals	livestock	term structure	contango	0.55%	2.17%	1.1%	0.37%
US	agriculturals	softs	market	whole period	4.78%	9.9%	18.39%	8.48%
US	agriculturals	softs	market	backwardation	5.82%	10.95%	15.58%	8.44%
US	agriculturals	softs	market	contango	3.87%	9.02%	21.64%	8.6%
US	agriculturals	softs	CHP	whole period	1.12%	1.59%	1.22%	0.44%
US	agriculturals	softs	CHP	backwardation	1.11%	2.07%	1.49%	1.35%
US	agriculturals	softs	CHP	contango	1.6%	1.57%	1.36%	0.94%
US	agriculturals	softs	open interest	whole period	0.29%	0.28%	0.36%	0.28%
US	agriculturals	softs	open interest	backwardation	0.51%	1.04%	1.23%	0.9%
US	agriculturals	softs	open interest	contango	0.4%	0.35%	0.66%	0.3%
US	agriculturals	softs	term structure	whole period	1.24%	1.41%	1.71%	2.42%
US	agriculturals	softs	term structure	backwardation	1.25%	1.44%	2.25%	3.08%
US	agriculturals	softs	term structure	contango	1.78%	1.53%	1.51%	2.32%
US	energy	all	market	whole period	26.58%	31.57%	38.94%	25.9%
US	energy	all	market	backwardation	26.08%	32.3%	33.74%	20.94%
US	energy	all	market	contango	26.84%	31.47%	42.16%	28.77%
US	energy	all	CHP	whole period	9.18%	1.61%	3.5%	4.79%
US	energy	all	CHP	backwardation	12.81%	1.01%	2.97%	5.68%
US	energy	all	CHP	contango	6.05%	2.32%	4.09%	7.91%
US	energy	all	open interest	whole period	40%	33.46%	21.16%	27.67%
US	energy	all	open interest	backwardation	38.82%	25.93%	17.59%	22.07%
US	energy	all	open interest	contango	41.02%	40.42%	23.88%	32.13%
US	energy	all	term structure	whole period	3.41%	2.99%	5.5%	1.86%
US	energy	all	term structure	backwardation	7.4%	3.75%	4.93%	3.4%
US	energy	all	term structure	contango	1.16%	2.76%	5.88%	1.26%
US	energy	gas	market	whole period	19.37%	18.38%	10.88%	7.86%

US	energy	gas	market	backwardation	21.36%	17.54%	12.6%	7.17%
US	energy	gas	market	contango	17.12%	20.07%	9.92%	7.96%
US	energy	gas	CHP	whole period	5.37%	3.62%	12.6%	16.2%
US	energy	gas	CHP	backwardation	10.16%	2.14%	11.42%	19.3%
US	energy	gas	CHP	contango	1.59%	5.26%	13.46%	13.84%
US	energy	gas	open interest	whole period	22.08%	27.47%	15.46%	16.03%
US	energy	gas	open interest	backwardation	23.23%	21.16%	14.53%	16.64%
US	energy	gas	open interest	contango	20.54%	32.65%	16.18%	15.41%
US	energy	gas	term structure	whole period	0.41%	4.24%	7.16%	5.22%
US	energy	gas	term structure	backwardation	0.36%	2.03%	11.66%	5.9%
US	energy	gas	term structure	contango	0.48%	6.51%	4.6%	4.55%
US	energy	petroleum	market	whole period	28.98%	35.97%	48.3%	31.91%
US	energy	petroleum	market	backwardation	27.65%	37.22%	40.79%	25.53%
US	energy	petroleum	market	contango	30.08%	35.26%	52.9%	35.71%
US	energy	petroleum	CHP	whole period	10.44%	0.94%	0.47%	0.99%
US	energy	petroleum	CHP	backwardation	13.69%	0.63%	0.15%	1.14%
US	energy	petroleum	CHP	contango	7.53%	1.34%	0.96%	5.93%
US	energy	petroleum	open interest	whole period	45.97%	35.46%	23.06%	31.56%
US	energy	petroleum	open interest	backwardation	44.02%	27.52%	18.61%	23.88%
US	energy	petroleum	open interest	contango	47.85%	43.02%	26.44%	37.7%
US	energy	petroleum	term structure	whole period	4.41%	2.57%	4.95%	0.74%
US	energy	petroleum	term structure	backwardation	9.74%	4.32%	2.68%	2.56%
US	energy	petroleum	term structure	contango	1.38%	1.51%	6.3%	0.16%
US	metals	all	market	whole period	7.54%	30.79%	38.2%	18.58%
US	metals	all	market	backwardation	7.5%	31.77%	42.95%	11.54%
US	metals	all	market	contango	7.63%	30.19%	36.15%	23%
US	metals	all	CHP	whole period	1.07%	21.76%	18.67%	12.79%
US	metals	all	CHP	backwardation	1.66%	20.33%	15.15%	12.71%
US	metals	all	CHP	contango	0.72%	23.49%	21.5%	13.38%
US	metals	all	open interest	whole period	0.5%	0.91%	3.68%	0.27%
US	metals	all	open interest	backwardation	0.47%	0.61%	2.83%	0.32%
US	metals	all	open interest	contango	0.61%	1.28%	4.31%	0.24%
US	metals	all	term structure	whole period	2.48%	7.31%	14.99%	0.24%
US	metals	all	term structure	backwardation	1.5%	6.51%	13.24%	0.33%
US	metals	all	term structure	contango	3.57%	8.4%	16.35%	0.34%
US	metals	base	market	whole period	5.39%	23.13%	50.77%	19.74%
US	metals	base	market	backwardation	4.96%	25.38%	48.58%	10.15%
US	metals	base	market	contango	5.66%	21.55%	52.45%	27.5%
US	metals	base	CHP	whole period	0.58%	5.78%	0.57%	0.6%
US	metals	base	CHP	backwardation	1.4%	5.18%	1.91%	0.29%
US	metals	base	CHP	contango	0.1%	6.42%	0.21%	0.88%
US	metals	base	open interest	whole period	0.18%	1.01%	2.78%	0.46%
US	metals	base	open interest	backwardation	0.1%	0.34%	1.84%	0.61%
US	metals	base	open interest	contango	0.24%	1.82%	3.42%	0.37%
US	metals	base	term structure	whole period	0.06%	9.72%	9.63%	0.24%
US	metals	base	term structure	backwardation	0.37%	7.74%	7.44%	0.12%

US	metals	base	term structure	contango	0.02%	11.67%	11.07%	0.43%
US	metals	precious	market	whole period	8.08%	32.7%	35.06%	18.3%
US	metals	precious	market	backwardation	8.13%	33.37%	41.54%	11.89%
US	metals	precious	market	contango	8.12%	32.35%	32.07%	21.88%
US	metals	precious	CHP	whole period	1.2%	25.76%	23.19%	15.84%
US	metals	precious	CHP	backwardation	1.72%	24.12%	18.46%	15.81%
US	metals	precious	CHP	contango	0.87%	27.76%	26.82%	16.5%
US	metals	precious	open interest	whole period	0.57%	0.89%	3.9%	0.22%
US	metals	precious	open interest	backwardation	0.56%	0.68%	3.07%	0.24%
US	metals	precious	open interest	contango	0.71%	1.15%	4.53%	0.21%
US	metals	precious	term structure	whole period	3.08%	6.71%	16.33%	0.24%
US	metals	precious	term structure	backwardation	1.79%	6.21%	14.69%	0.39%
US	metals	precious	term structure	contango	4.46%	7.58%	17.68%	0.31%
GB	all	all	market	whole period	1.74%	11.71%	33.71%	10.75%
GB	all	all	market	backwardation	2.14%	13.03%	34.39%	6.62%
GB	all	all	market	contango	1.48%	10.88%	33.45%	14.35%
GB	all	all	CHP	whole period	0.08%	3.74%	0.57%	1.02%
GB	all	all	CHP	backwardation	0.24%	4.26%	1.09%	0.72%
GB	all	all	CHP	contango	0.03%	3.33%	0.4%	1.31%
GB	all	all	open interest	whole period	0.07%	0.34%	2.17%	0.42%
GB	all	all	open interest	backwardation	0.08%	0.18%	1.44%	0.57%
GB	all	all	open interest	contango	0.22%	0.59%	2.7%	0.39%
GB	all	all	term structure	whole period	0.04%	3.28%	5.5%	0.09%
GB	all	all	term structure	backwardation	0.17%	2.37%	3.67%	0.09%
GB	all	all	term structure	contango	0.02%	4.34%	6.72%	0.24%

References

Acharya, V.V., Lochstoer, L.A., Ramadorai, T., 2013. Limits to arbitrage and hedging: evidence from commodity markets. Journal of Financial Economics 109, 441–465. doi:10.1016/j.jfineco.2013.03.003.

Asness, C., Frazzini, A., 2013. The devil in hml's details. The Journal of Portfolio Management 39, 49–68. doi:10.3905/jpm.2013.39.4.049, arXiv:https://jpm.pm-research.com/content/39/4/49.full.pdf.

Asness, C., Frazzini, A., Israel, R., Moskowitz, T., 2015. Fact, fiction, and value investing. The Journal of Portfolio Management 42, 34–52. doi:10.3905/jpm.2015.42.1.034, arXiv:https://jpm.pm-research.com/content/42/1/34.full.pdf.

Asness, C.S., Frazzini, A., Pedersen, L.H., 2019. Quality minus junk. Review of Accounting Studies 24, 34–112. doi:10.1007/s11142-018-9470-2.

Baker, S.D., 2021. The financialization of storable commodities. Management Science 67, 471–499. doi:10.1287/mnsc.2019.3445.

Bakshi, G., Gao, X., Rossi, A.G., 2019. Understanding the sources of risk underlying the cross section of commodity returns. Management Science 65, 619–641. doi:10.1287/mnsc.2017.2840.

Basak, S., Pavlova, A., 2016. A model of financialization of commodities. The Journal of Finance 71, 1511–1556. doi:10.1111/jofi.12408.

Basu, D., Bauthéac, O., 2024. Commodity definancialisation. Working paper .

Basu, D., Miffre, J., 2013. Capturing the risk premium of commodity futures: the role of hedging pressure. Journal of Banking & Finance 37, 2652–2664. doi:10.1016/j.jbankfin.2013.02.031.

Bohl, M.T., Stephan, P.M., 2013. Does futures speculation destabilize spot prices? new evidence for commodity markets. Journal of Agricultural & Applied Economics 45, 595–616. doi:10.1017/s1074070800005150.

Boons, M., De Roon, F., Szymanowska, M., 2012. The stock market price of commodity risk, in: AFA 2012 Chicago Meetings Paper. doi:10.2139/ssrn.1785728.

Boons, M., Prado, M.P., 2019. Basis-momentum. The Journal of Finance 74, 239–279. doi:10.1111/jofi.12738.

Boyd, N.E., Büyükşahin, B., Haigh, M.S., Harris, J.H., 2016. The prevalence, sources, and effects of herding. Journal of Futures Markets 36, 671–694. doi:10.1002/fut.21756.

Brennan, M.J., 1958. The supply of storage. The American Economic Review 48, 50–72. URL: https://www.jstor.org/stable/1812340, doi:10.1007/978-1-349-02693-7.

Brunetti, C., Büyükşahin, B., Harris, J.H., 2016. Speculators, prices, and market volatility. Journal of Financial & Quantitative Analysis 51, 1545–1574. doi:10.1017/s0022109016000569.

Brunetti, C., Reiffen, D., 2014. Commodity index trading and hedging costs. Journal of Financial Markets 21, 153–180. doi:10.1016/j.finmar.2014.08.001.

Bruno, V.G., Büyükşahin, B., Robe, M.A., 2017. The financialization of food? American Journal of Agricultural Economics 99, 243–264. doi:10.1093/ajae/aaw059.

Büyükşahin, B., Harris, J.H., 2011. Do speculators drive crude oil futures prices? The Energy Journal , 167–202URL: https://www.jstor.org/stable/41323326, doi:10.5547/ISSN0195-6574-EJ-Vol32-No.

Büyükşahin, B., Robe, M.A., 2014. Speculators, commodities and cross-market linkages. Journal of International Money & Finance 42, 38–70. doi:10.1016/j.jimonfin.2013.08.004.

Carhart, M.M., 1997. On persistence in mutual fund performance. The Journal of finance 52, 57–82. URL: https://www.jstor.org/stable/2329556, doi:10.2307/2329556.

Cheng, I.H., Kirilenko, A., Xiong, W., 2014. Convective risk flows in commodity futures markets. Review of Finance 19, 1733–1781. doi:10.1093/rof/rfu043.

Cheng, I.H., Xiong, W., 2014. Financialization of commodity markets. Annual Review of Financial Economics 6, 419–441. doi:10.1146/annurev-financial-110613-034432.

Christoffersen, P., Lunde, A., Olesen, K.V., 2014. Factor structure in commodity futures return and volatility. Journal of Financial & Quantitative Analysis , 1–74doi:10.1017/s0022109018000765.

Cootner, P.H., 1960. Returns to speculators: Telser versus keynes. Journal of political Economy 68, 396–404. doi:10.1086/258347.

Cortazar, G., Kovacevic, I., Schwartz, E.S., 2013. Commodity and asset pricing models: an integration. NBER Working Papers 19167. National Bureau of Economic Research, Inc. URL: https://ssrn.com/abstract=2287027.

Danthine, J.P., 1978. Information, futures prices, and stabilizing speculation. Journal of Economic Theory 17, 79–98. doi:10.1016/0022-0531(78)90124-2.

Daskalaki, C., Kostakis, A., Skiadopoulos, G., 2014. Are there common factors in individual commodity futures returns? Journal of Banking & Finance 40, 346–363. doi:10.1016/j.jbankfin.2013.11.034.

De Schutter, O., 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. URL: https://www2.ohchr.org/english/issues/food/docs/briefing_note_02_september_2010_en.pdf.

Domanski, D., Heath, A., 2007. Financial investors and commodity markets. Working Paper URL: https://www.bis.org/publ/qtrpdf/r_qt0703g.pdf.

Duffie, D., 2014. Challenges to a policy treatment of sspeculative trading motivated by differences in beliefs. The Journal of Legal Studies 43, S173–s182. doi:10.1086/677836.

Ederington, L., Lee, J.H., 2002. Who trades futures and how: evidence from the heating oil futures market. The Journal of Business 75, 353–373. doi:10.1086/338706.

Ekeland, I., Lautier, D., Villeneuve, B., 2016. Speculation in commodity futures markets: a simple equilibrium model URL: https://hal.archives-ouvertes.fr/hal-01655848.

Ekeland, I., Lautier, D., Villeneuve, B., 2019. Hedging pressure and speculation in commodity markets. Economic Theory 68, 83–123. doi:10.1007/s00199-018-1115-y.

Etula, E., 2013. Broker-dealer risk appetite and commodity returns. Journal of Financial Econometrics 11, 486–521. doi:10.1093/jjfinec/nbs024.

Fama, E.F., French, K.R., 1993. Common risk factors in the returns on stocks and bonds. Journal of Financial Economics 33, 3–56. URL: http://www.sciencedirect.com/science/article/pii/0304405X93900235, doi:10.1016/0304-405x(93)90023-5.

Fama, E.F., French, K.R., 2015. A five-factor asset pricing model. Journal of Financial Economics 116, 1–22. URL: http://www.sciencedirect.com/science/article/pii/S0304405X14002323, doi:10.1016/j.jfineco.2014.10.010.

Fattouh, B., Kilian, L., Mahadeva, L., 2013. The role of speculation in oil markets: what have we learnt so far? The Energy Journal 34, 7–33. URL: https://www.jstor.org/stable/41970495, doi:10.5547/01956574.34.3.2.

Fernandez-Perez, A., Frijns, B., Fuertes, A.M., Miffre, J., 2018. The skewness of commodity futures returns. Journal of Banking & Finance 86, 143–158. doi:10.1016/j.jbankfin.2017.06.015.

Frazzini, A., Pedersen, L.H., 2014. Betting against beta. Journal of Financial Economics 111, 1–25. URL: https://www.sciencedirect.com/science/article/pii/S0304405X13002675, doi:10.1016/j.jfineco.2013.10.005.

Fry-McKibbin, R., McKinnon, K., 2023. The evolution of commodity market financialization: Implications for portfolio diversification. Journal of Commodity Markets 32, 100360. URL: https://www.sciencedirect.com/science/article/pii/S2405851323000508, doi:10.1016/j.jcomm.2023.100360.

Fuertes, A.M., Miffre, J., Fernandez-Perez, A., 2015. Commodity strategies based on momentum, term structure, and idiosyncratic volatility. Journal of Futures Markets 35, 274–297. doi:10.1002/fut.21656.

Gilbert, C.L., 2010a. How to understand high food prices. Journal of Agricultural Economics 61, 398–425. doi:10.1111/j.1477-9552.2010.00248.x.

Gilbert, C.L., 2010b. Speculative influences on commodity futures prices 2006-2008. UNCTAD, Geneva URL: https://www.cftc.gov/sites/default/files/idc/groups/public/@swaps/documents/file/plstudy_14_cifrem.pdf.

Gilbert, C.L., Pfuderer, S., 2014. The role of index trading in price formation in the grains and oilseeds markets. Journal of Agricultural Economics 65, 303–322. doi:10.1111/1477-9552.12068.

Goldstein, I., Li, Y., Yang, L., 2014. Speculation and hedging in segmented markets. The Review of Financial Studies 27, 881–922. doi:10.1093/rfs/hht059.

Goldstein, I., Yang, L., 2022. Commodity financialization and information transmission. The Journal of Finance 77, 2613–2667. doi:10.1111/jofi.13165, arXiv:https://onlinelibrary.wiley.com/doi/pdf/10.1111/jofi.13165.

Gorton, G.B., Hayashi, F., Rouwenhorst, K.G., 2012. The fundamentals of commodity futures returns. Review of Finance 17, 35–105. doi:10.1093/rof/rfs019.

Grossman, S.J., Stiglitz, J.E., 1980. On the impossibility of informationally efficient markets. The American economic review 70, 393–408. doi:10.7916/d8765r99.

Hamilton, J.D., Wu, J.C., 2015. Effects of index-fund investing on commodity futures prices. International Economic Review 56, 187–205. doi:10.1111/iere.12099.

Henderson, B.J., Pearson, N.D., Wang, L., 2015. New evidence on the financialization of commodity markets. The Review of Financial Studies 28, 1285–1311. doi:10.1093/rfs/hhu091.

Herman, M.O., Kelly, R., Nash, R., 2011. Not a game, speculation v. food security: regulating financial markets to grow a better future. Oxfam policy & practice: agriculture, food & land 11, 127–138. URL: https://www.ingentaconnect.com/content/oxpp/oppafl/2011/00000011/00000007/art00005.

Hicks, J.R., 1939. Value and capital. 1 ed., Oxford University Press, Cambridge.

Hicks, J.R., 1946. Value and capital. 2 ed., Oxford University Press, Cambridge.

Hirshleifer, J., 1975. Speculation and equilibrium: information, risk, and markets. The Quarterly Journal of Economics 89, 519–542. URL: http://www.jstor.org/stable/1884690, doi:10.2307/1884690.

Hirshleifer, J., 1976. Reply to comments on" speculation and equilibrium: Information, risk, and markets". The Quarterly Journal of Economics , 689–696doi:10.2307/1885330.

Hirshleifer, J., 1977. The theory of speculation under alternative regimes of markets. The Journal of Finance 32, 975–999. URL: https://www.jstor.org/stable/2326507, doi:10.2307/2326507.

Hong, H., Yogo, M., 2012. What does futures market interest tell us about the macroeconomy and asset prices? Journal of Financial Economics 105, 473–490. doi:10.1016/j.jfineco.2012.04.005.

Hou, K., Xue, C., Zhang, L., 2015. Digesting anomalies: An investment approach. The Review of Financial Studies 28, 650–705. doi:10.1093/rfs/hhu068.

Houthakker, H., 1957a. Restatement of the theory of normal backwardation. Cowles Foundation Discussion Papers 44. Cowles Foundation for Research in Economics, Yale University. URL: https://EconPapers.repec.org/RePEc:cwl:cwldpp:44.

Houthakker, H.S., 1957b. Can speculators forecast prices? The Review of Economics & Statistics 39, 143–151. URL: http://www.jstor.org/stable/1928531, doi:10.2307/1928531.

Irwin, S.H., 2013. Commodity index investment and food prices: does the "masters hypothesis" explain recent price spikes? Agricultural Economics 44, 29–41. doi:10.1111/agec.12048.

Irwin, S.H., Sanders, D.R., 2011. Index funds, financialization, and commodity futures markets. Applied Economic Perspectives & Policy 33, 1–31. doi:10.1093/aepp/ppq032.

Irwin, S.H., Sanders, D.R., 2012. Financialization and structural change in commodity futures markets. Journal of Agricultural & Applied Economics 44, 371–396. doi:10.1017/s1074070800000481.

Irwin, S.H., Sanders, D.R., Merrin, R.P., 2009. Devil or angel? the role of speculation in the recent commodity price boom (and bust). Journal of Agricultural & Applied Economics 41, 377–391. doi:10.1017/s1074070800002856.

Isleimeyyeh, M., 2020. The role of financial investors in determining the commodity futures risk premium. Journal of Futures

Markets 40, 1375–1397. doi:10.1002/fut.22122, arXiv:https://onlinelibrary.wiley.com/doi/pdf/10.1002/fut.22122.
Juvenal, L., Petrella, I., 2015. Speculation in the oil market. Journal of Applied Econometrics 30, 621–649. doi:10.1002/jae.2388.
Kaldor, N., 1939. Speculation and economic stability. The Review of Economic Studies 7, 1–27. doi:10.2307/2967593, arXiv:https://academic.oup.com/restud/article-pdf/7/1/1/4398991/7-1-1.pdf.
Kang, W., Rouwenhorst, K.G., Tang, K., 2020. A tale of two premiums: The role of hedgers and speculators in commodity futures markets. The Journal of Finance 75, 377–417. doi:10.1111/jofi.12845.
Keynes, J.M., 1923. Some aspects of commodity markets. Manchester Guardian Commercial: European Reconstruction Series 13, 784–786.
Keynes, J.M., 1930. Treatise on Money. Macmillan, London.
Kilian, L., Murphy, D.P., 2014. The role of inventories and speculative trading in the global market for crude oil. Journal of Applied Econometrics 29, 454–478. doi:10.1002/jae.2322.
Kim, A., 2015. Does futures speculation destabilize commodity markets? Journal of Futures Markets 35, 696–714. doi:10.1002/fut.21716.
Knittel, C.R., Pindyck, R.S., 2016. The simple economics of commodity price speculation. American Economic Journal: Macroeconomics 8, 85–110. doi:10.1257/mac.20140033.
Kyle, A.S., 1989. Informed speculation with imperfect competition. The Review of Economic Studies 56, 317–355. URL: https://www.jstor.org/stable/2297551, doi:10.2307/2297551.
Leclercq, E., Praz, R., 2014. Equilibrium commodity trading. SSRN Scholarly Paper Id 2464400. Social Science Research Network. Rochester, NY. doi:10.2139/ssrn.2464400.
Manera, M., Nicolini, M., Vignati, I., 2016. Modelling futures price volatility in energy markets: is there a role for financial speculation? Energy Economics 53, 220–229. doi:10.1016/j.eneco.2014.07.001.
Masters, M.W., 2008. Testimony before the committee on homeland security and governmental affairs. U.S. Senate 20.
Masters, M.W., White, A.K., 2008. The accidental hunt brothers: How institutional investors are driving up food and energy prices. Working paper .
Mayer, H., Rathgeber, A., Wanner, M., 2017. Financialization of metal markets: Does futures trading influence spot prices and volatility? Resources Policy 53, 300–316. URL: https://www.sciencedirect.com/science/article/pii/S0301420716300587, doi:10.1016/j.resourpol.2017.06.011.
Miffre, J., Rallis, G., 2007. Momentum strategies in commodity futures markets. Journal of Banking & Finance 31, 1863–1886. URL: https://ssrn.com/abstract=702281, doi:10.1016/j.jbankfin.2006.12.005.
Moskowitz, T.J., Ooi, Y.H., Pedersen, L.H., 2012. Time series momentum. Journal of Financial Economics 104, 228–250. URL: http://www.sciencedirect.com/science/article/pii/S0304405X11002613, doi:10.1016/j.jfineco.2011.11.003.
Sakkas, A., Tessaromatis, N., 2020. Factor based commodity investing. Journal of Banking & Finance 115, 105807. doi:10.1016/j.jbankfin.2020.105807.
Sanders, D.R., Irwin, S.H., 2011a. The impact of index funds in commodity futures markets: a systems approach. The Journal of Alternative Investments 14, 40–49. doi:10.3905/jai.2011.14.1.040.
Sanders, D.R., Irwin, S.H., 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, 519–532. doi:10.1111/j.1744-7976.2011.01226.x.
Sanders, D.R., Irwin, S.H., Merrin, R.P., 2010. The adequacy of speculation in agricultural futures markets: too much of a good thing? Applied Economic Perspectives and Policy 32, 77–94. doi:10.1093/aepp/ppp006.
Schumann, H., 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 URL: https://www.foodwatch.org/uploads/media/foodwatchreport_TheHungerMakers_observationsandcallsforaction_ger_03.pdf.
Schwartz, E., Smith, J.E., 2000. Short-term variations and long-term dynamics in commodity prices. Management Science 46, 893–911. URL: https://www.jstor.org/stable/2661607, doi:10.1287/mnsc.46.7.893.12034.
Schwartz, E.S., 1997. The stochastic behavior of commodity prices: implications for valuation and hedging. The Journal of Finance 52, 923–973. doi:10.1111/j.1540-6261.1997.tb02721.x.
Senate, U., 2009. Excessive speculation in the wheat market. Majority & Minority Staff Report. Permanent Subcommittee on Investigations 24, 107–108. URL: https://www.hsgac.senate.gov/imo/media/doc/REPORTExcessiveSpecullationintheWheatMarketwoexhibitschartsJune2409.pdf?attempt=2.
Silvennoinen, A., Thorp, S., 2013. Financialization, crisis and commodity correlation dynamics. Journal of International Financial Markets, Institutions & Money 24, 42—65. doi:10.1016/j.intfin.2012.11.007.
Simsek, A., 2013. Speculation and risk sharing with new financial assets. The Quarterly Journal of Economics 128, 1365–1396. doi:10.1093/qje/qjt007.
Singleton, K.J., 2013. Investor flows and the 2008 boom/bust in oil prices. Management Science 60, 300–318. doi:10.1287/mnsc.2013.1756.
Sockin, M., Xiong, W., 2015. Informational frictions and commodity markets. The Journal of Finance 70, 2063–2098. doi:10.1111/jofi.12261.
Stoll, H.R., Whaley, R.E., 2011. Commodity index investing: speculation or diversification? The Journal of Alternative Investments 14, 50–60. doi:10.2139/ssrn.1633908.
Stout, L.A., 1998. Why the law hates speculators: regulation and private ordering in the market for otc derivatives. Duke Law Journal 48, 701–786. URL: https://www.jstor.org/stable/1373070, doi:10.2307/1373070.
Stulz, R.M., 1996. Rethinking risk management. Journal of Applied Corporate Finance 9, 8–25. doi:10.1111/j.1745-6622.1996.tb00295.x.
Szymanowska, M., De Roon, F., Nijman, T., Van Den Goorbergh, R., 2014. An anatomy of commodity futures risk premia.

The Journal of Finance 69, 453–482. doi:10.1111/jofi.12096.
Tang, K., Xiong, W., 2012. Index investment and the financialization of commodities. Financial Analysts Journal 68, 54–74. doi:10.2469/faj.v68.n6.5.
Telser, L.G., 1958. Futures trading and the storage of cotton and wheat. Journal of Political Economy 66, 233–255. doi:10.1086/258036.
Till, H., 2007. A long-term perspective on commodity futures returns, in: Intelligent Commodity Investing. Risk books, London. Oclc: 611263302.
Tokic, D., 2012. Speculation and the 2008 oil bubble: the dcot report analysis. Energy Policy 45, 541–550. doi:10.1016/j.enpol.2012.02.069.
Turnovsky, S.J., 1983. The determination of spot and futures prices with storable commodities. Econometrica 51, 1363–1387. URL: http://www.jstor.org/stable/1912279, doi:10.2307/1912279.
UNCTAD, S.T.F.o.S.I., Cooperation, E., 2009. The global economic crisis: systemic failures and multilateral remedies. UNCTAD, Geneva URL: https://unctad.org/system/files/official-document/gds20091_en.pdf.
Weymar, F.H., 1966. The supply of storage revisited. The American Economic Review 56, 1226–1234. URL: http://www.jstor.org/stable/1815306.
Working, H., 1933. Price relations between july and september wheat futures at chicago since 1885. Wheat Studies 9, 187. URL: https://ageconsearch.umn.edu/record/142876/files/wheat-1933-03-09-06.pdf, doi:10.22004/ag.econ.142876.
Working, H., 1948. Theory of the inverse carrying charge in futures markets. Journal of Farm Economics 30, 1–28. doi:10.2307/1232678.
Working, H., 1949. The theory of price of storage. The American Economic Review , 1254–1262URL: https://www.jstor.org/stable/1816601.
Working, H., 1953. Hedging reconsidered. Journal of Farm Economics 35, 544–561. doi:10.2307/1233368.
Yang, F., 2013. Investment shocks and the commodity basis spread. Journal of Financial Economics 110, 164–184. doi:10.1016/j.jfineco.2013.04.012.