Commodity Index Funds: The price impact of the roll on commodities futures contracts

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Abstract

We identify and date two significant breaks, previously only backed by anecdotal or visual evidence: i) one in index fund investment and ii) one in the amount of arbitrage capital. To see whether these changes in investors' clientele had an impact on commodity futures prices, we conduct an event study based on several benchmarks. The CASRs (cumulated abnormal spreading returns) of individual contracts are 17 basis points at most -the order of magnitude of minimum possible transaction costs- and are never statistically significant when we adjust the standard errors for event-induced cross-correlation and variance. The test hypotheses of hedging induced price pressure, sunshine trading and predatory trading yields mixed and mostly insignificant results.

JEL classification: G24, G28, K22, K42.

Keywords: Commodity index investment, predatory trading, price pressure, hedging pressure, sunshine trading.

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1. Introduction

Academic research shows that investing in commodities futures improves portfolio diversification (Bodie and Rosansky, 1980), as commodities display anti-cyclical behaviour (Gorton and Rouwenhorst, 2006), represent a hedge against inflation (Greer, 2000), are negatively correlated with the US Dollar (Rezitis, 2015). Moreover, their price change distribution is positively skewed (Deaton and Laroque, 1992).[1] These characteristics make this asset class particularly attractive. However, a direct investment in commodities is not easily achievable. In particular, long-term holdings are difficult to maintain because of the physical nature of the underlying (storage costs, decay, logistics). The major investment products that permit exposure to commodities are Exchange Traded Funds (ETFs), Exchange Traded Notes (ETNs), and mutual funds tracking long only indices. These indices are composed of various commodity futures contracts with different allocation.

Indeed, the primary focus of index investment is to obtain an exposure to commodities. These products replicate a specific index through long positions in the nearest to maturity (hereafter nearby) futures contracts to minimize the term-structure effects and maximize the liquidity. Hence these indices roll their positions at fixed time intervals before the underlying futures contracts mature. The products that replicate these indices represent a significant part of the long open interest (OI) of commodity futures. Because every position of these products is fully rebalanced before the maturity of the corresponding contracts, there are suspicions that such investments distort the market. In several news articles,[2] Dizard (2007) points out that the beneficiaries of the "congestion roll trade" or "date rape" are speculators on the floors of commodities exchanges or, more likely, the banks selling securities based on these indices. In a public hearing before the US Senate, Masters (2008) declared that "Index speculators have driven futures and spot prices higher". To support his view, he shows that the proportion of traditional speculators has been overtaken by that of index speculators. He also insists on the fact that index speculators' demand is unrelated to the supply and demand of the underlying commodities.

In this paper, we examine whether the changes of market participation induced by commodity indices traders (CITs), also called the "financialization" of commodities markets, has a material effect on commodity futures prices at the date the index rolls positions from the nearby to the second nearest (hereafter first deferred) contract. To address these questions,

[1] For an exhaustive review of these stylized facts, see also Gorton and Rouwenhorst (2006) and Erb and Harvey (2006).

[2] "Speculators profit from commodity investors", Financial Times, January 22, 2007. See also, "Goldman Sachs and its magic commodities box", Financial Times, February 5, 2007, and "U.S. oil fund finds itself at the mercy of traders", Wall Street Journal, March 6, 2009.

we focus on the constituents of the Standard and Poor's Goldman Sachs Commodity Index (SP-GSCI).[3]

The financialization should translate into a significant change in OI of the contracts included in the SP-GSCI and more specifically in the proportion of OI resulting from the "Managed Money" sub-category.[4] However, there is no official date for this change in market participation. Therefore, we check empirically for a structural change in index investment share of total OI over the period from 1992 to 2017. We find this change to occur in August 2003, about half a year before the dates used in Boons, Roon *de*, and Szymanowska (2014), and five years before the breaks identified on the Crude Oil futures returns series by Hamilton and Wu (2015). Academic studies also mention the sudden increase of arbitrage capital, approximated by the amount of spreading positions held by speculators, following the financialization. Hence, we also examine, over the same period, the ratio of spreading positions over total OI. A high value of this ratio should ease the index investors' activity during the roll. We find a break in August 2005 for this series.

If the financialization has a permanent effect on commodity futures markets, it should be visible when funds rebalance their positions from the nearby to the first deferred contract. The SP-GSCI rolls its position from the fifth to the ninth business day of the month preceding maturity. Every day, the index transfers 20% of its positions from one contract to the next.[5] We focus on this particular roll window, because it overlaps most of the other windows of first generation indices such as the BCOM or the procedure of US funds on diversified and single commodities. We analyze the spreading returns during the roll, and estimate the valuation effect of the financialization of commodity markets with an event-study. As a counterfactual of futures returns, we use several benchmarks that give consistent empirical results. We also control for event clustering as thirteen over twenty seven constituents of the SP-GSCI roll every month.

We confirm that, with no correction for event-induced variance and cross-correlation, the average cumulative spreading returns are positive (0.10 bp during the roll, 0.17 bp in

[3]The three major diversified indices in terms of tracking OI are the SP-GSCI, the Bloomberg Commodity Index (BCOM), formerly Dow Jones UBS Commodity Index (DJ-UBSCI) and the Deutsche Bank Commodity Index (DBCI). Other diversified indices exist, such as the Reuters-Jefferies CRB Index (RJ-CRB), the Rogers International Commodity Index (RICI), the Chase Physical Commodity Index, Pimco, Oppenheimer or Bear Sterns. Other non-diversified funds directly track subsectors (energy, agricultural futures) or single futures (crude oil, natural gas, gold).

[4]We focus on the SP-GSCI contracts in our setting but impute the value for the total index investment targeting these contracts, that follows closely the SP-GSCI methodology and roll.

[5]The roll procedure is the same for every contract, which creates a distortion in the actual time to maturity during the roll. The last notice day of the sugar NY#11 contract on NYMEX for instance is the last business day of the preceding month, while the grains contracts traded on the CME are generally the 15th business day of the maturity month.

the pre-roll window), and statistically significant at the 1% level up until 2003. However, once we correct for clustering, the significance disappears. When we consider individual futures contracts, we find that cumulative abnormal spreading returns (CASRs) are not statistically significant in any period and even before adjustement. In addition, previous studies documenting significant abnormal returns around the roll do not take into account the substantial transaction costs associated with such strategies; see, e.g., Mou (2011). We evaluate these transaction costs, and find that they are as high as the abnormal returns themselves. In brief, we find that the residual profit left by arbitragers is of the size of their potential transaction costs, would they enter the trade. Finally, while Bessembinder, Carrion, Tuttle, and Venkataram (2016) find that the roll of a major oil ETF on a single day does not affect significantly futures prices, we extend their results to the roll of the SP-GSCI constituents. Our results contribute to the view that index investment has not been detrimental for the functioning of the commodity futures markets themselves. However, our results do not discard the possibility of intraday predatory trading achieved by funds managers ahead of their hedging trades, which penalizes the funds and ETFs performance.

The remainder of the paper is organized as follows. Section 2 presents the hypothesis development with respect to the existing literature. Section 3 provides details on the methodology and the sample construction. Section 4 presents the main results and discusses their robustness. Section 5 shows additional findings using the futures contract written on the SP-GSCI and Section 6 concludes.

2. Prior literature and hypothesis development

Following Master's hearing before the US Senate, a series of papers examine whether the financialization of commodity futures affects commodity prices. In their survey, Cheng and Xiong (2014) list the consequences of this structural break: the increase of price pressure phenomena, the effects on risk sharing between hedgers and speculators, and the distortion of stock prices resulting from speculation. The scope of this section is more limited since we examine how this change should materialize, and what are the potential effects of the roll on futures prices.

2.1. Price pressure and hedging pressure

Grossman and Miller (1988) present a three period model in which there are two types of agents, market makers and outside customers. They derive the demand function assuming that prices are normally distributed, and investors maximize their expected (exponential) utility. In their setting, they analyze the consequences of a liquidity shock that creates a temporary order imbalance, and show how market makers are compensated for bearing the risk during the holding period. They show that the (absolute) expected returns are an increasing function of the order imbalance, and an inverse function of the number of market makers. In our case, assuming that the market cannot absorb instantaneously the positive demand (supply) shock on the first deferred (nearby) contract, we should observe an increase (decrease) in the current price.

Brunetti and Reiffen (2014) derive a two period model where CITs' demand is exogenous, and additional assumptions similar to those of Grossman and Miller (1988). There are two types of agents (hedgers and speculators) in the model that maximize their expected (exponential) utility. Under the assumption of normal futures prices, they derive the demand for futures positions. A comparative statistics shows that, as index traders roll their positions from the nearby to the first deferred contract, the spread between the futures prices widen. More specifically, the price of the nearby contract decreases (lower demand) while the price of the first deferred contract increases (higher demand). Their empirical results are consistent with this prediction. In addition, Aulerich, Irwin, and Garcia (2013) find a significant association for the index traders' position roll with the returns on the two legs of the spread but of opposite directions. That is, the return on the nearby contract increases when the index traders unwind their position, whereas the price of the first deferred contract decreases as index traders build their new position.

Henderson, Pearson, and Wang (2015) examine the impact of the flows of financial investors on commodity futures prices through commodity-linked notes (CLNs). These flows, generated by CLN issuers hedging their liabilities on the commodities futures markets, are also not based on information about futures price movements. Nevertheless, they cause increases (buy pressure) and decreases (sell pressure) in commodity futures prices. These results are consistent with Bessembinder et al. (2016) who study the roll from the nearby to the first deferred contract of the United States Oil Fund (USO), a large fund invested solely in WTI crude oil futures contracts. They show that accumulated trading costs resulting from this price pressure amounts to 3% per year.

Roon *de*, Nijman, and Veld (2000) propose a model for futures expected returns with three types of assets, two of which are marketable (financial securities and futures positions), and one is not. In a mean variance framework, they show that, beyond the market risk premium, own hedging and cross hedging pressures are priced. These results are confirmed empirically, and remain after controlling for price pressure measured by the change in own hedging pressure.

2.2. *Non-informative trades and the sunshine trading hypothesis*

The roll policy of commodity index funds (ETFs, ETNs, and mutual funds) is mentioned in their prospectus, and generally similar to that of the index they replicate. For the SP-GSCI futures, the roll period applies every month for 13 commodities, and every two, three or more months for the remaining 14 commodities.[6] The amounts involved in the rolling are also easy to estimate for the funds that strictly follow the index roll policy since the assets under management (AuM) are known. Therefore, most of the trades related to the rolling are initiated by known investors, of known size, and do not contain information that is not already known by market participants.[7]

Admati and Pfleiderer (1991) develop a model where some liquidity traders preannounce the size of their orders. These preannouncements are initiated with the goal to reduce the price impact of the trade. The preannouncement changes the nature of informational asymmetries in the market, in particular when trades are not related to information. The trading costs of traders that preannounce their trades are reduced, but the effect on other traders is ambiguous (trading cost and welfare). This practice, known as "sunshine trading", is of particular interest to us because it shares many commonalities with the commodity index funds roll. However, index fund managers neither explicitly announce their trades, nor the intraday timing within the window.

2.3. *Predatory trading*

Brunnermeier and Pedersen (2005) study a distressed trader, a distressed hedge fund for example, who reveals some information to predatory traders (e.g., its broker dealer). In their setting, the predatory trader is aware of the trader's needs to liquidate quickly her positions. The model foresees a higher price impact as the predator trades on this information along or before the distressed trader. Hence, the liquidation value of the distressed fund decreases. The model also features long-term investors who do not have this information or the willingness to initiate such predatory trades. It predicts that the more predatory traders compete, the lower the (permanent) price impact. With an infinity of predatory traders, the effect is similar to the one of price pressure alone. In our setting, we assume the entire market to know about the trades, and thus, to be in this corner case.

[6]See the contract description in appendix C.

[7]At first glance, the roll looks very much like stock index inclusion (first deferred contract) and deletion (nearby contract). However, there are two notable differences. First, changes in stock index composition are less frequent (20 per year on average for the S&P 500) than changes in the SP-GSCI index (more than 250 per year). Second, the index is built on stocks (positive net supply), and not on futures contracts (zero net supply).

From an empirical perspective, Mou (2011) explores the performance of a strategy that front runs the SP-GSCI official roll by five and ten days from 1980 to 2009. Both strategies take a long position in the second nearby contract and a short position in the first nearby contract. These strategies generate abnormal returns beyond that of the SP-GSCI constituents after controlling for the average roll yield of commodities, GDP growth, and inflation. For non SP-GSCI constituents, there is no abnormal returns. He argues that transaction costs are very low, and estimates them to the minimum possible fluctuation of one percentage in point (pip). The best performing strategy that takes positions ten days ahead the roll delivers an average monthly 31 bp per roll before transaction costs from 2000 to 2010. He attributes these findings to the limits of arbitrage capital leading to price pressure. Under these conditions, there is also potential room for front trading. Additionally, he shows that abnormal returns are positive and related to the ratio of index investment and arbitrage capital. Finally, he estimates the costs of this lack of arbitrage to USD 8.4 billion in 2009, for a total index investment of USD 211 billion.

Bessembinder et al. (2016) re-examine theoretically the predatory trading hypothesis by considering that the price impact of trades has both a transitory and a permanent component. In this setting, they demonstrate that a monopolistic predator benefits a sunshine trader if the permanent component is not very large, and if the transitory component vanishes quickly. They study empirically the roll of the USO, which takes place at a known date. They show that more individual trading accounts provide liquidity on roll date, and find no systematic use of predatory strategies. To summarize, their results are consistent with the sunshine trading hypothesis.

3. Methodology and hypotheses

3.1. Dating the financialization

Masters (2008) shows that the proportion of OI from CITs (IND) changed dramatically from 1998 to 2008, which makes this ratio a natural candidate to look for a potential break caused by index investors. As a result of the financialization, we should observe a common break affecting simultaneously the IND for the futures contracts constituents of the SP-GSCI index. Therefore, our first hypotheses set is as follows:

H1a: IND of commodities futures contracts constituents of the SP-GSCI show a common break during the 1992 – 2017 period.

A related question is whether there is enough arbitrage capital to offset the price pressure of CITs' roll. Following the literature (see, e.g., Stoll and Whaley, 2010 and Irwin and Sanders, 2012), we define the ratio of spreading positions over total OI as a proxy for the arbitrage capital deployed by speculators to ease the index investors' activity during the roll (or profit from it). We check for a common break affecting the constituents of the SP-GSCI index.

H1b: Ratios of arbitrage capital over total OI (ARB) on commodity futures contracts constituents of the SP-GSCI show a common break during the 1992 – 2017 period.

Since 1986, the "Commitment of Traders" (COT) reports on a weekly basis the long and short positions of the "commercial category", and the long, short and spreading positions of the "non-commercial category" for every US futures contract (that has at least 20 active trader positions above a threshold defined by the CFTC for each contract). In 2006, the CFTC revised these categories, and added the "supplemental" and "disaggregated" reports.[8] The disaggregated report splits the original categories of commercial and non-commercial traders, in hedgers,[9] swap dealers, managed money, and other reportable. The supplemental report refers to 13 agricultural futures contracts, and adds a CIT category that aggregates all the positions reported in the above mentioned categories and that are managed for commodity investment vehicles, ETFs, ETNs and funds. We download the COT report data from the CFTC website[10] and compute the variable IND, ARB and others, for the SP-GSCI futures contracts.

To compute the numerator of IND, we use the information of Masters and White (2008), the CFTC CIT report, the total OI, the SP-GSCI weights, the underlying quantities and the prices. We then apply the Masters' algorithm (see, e.g., Masters, 2008; Mou, 2011 and Sanders and Irwin, 2013[11]). We describe the procedure in the appendix A. In Figure 1, we plot the monthly SP-GSCI investment, total arbitrage capital, total OI and total trading

[8]The CFTC disaggregated the positions because of the classifications of most of the swap dealers into the commercial category. Despite their role is non-speculative, they dedicate a large part of their activity to hedge indices related position. In addition, for the same reasons, they could claim the exchanges for position limits exemptions, as if they were producers in needs of hedging.

[9]The official CFTC classification is Producer/Merchant/Processor/User.

[10]http://www.cftc.gov/MarketReports/CommitmentsofTraders/index.htm

[11]Sanders and Irwin (2013), argue that the Masters algorithm produces index investment figures that are sensitive to the low weighted contracts generally used to impute the overall index investment. In particular they find the correlation between index investment figures of the CFTC and the Masters algorithm to be extremely low and sometimes negative. Instead, we find that the lowest correlation is 0.62 for the Kansas Wheat contract and that all other coefficients are above 0.77. Moreover the index investment values lie in a close range.

volume, for the 27 selected contracts[12] and expressed in USD.

[Insert Figure 1 here]

We look for a break in the commodity futures contracts open interest ratios, IND and ARB, using the Bai, Lumsdaine, and Stock (1998) algorithm. We estimate a $VAR(1)$, and restrict the break to apply to the intercept only. The estimated equation is,

$$y_t = \left(G_t' \otimes G_t\right)\theta + d_t\left(k\right)\left(G_t' \otimes I_n\right)S'S\delta + \epsilon_t, \tag{1}$$

where y_t is the stack vector of IND or ARB series, G_t' is a row vector containing y_{t-1} and a constant, n is the number of equations, and S is a selection matrix such that only the intercept is allowed to break with $S = s \otimes I_n$ and $s = (1, 0, ..., 0)$. We estimate the system of equations for every potential breaking date k, such that $d_t\left(k\right) = 0$ for $t \leq k$ and $d_t\left(k\right) = 1$ for $t > k$. We identify the break date as the value of k that generates a maximum Wald statistic higher than the limiting χ^2 distribution. Then, we construct the confidence interval (in days) of the estimated break date $\hat{k}$, for a given level of statistical significance.

3.2. The valuation effect of the roll

We revisit the valuation effect of the financialization of commodity markets during the rolling period for several reasons. First, previous research use an ad hoc date to determine when financialization is supposed to materialize. Alternatively, we estimate the potential structural change through a statistical method, which is less arbitrary. Second, while the benchmarks in event studies based on stock returns are well established, there is no consensus on how to compute abnormal spreading returns in the existing literature. Mou (2011) does not adjust the CASRs directly, while Henderson et al. (2015) use a linear factor model for returns on single futures contracts. The period over which abnormal returns could materialize is not well identified. Depending on the scenario, abnormal returns are supposed to occur before or during the rolling period. Third, every month, between 16 and 24 futures commodity contracts are rolled. The residual terms, i.e. the error in the estimation window and the CASRs during the event window, could be cross-correlated because of missing variables in the benchmark model. Ignoring this cross-correlation shrinks the standard error of the CASRs, which in turns leads to an over-rejection of the null hypothesis (abnormal returns are too frequently different from zero).

[12]Except for the London Metal Exchange (LME) contracts, not covered by the CFTC and for which the spreading positions of speculators is not available.

We test the valuation effect on spreading returns for two reasons. First, during a roll, an index fund sells and buys the same quantity on both legs. Thus, we expect a magnified effect when looking at both contracts simultaneously. Second, spreading returns avoid the concurrent effect of fundamental shocks that may shift the whole term structure at once. We also examine the valuation effect on both the nearby and first deferred contracts. The reason is that the market reaction could be different on both legs. Therefore, we set our second hypothesis as follows:

H2a: Abnormal spreading returns (returns on the first deferred minus nearby contract) on SP-GSCI contracts are null during the SP-GSCI roll periods from 1992 to 2017 and during the sub-periods.

H2b: Abnormal returns on the nearby and first deferred contracts constituents of SP-GSCI are null during the roll periods from 1992 to 2017 and during the sub-periods.

H3a: Abnormal spreading returns are null during the week preceding the SP-GSCI roll periods from 1992 to 2017 and during the sub-periods.

H3b: Abnormal returns on the nearby and first deferred contracts are null during the week preceding the roll periods from 1992 to 2017 and during the sub-periods.

To test the aforementioned hypotheses, we conduct an event-study. First we download the daily closing prices of the 27 commodity futures constituents of the SP-GSCI for the first five consecutive maturities m. The sample starts on January 2, 1992 and ends on September 22, 2017. We compute the daily arithmetic futures returns for every maturity available as $R^m_{c,t} = \frac{F^m_{c,t}}{F^m_{c,t-1}} - 1$, when no expiry occurs between $t-1$ and t and $R^m_{c,t} = \frac{F^m_{c,t}}{F^{m+1}_{c,t-1}} - 1$ otherwise. $F^m_{c,t}$ is the futures price of commodity c, on day t and for each maturity.[13] We define the spreading returns as $SR^m_{c,t} = R^{m+1}_{c,t} - R^m_{c,t}$, for every maturity of the term structure.[14] Finally, we download and compute the returns on the MSCI emerging market index, SP-500 index, USD index, VIX, T-Bond, Baltic Dry Index, and inflation indices; see Henderson et al. (2015). We download the data from Thomson Reuters and the Commodity Research Bureau.

First, we estimate the valuation effect of the roll with an event study that relies on a parametric benchmark for both spreading and individual returns, and account for cross cor-

[13]There are expiry dates variations across the contracts, with maturity standing at the beginning or end of the quoted months. Other contracts matures during the month preceding their quoted months.

[14]Although it is only fully numerically true for log returns, the standard deviation is so small that we are confident to use this approximate raw-log equality.

relation of commodity returns during the window; see Kolari and Pynnonen (2010). The counterfactual (benchmark) of the nearby spreading returns is a linear function of the spreading returns based on further to maturity contracts (see the appendix B). We estimate the abnormal spreading returns during the roll as a Seemingly Unrelated Regression (SUR; see Zellner, 1962) with a single pass estimation,[15,16]

$$SR^1_{c,t} = \alpha_{0,c} + CASR_{c,e} \times \Delta^{roll}_{c,t} + \alpha_{1,c} \times SR^3_{c,t} + \epsilon_{c,t}, \tag{2}$$

where c is the commodity contract, t is the current time, $\Delta^{roll}_{c,t}$ is an individual commodity dummy vector equal to 0.2 for every day of the roll,[17] $CASR_{c,e}$ captures the cumulated abnormal spreading returns for all commodity c and event months e. To avoid confounding effects, we identify separately the January roll because the SP-GSCI is reweighted every year in that month during a period overlapping the normal roll of the contracts, i.e., from the 5th to the 9th business day. For the contracts that expire in January,[18] the index fund methodology is as follow. Every day of the roll period, 20% of the position is unwound normally from the nearby contract. The buying volume of the first deferred contract however, adjusts to reflect the new weights. For all other commodities of the index, the index reweighting is similar to that of a stock index.

Second, we control for possible benchmark misspecifications, and estimate abnormal spreading returns with a model free benchmark. As the counterfactual, we use a peer futures contract written on a similar commodity, which is not a constituent of any commodity index to our knowledge. We collect the first three maturities of these eighteen matching peers (non-indexed commodities with similar specifications); see the appendix C. Since there might be an asymmetric response on the long and short legs during the roll, we also repeat the event-study separately on each leg. The baseline estimation becomes,

$$NPCASR_{c,e} = \sum_{t=5}^{9} \left(SR^1_{c,t} - SR^1_{p(c),t} \right), \tag{3}$$

[15]We also repeat all parametric event-study methods with a 250 day rolling window of estimation with no noticeable difference.

[16]Our parametric tests also include two OLS estimations with common sets of covariates used by Henderson et al. (2015) and Bakshi, Gao, and Rossi (2019). The model takes the form, $SR^1_{c,t} = \beta_{0,c} + CASR \times \Delta^{roll}_{c,t} + \boldsymbol{\beta} \times \boldsymbol{Z_t} + \epsilon_{c,t}$, where $\boldsymbol{Z_t}$ indicates a matrix of stacked covariate vectors and $\boldsymbol{\beta}$ is the vector of coefficients, numbered from one to the number of covariates in $\boldsymbol{Z_t}$. To control for any misspecification we also include a zero benchmark. We report the results for these additional benchmarks in the appendix G.

[17]The dummy vector is coded 0.2 during the days of the roll to capture the CASRs using only one vector for the five days of the roll window. For any alternative window length, the value is $\frac{1}{\#eventdays}$.

[18]These contracts are, Lean Hogs, Live Cattle, WTI Crude Oil, Heating Oil, RBOB Gasoline, Brent Crude Oil, Gasoil, Natural Gas, Aluminium, Copper, Nickel, Lead, Zinc and Gold.

where c is the commodity contract, $p(c)$ is the peer commodity contract, t is the current day in a given month, $NPCASR_{c,e}$ captures the non-parametric cumulated abnormal spreading return of commodity c and event month e. From this panel of NPCASR, we rebuild the unadjusted and adjusted statistics accounting for event induced variance and cross correlation of commodity returns; see Kolari and Pynnonen (2010) and Boehmer, Musumecci, and Poulsen (1991).

3.3. Explaining the abnormal returns of indexed futures contracts during and around the roll

In a second step, we repeat the event study with as many dummy variables as there are commodity-events to capture a panel of CARs and CASRs for the parametric estimation and using eq.(3) for the non-parametric one. We choose the non-parametric benchmark computed with peers as the baseline benchmark to avoid potential issues with the small estimation-event window ratio. We keep the other generated panels of CARs and CASRs to control our results (with no noticeable differences). We then explain these events with panel data estimation in the light of our three null hypotheses.

H4a - Hedging demand induced price pressure: The variable IND and hedging pressure (HP), defined as the long minus short positions of commercial participants, scaled by the total commercial positions are not significantly and positively related to abnormal returns on the individual nearby and first deferred contracts during the roll window. In addition, the effect is not asymmetric, stronger on the nearby (first deferred) contract when HP is negative (positive).

H4b - Sunshine trading: The relative importance of IND (positive) and ARB (negative) does not explain abnormal returns.

H4c - Predatory trading. The importance of speculative spreading positions ahead of the roll does not explain the pre-roll abnormal returns on the nearby, first deferred and spreading positions. In this context (before roll) we use the variable ARB to proxy for the predatory capital.

To test for these three hypotheses the baseline model is,

$$CAR_{c,e}^{W,Leg} = \gamma_{0,c}^{W,Leg} + \boldsymbol{\gamma}^{\boldsymbol{W,Leg}} \times \boldsymbol{X}_{\boldsymbol{c,e}}^{\boldsymbol{W}} + \epsilon_{c,e}^{W,Leg}, \tag{4}$$

where $CAR_{c,t}^{W,Leg}$ is a panel of CARs or CASRs. The superscript W stands for the selected event window: R, PRE and $POST$ for the roll, pre-roll and post-roll window, respectively. The superscript Leg specifies the contract, nearby (1), first deferred (2) or spreading ($SPREAD$). The subscripts c and t indicate the commodity and time of event. $\gamma_{0,c}^{W,Leg}$ are commodity fixed effects. $\boldsymbol{X_{c,e}^{W}}$ is a matrix of stacked covariate vectors defined in each model and the superscript differentiate these vectors when weekly (or higher frequency) data are available. $\boldsymbol{\gamma^{W,Leg}}$ is the associated vector of coefficients, with subscripts numbered from one to the number of covariates.

To test $H4a$, we consider all roll and out-of-roll periods as abnormal, because CITs take a role in the hedging demand in the futures markets in any period. This is an additional reason to use a non-parametric benchmark, allowing us to keep the 75% of the data part of the estimation window. The correlation between abnormal returns computed with the peer contracts and with the parametric benchmark is about 70%. However, the correlation between alternatively computed CARs appears very sensitive, yet with no impact on the aggregated results (CARs magnitude and significance always fall in a very narrow range, for any benchmark, (see the appendix G). The model takes the specific form,

$$CAR_{c,e}^{R,Leg} = \gamma_{0,c}^{R,Leg} + \gamma_{1}^{R,Leg} \times IND_{c,e}^{R} + \gamma_{2}^{R,Leg} \times DHP_{c,e}^{R} \times |HP_{c,e}^{R}| + \epsilon_{c,e}^{R,Leg},$$

where $IND_{c,e}$ is the ratio of total passive index investment over total investment for the commodity c and the event month e; and $HP_{c,e}^{R}$ is the HP ratio[19] defined as $HP_{c,e}^{R} = \frac{COM_{c,e}^{R,L} - COM_{c,e}^{R,S}}{COM_{c,e}^{R,L} + COM_{c,e}^{R,S}}$, $COM_{c,e}^{R}$ is the position held by genuine commercials and is therefore adjusted from the CFTC data which used to include a significant part of the CITs in the legacy report. Hence for each month we subtract the CITs' OI from the raw CFTC measure. As for all CFTC data, it is measured each Tuesday at the market closing. We choose the value standing for the Tuesday immediately preceding the first day of the window. The superscripts L and S stand for the long or short position, respectively. the HP of contracts held for genuine commercial reasons (production or consumption) impacts CARs only if the total HP (including the one induced by index investment) changes over the window, with readjustment for varying premia or discounts. Thus, we expect the contracts held by CITs to be subject to higher price pressure when $HP_{c,e} \geq 0$ on the first deferred and $HP_{c,e} \leq 0$

[19] We also test for the cross hedging pressure ($XHP_{i,e}$) as defined by Roon *de* et al. (2000), who compute a measure of HP using the aggregated positions of contracts in each industrial (subscript i) sector (energy, agriculture, metals etc.) with no noticeable differences in the results.

on the nearby. We define the dummies,

$$\begin{cases} DHP^2_{c,e} = 1, & \text{if } COM^L_{c,e} \geq COM^S_{c,e} \text{ and 0 otherwise} \\ DHP^1_{c,e} = 1, & \text{if } COM^S_{c,e} \geq COM^L_{c,e} \text{ and 0 otherwise} \end{cases}$$

To reject the null, we must find significantly negative $\gamma_1^{R,1}$ and $\gamma_2^{R,1}$ and positive $\gamma_1^{R,2}$ and $\gamma_2^{R,2}$.

To test *H4b*, the model takes the following specific form for both individual contracts,

$$CAR^{R,Leg}_{c,e} = \gamma^{R,Leg}_{0,c} + \gamma^{R,Leg}_1 \times IND^R_{c,e} + \gamma^{R,Leg}_3 \times ARB^R_{c,e} + \gamma^{R,Leg}_4 \times IND^R_{c,e} \times ARB^R_{c,e} + \epsilon^{R,Leg}_{c,e},$$

where $ARB^R_{c,e}$ proxies for the arbitragers' activity on both legs of the spread during the window. To reject the null, we need $\gamma_1^{R,1}$ to be negative, $\gamma_3^{R,1}$ to be positive and the marginal effect captured by $\gamma_4^{R,1}$ should be negative. On the contrary, the same coefficients for the returns on the first deferred contract and the spread between first deferred and nearby contracts should be of opposite signs, except for the interaction term which should also be negative. We then focus on a second model that has the same specification, except that we now estimate it for $CAR^{POST,Leg}_{c,e}$ and with all chronologically matching covariates with superscripts set to $POST$. $\gamma_3^{POST,Leg}$ is now function of arbitrager's inventories built during the roll and should be negative for the nearby, positive for the first deferred and even more positive for the spread. Moreover, if there is any asymmetry, the effect on the nearby must be more significant than on the first deferred as arbitragers face more urgency to unwind their position in that leg which expires within five to 15 days (depending on the contract). We test it with an additional variable $DAYS^{POST,1}_{c,e}$, the number of days remaining until the contract expires. Hence finding a positive $\gamma_5^{POST,1}$ is an additional support for *H4b*.

Finally, to test the null of *H4c*, we use the following specific setting,

$$CAR^{PRE,Leg}_{c,e} = \gamma^{PRE,Leg}_{0,c} + \gamma^{PRE}_3 \times ARB^{PRE}_{c,e} + \epsilon^{PRE,Leg}_{c,e},$$

we use the variable $ARB^{PRE,Leg}_{c,e}$ alone in an estimation limited to the first generation index investment period: from January 1992 to December 2008. In the second period, we use an alternative model which adds the variable $IND^{PRE,Leg}_{c,e}$ to the equation. Both variables may proxy for the predatory trading activity.[20] Although the use of this variable complicates

[20] Part of the predatory traders register as speculators (active traders). In addition, from 2008 onwards, new passive funds with optimized roll yield appear, which roll ahead of the SP-GSCI, BCOM or US Funds.

the identification, we are confident that in this context it can provide additional support if the associated $\gamma_1^{PRE,Leg}$ is also significantly positive. In the first period, we consider that only active speculators are predators. In the second, we add the pre-roll index investment as predators. In the context of sunshine trading, active (passive) traders ease (worsen) the roll. In the context of predatory trading, they both influence the pre-roll. Hence, we expect the coefficients $\gamma_3^{PRE,1}$ to be negative, $\gamma_3^{PRE,2}$ and $\gamma_3^{PRE,SPREAD}$ to be positive. In the second setting, we would reject the null even more if all the three $\gamma_1^{PRE,Leg}$ are of the same signs as the three $\gamma_2^{PRE,Leg}$.

4. Empirical results

4.1. Break test and descriptive statistics

We report the results of the break tests in Table 1 for the 27 available IND series and for the 21 available ARB series of the SP-GSCI contracts.[21] We identify a break around August 2003, with a +/- 21 days confidence interval at 1%. Based on this test, the overall index investment break happens six months earlier than the previous research consensus (late 2003 to early 2004). We also identify a break in ARB which occurs in August 2005. Using CFTC legacy report data of commercial long share of total OI, another proxy for index investment[22] we compare the index investment break for the SP-GSCI contracts with the equivalent series for contracts with no index investment by definition. The SP-GSCI contracts break occurs in November 2003, while it occurs in November 2010 for the non-indexed contracts. This break may be due to late exotic index investment or because the traditional commercial positions for hedging purposes suddenly increased. Finally anecdotal evidence and the plots of index investment in the appendix E shows that index investment came back to a more moderate level after 2010. However, when we repeat the break test on IND on the post-break period, we cannot identify a second break at the 5% level, despite visual evidence of an IND reversal.

[Insert Table 1 here]

These new funds are sometimes advertised as "congestion". We do not have precise data for these new generation funds, but estimate they began in 2008 and took a significant share of the total diversified commodity index investment. The biggest as of 2018 is the Invesco DB Optimum Yield Diversified Commodity Strategy (USD 2.2 bln.). Another way to look at it is to consider the (smaller) funds tracking the Rogers Commodity Index, which has always rolled in the beginning of the pre-roll window.

[21] We exclude the industrial metals group traded on the LME, which is not under the CFTC supervision and does not report data on spreading speculative or commercial positions.

[22] Because the swap dealers and other index investment related hedgers are classified as commercials long in the legacy report, it allows us to build this loose proxy for index investment, only way to compare the indexed and non-indexed contracts.

In Table 2, we report the annualized mean, standard deviations of the spreading returns of the contracts for the entire, pre- and post-index investment periods, as identified in Table 1, i.e. from January 1992 to August 2003 and from September 2003 to September 2017. We report the same statistics for peer contracts (not in the SP-GSCI or any major index), and written on similar underlying products.[23]

[Insert Table 2 here]

4.2. Estimating abnormal returns during the index funds roll

In Table 3, we report the results of the event study with a parametric benchmark estimated with further deferred contracts for the full and sub-period samples defined by the breaks of index investment and arbitrage capital. In specification (1), we report the CASRs for the roll for the three periods. The unadjusted t-statistic is high (up to 3 for the 1992 – 2003 period with the peer benchmark) but as soon as we adjust for event-induced variance (BMP statistics, Boehmer et al., 1991) or cross-correlation (KP statistics, Kolari and Pynnonen, 2010), the results become insignificant for all benchmarks. In the post-financialization period however the CASRs become negative with the peer benchmark. In (2), we report the CASRs for the pre-roll period. Abnormal returns are significant both statistically and economically, consistent with Mou (2011) and Brunetti and Reiffen (2014). However, abnormal returns are no longer significant at the 5% level when the standard errors are adjusted. In (3), we report the results for the post-roll period which show a reversal (insignificant when adjusted). This favors the temporary price pressure effect documented by Harris and Gurel (1986). In specification (4), we report the results when each contract is weighted as per the SP-GSCI weights. These results are very similar to the equally weighted scheme, with significance vanishing as soon as we adjust the standard errors. In specifications (5) and (6), we report the tests on the individual and nearby contracts. Oddly enough, the nearby and first deferred abnormal returns are of identical signs for all benchmarks and periods, but this sign depends on the specification. All results are again insignificant when adjusted. The result of high t-statistics and of varying signs depending on the benchmark might be spurious and induced by the higher volatility of the legs alone. This discards the presence of abnormal returns on individual contracts. The abnormal returns on the nearby contract for the pre-financialization period are positive with up to 34 basis points on average, however in the post-financialization period it becomes negative (and significant when not adjusted). The first deferred contract shows average positive abnormal returns during

[23]Note that some SP-GSCI contracts share the same peer because the closest contract does not exist or is illiquid.

the pre-financialization period, which is the only driver of the positive CASRs over the sub-period. In the post-financialization period however, the abnormal returns become negative, albeit less significantly than on the first nearby contract. Hence this first leg appears to be driving the CASRs in the second sub-period. In (7) we repeat the event-study on the peer contracts themselves, on the roll period (we use a zero benchmark for the non-parametric case, see the appendix G). Not a single unadjusted t-statistic is higher than one, which by contrast, gives more support to the presence of abnormal returns in the SP-GSCI contracts. Finally in (8) we subtract the minimum possible transaction costs that a price taker (which index funds and arbitragers are most likely to be) could face in the form of a one tick bid/ask spread, scaled by the price level of the day. When transaction costs are considered, all abnormal returns disappear in the 1992 – 2003 period and become strongly negative in the post-financialization period. Again, this assumes the minimum possible transaction costs, no exchange commissions and infinite market depth.

[Insert Table 3 here]

4.3. Explaining abnormal returns

In the specifications (1) and (2) of Table 4, we report the test for the hedging demand induced price pressure hypothesis, achieved on the nearby and first deferred abnormal returns, respectively. The coefficient of IND ($\gamma_1^{R,Leg}$) is positive on both contracts, while the theory predicts a negative $\gamma_1^{R,1}$ and a positive $\gamma_1^{R,2}$. However, only the latter is significant at 5%. The coefficient $\gamma_2^{R,Leg}$, testing for the contribution of HP to the price pressure is negative in both cases, albeit with no statistical significance, whereas the theory predicts a negative $\gamma_2^{R,1}$ and positive $\gamma_2^{R,2}$. The higher t-statistics on the nearby contract does not suffice to reject the null at 5% and hence this test does not reject the null of no price pressure - hedging pressure effect of the financialization.

[Insert Table 4 here]

In the specifications (3), (4) and (5), we begin the test of the sunshine trading hypothesis, on the nearby, first deferred and spreading abnormal returns, respectively. The coefficients for IND ($\gamma_1^{R,Leg}$) and ARB ($\gamma_3^{R,Leg}$) on the nearby contracts are significant at 5% and not significant, respectively, but with signs in agreement with the theory. In contrast, the coefficients of the first deferred contract are slightly more significant, but with the same signs as those of the nearby. Obviously, when explaining the abnormal returns on the spread, the coefficients do not reject either the null of no sunshine trading. We do not find any of the three coefficients $\gamma_4^{R,1}$, $\gamma_4^{R,2}$ and $\gamma_4^{R,SPREAD}$, the coefficients associated with the interaction between IND and ARB, to be significant. We state above that the post-roll window might give additional support (or contradiction) for the theory. Hence, the specifications (6), (7) and (8) repeat the former specifications during the post-roll window. We add the estimation of $\gamma_5^{W,Leg}$, the coefficient associated with the number of days remaining before maturity. The results are again inconclusive for the individual contracts. Only the highly negative and significant $\gamma_1^{POST,SPREAD}$ (t-statistic of -6.47) indicates a substantial effect of index investment on the post-roll window. The time to maturity is non-significant at the 5% level in all cases. Hence, these results are more consistent with the temporary price pressure than with the sunshine trading hypothesis. We can infer this, given that the CASRs of the post-roll window, found e.g., in Table 3 specification (3), are nonetheless significant.

In the specifications (9), (10) and (11) we test for the effect of predatory activity on the five days window ahead of the roll (pre-roll). We first find support for the theory, on the nearby contract, during the first sub-period with significant and negative $\gamma_3^{PRE,1}$ associated with the variable ARB. However, the abnormal returns on the first deferred also gets a negative coefficient with an even higher t-statistic (both are significant at 1%) In contrast, the coefficient $\gamma_3^{PRE,SPREAD}$ for spreading returns is significant at 1% and support the hypothesis. In the second sub-period however (specifications 12, 13 and 14), the same pattern applies for the individual legs but the$\gamma_3^{PRE,SPREAD}$ coefficient is not significant at 5% anymore. Similarly, the addition of the variable IND in the pre-roll period, that has now an interpretation of predatory activity, does not deliver any significant $\gamma_1^{PRE,SPREAD}$ at 5%. Additional robustness tests omitting the IND as proxy for passive predatory trading coming from second generation indices do not change these results either.

5. Additional tests on the futures contract written on the SP-GSCI

One key issue of this study is to differentiate the positions taken by the various class of investors, their timing and on which contract they are held. To overcome this identification problem, the literature adopts sometimes the usage of the Large Trader Reporting System (LTRS), an internal database of the CFTC with a higher frequency (daily) and splits positions of each investor by maturity. We propose an alternative identification test with the study of a futures contract traded on the CME and that is directly written on the SP-GSCI performance,[24] which was launched by the CME in January 1994. Because this contract has no use for genuine underlying hedgers such as commodity or commodity processors, it is

[24]CME specifications of the SP-GSCI futures contract

likely that its reported daily OI and volume will indicate when SP-GSCI trackers, predators or arbitragers take most of their positions. Figure 2 shows the SP-GSCI futures contract total OI and volume for the nearby and first deferred contract. In particular in Panel B, we focus on the year 2010 (randomly chosen) and display the strong repeating pattern of the trading volume occurring during the five days of the SP-GSCI roll (highlighted with shaded areas). In Table 5 Panel A, we report the regression of the SP-GSCI futures contract' volume on a dummy coded one during the five days of the roll. The t-statistic of 69 and the mean difference of 4812 contracts indicate that almost all traders are active only during the roll. Despite this strong repeating pattern, the remaining trading volume out of the window might play a role in explaining abnormal returns. We first repeat the tests of CASRs and CARs on the nearby and first deferred contract (*H2a,b*), based on a benchmark consisting of the weighted returns on the peer contracts, themselves weighted following the SP-GSCI scheme. Again, we conduct these tests on the pre-roll and roll windows,[25] for the different sub-periods. We report the results in Table 5 Panel B. Finally, we repeat the test of hypotheses *H4b,c* explaining the abnormal returns of the pre-roll and roll-window with the spreading positions of the speculators reported by the CFTC. The methodology is the same as in Table 4. We use the data of the Tuesday close when this day falls immediately before the roll window. We report the results in Table 5 Panel C.

[**Insert Figure 2 here**]

[**Insert Table 5 here**]

Table 5 Panel A and Figure 2 Panel B shows dramatic increase of trading volume during the SP-GSCI roll for the roll contract. There is almost no trading volume out of the window which gives clear hints that index investment volume in the 27 SP-GSCI contracts stands in the window as well. In Table 5 Panel B we display the abnormal returns computed with the above-described benchmark (a SP-GSCI weighted portfolio of peer contracts). The pattern is very similar to the one of Table 4. The individual SP-GSCI contract displays significant CARs only for the first deferred contract during the pre-financialization period. In contrast, the spreading returns are significant at 1% for all periods and all windows. As for the CASRs of individual constituents of SP-GSCI, the magnitude is of 19 basis points at most. In contrast, considering a one pip bid-ask spread for this contract yields transaction costs with order of magnitude of about two or three basis points only. Hence the strategy might remain highly profitable in this contract, assuming low transaction costs.

[25]The contract matures one day after the roll and hence we do not analyze the post-window.

6. Conclusion

We study the consequences of the financialization of commodity futures markets. First, we identify a structural break of index investment over total open interest common to the 27 constituents of the SP-GSCI. This break occurs by the middle of 2003. We also identify a break in the amount of overcoming arbitrage capital that occurs by the middle of 2005. We find that the decrease in abnormal spreading returns, both in magnitude, and statistical significance appears as early as 2003. Thus, we document a price pressure effect in the pre-index investment period only. In contrast, the fact that the break in index investment is concurrent with the decrease of abnormal returns supports the sunshine trading hypothesis, with arbitragers providing liquidity, instead of conducting predatory trading. Hence, the index investment boom might have ease the activity of index investors due to the concurrent public awareness of these predictable trades. However, when explaining abnormal returns, we do not obtain the coefficients predicted by the models of hedging pressure, sunshine trading and predatory trading.

These findings, however, do not rule out the possibility of intraday predatory trading from a monopolistic predator that front-runs the trades of index investors. We also question the small size of the abnormal returns, and relate them to the transaction costs bore by a price taker arbitrager. This supports the sunshine trading hypothesis as arbitragers provide liquidity, and ease the roll activity of hedgers as soon as the price impact overcomes their transaction costs. Hence, what is perceived as abnormal returns in a back-test actually becomes a non profitable strategy. This cost simply appears to shrink to the size of the arbitragers' transaction costs. This study reconciles the two opposite findings of the literature on commodity index investment. On the one hand, we document a significant effect almost surely caused by index investment. On the other hand, the size of the effect is limited to the transaction costs, and it is very unlikely that index investors' position roll over have modified the term structure as it has previously been advocated.

References

Admati, A. R., Pfleiderer, P., 1991. Sunshine trading and financial market equilibrium. Review of Financial Studies 4, 443–481.

Aulerich, N. M., Irwin, S. H., Garcia, P., 2013. Bubbles, food prices, and speculation: Evidence from the CFTC's daily large trader data files. Available at: `http://dx.doi.org/10.3386/w19065` .

Bai, J., Lumsdaine, R. L., Stock, J. H., 1998. Testing for and dating common breaks in multivariate time series. Review of Economic Studies 65, 395–432.

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.

Bekaert, G., Harvey, C. R., Lumsdaine, R. L., 2002. Dating the integration of world equity markets. Journal of Financial Economics 65, 203–247.

Bessembinder, H., Carrion, A., Tuttle, L., Venkataram, K., 2016. Liquidity, resiliency and market quality around predictable trades: Theory and evidence. Journal of Financial Economics 121, 142–166.

Bodie, Z., Rosansky, V. I., 1980. Risk and return in commodity futures. Financial Analysts Journal 36 (3), 33–39.

Boehmer, E., Musumecci, J., Poulsen, A. B., 1991. Event-study methodology under conditions of event-induced variance. Journal of Financial Economics 30, 253–272.

Boons, M., Roon *de*, F., Szymanowska, M., 2014. The price of commodity risk in stock and futures markets. Available at: `http://dx.doi.org/10.2139/ssrn.1785728` .

Brunetti, C., Reiffen, D., 2014. Commodity index trading and hedging costs. Journal of Financial Markets 21, 153–180.

Brunnermeier, M. K., Pedersen, L. H., 2005. Predatory trading. Journal of Finance 60, 1825–1863.

Cheng, I.-H., Xiong, W., 2014. The financialization of commodity markets. Annual Review of Financial Economics 6, 419–441.

Deaton, A., Laroque, G., 1992. On the behaviour of commodity prices. Review of Economic Studies 59, 1–23.

Erb, C. B., Harvey, C. R., 2006. The strategic and tactical value of commodity futures. Financial Analysts Journal 62 (2), 69–97.

Gorton, G., Rouwenhorst, K. G., 2006. Facts and fantasies about commodity futures. Financial Analysts Journal 62 (2), 47–68.

Greer, R. J., 2000. The nature of commodity index returns. Journal of Alternative Investments 3 (1), 45–52.

Grossman, S. J., Miller, M. H., 1988. Liquidity and market structure. Journal of Finance 43, 617–633.

Hamilton, J. D., Wu, J. C., 2015. Effects of index-funds investing on commodity futures prices. International Economic Review 56, 187–205.

Harris, L., Gurel, E., 1986. Price and volume effects associated with changes in the S&P 500 list: New evidence for the existence of price pressures. Journal of Finance 41, 815–829.

Henderson, B. J., Pearson, N. D., Wang, L., 2015. New evidence on the financialization of commodity markets. Review of Financial Studies 28, 1285–1311.

Irwin, S. H., Sanders, D. R., 2012. Testing the Masters hypothesis in commodity futures markets. Energy Economics 34, 256–269.

Kolari, J. W., Pynnonen, S., 2010. Event study testing with cross-sectional correlation of abnormal returns. Review of Financial Studies 23, 3996–4025.

Masters, M. W., 2008. Testimony before the committee on homeland security and governmental affairs United States senate, may 20. Available at: `https://www.hsgac.senate.gov/download/052008masters` .

Masters, M. W., White, A. K., 2008. The accidental Hunt brothers, how institutional investors are driving up food and energy prices. Available at: `https://www.loe.org/images/content/080919/Act1.pdf` .

Mou, Y., 2011. Limits to arbitrage and commodity index investment: Front-running the Goldman roll. Available at: `http://dx.doi.org/10.2139/ssrn.1716841` .

Rezitis, A. N., 2015. Empirical analysis of agricultural commodity prices, crude oil prices and US dollar exchange rates using panel data econometric methods. International Journal of Energy Economics and Policy 5, 851–868.

Roon *de*, F. A., Nijman, T. E., Veld, C., 2000. Hedging pressure effects in futures markets. Journal of Finance 55, 1437–1456.

Sanders, D. R., Irwin, S. H., 2013. Measuring index investment in commodity futures markets. Energy Journal 34, 105–127.

Schwartz, E. S., 1997. The stochastic behavior of commodity prices: Implications for valuation and hedging. Journal of Finance 52, 923–973.

Stoll, H. R., Whaley, R. E., 2010. Commodity index investing and commodity futures prices. Journal of Applied Finance 1, 7–46.

Zellner, A., 1962. An efficient method of estimating seemingly unrelated regressions and tests for aggregation bias. Journal of the American Statistical Association 57, 348–368.

Break detection in commodity index investment and arbitrage capital.

Table 1:
The table reports the results of the break detection algorithm for multivariate stationary time series of Bai et al. (1998). The algorithm loops the following estimation, $y_t = (G_t' \otimes G_t)\,\theta + d_t\,(k)\,(G_t' \otimes I_n)\,S'S\delta + \epsilon_t$, over the k possible break dates, trimmed to begin (end) at the first (last) decile of the sample. the model is a $VAR\,(1)$ chosen according to AIC and BIC on uni- and multivariate autoregressions. We restrict the model to test for a break on the intercept only. We report the highest F-statistic ($max_k F\,(k)$), of the generated distribution, its significance according to the Bekaert, Harvey, and Lumsdaine (2002) critical values, the corresponding date, the dimension of the test (equal to the amount of series in the $VAR\,(1)$ case),the confidence intervals (CI) expressed in days at 10%, 5% and 1%, and the magnitude of the intercept shift. In Panel A, we report the results of the test on the SP-GSCI contracts index investment: (i) OI of CITs imputed with the Masters (2008) algorithm, denoted $IND\,(1)$ and (ii) commercial long OI from the CFTC legacy report denoted $IND\,(2)$; both scaled by the total OI. For the arbitrage capital we use the spreading position of speculators, scaled by the total OI. In Panel B, we report the results for the non-indexed contracts' covered by the CFTC (Oats, Rough Rice, Butter, Milk and Lumber). Their test series are the commercial long positions and spreading positions of speculators scaled over total OI. In Panel C, we report the results for an additional break test of the SP-GSCI contracts index investment achieved in the post-break sub-period. The series are monthly and the period of study is from January 1992 to September 2017.

Variable	# Contracts	Break date	CI (10%)	CI (5%)	CI (1%)	Intercept shift %	F-statistic	Significance
				Panel A: SP-GSCI contracts				
$IND\,(1)$	27	Aug-03	$+/-13$	$+/-16$	$+/-21$	4.5	189.87	$***$
$IND\,(2)$	21	Nov-03	$+/-11$	$+/-13$	$+/-20$	3.2	63.82	$***$
ARB	21	Aug-05	$+/-6$	$+/-8$	$+/-13$	6.2	94.62	$***$
				Panel B: Non-Indexed contracts				
$IND\,(2)$	5	Nov-10	$+/-8$	$+/-11$	$+/-14$	0.6	73.28	$***$
ARB	5	Dec-13	$+/-20$	$+/-25$	$+/-35$	2.5	34.48	$***$
				Panel C: Post-period test				
$IND\,(1)$	21	Aug-11	$+/-35$	$+/-42$	$+/-55$	-6.6	26.04	

SP-GSCI and matching peers nearby contracts: descriptive statistics.

Table 2:
We report the annualized mean, standard deviation, skewness, kurtosis of the daily returns on SP-GSCI futures contracts and their matching peers by underlying commodity. We also report the proportion of days during which the corresponding contract was in contango. The period is from January 1992 to September 2017.

	SP-GSCI contracts					Peer contracts				
SP-GSCI Ticker	Mean %	σ %	Skewness	Kurtosis	Contango %	Mean %	σ %	Skewness	Kurtosis	Contango %
C	−4.83	23.27	0.00	0.02	11	−3.49	14.28	0.00	0.02	16
CC	−2.93	26.88	0.00	0.01	22	−4.21	24.42	0.00	0.02	21
CL	2.16	31.44	−0.01	0.02	35	3.34	15.34	−0.01	0.03	55
CT	−6.31	24.50	−0.01	0.01	25	−2.38	7.57	−0.01	0.04	28
FC	4.53	11.32	−0.01	0.02	54	0.12	13.25	−0.01	0.02	43
GC	4.87	14.22	−0.01	0.02	5	4.92	16.01	−0.01	0.02	38
HO	6.02	30.27	0.00	0.01	27	7.23	19.18	−0.01	0.02	43
KC	−4.02	33.20	0.00	0.02	13	−13.51	27.85	−0.02	0.03	25
KW	−2.34	24.04	0.00	0.01	25	5.67	22.55	0.01	0.02	36
LC	7.17	13.46	0.00	0.01	43	0.12	13.25	−0.01	0.02	43
LCO	6.26	29.47	−0.01	0.02	48	3.34	15.34	−0.01	0.03	55
LGO	3.68	26.82	0.00	0.02	38	3.78	10.90	0.01	0.04	46
LH	0.12	21.77	−0.01	0.02	42	0.12	13.25	−0.01	0.02	43
MAL	−1.11	17.58	0.00	0.02	15	−0.31	13.85	−0.02	0.04	47
MCU	6.72	21.25	0.00	0.02	43	9.59	23.64	0.00	0.02	34
MNI	1.34	28.22	0.00	0.02	22	9.59	23.64	0.00	0.02	34
MPB	5.41	25.45	−0.01	0.02	26	9.59	23.64	0.00	0.02	34
MSN	6.46	20.21	−0.01	0.02	35	9.59	23.64	0.00	0.02	34
MZN	4.05	20.71	0.00	0.03	17	9.59	23.64	0.00	0.02	34
NG	−16.17	46.58	0.00	0.01	19	−33.68	31.18	0.00	0.02	39
OJ	2.07	25.14	0.01	0.01	32	10.79	20.92	0.00	0.02	62
PL	6.33	17.75	−0.01	0.02	40	6.09	20.00	−0.02	0.02	62
RB	2.19	21.12	−0.01	0.03	57	6.17	18.67	−0.01	0.02	58
S	8.77	20.94	−0.01	0.02	33	−2.66	26.97	−0.01	0.02	51
SB	3.02	29.41	0.00	0.02	53	10.79	20.92	0.00	0.02	62
SI	8.43	25.56	−0.02	0.02	5	3.32	24.26	−0.02	0.02	44
W	−7.16	26.26	0.01	0.01	14	5.67	22.55	0.01	0.02	36

Abnormal returns on nearby, first deferred and spreads of SP-GSCI contracts.

Table 3:
This table reports the abnormal returns of an event study based on a parametric benchmark estimated in one pass. It uses the returns and difference of returns on the second and third deferred contracts (assumed to be free of most of the index investment), see, eq.(2). and appendix B. Because this benchmark is contract specific, we use a seemingly unrelated regression (SUR) for the estimation, where the convergence of the feasible generalized least square is achieved over seven iteration at most. To capture the per-series average cumulated abnormal returns, we use a dummy coded 0.2 during the five days of the window of interest for each month which has a contract rolled by the SP-GSCI. In addition, to control for the index reweighting that occurs in concurrence with the January roll, we report the results for 11 months excluding January. We report the adjusted R^2 of the parametric estimations, the average cumulated abnormal return for the five days, the unadjusted t-statistics as well as their adjustments: for event-induced variance (Boehmer et al., 1991) and abnormal return cross-correlation (Kolari and Pynnonen, 2010). Specifications (1), (2) and (3) stands for the estimation of the roll, pre-roll and post-roll window. In Specification (4), we weight each return as per the SP-GSCI. In (5) and (6), we use the individual nearby and first deferred contract, resp. In (7) we report the results for the event study achieved on the peer contracts during the roll. In (8) we subtract the minimum possible transaction costs.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Panel A: January 1992 – September 2017							
CAR/CASR %	0.05	0.11	−0.06	0.01	−0.12	−0.07	−0.02	−0.03
t-statistic	2.19	4.17	−2.13	2.14	−1.98	−1.16	−0.61	−1.22
BMP	0.11	0.23	−0.09	0.01	−0.44	−0.26	−0.08	−0.04
KP	0.05	0.11	−0.04	0.01	−0.10	−0.06	−0.03	−0.02
R^2 %	2.60	2.63	2.63	1.92	12.77	12.89	0.04	2.66
	Panel B: January 1992 – August 2003							
CAR/CASR %	0.10	0.17	−0.10	0.01	0.02	0.16	−0.04	−0.01
t-statistic	2.70	3.55	−2.07	2.62	0.31	2.40	−0.63	−0.26
BMP	0.10	0.16	−0.08	0.01	0.04	0.27	−0.05	−0.01
KP	0.06	0.09	−0.04	0.00	0.02	0.11	−0.02	0.00
R^2 %	2.46	2.53	2.51	1.99	13.47	14.90	0.15	2.48
	Panel C: September 2003 – September 2017							
CAR/CASR %	0.03	0.06	−0.02	0.00	−0.21	−0.22	0.02	−0.04
t-statistic	1.64	3.41	−0.86	1.55	−2.53	−2.42	0.40	−2.01
BMP	0.05	0.11	−0.02	0.01	−0.47	−0.53	0.04	−0.05
KP	0.03	0.06	−0.01	0.00	−0.12	−0.13	0.02	−0.03
R^2 %	3.90	3.92	3.97	3.00	15.40	15.19	0.08	3.81

Explaining abnormal returns.

Table 4:
This table reports the test results of the three hypotheses of hedging induced price-pressure, sunshine trading and predatory trading. The baseline model is eq.(4),

$$CAR_{c,e}^{W,Leg} = \gamma_{0,c}^{W,Leg} + \boldsymbol{\gamma^{W,Leg}} \times \boldsymbol{X_{c,e}^{W}} + \epsilon_{c,e}^{W,Leg}$$

The estimation stands for the 21 contracts with available index investment and arbitrage capital data (excluding LME contracts). We use the abnormal returns estimated with peer contracts on the nearby, first deferred and spreading positions. The estimation period is from January 1992 to September 2017, all estimations use commodity fixed effects. t-statistics are reported in parenthesis. Specification (1) and (2) corresponds to the test of *H4a*. Specifications (3) to (8) corresponds to the test of *H4b*. Specifications (9) to (14) are for the test of *H4c*. We split the sample to include IND as potential source of predatory trading after January 2008 (specifications 12 to 14). We indicate the nearby, first deferred contract and their spread by 1, 2 and $SPREAD$, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	H4a		H4b						H4c					
			Roll			Post-roll			Pre-Roll					
			January 1992 – September 2017						January 1992 – December 2007			January 2008 – September 2017		
	1	2	1	2	SPREAD	1	2	SPREAD	1	2	SPREAD	1	2	SPREAD
$\gamma_1^{W,Leg}$ %	0.35	0.47	0.46	0.59	0.04	0.10	-0.25	-0.37				0.53	-0.57	0.07
	(1.40)	(1.97)	(1.81)	(2.41)	(0.96)	(0.34)	(-0.96)	(-6.47)				(-0.80)	(-0.88)	(0.87)
$\gamma_2^{W,Leg}$ %	-0.22	-0.07												
	(-1.35)	(-0.47)												
$\gamma_3^{W,Leg}$ %			-0.83	-0.88	0.29	1.53	0.52	-0.34	-2.90	-5.77	0.68	-1.98	-2.09	-0.05
			(-1.39)	(-1.53)	(2.71)	(2.34)	(0.83)	(-2.51)	(-2.99)	(-3.45)	(4.18)	(-2.61)	(-2.83)	(-0.51)
$\gamma_4^{W,Leg}$ %			0.59	0.76	0.37	-0.42	-1.39	0.22						
			(0.29)	(0.40)	(1.00)	(-0.19)	(-0.65)	(0.48)						
$\gamma_5^{W,Leg} \times 10^5$						1.72	2.94	-1.03						
						(0.44)	(0.79)	(-1.27)						
R^2 %	0.40	0.39	0.10	0.13	0.41	1.37	0.50	1.70	0.25	0.42	1.89	0.48	0.57	0.08
# observations	6468	6468	6468	6468	6468	6468	6468	6468	4032	4032	4032	2436	2436	2436

Additional tests on the SP-GSCI futures.

Table 5:
In Panel A, we display the results of a regression of trading volume on the SP-GSCI contracts for all maturities aggregated on a dummy coded one during the roll window and zero otherwise; t-statistics are in parenthesis. Panel B reports the CARs and CASRs on the SP-GSCI futures contracts for the pre- and roll windows and for the entire, pre- and post-financialization sub-periods. The benchmark is computed as the returns on the peer contracts, weighted according to the SP-GSCI. We report t-statistics in parenthesis. In Panel C, we report the results of a regression of the CARs and CASRs estimated on the whole period in Panel B, using speculative spreading positions (from the CFTC) as dependent variables. We display t-statistics in parenthesis and adjusted R^2. The general equation is,

$$CAR_e^{W,Leg} = \lambda_0^{W,Leg} + \lambda_1^{W,Leg} \times ARB_e^W + \epsilon_e^{W,Leg}.$$

Panel A

intercept	695.08
	(20.58)
SP-GSCI roll dummy	4812.34
	(69.3)
R^2 %	44.68
# observations	5968

Panel B

	January 1994 – September 2017			January 1994 – August 2003			September 2003 – September 2017		
	1	2	SPREAD	1	2	SPREAD	1	2	SPREAD
					Roll				
CAR/CASR %	0.39	0.54	0.16	-0.08	0.00	0.08	0.11	0.22	0.11
	(1.57)	(2.36)	(3.63)	(-0.30)	(0.00)	(3.44)	(0.62)	(1.23)	(4.97)
					Pre-roll				
CAR/CASR %	0.23	0.41	0.19	-0.40	-0.27	0.13	-0.14	0.01	0.16
	(0.91)	(1.78)	(3.46)	(-1.32)	(-0.91)	(4.51)	(-0.67)	(0.04)	(5.48)

Panel C

	Roll			Pre-Roll		
	1	2	SPREAD	1	2	SPREAD
$\lambda_0^{R,Leg}$ %	-0.33	-0.37	-0.36	0.01	-0.09	-0.10
	(-0.91)	(-1.05)	(-0.80)	(0.03)	(-0.21)	(-1.75)
R^2 %	0.06	0.81	0.05	0.00	0.00	0.23

SP-GSCI futures contracts investment, arbitrage capital, open interest and trading volume.

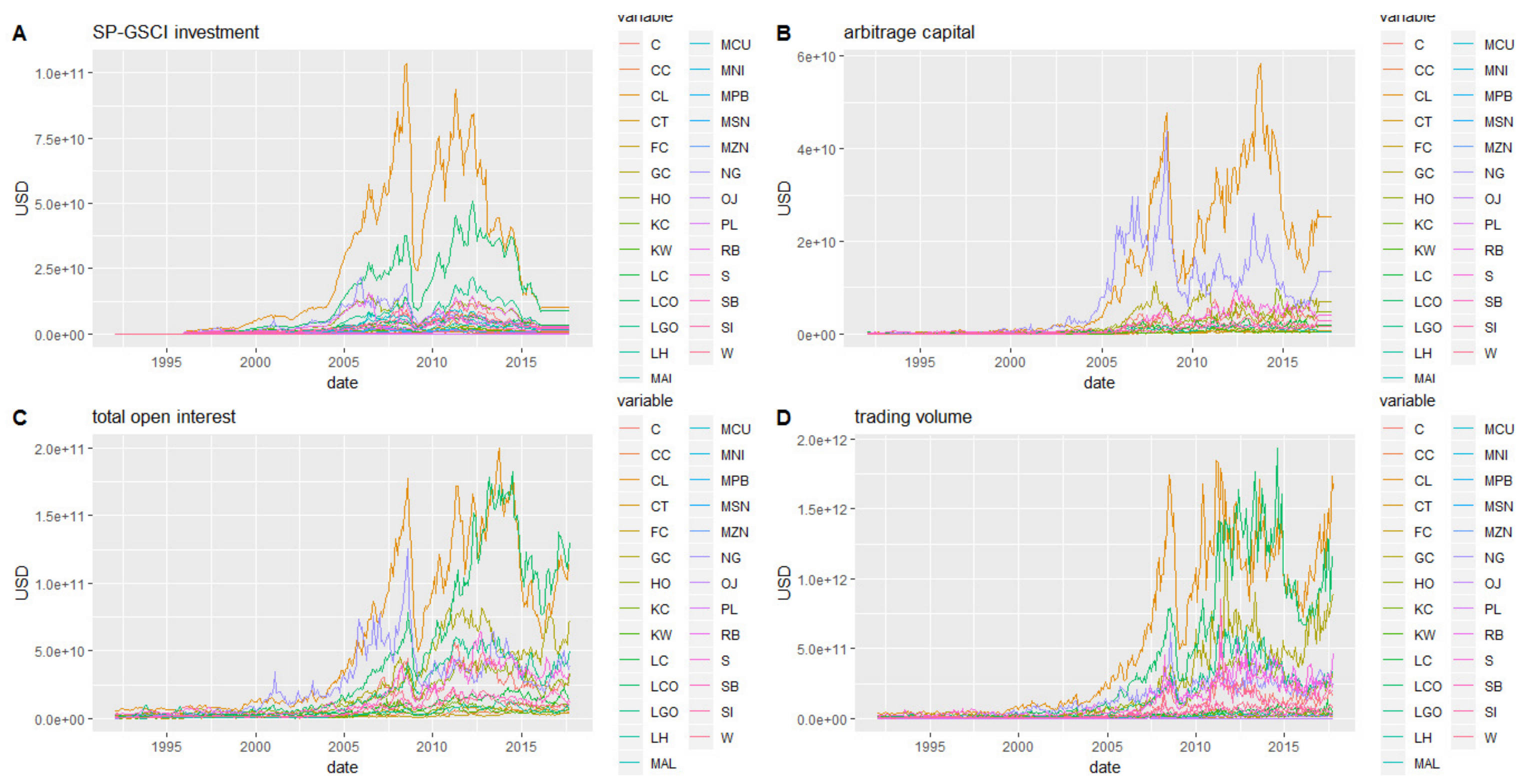
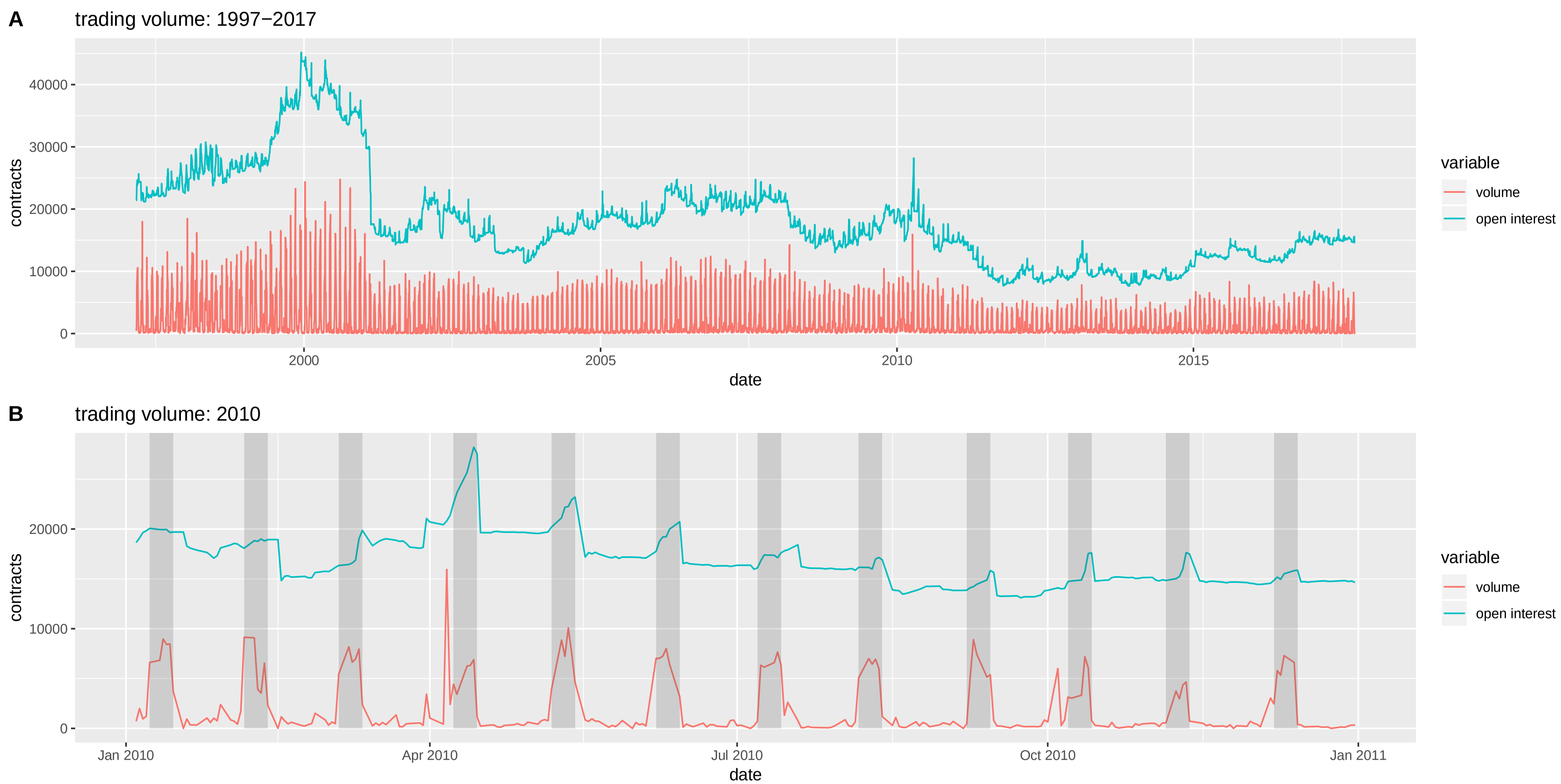


Fig. 1:
In this figure we plot the monthly series of index investment IND (Panel A), total open interest (Panel C) and trading volume (Panel D) for the 27 futures contracts constituents of the SP-GSCI. In Panel B, we plot the spreading positions of speculators, proxy for arbitrage capital ARB, for the 21 contracts covered by the CFTC (excluding the metal contracts of the LME that are combined with the horizontal axis).

Trading volume and open interest of futures contract written on the SP-GSCI.

Fig. 2:
In Panel A, we plot the daily total trading volume of the future contract written on the SP-GSCI for the period 1997 – 2017. In Panel B, we focus on the year 2010, to highlight the concentration of trading activity during the five days of the official SP-GSCI roll, we shade the corresponding surfaces.



Appendix A. Masters (2008) procedure

- We compute the value of each futures contract at each date, in multiplying the underlying deliverable quantity (available from the contract specifications) by the contract price.
- Masters and White (2008) report the yearly *OI* for the period 1995-2006 for all CITs with the following breakdown, SP-GSCI, BCOM and "other funds". We reallocate these values in each futures contracts based on the weights of the SP-GSCI and BCOM (provided by SP-Global and Bloomberg, respectively.)
- The Masters and White (2008) data are sampled annually. We assume a constant growth rate and convert it monthly. This leaves the overall impact of index investment unchanged but allows for a more precise allocation given the frequencies of our SP-GSCI (monthly) and BCOM (daily) weights.
- We assume zero index investment before 1995 as Masters and White (2008) data already indicate that the index investment before 1998 is negligible.
- From 2006 onwards, the CFTC publishes weekly the CIT report that precisely allocates the *OI* of all index investors for 13 agriculture contracts. We convert the reported *OI* in USD.
- To extrapolate the total index investment, We select the Cocoa contract among the 13 commodities of the CIT report. Indeed, the Cocoa contract is indexed only by the SP-GSCI and the BCOM (and no other majour index funds to our knowledge). Our results are unchanged if another unique SP-GSCI/BCOM contract is chosen such as Coffee or Cotton).
- We divide the selected series of *OI* by the contemporaneous percent weight of the contract in the indices to obtain 100% of the index investment tracking these indices.

Appendix B. Further deferred contracts benchmark

We start from the standard commodity futures fair value equation in logs,

$$f_{c,t}^{m} = s_{c,t} + \left(r + w_c - y_{c,t}^{m}\right)\left(T^{m} - t\right), \tag{5}$$

and assume that r, the per-period common interest rates and w_c the individual storage costs are constant over time and over maturity, whereas $y_{c,t}^{m}$, the convenience yield is maturity and time varying (see, Schwartz, 1997). T^{m} stands for the stopping time, of maturity m. Hence, we can write any contract of the term structure in term of another one,

$$f_{c,t}^{m+k} = f_{c,t}^{m} + \left(r + w_c\right)\left(k - m\right) - \sum_{i=m+1}^{m+k} y_{c,t}^{i}, \forall k \geq 0, \tag{6}$$

For the spreading position benchmark, we relate the difference of the nearby and first deferred prices $f_{c,t}^{2} - f_{c,t}^{1}$ with the second and third deferred prices, $f_{c,t}^{4} - f_{c,t}^{3}$, such as, $f_{c,t}^{2} - f_{c,t}^{1} = f_{c,t}^{4} - f_{c,t}^{3} + y_{c,t}^{4} - y_{c,t}^{3}$. Hence the log spreading returns is,

$$\left(f_{c,t+1}^{2} - f_{c,t}^{2}\right) - \left(f_{c,t+1}^{1} - f_{c,t}^{1}\right) = \left(f_{c,t+1}^{4} - f_{c,t}^{4}\right) - \left(f_{c,t+1}^{3} - f_{c,t}^{3}\right) + \left(y_{c,t+1}^{4} - y_{c,t}^{4}\right) - \left(y_{c,t+1}^{2} - y_{c,t}^{2}\right),$$

or simplified is,

$$sr_{c,t+1}^{1} = sr_{c,t+1}^{2} + \left(y_{c,t+1}^{4} - y_{c,t}^{4}\right) - \left(y_{c,t+1}^{2} - y_{c,t}^{2}\right) \tag{7}$$

The maximum annualized standard deviation for the spreading returns on the nearby and first deferred contracts (typically the most volatile of the term structure) is below 12% and is typically around 5%. Moreover, the absolute annualized spreading returns is below 3%. Thus, we use the approximate raw log equality, $SR_{c,t+1}^{1} = SR_{c,t+1}^{3} \times e^{\left(\left(y_{c,t+1}^{4} - y_{c,t}^{4}\right) - \left(y_{c,t+1}^{2} - y_{c,t}^{2}\right)\right)}$. We can estimate the exponent term as a regression beta and create a parametric benchmark free of any first generation fund activity (SP-GSCI and BCOM tracking investment is absent of further deferred contracts by definition). The model for the benchmark is, $SR_{c,t}^{1} = \alpha_{0,c} + \alpha_{1,c} \times SR_{c,t}^{3} + \epsilon_{c,t}$, as used in eq.(2).

Appendix C. Contracts description

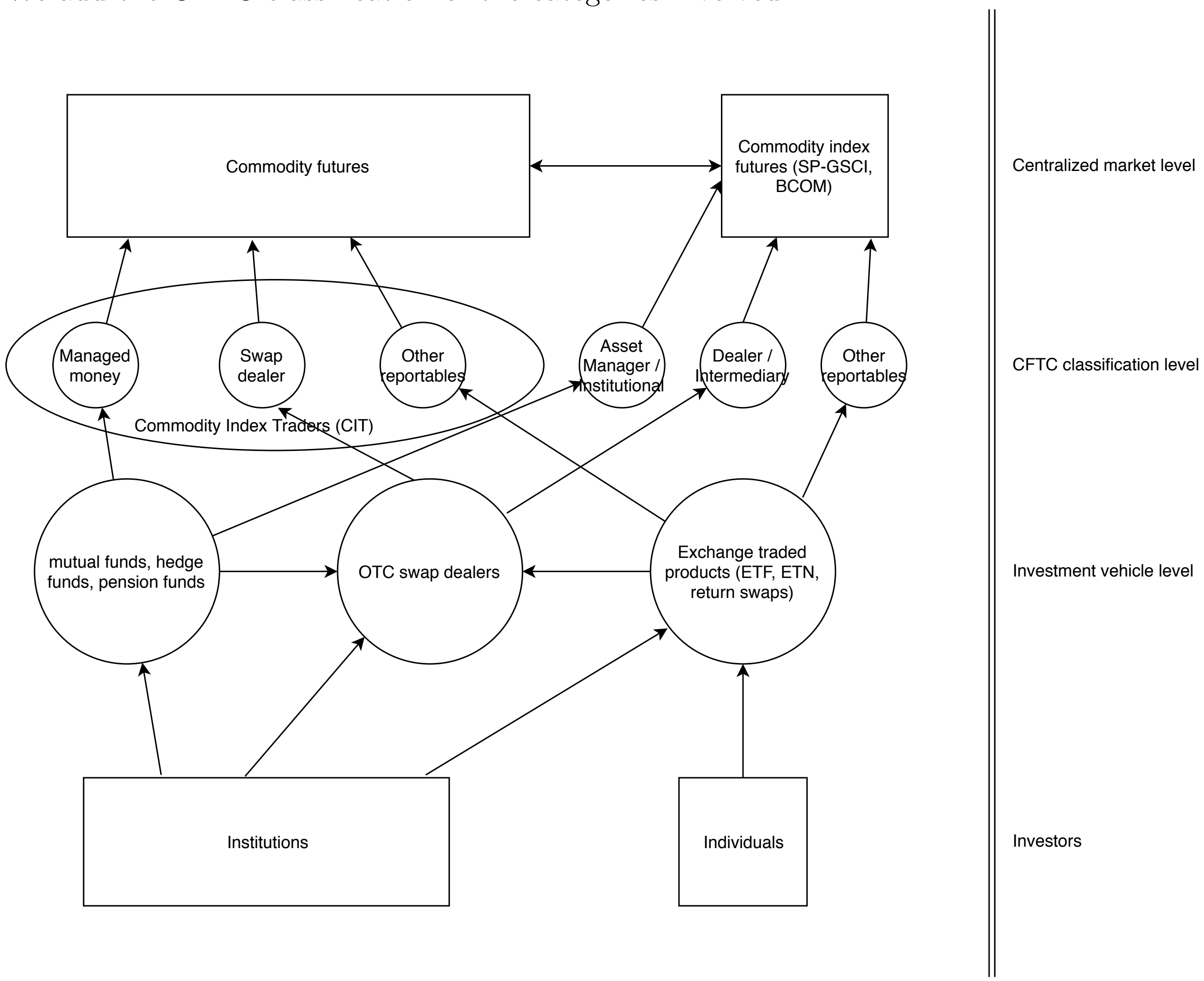
Table 6:
We report the specifications of the 27 SP-GSCI contracts as well as their peer futures contracts (non-indexed and with similar underlying commodities) The specifications include their trading venues, ticker, underlying commodities, unit and currencies if applicable. We also report their maturity months with the appropriate code letter in use, as well as the traded currency for the peer contracts.

SP-GSCI contracts					Peer contracts					
Ticker	Trading venue	Underlying	Unit	Maturity	Ticker	Trading venue	Underlying	Unit	Maturity	Currency
C	CBT	Corn	bu (5,000)	HKNUZ	EMA	MATIF (EURONEXT)	Corn	MT (50)	FHMQX	EUR
CC	ICE-US	Cocoa	MT (10)	HKNUZ	LCC	ICE-EUROPE	Cocoa	MT (10)	HKNUZ	GBP
CL	NYMEX/ICE	WTI	bbl (1,000)	FGHJKMNQUVXZ	JCO	TOCOM	Crude oil	KL (50)	FGHJKMNQUVXZ	JPY
CT	ICE-US	Cotton	lbs (50,000)	HKNVZ	CCF	ZCE	Cotton#1	MT (5)	FHKNUX	RMB
FC	CME	Feeder cattle	lbs (50,000)	FHJKQUVX	BGI	BM&F Bovespa	Beef	net arrobas. (330)	FGHJKMNQUVXZ	BRL
GC	CMX	Gold	oz (100)	GJMQVZ	JAU	TOCOM	Gold standard	Kg (1)	GJMQVZ	JPY
HO	NYMEX	Heating Oil	gal (42,000)	FGHJKMNQUVXZ	JKE	TOCOM	Kerosene	KL (50)	FGHJKMNQUVXZ	JPY
KC	ICE-US	Coffee	lbs (37,500)	HKNUZ	0JAC	TGE (TOCOM)	Coffee	MT (3.45)	FHKNUX	JPY
KW	KBT	Kansas wheat	bu (5,000)	HKNUZ	1MWE	MGE	Wheat	bu (5000)	HKNUZ	USD
LC	CME	Live cattle	lbs (40,000)	GJMQVZ	BGI	BM&F Bovespa	Beef	net arrobas. (330)	FGHJKMNQUVXZ	BRL
LCO	ICE-UK	Brent	bbl (1,000)	FGHJKMNQUVXZ	JCO	TOCOM	Crude oil	KL (50)	FGHJKMNQUVXZ	JPY
LGO	ICE-UK	Gasoil	MT (100)	FGHJKMNQUVXZ	JGO	TOCOM	Gasoil	KL (50)	FGHJKMNQUVXZ	JPY
LH	CME	Lean hogs	lbs (40,000)	GJMNQVZ	BGI	BM&F Bovespa	Beef	net arrobas. (330)	FGHJKMNQUVXZ	BRL
MAL	LME	Aluminum	MT (25)	FGHJKMNQUVXZ	0JAL 1	TOCOM	Aluminium	MT (5)	GJMQVZ	JPY
MCU	LME	Copper	MT (25)	FGHJKMNQUVXZ	HG	COMEX	Copper	lb (25,000)	FGHJKMNQUVXZ	USD
MNI	LME	Nickel	MT (6)	FGHJKMNQUVXZ	HG	COMEX	Copper	lb (25,000)	FGHJKMNQUVXZ	USD
MPB	LME	Lead	MT (25)	FGHJKMNQUVXZ	HG	COMEX	Copper	lb (25,000)	FGHJKMNQUVXZ	USD
MSN	LME	Tin	MT (5)	FGHJKMNQUVXZ	HG	COMEX	Copper	lb (25,000)	FGHJKMNQUVXZ	USD
MZN	LME	Zinc	MT (25)	FGHJKMNQUVXZ	HG	COMEX	Copper	lb (25,000)	FGHJKMNQUVXZ	USD
NG	NYMEX/ICE	Natural gas	MMBtu (10,000)	FGHJKMNQUVXZ	NGLNM	ICE-UK	Natural gas	therms/day (1000)	FGHJKMNQUVXZ	GBP
OJ	ICE	Orange juice	lbs (15,000)	FHKNUX	LSU	LIFFE	White sugar	MT (50)	HKQVZ	USD
PL	NYMEX	Platinum	oz (50)	FGHJKMNQUVXZ	JPL	TOCOM	Platinum	g (500)	GJMQVZ	JPY
RB	NYMEX	RBOB gasoline	gal (42,000)	FGHJKMNQUVXZ	JGL	TOCOM	Gasoline	KL (50)	FGHJKMNQUVXZ	JPY
S	CBT	Soybeans	bu (5,000)	FHKNQUX	JAS	TGE (TOCOM)	Soybeans	MT (25)	FGHJKMNQUVXZ	JPY
SB	ICE-US	Sugar#11	lbs (112,000)	HKNVZ	LSU	LIFFE	White sugar	MT (50)	HKQVZ	USD
SI	CMX	Silver	oz (5,000)	FHKNUZ	JSV	TOCOM	Silver	Kg (1)	GJMQVZ	JPY
W	CBT	Chicago wheat	bu (5,000)	HKNUZ	1MWE	MGE	Wheat	bu (5,000)	HKNUZ	USD

Maturity month code: F = January, G = February, H = Mars, J = April, K = May, M = June, N = July, Q = August, U = September, V = October, X = November, Z = December.

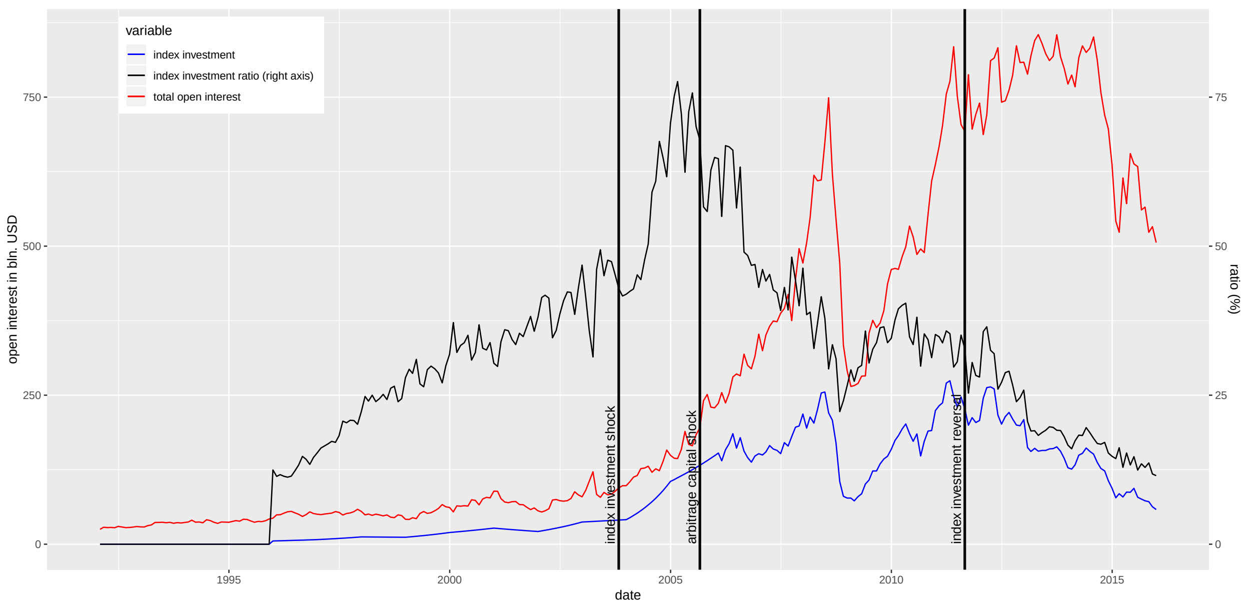
Appendix D. Index investment's paths to trading venues

Fig. 3:
In this functional chart, we describe the various vehicles that commodity index investment may use, and how these vehicles hedge on the commodity futures markets, through a portfolio of futures or directly with a futures contract written on the performance of this portfolio. We add the CFTC classification of the categories involved.



Appendix E. Index investment and arbitrage capital breaks

Fig. 4:
We plot the sums of the monthly total OI and index investment of the 27 SP-GSCI contracts in USD, and their ratios. We add three vertical lines set at the index investment break (August 2003), arbitrage capital break (August 2005) and non significant reversal, that is, the date for which the F-statistic of the Bai et al. (1998) test is maximum in the second sub-period (August 2011).



Appendix F. Variable definition

Table 7:
We define all variables used throughout the article, with their symbols, plain definition, how we compute them (if applicable), their units, frequency, period of availability and additional descriptions if needed.

Symbol	Title	Computation	Unit	Frequency	Period	Description
$F^m_{c,t}$	Futures price	–	USD	D	1992 – 2017	m: maturity, c: commodity, t: time
$f^m_{c,t}$	Log futures price	–	–	D	1992 – 2017	–
$R^m_{c,t}$	Arithmetic return	$R^m_{c,t} = \frac{F^m_{c,t}}{F^m_{c,t-1}} - 1$	%	D	1992 – 2017	We use "return" for simplicity but it is a misnomer, "percent price change" is more appropriate.
$r^m_{c,t}$	Log return	$r^m_{c,t} = f^m_{c,t} - f^m_{c,t-1}$	%	D	1992 – 2017	–
$SR^m_{c,t}$	Arithmetic spreading return	$SR^m_{c,t} = R^{m+1}_{c,t} - R^m_{c,t}$	%	D	1992 – 2017	–
$sr^m_{c,t}$	Log spreading return	$sr^m_{c,t} = r^{m+1}_{c,t} - r^m_{c,t}$	%	D	1992 – 2017	–
$CASR^m_{c,e}$	Cumulated abnormal spreading returns	$CASR^m_{c,e} = \sum_{t=1}^{t+\tau} \left(SR^m_{c,t} - Benchmark_{c,t}\right)$	%	M	1992 – 2017	e: event month, τ: number of event days
$B^m_{c,t}$	Basis	$B^m_{c,t} = \left(\frac{F^{m+1}_{c,t}}{F^m_{c,t}} - 1\right) \times \frac{1}{\#\text{interval days}}$	%	D	1992 – 2017	We use "Basis" for simplicity but it is a misnomer as we use the nearby contract to proxy for the spot price. "Maturity ratio" is more appropriate.
$b^m_{c,t}$	Log basis	$b^m_{c,t} = \left(f^{m+1}_{c,t} - f^m_{c,t}\right) \times \frac{1}{\#\text{interval days}}$	%	D	1992 – 2017	–
$V^m_{c,t}$	Volume	–	# contracts	D	1992 – 2017	–
CQ_c	Deliverable quantity	–	–	–	1992 – 2017	–
$CVAL^m_{c,t}$	Contract value	$CVAL^m_{c,t} = CQ_c \times F^m_{c,t}$	USD	D	1992 – 2017	–
$XVAL^m_{c,t}$	Contract value	$XVAL^m_{c,t} = CQ_c \times X_{c,t}$	USD	D	–	For any value $X_{c,t}$ denominated in # of contracts, there is a $XVAL^m_{c,t}$ denominated in USD.
$TO^m_{c,t}$	Turnover	$TO^m_{c,t} = CVAL^m_{c,t} \times V^m_{c,t}$	USD	D	1992 – 2017	–
$OI^m_{c,t}$	Open interest	–	# contracts	D	1992 – 2017	Total # of contracts opened in the exchange for each maturity.
$TOI_{c,t}$	Total open interest	–	# contracts	D	1992 – 2017	Total # of contracts opened in the exchange for all maturities.
$COM^P_{c,t}$	Commercial position	–	# contracts	W	1992 – 2017	Total # of contracts held by the "commercial" category, for all maturities. P stands for the position either long (L), short (S) or spreading ($SPREAD$).
$SPEC^P_{c,t}$	Speculative position	–	# contracts	W	1992 – 2017	Total # of contracts held by the speculative category for all maturities.
$ARB_{c,t}$	Arbitrage capital ratio	$ARB_{c,t} = \frac{SPEC^{SPREAD}_{c,t}}{TOI_{c,t}}$	% $\in [0,1]$	W	1992 – 2017	Total net spreading position (always positive) scaled by total open interest.
$TGSCI_t$	Total SP-GSCI type investment	see appendix A	USD	M	1995 – 2017	–
$GSCIW_{c,t}$	Weights of SP-GSCI	–	% $\in [0,1]$	M	1992 – 2017	–
$GSCI_{c,t}$	Amount tracking SP-GSCI type funds	$GSCI_{c,t} = GSCIW_{c,t} \times TGSCI_t$	USD	D	1992 – 2017	–
$IND_{c,t}$ (1)	Index investment ratio	$IND_{c,t} = \frac{GSCI_{c,t}}{TOI_{c,t}}$	% $\in [0,1]$	W	1992 – 2017	–
$IND_{c,t}$ (2)	Index investment ratio (alternative)	$IND_{c,t} = \frac{COM^P_{c,t}}{TOI_{c,t}}$	% $\in [0,1]$	W	1992 – 2017	Alternative using total commercial long position from the legacy report, as this report includes swap dealers in this category.
$HP_{c,t}$	Hedging pressure	$HP_{c,t} = \frac{COM^S_{c,t} - COM^L_{c,t}}{COM^S_{c,t} + COM^L_{c,t}}$	% $\in [-1,1]$	W	1992 – 2017	–

Appendix G. CARs and CASRs with alternative benchmarks

Table 8:
In this table we extend Table 3 and use five different benchmarks. The benchmark (1) is parametric. We use individual further deferred contracts as covariates (see appendix B) and we estimate the model with a SUR system. The benchmarks (2) and (3) use the factors of the event-study of Henderson et al. (2015) and those of the asset-pricing study of Bakshi et al. (2019). We estimate them with OLS. The benchmark (4) is non-parametric and we use the returns on peer contracts. Finally the benchmark (5) is a zero-benchmark to investigate for any model misspecification. We report the same statistics as in Table 3, for the pre-, post- and roll windows. We compute the CASRs from the returns on the spreading position between the first deferred and nearby contracts. In Panel A, we restrict the rolls to be in the February – December range, (as in Table 3) while in Panel B we report the results for the roll of January alone. The period is from January 1992 to September 2017.

	Roll					Pre-roll					Post-roll				
Panel A	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
CASR %	0.05	0.04	0.02	0.03	0.01	0.11	0.07	0.08	0.04	0.07	-0.06	-0.02	-0.03	-0.05	-0.09
t-statistic	2.19	1.99	1.21	0.84	0.30	4.17	2.71	3.10	1.30	3.27	-2.13	-0.64	-1.14	-1.46	-3.25
BMP	0.11	0.10	0.06	0.03	0.01	0.23	0.14	0.16	0.05	0.09	-0.09	-0.03	-0.05	-0.04	-0.11
KP	0.05	0.08	0.03	0.02	0.00	0.11	0.12	0.08	0.03	0.05	-0.04	-0.02	-0.02	-0.02	-0.05
R^2 %	2.60	4.68	4.68			2.63	4.70	4.70			2.63	4.72	4.70		
Panel B															
CASR %	0.06	0.00	0.08	0.02	0.06	0.10	0.00	0.07	0.04	0.08	-0.08	0.00	-0.01	-0.02	-0.11
t-statistic	1.20	0.00	1.68	0.30	1.36	1.19	0.00	0.84	0.49	1.00	-1.36	0.00	-0.16	-0.23	-1.51
BMP	0.10	0.00	0.14	0.02	0.10	0.13	0.00	0.08	0.04	0.10	-0.08	0.00	-0.01	-0.01	-0.09
KP	0.03	0.00	0.06	0.01	0.04	0.04	0.00	0.03	0.02	0.04	-0.03	0.00	0.00	-0.01	-0.03
R^2 %	3.94	8.12	8.05			3.95	8.13	8.06			3.97	8.15	8.07		