Identifying the Impact of Financialization on Commodity Futures Prices from Index Rebalancing

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Attempts to detect the impact of financialization on commodity futures prices are often subject to the criticism of weak identification. This paper addresses the issue by investigating the rebalancing of the S&P Goldman Sachs Commodity Index. Investment flows caused by the rebalancing are predetermined and not based on information about futures prices, providing a clear identification to study the price impact. Results show that average futures returns are not significantly different from zero during the rebalancing period and there is no or a weak negative causal link between index investment flows and commodity futures returns. This finding is consistent with the hypothesis that uninformed and predictable order flows tend to attract natural counterparties and would not disrupt the market.

Keywords: Financialization, commodity futures, commodity index, index investment

Introduction

Over the past decade, financial investors have substantially increased their exposure to commodity futures markets via exchange-traded funds (ETFs), exchange-traded notes (ETNs), and swaps, whose returns are tied to an index of commodity futures prices. According to the *Index Investment Data* (IID) from the *U.S. Commodity Futures Trading Commission* (CFTC), the total notional value of index investment in the main commodity futures markets was about $160 billion by June 2015, accounting for 30-60% of open interests in futures contracts. The process of increasing participation of financial investors is often referred to as the financialization of commodity futures markets. The rapid growth in commodity index investment during the last decade, concurrent with the boom/bust in commodity prices, has led to a heated debate among both policymakers and academics about whether the investment flows of commodity index traders (CITs) impacted commodity futures prices. After back-and-forth discussions for several years, the CFTC issued a new version of proposed rules regarding position limits on derivatives at the end of 2016 in fulfillment of the Dodd-Frank Wall Street Reform and Consumer Protection Act, although there is still a lack of conclusive evidence on the market impact of speculation and financial investment in commodity futures markets.

Most empirical studies rely on time-series tests including linear regressions, vector autoregressions (VAR) or Granger causality tests to estimate the effects of financialization. Specifically, they directly link futures price changes to CIT trading based on the notion that the CIT trading flows must be correlated with contemporaneous futures returns or be predictive of futures returns (e.g., Gilbert, 2010; Stoll and Whaley, 2010; Buyuksahin and Harris, 2011; Sanders and Irwin, 2011; Irwin and Sanders, 2012; Singleton, 2014; Brunetti, Büyükşahin, and Harris, 2015; Hamilton and Wu, 2015).[1] Using various data and methods, these studies provide limited evidence of financialization impacts in commodity futures markets.

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[1] Irwin and Sanders (2011) and Cheng and Xiong (2014) provide a literature review from different perspectives. Hasse, Zimmermann, and Zimmermann (2016) evaluate 100 published papers and find an equal number of studies which support and contradict the effects of speculation. The recently proposed rules by the CFTC also contain a thorough review of related studies. See www.cftc.gov/LawRegulation/DoddFrankAct/Rulemakings/PositionLimitsforDerivatives/index.htm.

A major issue with existing studies is that they may be subject to identification problems. Specifically, time-series tests are built on a common, but typically unstated, assumption that CIT trading activity is exogenous to futures price movements. Otherwise, the estimates may suffer from an endogeneity bias that leads to unreliable results. There are three reasons why this assumption may fail.[2] First, CIT trades may be initiated based on price signals or price expectations, causing a reverse causality from futures prices to index positions. If so, it is problematic for models to use changes in index positions to explain or predict futures price changes. Second, the reverse causality can also arise from omitted variables. The models used by previous studies generally are quite simple and most frequently bivariate in nature, which means that some important factors may be excluded. If CIT trades and futures prices are influenced by common missing factors, the impact of CIT trades on futures prices could be mis-identified. Third, the quality of index position data may make it even more difficult to justify the exogeneity assumption. Position data from the CFTC are widely-used in previous research but they are highly aggregated and may comprise trades with different motives. As argued by Cheng, Kirilenko, and Xiong (2015), the multiple and opposite motives for trading may obscure the relationship between CIT positions and futures prices. Overall, identification is one the biggest challenges in evaluating the market impact of financialization in commodity futures markets.

Two studies are of particular importance due to their approach to the identification challenge. Tang and Xiong (2012) use a difference-in-difference approach and find that the increased correlation of non-energy commodity futures prices with crude oil prices after 2004 is significantly higher for commodities in two popular commodity indexes. They interpreted this as evidence of the financialization of commodity futures markets and argued this helped to explain the large increase in the price volatility of non-energy commodities. The difference-in-difference approach of Tang and Xiong has been criticized by several authors (e.g., Buyuksahin, and Robe, 2014; Bhardwaj, Gorton, and Rouwenhorst, 2015; Bruno, Buyuksahin, and Robe, 2016) for omitting relevant variables that could explain the rising correlations, especially credit default risks. Henderson, Pearson, and Wang (2014) (henceforth "HPW") examine the price impact related to Commodity-Linked Notes (CLNs) trades based on the assumption that hedging flows into and out of CLNs are not based on information about contemporaneous or subsequent prices. They find CLNs flows to have a statistically and economically significant impact on commodity futures prices and conclude that non-information-based financial investments have important impacts. However, the CLNs market is relatively small and may not be a good proxy for the entire financial investment in commodity futures markets.

In this paper, we propose a novel identification strategy based on commodity index rebalancing to investigate the impact of CIT trading on futures prices. Specifically, we consider the Standard and Poor's Goldman Sachs Commodity Index (S&P GSCI), one of the benchmarks for investment in commodities. The S&P GSCI determines weights mainly based on a five-year average of world production and rebalances them once a year. The rebalancing changes relative weights of commodities in the S&P GSCI and then causes net investment flows into or out of the markets. The S&P GSCI rebalancing provides a unique identification to study the price impact of CIT trading for three reasons. First, the rebalancing is a public and predetermined event. It is

[2] Grosche (2014) provides a similar discussion about the limitations of Granger causality analysis.

typically announced in early November and takes effect from the 5th through 9th business day in the following January. The fixed schedule enables us to narrow down the impact of CIT trading by examining futures prices during the rebalancing period. Second, the rebalancing is strictly exogenous because it is driven by historical production instead of information about futures prices. Changes in index positions caused by the rebalancing are also not based on information and then exogenous to futures prices. To track the S&P GSCI index investors must adjust their futures positions regardless of changes in prices, which eliminates reverse causality. Third, the rebalancing provides the only motive for changes in CIT positions. Unlike the aggregate CFTC positions, position changes caused by the rebalancing are exogenous since they are only driven by production changes. Therefore, the S&P GSCI rebalancing provides a clear identification to estimate the impact of CIT trading on commodity futures prices.

For the S&P GSCI, percentage changes in CIT positions caused by the rebalancing must be equal to percentage changes in Contract Production Weights (CPWs), that will be defined and discussed later. The CPWs serve as the basis of weights, and more importantly, their changes provide an exact measure of CIT position changes during the rebalancing period. We collect CPWs of the 19 commodities that are included in the S&P GSCI and traded on U.S exchanges for 2003-2016. The CPW changes are positive for most commodities over half of the years and show a large variation across commodities. Investment flows implied by CPW changes are economically large enough to allow for a plausible price impact.

We find that average returns on commodity futures contracts during the rebalancing period are not significantly different from zero and generally have inconsistent signs with CPW changes, suggesting that futures returns are not correlated to CIT position changes. This result remains when we use abnormal returns based on a factor model and account for the effects of rolls and the release of USDA reports. Regression analysis further shows that there is no significant relationship between CPW changes and futures returns during the rebalancing period after controlling for market size and return correlations. In addition, there is no price impact on the days when new CPWs are announced.

Commodity Index Rebalancing

In this section, we first describe the S&P GSCI with a focus on its rolling and rebalancing schemes. Next, we show how CIT positions tracking the index change during the rebalancing period. Last, we evaluate significance of the rebalancing by calculating implied CIT flows.

The S&P GSCI

The S&P GSCI, first launched by Goldman Sachs in 1991, is the first major investable commodity index and serves as a benchmark for investment in the commodity markets. The index currently comprises 24 commodities from all commodity sectors—energy, industrial metals, precious metals, agriculture, and livestock. The composition has remained the same since 2002. The S&P GSCI holds long positions in the nearby contract, which usually is the most liquid contract. To avoid physical delivery, the index rolls positions forward from contracts that are close to maturity to contracts that have later maturity dates. The rolling takes place over a five-day window from the 5th to the 9th business day each month, and on each day, an equal amount (one-fifth) of the positions are rolled. The weights in the S&P GSCI are based primarily on the average quantity of world production of each commodity over the last five years of available data. The index weights are rebalanced on a yearly basis during the January roll period. When the weights are updated, index investors must buy or sell additional positions on the underlying futures contracts to track the index, leading to new investment flows into or out of the markets.

Table 1 lists the 19 commodities that are in the S&P GSCI and traded on U.S. exchanges and their target weights in 2016. The five industrial metals (aluminum, copper, lead, nickel, and zinc) traded on London Metal Exchange are excluded because futures contracts for these commodities have consecutive maturities from one day to three months such that it is unclear which contract the index chooses. The S&P GSCI is heavily tilted to energy products, especially WTI and Brent crude oil with a total weight of 43.47% in 2016. Table 1 also shows the rolling scheme by listing maturities of the futures contracts held by the S&P GSCI at the beginning of each calendar month. For example, the index holds the February and March contracts of WTI crude oil at the beginning of January and February, respectively, suggesting that the positions are rolled from the February to March contract during the January roll period. Note that 10 commodities do not roll in January because the same contract is held at the beginning of January and February.

The S&P GSCI Rebalancing

Following its manual (S&P Dow Jones Indices, November 2016, p.33), the S&P GSCI Total Return Index is constructed in a cumulative manner,

$$S_d = S_{d-1}(1 + CDR_d + TBR_d), \tag{1}$$

where S_d is the S&P GSCI Total Return Index, $CDR_d = TDW_d/TDW_{d-1} - 1$ is the Contract Daily Return computed as the percentage change of the Total Dollar Weight (TDW), and TBR_d is the Treasury Bill Return on day d. The TDW_d of the S&P GSCI on any non-roll day is,[3]

$$TDW_d = \sum_c (CPW^c * DCRP_d^c), \tag{2}$$

where CPW^c is the Contract Production Weight of commodity c and $DCRP_d^c$ is the Daily Contract Reference Price of commodity c on day d. Intuitively, TDW measures the total dollar value of world production of all commodities in the index. The CPW reflects the relative significance of each of the commodities and is mainly based on a five-year average of world production. Specifically, the CPW is defined as (S&P Dow Jones Indices, November 2016, p.21),

$$CPW = \frac{Percentage\ TQT * WPA}{1{,}000{,}000}, \tag{3}$$

where $Percentage\ TQT$ is the Percentage Total Quantity Traded and WPA is the five-year average of world production. The TQT is measured by total trading volume of futures contracts during the relevant annual calculation period expressed in physical units. The WPA is the same

[3] TDW on the roll and rebalancing days is defined in the appendix.

for commodities that are almost homogeneous (Chicago wheat and Kansas wheat), or linked in a process of production (live cattle and feeder cattle), or both (WTI crude oil, Brent crude oil, heating oil, RBOB gasoline, and gasoil). For these commodities, their CPWs are obtained by allocating WPA in proportion to $Percentage\ TQT$, which equals the TQT of one commodity divided by the total TQT of all relevant commodities. Because WPA is based on world production and only updated once a year, the CPWs maintain constant during a calendar year except the January rebalancing period.

Next, we examine how index investors adjust their positions in response to CPW changes during the rebalancing period. Let X_{old}^{c} and X_{new}^{c} be total positions in commodity c held by an index investor before and after the rebalancing. Let CPW_{old}^{c} and CPW_{new}^{c} be Contract Production Weights of the same commodity based on the old and new production data. We show in appendix that percentage changes in futures positions caused by the rebalancing are equal to percentage changes in $CPWs$,

$$\frac{X_{new}^{c}}{X_{old}^{c}} = \frac{CPW_{new}^{c}}{CPW_{old}^{c}}. \tag{4}$$

Equation (4) has important implications for identifying the price impact of CIT flows. As argued earlier, the rebalancing is strictly exogenous and provides a clear identification to study the price impact of CIT flows. However, changes in positions caused by the rebalancing are not directly observable. Equation (4) enables us to measure position changes caused by the rebalancing using CPW changes, which are available from public announcements released by the index provider. Although we derive Equation (4) for the S&P GSCI Total Return Index, the same result can be achieved for the S&P GSCI Excess Return Index.

The Contract Production Weights

We collect CPWs for the 19 commodities over 2003-2016 from public announcements released by the index issuer. This period is chosen because index investment in commodity futures markets is negligible before 2003 (Aulerich, Irwin, and Garcia, 2013). The CPWs of RBOB gasoline start in 2008 since the index replaced unleaded gas with RBOB gasoline in 2007. Table 2 reports summary statistics for percentage changes in CPWs for 2003-2016. The means of percentage changes in CPWs are small with an average of 2.25% across commodities. For some commodities, the CPWs vary substantially through time as reflected by large standard deviations and extreme values. For example, the CPWs of Kansas wheat have a minimum change of -26.65% and a maximum change of 21.04%, which are much greater than the mean (-0.54%) in magnitude. This large variability of CPWs is attributed to fluctuations in production and relative changes in trading volumes between the two wheat futures markets. Table 2 also presents the percentages of positive CPW changes in the last column. Most commodities have positive changes in CPWs over half of the time, and on average, 73.5% of CPW changes are positive. For corn, soybeans, and silver, the CPWs have always been increasing throughout the sample period.

To evaluate the economic significance of rebalancing, we calculate implied CIT flows caused by the CPW changes in 2016. We assume that the value of index investment in the S&P GSCI is \$50 billion, about half of the total index investment in U.S. futures markets (\$106.9 billion based on the CFTC IID report as of October 2015). The dollar value of index investment for a particular commodity is obtained by assigning \$50 billion to its weight and the position is equal to the dollar value divided by the value of contract. Since percentage changes in CIT positions are equal to percentage changes in CPWs (Equation (4)), we calculate index position changes caused by the rebalancing as the product of pre-rebalancing positions and percentage changes in CPWs. Table 3 shows percentage changes in CPWs for the 19 commodities in 2016 (column 2) and daily implied CIT flows in terms of number of contracts (column 3) and dollars (column 4). To remove the effect of market size, we normalize the number of contracts by average daily volume and open interest, based on a 15-day window prior to the rebalancing, and report them in the last two columns in Table 3. The percentage changes in CPWs in 2016 show a large variation across commodities. For example, feeder cattle have the largest CPW increase (29.31%) due to its increased trading volume in futures relative to live cattle. This large CPW increase means that index investors need to buy 444 feeder cattle futures contracts (\$35.75 million) on each rebalancing day, which accounts for 13.63% and 3.98% of daily volume and open interest, respectively. Regardless of the sign, the average change in implied CIT flows is \$28.97 million, which is greater than the average proceeds (\$20.72 million) of issuing CLNs reported by HPW in their appendix Table 2. HPW find a statistically significant price impact from CLN issues with proceeds greater than \$2 million. Here, the CIT flows caused by the rebalancing are greater than \$1.5 million for all commodities except cotton. Therefore, it is reasonable to argue that CIT flows caused by the rebalancing are economically large in terms of potential price affects. These relatively large CIT flows, coupled with the absence of endogeneity, make the annual rebalancing of positions a powerful test for detecting the price impact of CIT investment flows.

Price Impact of the S&P GSCI Rebalancing

We investigate the price impact of CIT investment by examining commodity futures returns during the rebalancing period. Returns are linked to changes in CIT positions based on the assumption that CIT position changes during the rebalancing period equal CPW changes.

Measure of futures returns

Price impact is measured using raw returns and abnormal returns of commodity futures contracts. Raw returns are defined as the difference in log settlement futures prices of the contract held by the index. In presence of rolling, raw returns are based on the deferred contract that the index rolls toward. Abnormal returns are the difference between raw returns and benchmark returns. We follow HPW to construct benchmark returns from a linear regression model,

$$R_{i,t} = \beta_0 + \beta' X_t + \epsilon_{i,t}, \tag{5}$$

where $R_{i,t}$ is the raw return on futures contract of commodity i on day t. Control variables in X_t include: (1) the returns on the S&P 500 Index and the MSCI Emerging Markets Asia Index, measuring the impact of changes in expectations about U.S. and emerging market Asian economic growth; (2) the next day return on the MSCI Emerging Markets Asia Index, accounting for trade non-synchronicity between Asian and U.S. markets; (3) the return on the JP Morgan Treasury Bond Index, which captures the linkage between commodity futures and interest rate markets; (4) the return on the Trade Weighted U.S. Dollar Index, reflecting the fact that the U.S. Dollar is the most common settlement currency for commodity transactions; (5) the percentage change in the VIX Index, controlling for the relationship between commodity prices and innovations to the VIX index found by Cheng, Kirilenko, and Xiong (2014); (6) the percentage change in the Baltic Dry Index (BDI), which measures changes to the cost of transporting raw materials by sea; (7) the 10-year breakeven inflation rate change, measuring changes in expected inflation; (8) the basis, defined as the difference in log futures prices between the deferred and nearby contracts and used as a proxy of inventory based on the theory of storage; and (9) the lagged raw return to control for autocorrelation. For each day of interest, we estimate Equation (5) using data from the previous 60 trading days.[4] The benchmark return is defined as the fitted value of the model and the abnormal return is obtained by subtracting benchmark returns from raw returns. Future prices are from the Commodity Research Bureau. The BDI index is from Bloomberg and the rest of the control variables are from the FRED database at Federal Reserve Bank of St. Louis.

Because the rebalancing period overlaps with the January roll period, the price impact of CIT flows could be masked by the roll effect. Mou (2011) finds that the price spread between the nearby and deferred futures contracts increases during the week prior to the rolls. To avoid the possible effect of rolls, we examine a group of commodities that have no rolls during the rebalancing period (Table 1), including Chicago wheat, Kansas wheat, corn, soybeans, coffee "C", sugar #11, cocoa, cotton #2, feeder cattle, and silver.

The price impact of CIT flows during the rebalancing period can also be confounded by the effect of the release of USDA reports such as Crop Production (CP) and World Agricultural Supply and Demand Estimates (WASDE). Previous research shows that these reports can cause significant price and volatility movements on the release day (e.g., Adjemian, 2012; Dorfman and Karali, 2015), and this announcement effect is not captured by our factor model. To avoid the influence of the release of USDA reports, we exclude days on which the CP and WASDE reports were released for relevant agricultural commodities (corn, soybeans, Chicago wheat, Kansas wheat, cotton #2, and sugar #11). In total, 78 days are removed which constitutes only a small portion of total observations (1,210 days).

Returns during the rebalancing period

Table 4 presents average raw and abnormal returns per day during the rebalancing period for two groups of commodities. Group (1) consists of the 19 commodities included in the S&P GSCI and Group (2) contains 10 of the 19 commodities that have no rolls during the rebalancing period. If the price impact of CIT flows exists, the average futures returns are expected to be positive (negative) during the rebalancing period when CPW increases (decreases). Hence, we report average futures returns for the whole sample (All) and two subsamples ($\Delta CPW>0$ and $\Delta CPW<0$) based on the direction of CPW changes. The *p*-values for *t* tests on the null hypothesis that the

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[4] The average adjusted R^2 of estimating Equation (5) for the 19 commodities during the rebalancing period is 12.1%, suggesting that the model explains a small portion of the variation in commodity futures returns. Not surprisingly, the adjusted R^2 is larger for energy products and precious metals and smaller for agricultural commodities and livestock since the former two sectors tightly integrated with the global economy and financial markets.

average return is equal to zero are provided below the means. We also calculate the number of positive average returns and the corresponding *p*-values for sign tests on the null hypothesis that the probability of a positive return is equal to 0.5. Right-tailed (left-tailed) *t* and sign tests are used for the subsample $\Delta CPW>0$ ($\Delta CPW<0$).

From the upper half of Table 4, the average raw returns on commodities in Group (1) during the rebalancing period are -0.08% and 0.01% per day for the entire sample and subsample $\Delta CPW>0$, but are not statistically significant. The average raw return for $\Delta CPW<0$ (-0.34%) is significantly negative at a level of 1%. For commodities in Group (2) that have no rolls during the rebalancing period, the average raw returns are 0.06%, 0.10%, and -0.13% per day for the entire sample and the two subsamples, respectively, which have expected signs but are only statistically significant for $\Delta CPW>0$. The number of positive raw returns provides slightly weaker results. Specifically, 243 out of 473 raw returns are positive for commodities in Group (2) when $\Delta CPW>0$, and this proportion is greater than 0.5 but not statistically significant. I n the rest of the cases, the number of positive raw returns has the same level of significance as the average returns.

The lower half of Table 4 provides results based on abnormal returns. The average abnormal returns on commodities in Group (1) during the rebalancing period are 0.02%, 0.07%, and -0.11% per day for the entire sample and two subsamples, respectively, which have expected signs but are not significant. The average abnormal returns on commodities that have no rolls during the rebalancing period (Group (2)) also have expected signs and are only marginally significant for $\Delta CPW>0$. Note that the differences between raw and abnormal returns are smaller for commodities in Group (2) because the factors that are used to generate benchmark returns have a weak ability in explaining raw returns on agricultural and livestock commodities. The number of positive abnormal returns is not statistically significant in any case, meaning that changes in CIT positions generate equally likely positive and negative abnormal returns. Overall, an analysis of commodity futures returns during the rebalancing period provides limited evidence that CIT flow impact futures prices.

Although the rebalancing happens during a five-day window, index investors may not buy or sell an equal amount of contracts each day; instead, they can choose the day (days) to do the transaction depending on market conditions. To account for this possibility, we calculate average abnormal returns on each of the rebalancing days (Day 1 to 5) and present results in Table 5. We define the same commodity groups and split the sample based on the direction of CPW changes as in Table 4. The average abnormal returns vary considerably from day-to-day for commodities in Group (1). On each of the rebalancing days except Day 1, the average abnormal returns, despite statistical significance in some cases, tend to have the same signs regardless of CPW changes. That the sign of returns is not consistent with the direction of CPW changes suggests that commodity futures returns may not be affected by CIT flows. The average abnormal returns for commodities in Group (2) that have no rolls during the rebalancing period are positive for $\Delta CPW>0$ and negative for $\Delta CPW<0$ on Day 1 to 4 though insignificant in most cases. Similar results can be obtained using raw returns. In all, these results show that CIT flows have little, if any, impact on commodity futures prices.

Returns around the rebalancing period

To account for the possibility that index investors may adjust their positions ahead of or beyond the rebalancing period, we examine daily futures returns during the pre- and post-rebalancing periods. Since the rebalancing lasts for a week or five business days, we consider two weeks prior to the first rebalancing day (week -2 and -1) and two weeks after the last rebalancing day (week +1 and +2). Accordingly, we compute average abnormal returns for the four weeks around the rebalancing period and report results in Table 6. Commodity groups and subsamples are defined in the same way as before and *p*-values for *t* tests are shown in the parentheses. Week 0 represents abnormal returns during the rebalancing period, which are the same as in the lower half of Table 4 and included here for comparison. The average abnormal returns on commodities in Group (1) do not significantly differ from zero except during Week -1 for the whole sample and ΔCPW>0, which may be explained by the roll effect (Mou, 2010). The average abnormal returns on commodities in Group (2) that have no rolls during the pre- and post-rebalancing weeks are also insignificant except in one case. Moreover, the sign of returns is not consistent with the direction of CPW changes, suggesting no price impact of CIT flows during days prior to or beyonbd the rebalancing period.

A possible concern about the results above is that futures returns can be correlated across commodities, especially those within the same sectors. The issue is less serious for abnormal returns since they are generated from a factor model that accounts for a set of economic variables, but they are still subject to commodity specific shocks. For example, a production decision announced by the OPEC may drive down the prices of all oil-related commodities. If such an event happens during the rebalancing period, examining average abnormal returns may fail to reflect the impact of CIT flows. We address this issue within a regression framework in the following section.

Cross-Sectional Regressions

In this section, we use cross-sectional regressions to examine the relationship between futures returns and CIT flows represented by CPW changes during the rebalancing period. We also test whether the returns respond to CPW changes on the announcement days.

Regression analysis during the rebalancing period

To directly examine the impact of CIT flows on futures returns, we consider a regression model,

$$R_{i,t} = \alpha + \beta \Delta CPW_{i,t} + \sum_{l \in Y} \gamma_l D_l + \sum_{m \in S} \theta_m D_m + \epsilon_{i,t}, \qquad (6)$$

where the dependent variable, $R_{i,t}$, is the raw or abnormal futures return expressed in percent for commodity *i* on the rebalancing day *t*, $\Delta CPW_{i,t}$ is the percentage change in CPWs, D_l is the year dummy variable that equals to one if day *t* belongs to year *l*, and D_m is the sector dummy variable that equals to one if commodity *i* belongs to sector *m*. Year *2004* and sector *Grains* are set as baselines, so $Y \in \{2005, 2006, \ldots, 2016\}$ and $S \in \{Energy, Softs, Livestock, Metals\}$. These dummy variables are introduced to account for return correlations between commodities. A nonzero γ_l means that the average return in year *l* is different from that in baseline year (2004).

Similarly, a nonzero θ_m means that the average return in sector m is different from that in baseline sector (Grains). In the presence of a price impact, we expect $\beta > 0$, implying that buying orders from index investors measured by an increase of CPWs lead to higher futures prices during the rebalancing period. Given changes in CPWs, the price impact might be larger in smaller commodity markets. To control for the effect of market size, we use scaled ΔCPW as the independent variable, which is defined as ΔCPW divided by the average open interest over the two weeks prior to the rebalancing.

Table 7 presents coefficient estimates and t-statistics of regression (6) for the two commodity groups during the rebalancing period. We use raw or abnormal return as dependent variable and changes in CPWs (ΔCPW) or scaled ΔCPW as independent variable. Column (1) in the upper half of Table 7 shows that the point estimate of 3.249 on ΔCPW is not statistically significant at common significance levels, suggesting that this proxy for index position changes due to the rebalancing is not related to the raw returns. The coefficient estimates on dummy variables are omitted to save space. Some of the year dummy variables are statistically significant, revealing that the average raw returns across commodities in those years significantly differ from those in baseline year. The adjusted R^2 of 4.4% indicates that the regression model has a very weak ability to explain the variation of raw returns. The use of abnormal returns provides similar results. The coefficient estimate on ΔCPW (0.459) is smaller and insignificant. The adjusted R^2 is also smaller because part of the return correlation between commodities is removed by the factor model (5). Considering commodities in Group (2) that have no rolls, the estimates on ΔCPW become negative but insignificant for both raw or abnormal return regressions. The unreported estimates on dummy variables as well as lower adjusted R^2's suggest that the returns are less correlated between non-energy commodities. Using scaled ΔCPW as an independent variable, we obtain qualitatively similar results. That is, changes in index positions due to the rebalancing are not related to futures returns even after controlling for the effect of market size.

We also estimate model (6) using returns on each of the rebalancing days and present results for the last rebalancing day in Table 8. The coefficient estimates on ΔCPW are consistently negative in all cases and statistically significant when market size is controlled. For example, the point estimate on scaled ΔCPW for raw returns on commodities in Group (1) is -325.8 with a t-statistic of -3.46. Since the standard deviation of scaled ΔCPW is 0.064%, a one-standard-deviation increase in scaled ΔCPW leads to a decrease in daily raw return by 20 basis point. Surprisingly, changes in index positions are negatively related to futures returns on the last rebalancing days and the magnitude is not economically trivial.

The findings that index trading positions have no or even negative impacts on commodity futures returns during the rebalancing period contrast with HPW who document a positive relationship between investor flows of CLNs and futures returns. One possible reason is that CLNs trades occur in an over-the-counter market and may be not well known by market participants. An unexpected arrival of CLNs trade may be regarded as a surprise to the market and causes impacts on prices. In contrast, the index rebalancing used in our study is broadly understood and more likely to reflect a real price impact from index flows, if any. In this sense, our results are consistent with Bessembinder et al. (2016) who argue that predictable and uninformed order flows tend to attract neutral counterparties and have modest effects on asset prices.

Regression analysis on the announcement days

To further examine the information content of the rebalancing, we re-estimate regression model (6) using the announcement date returns and present results in Table 9. We use the same dependent and independent variables and omit estimates on dummy variables. Presumably, if the rebalancing contains any new information, the announcement of CPWs should result in a price impact. Not surprisingly, the coefficient estimates on ΔCPW and scaled ΔCPW are not significant in any specification, suggesting that announcing the news of index rebalancing does not impact commodity futures prices. Some of the unreported dummy variables are significant and the adjusted R^2 is greater than on non-announcement days, suggesting that the returns on the announcement dates are more correlated between commodities in some years.

Conclusion

The market impact of financialization in commodity futures markets during the last decade has been one of the most controversial issues among both policymakers and academics. Many of the empirical studies of the price impact of financialization have been criticized for weak identification due to potential mis-specification of models or measurement error in index positions. This paper uses the rebalancing of the Standard and Poor's Goldman Sachs Commodity Index (S&P GSCI) as an event to study the price impact of commodity index investment. The S&P GSCI rebalancing provides a strong and novel identification because it is pre-determined and public, not based on information about futures prices, and driven by a unique motive. Using changes in Contract Production Weights (CPWs) to measure index position changes during the rebalancing period, we find little evidence of the impact of index investment on futures prices. Also, there is no price impact during the pre- or post-rebalancing period or on the days when new CPWs were announced.

These findings are consistent with the recent theoretical model developed by Bessembinder et al. (2016), who argue that predictable and uninformed order flows such as index investment flows caused by rebalancing have modest market effects because they attract natural counterparties and additional liquidity suppliers. Our results do not rule out a rational impact of financialization on commodity futures prices especially during times of market distress (e.g., Acharya et al., 2013; Etula, 2013; Brunetti and Reiffen, 2014; Hamilton and Wu, 2014, 2015; Cheng et al., 2015). In contrast, our study adds to the growing body of literature showing that buying pressure from index investors does not cause a "large" increase in commodity futures price. Given the failure of identifying a "large" price impact of financialization, new regulation rules should be made cautiously in consideration of the potential costs to market participants.

Appendix: Derivation of Equation (4)

The appendix provides a derivation of equation (4), i.e., the percentage changes in futures positions caused by the S&P-GSCI rebalancing are equal to the percentage changes in CPWs. Consider an index investor tracking the S&P GSCI Total Return Index. To replicate the index, the notional value of the index on day d must be equal to the sum of notional values of positions held in each commodity plus the interest earned on notional value on previous day,

$$S_d = \sum_c (X_d^c * CS^c * DCRP_d^c) + S_{d-1} * TBR_d, \qquad \text{(A1)}$$

where c and d denote commodity and day, S_d is the S&P GSCI Total Return Index, X_d^c is the position, CS^c is the Contract Size, $DCRP_d^c$ is the Daily Contract Reference Price, and TBR_d is the Treasury Bill Return. Combine equation (1) and (A1),

$$S_{d-1} \frac{\mathrm{TDW_d}}{\mathrm{TDW_{d-1}}} = \sum_c (X_d^c * CS^c * DCRP_d^c). \qquad \text{(A2)}$$

During the rebalancing days, there are two types of changes in the index – rolling the positions from the nearby to deferred contract and rebalancing the weights to reflect the new production. To include these changes, the TDW_d is (S&P Dow Jones Indices, 2016, p.31),

$$TDW_d = \frac{NC_{new}}{NC_{old}} \sum_c [CPW_{old}^c * CRW_d * DCRP1_d^c + CPW_{new}^c * (1 - CRW_d) * DCRP2_d^c] \qquad \text{(A3)}$$

where CPW_{old}^c and CPW_{new}^c are the Contract Production Weights of the preceding and current year, CRW_d and $1 - CRW_d$ are the Contract Roll Weights of the nearby and deferred contracts, $DCRP1_d^c$ and $DCRP2_d^c$ the Daily Contract Reference Price of the nearby and deferred contracts, and NC_{old} and NC_{new} are the normalizing constants of the preceding and current year, which are introduced to assure the continuity of the index and to allow comparison over time. Accordingly, the right-hand side of equation (A2) is adapted to include the nearby and deferred contracts,

$$S_{d-1} \frac{\mathrm{TDW_d}}{\mathrm{TDW_{d-1}}} = \sum_c CS^c (X1_d^c * DCRP1_d^c + X2_d^c * DCRP2_d^c), \qquad \text{(A4)}$$

where $X1_d^c$ and $X2_d^c$ are the positions held in the nearby and deferred contracts.

Substitute equation (A3) into (A4),

$$\sum_c \frac{S_{d-1}}{TDW_{d-1}} \frac{NC_{new}}{NC_{old}} [CPW_{old}^c * CRW_d * DCRP1_d^c + CPW_{new}^c * (1 - CRW_d) * DCRP2_d^c] = \sum_c CS^c (X1_d^c * DCRP1_d^c + X2_d^c * DCRP2_d^c). \qquad \text{(A5)}$$

Note that $DCRP1_d^c$ and $DCRP2_d^c$ are unknown on day $d - 1$. To ensure that equation (A5) holds for arbitrary prices, the coefficients of $DCRP1_d^c$ and $DCRP2_d^c$ on both sides must be equal,

$$X1_d^c = \frac{S_{d-1} * CRW_d}{TDW_{d-1}} * \frac{NC_{new}}{NC_{old}} * \frac{CPW_{old}^c}{CS^c} \text{ and } X2_d^c = \frac{S_{d-1} * (1 - CRW_d)}{TDW_{d-1}} * \frac{NC_{new}}{NC_{old}} * \frac{CPW_{new}^c}{CS^c}. \qquad \text{(A6)}$$

The total position is the sum of $X1_d^c$ and $X2_d^c$,

$$X1_d^c + X2_d^c = \frac{S_{d-1}}{TDW_{d-1}} * \frac{NC_{new}}{NC_{old}} * \frac{CRW_d * CPW_{old}^c + (1 - CRW_d) * CPW_{new}^c}{CS^c}. \quad \text{(A7)}$$

The daily percentage change in total positions on the rebalancing days is,

$$\frac{X1_d^c + X2_d^c}{X1_{d-1}^c + X2_{d-1}^c} = \frac{\frac{S_{d-1}}{S_{d-2}}}{\frac{TDW_{d-1}}{TDW_{d-2}}} * \frac{CRW_d * CPW_{old}^c + (1 - CRW_d) * CPW_{new}^c}{CRW_{d-1} * CPW_{old}^c + (1 - CRW_{d-1}) * CPW_{new}^c}. \quad \text{(A8)}$$

Since we have $\frac{S_{d-1}}{S_{d-2}} = \frac{TDW_{d-1}}{TDW_{d-2}} + TBR_{d-1}$ from equation (1), the first term on the right-hand side of equation (A8) is approximately equal to one as the TBR_{d-1} on a single day is negligible. Then,

$$\frac{X1_d^c + X2_d^c}{X1_{d-1}^c + X2_{d-1}^c} = \frac{CRW_d * CPW_{old}^c + (1 - CRW_d) * CPW_{new}^c}{CRW_{d-1} * CPW_{old}^c + (1 - CRW_{d-1}) * CPW_{new}^c}. \quad \text{(A9)}$$

The CRW_d is equal to one (zero) before (after) the rebalancing. Let X_{old}^c and X_{new}^c be the total positions before and after the rebalancing,

$$\frac{X_{new}^c}{X_{old}^c} = \frac{CPW_{new}^c}{CPW_{old}^c}. \quad \text{(A10)}$$

The percentage changes in positions caused by the rebalancing are equal to the percentage changes in $CPWs$ for any commodity c. Moreover, this ratio is always equal to one on non-rebalancing days, suggesting that the total positions tracking the S&P GSCI do not change most of the time during a calendar year.

References

Acharya, V. V., L. A. Lochstoer, and T. Ramadorai (2013). Limits to arbitrage and hedging: Evidence from commodity markets. *Journal of Financial Economics*, 109(2):441-465.

Adjemian, M. K. (2012). Quantifying the WASDE announcement effect. *American Journal of Agricultural Economics*, 94(1):238-256.

Aulerich, N.M., S.H. Irwin, and P. Garcia. (2013). Bubbles, food prices, and speculation: Evidence from the CFTC's daily large trader data files. Working Paper No. 19065, National Bureau of Economics Research.

Bessembinder, H., A. Carrion, L. Tuttle, and K. Venkataraman (2016). Liquidity, resiliency and market quality around predictable trades: Theory and evidence. *Journal of Financial Economics*, 121(1):142-166.

Bhardwaj, B., G. Gorton, and G. Rouwenhorst (2015). Facts and fantasies about commodity futures ten years later. Working Paper No. 21243, National Bureau of Economics Research.

Brunetti, C., B. Büyükşahin, and J. H. Harris (2015). Speculators, prices, and market volatility. *Journal of Financial and Quantitative Analysis*, 51(5), 1545-1574.

Brunetti, C. and D. Reiffen (2014). Commodity index trading and hedging costs. *Journal of Financial Markets*, 21:153-180.

Bruno, V.G., B. Buyuksahin, and M.A. Robe (2016). The financialization of food? *American Journal of Agricultural Economics*, published online September 25.

Büyüksahin, B., and J. H. Harris (2011). Do speculators drive crude oil futures prices? *Energy Journal* 32(2):167-202.

Buyuksahin, B. and M.A. Robe (2014). Speculators, commodities, and cross-market linkages. *Journal of International Money and Finance*, 42:38-70.

Cheng, I.-H. and W. Xiong (2014). Financialization of commodity markets. *Annual Review of Financial Economics*, 6:419-441.

Cheng, I.-H., A. Kirilenko, and W. Xiong (2015). Convective risk flows in commodity futures markets. *Review of Finance*, 19(5):1733-1781.

Dorfman, J. H. and B. Karali (2015). A nonparametric search for information effects from USDA reports. *Journal of Agricultural and Resource Economics*, 40(1):124-143.

Etula, E. (2013). Broker-dealer risk appetite and commodity returns. *Journal of Financial Econometrics*, 11(3):486-521.

Gilbert, C. L. (2010). Speculative influences on commodity futures prices 2006--2008. Working paper, University of Trento. https://ideas.repec.org/p/unc/dispap/197.html

Grosche, S-C. (2014). What does granger causality prove? A critical examination of the interpretation of Granger causality results on price effects of index trading in agricultural markets. *Journal of Agricultural Economics*, 65(2):279-302.

Hamilton J. D. and J. C. Wu (2014). Risk premia in crude oil futures prices. *Journal of International Money and Finance*, 42:9-37.

Hamilton J. D. and J. C. Wu (2015). Effects of index-fund investing on commodity futures prices. *International Economic Review*, 56(1):187-204.

Hassse, M., Y. S. Zimmermann, and H. Zimmermann (2016). The impact of speculation on commodity futures markets – A review of the findings of 100 empirical studies. *Journal of Commodity Markets*, 3:1-15.

Henderson, B. J., N. D. Pearson, and L. Wang (2015). New evidence on the financialization of commodity markets. *Review of Financial Studies*, 28(5):1285-1311.

Irwin, S. H. and D. R. Sanders (2011). Index funds, financialization, and commodity futures markets. *Applied Economic Perspectives and Policy*, 33(1):1-31.

Irwin, S. H. and D. R. Sanders (2012). Testing the Masters Hypothesis in commodity futures markets. *Energy Economics*, 34(1):256-269.

Mou, Y. (2011). Limits to arbitrage and commodity index investment: Front-running the Goldman roll. Working paper.
http://www.cftc.gov/idc/groups/public/@swaps/documents/file/plstudy_33_yu.pdf

Sanders, D. R. and S. H. Irwin (2011). The impact of index funds in commodity futures markets: A systems approach. *Journal of Alternative Investments*, 14(1):40-49.

Singleton, K. J. (2014). Investor flows and the 2008 boom/bust in oil prices. *Management Science*, 60(2):300-318.

S&P Dow Jones Indices (2016). S&P GSCI methodology. November 2016.
http://us.spindices.com/documents/methodologies/methodology-sp-gsci.pdf

Stoll, H. R. and R. E. Whaley (2010). Commodity index investing and commodity futures prices. *Journal of Applied Finance*, 20(1):7-46.

Tang, K. and W. Xiong (2012). Index investment and the financialization of commodities. *Financial Analysts Journal*, 68(5):54-74.

Table 1: Commodity futures in the S&P GSCI

Commodity	Trading facility	2016 dollar weight %	Contract expirations at month begin											
			1	2	3	4	5	6	7	8	9	10	11	12
Wheat SRW	CBT	3.53	H	H	K	K	N	N	U	U	Z	Z	Z	H
Wheat HRW	KBT	0.88	H	H	K	K	N	N	U	U	Z	Z	Z	H
Corn	CBT	4.23	H	H	K	K	N	N	U	U	Z	Z	Z	H
Soybeans	CBT	2.95	H	H	K	K	N	N	X	X	X	X	F	F
Coffee "C"	ICE	0.94	H	H	K	K	N	N	U	U	Z	Z	Z	H
Sugar #11	ICE	1.59	H	H	K	K	N	N	V	V	V	H	H	H
Cocoa	ICE	0.45	H	H	K	K	N	N	U	U	Z	Z	Z	H
Cotton #2	ICE	1.19	H	H	K	K	N	N	Z	Z	Z	Z	Z	H
Lean Hogs	CME	2.30	G	J	J	M	M	N	Q	V	V	Z	Z	G
Live Cattle	CME	4.79	G	J	J	M	M	Q	Q	V	V	Z	Z	G
Feeder Cattle	CME	1.55	H	H	J	K	Q	Q	Q	U	V	X	F	F
Crude Oil (WTI)	NYM	23.04	G	H	J	K	M	N	Q	U	V	X	Z	F
Heating Oil #2	NYM	5.21	G	H	J	K	M	N	Q	U	V	X	Z	F
RBOB Gasoline	NYM	5.31	G	H	J	K	M	N	Q	U	V	X	Z	F
Crude Oil (Brent)	ICE	20.43	H	J	K	M	N	Q	U	V	X	Z	F	G
Gasoil	ICE	5.82	G	H	J	K	M	N	Q	U	V	X	Z	F
Natural Gas	NYM	3.24	G	H	J	K	M	N	Q	U	V	X	Z	F
Gold	CMX	3.24	G	J	J	M	M	Q	Q	Z	Z	Z	Z	G
Silver	CMX	0.41	H	H	K	K	N	N	U	U	Z	Z	Z	H

This table lists futures contracts of 19 commodities that are included in the S&P GSCI and traded on U.S. exchanges. Column 2 and 3 show the trading facility and target dollar weight of each commodity in 2016. The following twelve columns show the rolling scheme by listing the maturities of the futures contracts held by the index at the beginning of each calendar month. Futures month codes are: January (F), February (G), March (H), April (J), May (K), June (M), July (N), August (Q), September (U), October (V), November (X), and December (Z).

Table 2: Descriptive statistics of CPW changes for the S&P GSCI, 2003-2016

	Mean %	SD %	Min %	Max %	Positive %
Wheat (Chicago)	2.01	4.02	-1.61	11.59	61.5
Wheat (Kansas)	-0.54	13.63	-26.65	21.04	46.2
Corn	3.01	1.61	0.61	5.37	100.0
Soybeans	4.21	1.44	1.57	6.09	100.0
Coffee "C"	2.47	2.23	-0.78	7.19	92.3
Sugar #11	1.77	1.34	-0.79	4.13	92.3
Cocoa	3.32	2.38	-0.49	8.41	92.3
Cotton #2	2.30	2.69	-1.72	6.75	76.9
Lean Hogs	4.35	3.41	-0.68	13.37	92.3
Live Cattle	2.11	3.95	-2.54	11.20	76.9
Feeder Cattle	3.66	11.32	-12.23	29.31	61.5
Crude Oil (WTI)	0.76	8.84	-18.62	14.47	46.2
Heating Oil #2	-1.86	12.15	-30.45	22.64	46.2
RBOB Gasoline	3.35	7.99	-4.41	19.88	50.0
Crude Oil (Brent)	4.36	8.05	-8.19	24.13	69.2
Gasoil	3.30	10.62	-13.57	23.46	61.5
Natural Gas	0.96	1.19	-0.73	2.85	69.2
Gold	0.45	1.98	-2.48	3.08	61.5
Silver	2.86	1.41	0.45	5.02	100.0
Average	2.25	5.28	-6.49	12.63	73.5

This table reports descriptive statistics of percentage changes in CPWs for each of the 19 commodities for 2003--2016. The last column shows the percentage of positive CPW changes and the last row shows the average statistics across commodities.

Table 3: Changes in CIT flows caused by the 2016 rebalancing, assuming the value of total index investment in the S&P GSCI is $50 billion

Commodity	CPW changes in 2016 (%)	Implied CIT flows in terms of			
		Number of contracts	Dollars (million)	% of average volume	% of average open interest
Wheat (Chicago)	1.27	191	4.47	0.44	0.08
Wheat (Kansas)	3.78	140	3.25	1.16	0.13
Corn	1.99	476	8.39	0.40	0.07
Soybeans	1.78	121	5.24	0.13	0.04
Coffee “C”	1.64	35	1.54	0.29	0.04
Sugar #11	0.96	93	1.54	0.22	0.02
Cocoa	5.17	77	2.27	0.41	0.08
Cotton #2	1.06	41	1.26	0.28	0.03
Lean Hogs	3.18	274	7.19	4.54	0.65
Live Cattle	-0.76	-70	-3.73	-0.59	-0.10
Feeder Cattle	29.31	444	35.75	11.99	3.17
Crude Oil (WTI)	11.72	7106	245.08	6.81	2.51
Heating Oil #2	-5.07	-618	-28.17	-2.57	-1.00
RBOB Gasoline	-2.21	-238	-11.75	-1.13	-0.41
Crude Oil (Brent)	-3.77	-2317	-81.12	-3.50	-1.09
Gasoil	-13.57	-2783	-92.67	-9.02	-4.40
Natural Gas	1.68	227	5.43	0.41	0.11
Gold	3.00	86	9.56	1.17	0.16
Silver	5.02	27	1.96	0.08	0.02
Absolute average	5.10	809	28.97	2.38	0.74

This table shows changes in CIT flows caused by the 2016 rebalancing per day in terms of dollars (million), number of contracts, and percentages in terms of average volume and open interest. The last row shows the absolute averages across commodities. The value of total index investment in the S&P GSCI is assumed to be $50 billion, around half of total index investment in the U.S. futures markets based on the CFTC IID report as of October 2015. Average volume and open interest are computed over a two-week window preceding the 2016 rebalancing period.

Table 4: Average futures returns during the rebalancing week

Commodity group	Group (1)			Group (2)		
	All	ΔCPW>0	ΔCPW<0	All	ΔCPW>0	ΔCPW<0
Sample size (days)	1132	833	299	572	473	99
			Raw return			
Mean %	-0.08	0.01	-0.34***	0.06	0.10*	-0.13
p-value	0.13	0.40	0.00	0.30	0.07	0.10
Number > 0	540	413	127**	291	243	48
p-value	0.13	0.61	0.01	0.71	0.29	0.42
			Abnormal return			
Mean %	0.02	0.07	-0.11	0.07	0.09*	-0.04
p-value	0.70	0.11	0.12	0.14	0.06	0.34
Number > 0	568	424	144	291	240	51
p-value	0.93	0.31	0.28	0.71	0.39	0.66

This table shows the average raw and abnormal returns per day during the rebalancing period for two commodity groups for 2004--2016, excluding the release dates of USDA reports. Group (1) includes the 19 commodities in the S&P GSCI and Group (2) includes the 10 of 19 commodities that have no rolls during the rebalancing period. The returns are split based on the direction of CPW changes. Abnormal returns are obtained by subtracting raw returns by benchmark returns that are derived from Equation (5). The *p*-values for *t* tests on the null hypothesis that the mean return is equal to zero is provided below the Means. Number > 0 represents the number of positive returns and the *p*-values below are based on sign tests with the null hypothesis that the probability of a positive return is equal to 0.5. Right-tailed (left-tailed) *t* and sign tests are used for ΔCPW>0 (ΔCPW<0).

Table 5: Average futures returns on each of the rebalancing days

Commodity group	Group (1)			Group (2)		
	All	ΔCPW>0	ΔCPW<0	All	ΔCPW>0	ΔCPW<0
Sample size (days)	227	167	60	115	95	20
Day 1	0.00	0.05	-0.13	-0.04	0.00	-0.21*
	(0.98)	(0.34)	(0.17)	(0.75)	(0.51)	(0.09)
Day 2	0.13	0.14**	0.08	0.16	0.21*	-0.04
	(0.13)	(0.04)	(0.72)	(0.17)	(0.05)	(0.39)
Day 3	-0.24**	-0.16	-0.44***	0.03	0.05	-0.03
	(0.01)	(0.91)	(0.00)	(0.82)	(0.39)	(0.44)
Day 4	-0.15	-0.03	-0.49***	0.00	0.06	-0.36
	(0.23)	(0.59)	(0.00)	(0.98)	(0.35)	(0.12)
Day 5	0.29***	0.28***	0.33	0.18*	0.14	0.35
	(0.00)	(0.00)	(0.91)	(0.08)	(0.14)	(0.96)

This table shows the average abnormal returns on each of the rebalancing days (Day 1 to 5) for two commodity groups for 2004--2016, excluding the release dates of USDA reports. Group (1) includes the 19 commodities in the S&P GSCI and Group (2) includes the 10 of 19 commodities that have no rolls during the rebalancing period. The returns are split based on the direction of CPW changes. Abnormal returns are obtained by subtracting raw returns by benchmark returns that are derived from Equation (5). The *p*-values for *t* tests on the null hypothesis that the mean return is equal to zero is provided below the Means. Number > 0 represents the number of positive returns and the *p*-values below are based on sign tests with the null hypothesis that the probability of a positive return is equal to 0.5. Right-tailed (left-tailed) *t* and sign tests are used for ΔCPW>0 (ΔCPW<0).

Table 6: Average futures returns during the pre- and post-rebalancing weeks

Commodity group	Group (1)			Group (2)		
	All	ΔCPW>0	ΔCPW<0	All	ΔCPW>0	ΔCPW<0
Sample size (days)	1210	895	315	650	535	115
Week -2	-0.04	-0.07	0.04	-0.04	-0.06	0.04
	(0.48)	(0.86)	(0.67)	(0.49)	(0.82)	(0.63)
Week -1	0.13***	0.14**	0.12	0.04	0.05	0.01
	(0.00)	(0.01)	(0.87)	(0.41)	(0.20)	(0.53)
Week 0	0.02	0.07	-0.11	0.07	0.09*	-0.04
	(0.70)	(0.11)	(0.12)	(0.14)	(0.06)	(0.34)
Week +1	0.00	0.02	-0.04	0.01	0.02	-0.02
	(0.96)	(0.38)	(0.34)	(0.82)	(0.37)	(0.42)
Week +2	-0.03	-0.07	0.08	-0.12**	-0.13	-0.07
	(0.49)	(0.92)	(0.82)	(0.04)	(0.98)	(0.27)

This table shows the average abnormal returns per day during the pre- and post-rebalancing weeks for two commodity groups for 2004--2016, excluding the release dates of USDA reports. Group (1) includes the 19 commodities in the S&P GSCI and Group (2) includes the 10 of 19 commodities that have no rolls during the rebalancing period. The returns are split based on the direction of CPW changes. Week 0 represents the rebalancing week and Week -2, -1, +1, and +2 are weeks before and after the rebalancing week. Abnormal returns are obtained by subtracting raw returns by benchmark returns that are derived from Equation (5). The *p*-values for *t* tests on the null hypothesis that the mean return is equal to zero is provided below the Means. Number > 0 represents the number of positive returns and the *p*-values below are based on sign tests with the null hypothesis that the probability of a positive return is equal to 0.5. Right-tailed (left-tailed) *t* and sign tests are used for ΔCPW>0 (ΔCPW<0).

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Table 7: Cross-sectional regressions during the rebalancing week

Commodity group	Group (1)		Group (2)	
	Raw	Abnormal	Raw	Abnormal
Sample size (days)	1145	1145	585	585
Independent variable: Percentage changes in CPWs				
Constant	-0.016	0.055	-0.092	-0.183
	(-0.10)	(0.34)	(-0.58)	(-1.16)
ΔCPW	3.249	0.459	-2.629	-4.856
	(1.13)	(0.15)	(-0.69)	(-1.35)
Adjusted R^2	4.4%	2.1%	0.9%	0.2%
Independent variable: Percentage changes in CPWs scaled by average open interests				
Constant	0.004	0.058	-0.098	-0.203
	(0.02)	(0.35)	(-0.60)	(-1.30)
Scaled ΔCPW	37.97	3.804	1.163	-14.16
	(0.74)	(0.09)	(0.02)	(-0.43)
Adjusted R^2	4.3%	2.1%	0.8%	0.0%

This table reports coefficient estimates and *t*-statistics (in parentheses) from regressions of the rebalancing date futures returns on proxies for CIT position changes. The sample consists of rebalancing days for two groups of commodities for 2003--2016, excluding the release dates of USDA reports. Group (1) includes the 19 commodities in the S&P GSCI and Group (2) includes the 10 of 19 commodities that have no rolls during the rebalancing period. The dependent variables are raw and abnormal futures returns, where abnormal returns are obtained by subtracting raw returns by benchmark returns that are derived from Equation (5). The independent variables are percentage changes in CPWs (ΔCPW) and scaled ΔCPW, defined as ΔCPW divided by the average open interest (in thousand contracts) over the two weeks prior to the rebalancing. Estimates on dummy variables are omitted to save space. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Table 8: Cross-sectional regressions on the last rebalancing days

Commodity group	Group (1)		Group (2)	
	Raw	Abnormal	Raw	Abnormal
Sample size (days)	237	237	125	125
Independent variable: Percentage changes in CPWs				
Constant	-0.240	0.177	-0.213	0.078
	(-0.68)	(0.55)	(-0.52)	(0.21)
ΔCPW	-7.346	-5.523	-6.743	-7.812
	(-1.31)	(-1.06)	(-0.86)	(-0.89)
Adjusted R^2	16.5%	8.6%	14.4%	4.8%
Independent variable: Percentage changes in CPWs scaled by average open interests				
Constant	-0.359	0.059	-0.359	-0.100
	(-1.06)	(0.20)	(-0.96)	(-0.33)
Scaled ΔCPW	-325.8***	-340.5***	-242.4***	-298.5***
	(-3.46)	(-3.92)	(-3.17)	(-3.11)
Adjusted R^2	17.5%	10.2%	15.9%	7.5%

This table reports coefficient estimates and *t*-statistics (in parentheses) from regressions of futures returns on the last rebalancing days on proxies for CIT position changes. The sample consists of rebalancing days for two groups of commodities for 2003--2016, excluding the release dates of USDA reports. Group (1) includes the 19 commodities in the S&P GSCI and Group (2) includes the 10 of 19 commodities that have no rolls during the rebalancing period. The dependent variables are raw and abnormal futures returns, where abnormal returns are obtained by subtracting raw returns by benchmark returns that are derived from Equation (5). The independent variables are percentage changes in CPWs (ΔCPW) and scaled ΔCPW, defined as ΔCPW divided by the average open interest (in thousand contracts) over the two weeks prior to the rebalancing. Estimates on dummy variables are omitted to save space. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Table 9: Cross-sectional regressions on the announcement days

Commodity group	Group (1)		Group (2)	
	Raw	Abnormal	Raw	Abnormal
Sample size (days)	242	242	130	130
Independent variable: Percentage changes in CPWs				
Constant	0.230	0.437	0.256	0.334
	(0.61)	(1.30)	(0.49)	(0.69)
ΔCPW	-1.597	0.254	-8.235	-4.963
	(-0.26)	(0.05)	(-0.90)	(-0.66)
Adjusted R^2	20.3%	11.1%	27.7%	24.5%
Independent variable: Percentage changes in CPWs scaled by average open interests				
Constant	0.186	0.402	0.172	0.265
	(0.48)	(1.18)	(0.29)	(0.50)
Scaled ΔCPW	-130.2	-117.3	-118.0	-106.4
	(-1.35)	(-1.39)	(-0.91)	(-1.20)
Adjusted R^2	20.5%	11.3%	27.7%	24.7%

This table reports coefficient estimates and *t*-statistics (in parentheses) from regressions of futures returns on the announcement dates on proxies for CIT position changes. The sample consists of rebalancing days for two groups of commodities for 2003--2016, excluding the release dates of USDA reports. Group (1) includes the 19 commodities in the S&P GSCI and Group (2) includes the 10 of 19 commodities that have no rolls during the rebalancing period. The dependent variables are raw and abnormal futures returns, where abnormal returns are obtained by subtracting raw returns by benchmark returns that are derived from Equation (5). The independent variables are percentage changes in CPWs (ΔCPW) and scaled ΔCPW, defined as ΔCPW divided by the average open interest (in thousand contracts) over the two weeks prior to the rebalancing. Estimates on dummy variables are omitted to save space. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.