Rebalancing effects of commodity indices on open interest, volume and prices

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Abstract

The investment volume for commodity indices has increased rapidly over the past years. This financialization is intensively discussed in politics and science with mixed results because of several problems. We use a novel idea to measure the effect of the growing investment volume of index investors by looking at index rebalancing, in which only financial traders are forced to trade. Analyzing 289 rebalancing between 2006 and 2021 for the BCOM and the S&P GSCI, we observe significant results—with abnormal returns up to 14.1%—only for open interest and volume data. We cannot prove an effect on prices and, therefore, no effect of financialization on the real economy.

Keywords: financialization, commodity index, index investors, event study

JEL Classification Codes: G11, G14, Q02, Q31

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1. Introduction

Investment in commodities has become a large, popular, and profitable activity (Gilbert 2010a). According to a Commodity Futures Trading Commission report (2008) and Masters (2008), the total value of various commodity index-related instruments purchased by institutional investors has increased from an estimated $15 billion in 2003 to at least $200 billion in mid-2008. After a decline during the Great Recession, the total amount of invested money grew to about $300 billion in 2010 (Irwin and Sanders 2011) and $435 billion in 2012 (Miffre 2014). According to a report from the Futures Industry Association, the commodity futures volume increased from one to six billion contracts between 2007 and 2016. Commodity futures options volume increased by 100 to 700 million contracts (Acworth 2016; Simon 2014). Commodity futures have become a popular asset class for investors, just like stocks and bonds. The process of strongly growing invested money in commodity markets is called the financialization of the commodity markets (e.g., Tang and Xiong 2012). Many studies have been published during further research concerning this phenomenon (e.g., Adams and Glück, 2015 and Bianchi et al., 2020). We analyze the effects of the financialization of the commodity markets using commodity indices.

According to Arnott et al. (2014) and Pereira et al. (2017), commodities are attractive for investors for several reasons, e.g., inflation protection and portfolio diversification. Both reasons can be materialized in investing in index products as described in Gorton and Rouwenhorst (2006). Commodity indices aggregate the market activities concerning the commodity market itself. Commodity index funds and commodity index-based products show an appropriate opportunity to participate in the overall performance of commodity markets for commercial investors. We use the term index investors for market participants who invest in commodity indices. The decision-making processes of commercial investors are oriented to the Commodity Futures Trading Commission (CFTC).

Our idea is to use the annual rebalancing of commodity indices to analyze financialization based on the assumption that index investors have to follow the strategy of the index. The rebalancing attempts to reflect the actual market situation and adjust positions for commodity index-based products. Financial products based on commodity indices want to copy or benchmark the respective index; for example, when a bank issues an ETF based on the S&P GSCI aimed at investors (private or institutional) looking to invest in commodities. To hedge the risk, the bank holds a long position in future contracts of the underlying commodities. Therefore, the bank hedges its risks via the future market by buying or selling the counter position. Every rebalancing has to be reproduced to match the index and result in additional trading activities. With the growing volume and financialization of commodity markets, we assume a direct influence first on the trading activity or volume of the commodities or commodity indices, second on the open interest of the underlying commodities, and third on the commodity prices (future and spot) as shown in Figure 1.

Many studies like Brunetti and Buyuksahin (2009), Haase et al. (2016), Sanders and Irwin (2011), and Wimmer et al. (2020) measure the effects of financialization directly. These studies measure the subsequent price changes given changes in aggregated volume data of index investors. Therefore, the rise in trading activity due to index investors is analyzed as a driver of prices. The volume increase consists of an aggregated position regarding different points in time as well as different traders. Nearly all studies related to this topic (with one exception) are introduced in section two using indirect measurement. Our approach is to isolate the transaction in the indices, better known as rebalancing, to date the effect.

Furthermore, the possible effect can be attributed only to index investors. In doing so, we measure the reason for index investors to act. Thereby, our measurement is analogous to that of Henderson et al. (2014), who show evidence of financialization regarding the emitting processes of financial products. We select both benchmark commodity indices, the Standard & Poor's Goldman Sachs Commodity Index (S&P GSCI) and the Bloomberg Commodity Index (BCOM), to answer the questions in the period of financialization with the peak in 2008. Therefore, the study covers the period from 2006 to 2021. Both indices are described explicitly in section three. The BCOM has 135 positive and 157 negative rebalancing within fifteen years and three cases without a weight change. The S&P GSCI has 152 positive and 148 negative rebalancings. There are 289 rebalancing with 135 negatives and 154 positives in a combined view. The rebalancing can be seen in detail in Tables 6 and 7 in the appendix. Broad literature research concerning index effects for stock indices reveals that the commonly used methodology is an event study. Section 4 includes the methodology in more detail.

We find significant results for an index effect for commodity indices concerning open interest and volume data using an event study. The results show no significance for spot and future prices. We can prove these results for the cumulative weighting of both indices (BCOM and S&P GSCI) and the weighting in the same direction by both indices shown in Table 3 and Table 4. The results stay robust in these cases for the fit to the trading volume concerning the rebalancing dates. The results show fewer or even no significant results for other event days and other settings concerning the parameters for the event study. Hence we contribute to the literature stream in applying an alternative method to analyze the effects of financialization of commodity markets. Because our results on prices show no significant influence, we strengthen the literature stream, which observes no price effects. Due to our method, we can also analyze volume and open interest effects, enriching the literature in this case. Section five shows the results in detail. Section two addresses the literature. In section three, both commodity indices are described in more detail, and section four introduces the event study methodology. The final section concludes the topic.

2. Literature

The literature review is split into two parts, on the one hand, literature concerning the financialization of commodity markets and, on the other hand, studies related to an index effect by stock indices. Starting with the studies concerning financialization that aim to prove the impact of financialization on commodity prices, the basic idea of the tests is to measure the impact of financialization operationalized by additional market activity with variables like the open interest of commercial investors or trading volume on future and spot returns, as well as the volatility of spot and future prices. To mention some of the studies in this field, Brunetti and Buyuksahin (2009), Brunetti et al. (2016), and Sanders and Irwin (2011) support the effects of financialization for volatility with the help of Granger-causality. The first two studies analyze the period from 2005 to 2009 for crude oil, natural gas, and agricultural commodities. The third study shows the result for natural gas and agricultural commodities from 2006-2009.

Turning to the correlation structure between commodities and stock markets. Adams and Glück (2015) show with their study the change of correlation between commodity prices and stock indices as a result of correlation. Bianchi et al. (2020) prove with their research the impact of financialization on commodity futures markets has a longer duration than older studies mentioned. But Zaremba et al. (2021) prove that commodity price co-movement is not unprecedented and was similar in episodes during the 18th and 19th centuries. In addition, Al Rahahleh et al. (2017) analyze the information flow between financial markets to deviate an benefit for investors. Nguyen et al. (2016) investigate the role of gold as a safe haven and its nexus between stock markets. Al Rahahleh et al. and Nguyen et al. therefore present a possible way for investors to diversify their portfolio by using nexus between markets.

Furthermore, Gilbert (2010b, 2010c) can prove financialization for prices of crude oil, metals, and agricultural commodities as well as Mayer (2012) and Robles et al. (2009) only for agricultural commodities. Mayer et al. (2017) find effects on volatilities for metal commodities in boom times or other special market situations. In contrast, the studies of Bohl et al. (2012), Brunetti et al. (2016), Harris and Buyuksahin (2009), and Mutafoglu et al. (2012) cannot find any evidence for financialization for prices and volume in the different commodity classes. Using a Meta-Granger Analysis, Wimmer et al. (2020) also find no overall effect on the effects of financialization. In this case, the unclear results align with those of Haase et al. (2016), who analyzed 100 studies with similar results. A problem is often the measurement of financialization in the context of commodity indices. The most used data is from the CFTC, which are weekly data in this case, and the effects are short-term—daily or intraday. Additionally, the position of traders in the different commodities and the trading motives (hedging, speculation, etc.) cancel each other out. Furthermore, it is unclear how to define specific allocation to the different trader groups concerning the CFTC classification.

Henderson et al. (2014) take a different path, avoiding problems arising from an aggregation of filtering for days when index investors are forced to trade. Henderson et al. (2014) find evidence for price impact around pricing dates of newly issued certificates and new inflows for the commodity future market. They can isolate the effect by assuming that banks hedge their positions and avoid indirect measurement problems to minimize risk or avoid possible losses. That includes an increase or additional demand, and therefore the increasing effect is to be expected. They measure this effect concerning prices (spot and future).

Our approach is similar. We try to isolate and focus the effects around the rebalancing of the two benchmark commodity indices. Therefore, we analyze the effects on open interest (OI), volume (Vol), and price (future and spot) data around the exact rebalancing dates in January of each year. With the assumption of the invested money in those indices, the rebalancing increases the need to shift the positions. These effects can be assigned directly to commercial investors and the effects of financialization.

This idea is closely related to the approach of Henderson. We adopt the method from stock index literature with a different theory. This part of the literature primarily analyzes the S&P 500 between 1966 and 2015. Most of the studies like Shleifer (1986), Harris and Gurel (1986), Woolridge and Ghosh (1986), Lamoureux and Wansley (1987), Edmister et al. (1994), Lynch and Mendenhall (1997), and Beneish and Whaley (1997) find an index effect concerning the addition to or removal from the S&P 500 related with price, volume, and open interest of the underlying companies. Inclusion or being part of the S&P 500 means that companies are of more interest to investors or more covered by analysts, which implies lower information asymmetry. Therefore, the prices are significantly higher than those not included companies. The change in positions reduces or increases the information asymmetry and the cost of capital. The lower information asymmetry results in a lower cost of capital and higher stock prices, determining positive returns. Consequently, they confirm an index effect around the issue dates for addition or removal to or from the S&P 500. With the addition or removal to or from an important stock index, the related companies' information is different.

In contrast, commodity indices have fewer additions and removals to or from the index. Therefore, our focus is on the commodity rebalancing concerning each proportion, comparable to capital adjustments for stock indices. Although we can apply the same method in our work, higher weighting does not have the same economic implication as stock indices. Because commercial investors mostly use commodity indices, the rebalancing leads to an adjustment of their positions. Figure 1 below shows the process for the positive rebalancing as well as for the negative rebalancing. We describe it only for the positive direction because the negative one has the same influence vice versa. In our research, we follow the wording of the CFTC. Commercial investors include traders who use derivatives markets as a hedging tool—often called “hedgers”. Non-commercial investors include all investors who are not interested in the physical commodity and are therefore considered speculators. If the rebalancing for the commodity is positive, the non-commercial long (NCL) traders raise the long positions to replicate the index.

The first of the three possible channels—designated by black arrows—shows as a consequence of more long non-commercial traders that the commercial-long (CL) traders drop and close their positions in the top part of the figure. This effect is evident within the volume data. In the middle part, the commercial short (CS) traders raise their positions. This effect is noticeable in the open interest and volume data. Finally, without a direct reaction to the commercial traders and their positions, aka "commercials", the third part shows a rise in the future price (F_t), leading to two effects. The first one is identical to the middle, horizontal channels in Figure 1. But the second effect shows no change for the commercial short positions and, in the end, a rise in the spot price. Figure 1 displays the link between the change in future prices and spot prices mentioned by Cheng and Xiong (2014). The channels for the link concern the theory of storage, the theory of normal backwardation, and the theory of information asymmetry. This effect should be seen in all three analyzed data types: price, volume, and open interest. Therefore, the effect can be seen most easily in open interest data, then in volume data, followed by future prices, and finally, spot prices. Effects on prices have effects on the real economy. Allocation effects, e.g., are possible when supply and demand do not determine the price. Moreover, we would like to add that all commercial positions can be non-commercials, which are not index traders, and combinations are also possible.

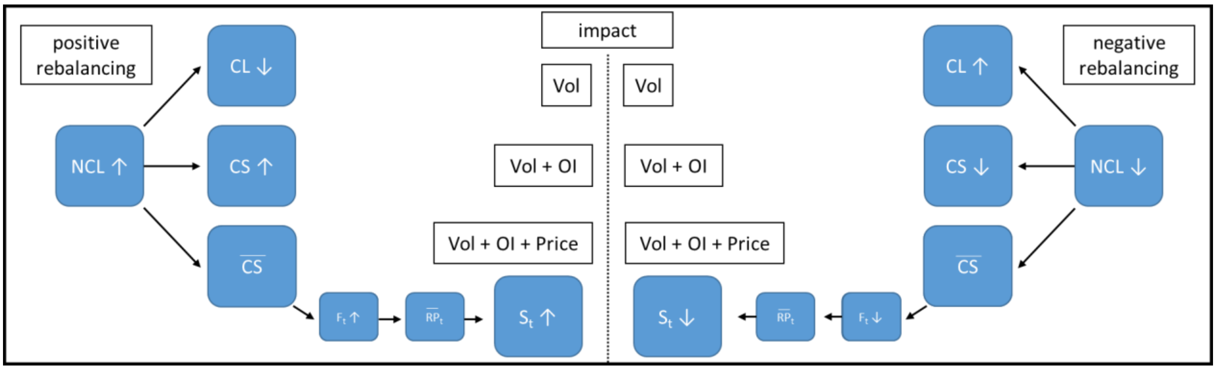

Figure 1 shows the influence of positive or negative rebalancing. If the rebalancing is positive, the non-commercial investors long (NCL, also called speculators) raise their positions. That means, in the first case, the commercial long (CL, also called hedgers) drop. This behavior can be seen only in volume (Vol) data and has no price effect. In the second case, the commercial short (CS) rises. Also, this can be seen with Vol and open interest (OI) data. And in the third case, the future price (F_t) may or may not cause a rise, which can follow in two cases. The first case can be seen in the middle part of the figure concerning Vol and OI data. If, e.g., risk premium remains constant in the third case, the spot price (S_t) rises. This case can be observed in open interest, volume, and price data. The effect should be the same with negative rebalancing; only the direction is opposite.

3. Commodity indices and descriptive statistics

To describe index effects in detail, further information on both indices is needed. Therefore, this section gives a short overview of the characteristics of the BCOM and the S&P GSCI.

For our study, we chose the largest commodity indices: the BCOM and the S&P GSCI (Thürer 2014; Ludwig et al. 2017). The effects presented in Figure1 are easier to observe with large indices because the influence (concerning trading volume) is more prominent, as more money will be invested and shifted by index changes. Over the period from January 2006 to December 2021, we analyze both indices, but Figure 2 shows that both indices have performed differently during that time. This performance difference is explainable by differences in the methodology to calculate the weightings of commodities. These differences are explained below.

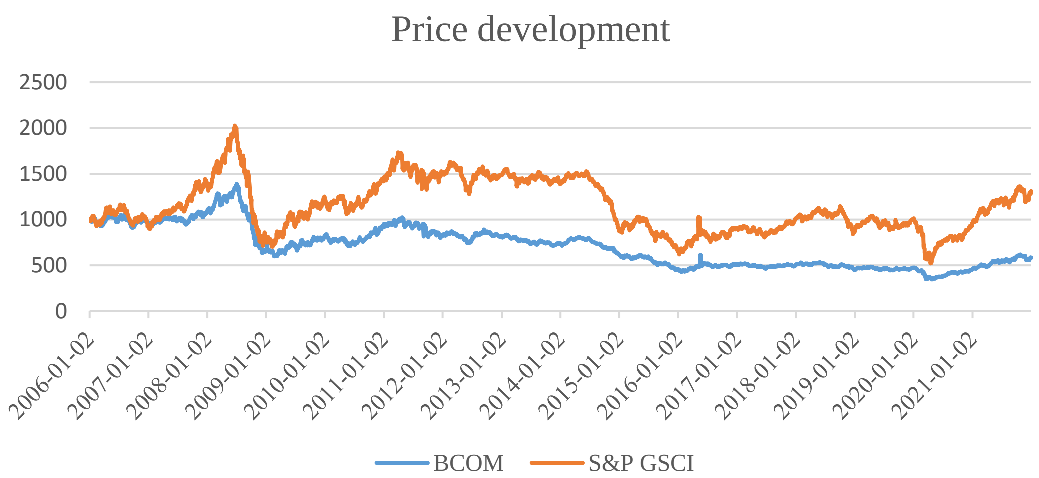

Figure 2 shows the price development from the BCOM (blue curve) and the S&P GSCI (orange curve). The shown period extends from 2006 to 2021. The starting value is standardized to 1000 basis points. The remaining data is also adjusted so that the progress is depicted correctly.

With a standardized starting point of 1000 basis points, it is clear that the S&P GSCI (orange curve) performs better than the BCOM (blue curve) because the relevant curve is on almost all points higher.

The differences are due to different weighting schemes. In detail, the S&P GSCI is a production-weighted index. The central design aspect is to reflect the relative significance of each of the constituent commodities to the world economy. The index rebalancing takes place at the beginning of January each year. The new weightings for each commodity become effective around the fifth business day, with the announcement taking place roughly half a year before. The index of 2021 includes 24 commodities, which can be divided into four commodity classes. Consequently, the focus concerning the weightings lies in the energy commodities, with about 53.93%. The next most significant class is agricultural with 19.29%, followed by metal commodities with 18.78%, and livestock commodities with 7.99%. This unequal distribution has been nearly the same over the years.

According to Bloomberg, the BCOM is designed on four principles (economic significance, diversification, continuity, and liquidity) to be highly liquid and diversified for commodity investments. This leads to the following weights for the commodity classes (2021). Energy commodities have 29.97%, metal commodities 34.56%, agricultural 29.88%, and livestock commodities 5.57%. The rebalancing rhythm is similar to the S&P GSCI rhythm. The rebalancing becomes effective also on the fifth business day of January, which is announced roughly half a year before.

To close the comparison of both indices, the following table sums up the essential key facts. The data for both indices covers the period from 2006 to 2021.

<table>
<tr><th></th><th colspan="2">S&P GSCI</th><th colspan="2">BCOM</th></tr>
<tr><th></th><th>Positive</th><th>Negative</th><th>Positive</th><th>Negative</th></tr>
<tr><td>Number of commodities</td><td colspan="4">20[1]</td></tr>
<tr><td>Removed from the index</td><td colspan="2">0</td><td colspan="2">0</td></tr>
<tr><td>Added to the index</td><td colspan="2">0</td><td colspan="2">2</td></tr>
<tr><td>Number of rebalancing</td><td>152[2]</td><td>148[2]</td><td>132[2]</td><td>154[2]</td></tr>
<tr><td>Largest rebalancing</td><td>12.01%[3]</td><td>- 14.76%[3]</td><td>5.31%</td><td>- 5.02%</td></tr>
<tr><td>Smallest rebalancing</td><td>0.01%</td><td>- 0.01%</td><td>0.00%</td><td>0.00%</td></tr>
<tr><td>Mean rebalancing</td><td>0.91%</td><td>- 0.97%</td><td>0.31%</td><td>- 0.31%</td></tr>
<tr><td>No rebalancing</td><td colspan="2">0</td><td colspan="2">3</td></tr>
</table>

Table 1 shows the descriptive statistics and key facts of both indices. [1]The study analyzes 20 shared commodities over the period 2006 – 2021. [2]The different size concerning positive and negative rebalancing is based on the choice of commodities included in both indices. The different sum of BCOM and S&P GSCI weightings is based on the three constant periods in the BCOM and the two additions. [3]The substantially higher rebalancing for the S&P GSCI is based on a calculation change for WTI and Brent Crude Oil.

Referring to Table 6 in the appendix, it is conspicuous that no commodity is equal in both indices over the entire period (2006 – 2021). However, most of the parameters concerning rebalancing are similar.

The data concerning the indices are obtained from S&P and Bloomberg. For our event study, we use spot and future prices as well as volume and open interest data. We designed a future price that fits index investors for each commodity related to the index methodology. These future prices follow the rolling strategies of the indices described in the methodology of both index providers. The spot prices are acquired from the Thomson Reuters DataStream and Barchart. The volume, open interest, and future price data are gained from Quandl and Barchart. All descriptive statistics are summarized in Table 2. The first panel shows the statistics for the volume data. The second panel deals with the open interest data. The third illustrates future prices, and the fourth does the same with spot prices.

Descriptive statistic - volume

Commodity	Minimum	Maximum	Mean	Median	Sigma	Unit
Brent	13814	3245000	623675.18	573004	377546.06	U$/Barrel
Coffee	1345	171641	30905.13	25591.5	20182.72	Cents/lb.
Copper	2670	332467	65479.51	59403	41453.69	Cents/lb.
Corn	1119	1127803	290489.30	264943	143214.58	Cents/Bushel
Cotton	1360	107101	24776.58	21153.5	14119.29	Cents/lb.
Gasoline	730	531754	145182.67	146691	61516.90	U$/Gallon
Gold	1048	897219	203057.91	179598	110545.00	U$/Troy Oz
Heating Oil	20602	464204	133257.04	131097.5	50977.39	U$/Gallon
HRW Wheat	22	149921	31539.90	24857.5	23046.19	Cents/lb.
Lean Hogs	5048	148195	40958.97	38371	17097.24	Cents/lb.
Live Cattle	318	206302	51219.36	47798	20712.91	Cents/lb.
Natural Gas	3122	1602673	319784.54	311349	155033.78	U$/Million Btu
Silver	616	397177	62989.22	55485	39589.91	U$/Troy Oz
Soybeans	819	804244	175620.83	171368	94167.35	Cents/Bushel
Sugar	6002	516021	117148.76	106851	53073.97	Cents/lb.
Wheat	410	369339	98341.77	93098	55833.58	Cents/Bushel
WTI	30819	4137911	791843.16	702958	376671.61	U$/BBL

Descriptive statistic – open interest

Commodity	Minimum	Maximum	Mean	Median	Sigma	Unit
Brent	401038	2805740	1321287.32	1360948	581091.70	U$/Barrel
Coffee	93025	357447	183931.38	164608.5	62403.91	Cents/lb.
Copper	64516	337907	170465.78	160370	63609.27	Cents/lb.
Corn	736567	2006600	1361919.67	1343451	236915.35	Cents/Bushel
Cotton	105969	322253	202012.01	195177	39901.02	Cents/lb.
Gasoline	23524	501305	306984.93	317835	97105.84	U$/Gallon
Gold	259596	799541	460140.26	453360	87484.76	U$/Troy Oz
Heating Oil	137569	490790	332916.72	329618	76589.22	U$/Gallon
HRW Wheat	75047	342096	188372.54	168326.5	65258.16	Cents/lb.
Lean Hogs	113879	333948	222692.47	224121	41446.60	Cents/lb.
Live Cattle	195389	454749	301466.40	303346	50186.10	Cents/lb.
Natural Gas	3677	1699571	1044734.08	1045649	311813.51	U$/Million Btu
Silver	71359	244705	153281.14	149847	38676.42	U$/Troy Oz
Soybeans	276210	1050780	632903.31	647694	154878.80	Cents/Bushel
Sugar	465556	1260387	827874.05	830451	125589.76	Cents/lb.
Wheat	245009	581134	420130.95	423742	57347.45	Cents/Bushel
WTI	968540	2713986	1710302.57	1634876.5	402593.72	U$/BBL

Descriptive statistic – future prices

Commodity	Minimum	Maximum	Mean	Median	Sigma	Unit
Aluminum	93.85	255.35	129.96	122.43	28.84	U$/t
Brent	38.04	147.05	77.04	69.75	23.08	U$/Barrel
Coffee	94.05	304.90	150.81	139.80	37.88	Cents/lb.
Copper	1.27	4.77	3.11	3.11	0.65	Cents/lb.
Corn	218.75	831.25	446.54	392.75	128.68	Cents/Bushel
Cotton	34.26	215.15	75.28	69.82	23.18	Cents/lb.
Gasoline	0.62	3.40	2.17	2.09	0.61	U$/Gallon
Gold	565.94	2062.98	1276.97	1276.23	337.10	U$/Troy Oz
Heating Oil	0.87	4.12	2.16	2.02	0.61	U$/Gallon
HRW Wheat	309.75	1337	603.32	559.5	165.63	Cents/lb.
Lean Hogs	43.98	132.65	75.93	75.08	16.16	Cents/lb.
Live Cattle	73.12	171	116.13	117.47	21.31	Cents/lb.
Natural Gas	2.00	13.58	4.27	3.74	1.86	U$/Million Btu
Nickel	7720	33177.23	15823.38	15229.5	4862.69	U$/t
Silver	8.79	48.59	19.80	17.55	6.63	U$/Troy Oz
Soybeans	538.5	1768.25	1063.80	992	241.39	Cents/Bushel
Sugar	8.56	35.31	16.71	15.26	4.72	Cents/lb.
Wheat	339.75	1280	587.67	555.25	142.06	Cents/Bushel
WTI	26.14	145.94	70.11	65.23	22.32	U$/BBL

Zinc	96.1	322.5	159.84	152.2	46.76	U$/t
Descriptive statistic – spot prices						
Commodity	Minimum	Maximum	Mean	Median	Sigma	Unit
Aluminum	1251.75	3271.25	2072.61	1990.5	403.94	U$/t
Brent	-37.63	143.95	74.08	68.29	26.16	U$/Barrel
Coffee	87	296.75	138.99	126.16	40.51	Cents/lb.
Copper	114.14	477.85	311.34	311.9	67.23	Cents/lb.
Corn	189	849	439.24	375.5	143.18	Cents/Bushel
Cotton	35.93	210.64	72.92	68.44	23.70	Cents/lb.
Gasoline	0.44	4.71	2.11	2.01	0.61	U$/Gallon
Gold	516	2062.98	1260.83	1267.83	352.12	U$/Troy Oz
Heating Oil	0.61	4.08	2.13	1.99	0.64	U$/Gallon
HRW Wheat	309.75	1337	599.09	558.25	168.80	Cents/lb.
Lean Hogs	44.55	134.17	74.42	72.22	16.93	Cents/lb.
Live Cattle	78.23	171.38	113.61	114.84	21.16	Cents/lb.
Natural Gas	1.48	13.31	4.10	3.5	2.00	U$/Million Btu
Nickel	7705	54050	17715.19	16041	7674.52	U$/t
Silver	8.81	48.55	19.50	17.27	6.85	U$/Troy Oz
Soybeans	504.5	1790	1059.49	991.5	267.69	Cents/Bushel
Sugar	8.87	32.57	16.49	15.55	4.57	Cents/lb.
Wheat	247.5	1194.5	556.95	531	144.03	Cents/Bushel
WTI	13.27	145.66	70.92	68.37	22.56	U$/BBL
Zinc	1046.75	4603	2373.85	2265.13	611.46	U$/t

Table 2 shows the descriptive statistics for volume, open interest, future prices, and spot prices. The datasets for all four panels cover the period 2006-2021. The different length of the datasets is based on the different datasets for the different settings. In the case of prices, the full dataset with 20 commodities is analyzed, and for volume and open interest, 17 commodities are analyzed.

4. Methodology

Following Henderson et al. (2014), we use an event study method to analyze a possible index effect on volume, open interest, future or spot prices.

To use the event study method, first, we calculate log-returns (R_{it}) from the raw data. Next, we calculate abnormal returns ($AR_{i,}$) from the returns (R_{it}) and test these ARs for statistical significance. The 15-day estimation window is the basis of the abnormal returns. For open interest and volume data, we use the final trading peak in November as a period. Figure 4 shows all peaks concerning the trading. The exact use is described later in this section in conjunction with trading characteristics at the beginning of January. The term "one day" means one trading day in this case and the following sections. To account for non-normality in our sample, we use either the non-parametric test of Corrado (1989) or the parametric t-test as a comparison.

To calculate the abnormal return, we need an expected or normal (benchmark) return ($NR_{i,}$) as

$$AR_{it} = R_{it} - NR_{it}, \tag{1}$$

where R_{it} is the day t log-return for commodity i of a specific commodity index. One event day is defined as a trading day of a particular commodity. The normal return NR is calculated with the constant mean approach (CMR) or the market model (MM) concerning Henderson et al. (2014).

Beginning with the market model approach consists of a linear factor model. To ensure comparability, we use the same factors as Henderson et al. (2014), which are motivated by Singleton (2013) and Tang and Xiong (2012):

$$\begin{aligned} NR_{i,t}^{MM} &= \beta_0 + \beta_{i,EM} \cdot R_{EM,t} + \beta_{i,EM,t+1} \cdot R_{EM,t+1} + \beta_{i,S\&P} \cdot R_{S\&P,t} + \beta_{i,USD} \cdot R_{USD,t} \\ &+ \beta_{i,TBond} \cdot R_{TBond,t} + \beta_{i,VIX} \cdot R_{VIX,t} + \beta_{i,BDI} \cdot R_{BDI,t} + \beta_{i,INF} \cdot R_{INF,t} + \beta_{i,lag} \cdot R_{i,t-1} + \epsilon_{i,t} \end{aligned} \tag{2}$$

The market is represented by the returns of the MSCI Emerging Markets Asia Index (R_{EM}), the S&P 500 index ($R_{S\&P}$), the U.S. Dollar Index futures contracts (R_{USD}), the JP Morgan Treasury Bond Index (R_{TBond}) and the Chicago Board Options Exchange Volatility Index (R_{VIX}). Additionally, two macroeconomic control variables are used: R_{BDI} (returns of the costs of transport by ship) and R_{INF} (tenyear breakeven inflation rate change). To avoid autocorrelation effects, lagged returns of the commodity prices are also included.

Concerning the CMR-model, McKenzie et al. (2004) point out that the constant mean approach is often more suited to obtain the NR due to misinterpretation of the benchmark effect regarding the market model. NR for the constant mean return model is calculated with

$$NR_{i,t}^{CRM} = \frac{1}{L_{Estim}} \sum_{t=T_{Estim}^{Begin}}^{T_{Estim}^{End}} R_{i,t} \tag{3}$$

where L_{Estim} is the length, T_{Estim}^{Begin} the beginning and T_{Estim}^{End} the end of the estimation window.

All NR parameters (the βs and the mean return, respectively) are estimated in a window preceding the event window. To cover all other approaches concerning indices studies, the estimation window differs between 15-day (basic setting) and 113-days (maximum expansion). In addition to the open interest and the volume data, we had to use the final trading peak in November as end point for an estimation window. This is the result of the cyclicality of commodity future trading that can explain the course of Figure 4. Here the rollover activity of a future contract from the front month into the back month contract leads to higher volume. Our calculations account for this effect in comparison with the increase around the rebalancing—the so-called January-Effect. The cyclicality is the result of the maturity of contracts as well as the low trading activity around the beginning of a new year. We observe a clear peak shortly before the maturity of the front-month contract. Therefore, it is interesting to investigate if the pattern with the peak at the beginning of November (first peak in Figure 4) is not as regular as the peak at the beginning of the year, which is synchronous with the rebalancing of the BCOM and the S&P GSCI. All concerning windows are adjusted separately to this case. The exact approach is shown below in Figure 3.

1. Calculate the average commodity trading related to the volume data concerning each day and each commodity
2. Find event day in January concerning each commodity
3. Fitting the gap between event day in January and maximum trading peak in November
4. Calculate abnormal and normal return concerning formula 1 and 3
5. Testing the results concerning significances

Figure 3 shows the different steps to calculate the normal and abnormal returns relating to the special trading behavior of commodities. With the following steps, we compare the increase at the beginning of January with the increase concerning the trading peak in November. Figure 4 shows this trading curve.

Figure 3 connects the setting for an event study (Figure 5) and the trading curve (Figure 4) and our idea to measure the impact concerning the rebalancing of commodity indices in January and the special market behavior of commodities.

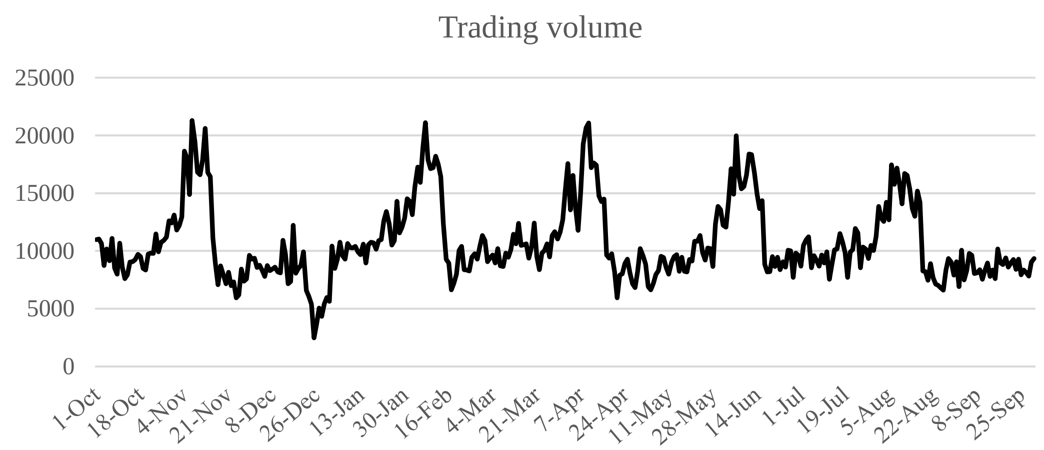

Figure 4 shows the trading volume in contracts for over one year. The figure covers the average volume of 20 years. This figure shows the trading development for cocoa, exemplary for all commodities. Noticeable are the five peaks. We matched the peak in November (first peak) with the increase period from the end of December until mid-January to see possible abnormalities concerning the rebalancing date, which takes place in the first trading week of January for BCOM and the S&P GSCI.

The rebalancing day of each commodity index is specified and familiar to all trading groups, so it is not clear when exactly investors hedge their positions. Therefore, it is interesting if significant abnormal returns are present before the rebalancing becomes effective. This could be an indication that index investors hedge their positions ex-ante.

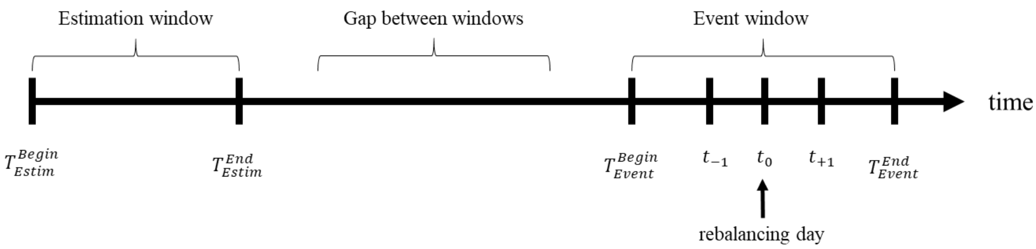

Figure 5 shows an illustrative timeline of the event study. The basic design is an event window of 3 days, a gap of 35 days, and an estimation window of 15 days. In addition to the basic design, the estimation window (left side) differs between 25 and 15 trading days (25/20/15). The gap between the event and the estimation window varies from 59 to 0 trading days (59/30/0). The event window differs between 11 and 5 trading days (11/9/7/5). The trading of the New York stock exchange will serve as a reference for active trading days.

For these reasons, we do not only focus on the single rebalancing day (t_0) and subsequent days (t_{-1},t_{+1}). Our study considers a broader event window with up to eleven days. We test up to five days before and after the rebalancing day. The event window length is always the minimum required. All AR_i, are calculated with the estimated NR_i, of the issue date itself.

Further problems with the timeline (Figure 5) occur by calculating the estimation window. For the used parameters, these variables include the December-Effect and the January-Effect. Both effects have to be taken into account for further analysis and thus are recognized with the help of a dummy variable in the calculation of NR_i for the MM.

In the analysis of specific days within the event window, the non-parametric test of Corrado (1989) is used: Let $K_{i,t}$ be the mean rank of the abnormal return of the estimation and event window and $L = L_{Estim} + L_{Event}$ the corresponding length. N is the number of events, where $AR_{i,\tau_j} \leq AR_{i,\tau_{j+1}}$ implies $K_{i,\tau_j} \leq K_{i,\tau_{j+1}}$ and $1 \leq K_{i,\tau_j} \leq L$ with $T_{Estim}^{Begin} \leq \tau_j \leq T_{Event}^{End}$. Then the test statistic is

$$\theta(\hat{T}) = \frac{\frac{1}{N}\sum_{i=1}^{N}\left(K_{i,\hat{T}} - \frac{L+1}{2}\right)}{\sigma(K_i)} \sim t_{N-1} \tag{4}$$

with $T_{Event}^{Begin} \leq \hat{T} \leq T_{Event}^{End}$ and

$$\sigma(K_i) = \sqrt{\frac{1}{L}\sum_{t=T_{Estim}^{Begin}}^{T_{Event}^{End}}\left(\frac{1}{N}\sum_{i=1}^{N}\left(K_{i,t} - \frac{L+1}{2}\right)\right)^2} \ . \tag{5}$$

We use an additional parametric test, a simple t-test, in accordance with Brown and Warner (1980). This test implies the assumption of a normal distribution but can cumulate the effects of different days. Therefore, it is possible to analyze effects if it is unclear when those effects occur or if effects occur on other dates within the event window. As outlined above, both may be the case. Furthermore, it is possible to present the data and possible trends with this method conveniently.

We apply the cumulative abnormal returns (CARs) to analyze the ARs within the whole event window. The CAR of time $\hat{T}$ is calculated, following, e.g., MacKinlay (1997) via:

$$\overline{CAR}(\hat{T}) = \frac{1}{N}\sum_{i=1}^{N}\left(\sum_{t=T_{Event}^{Begin}}^{\hat{T}} AR_{i,t}\right) \quad , \tag{6}$$

with $T_{Event}^{Begin} \leq \hat{T} \leq T_{Event}^{End}$ and $\sigma^2\left(\overline{CAR}(\hat{T})\right) = \sum_{t=T_{Event}^{Begin}}^{\hat{T}} \sigma^2\left(\overline{AR}\right)$ as standard deviation.

5. Results and discussion

The basic results are measured with adjustments related to Figure 4 and the trading peak in November as a benchmark and reference. Furthermore, a short event window with three trading days (one before and one day after the event) and a gap between the event and the estimation window of 35 days was used to fit the peak in November. The estimation length is 15 days for all settings. We account for the January-Effect in prices, especially at the beginning of January (Moller and Zilca 2008). The used data determines the most appropriate estimation window length. To measure the significant p-values, we use a non-parametric t-test. The dependent variables are volume, open interest, and prices (spot and future prices) of the underlying commodities of both indices (S&P GSCI and BCOM). The rebalancing days are divided into positive and negative ones. The direction is measured cumulatively over both indices, seen in Table 7 in the appendix. For the volume and open interest data, the CMR method is chosen, and for the prices, the CMR and the MM method after Henderson et al. (2014).

Table 3 starts with the results for volume and open interest data. The measurements are calculated with the CMR method. The results show a high significance for the event day for all settings. The increasing direction of the change for open interest and volume is in line with the theory related to points one and two in Figure 1. Results are also significant for the open interest one day after the event due to persistent position changes and for volume data only on the event day with a 10% level in a negative direction one day before. This coincides with the theoretical prediction of rising volumes and open interest in the case of index rebalancing. Hence, we can conclude that index investors are forced to trade and alter their positions and do not close positions even if a negative rebalancing occurs. It is important to note the peak in January is, therefore, more pronounced than in November. Concerning the price data, the second panel shows the result and contains the analysis with the CMR and the MM model. We measure both with a non-parametric test. Related to Figure 1, we start with the future prices, which show the significance of the positive rebalancing for all days. Concerning the positive rebalancing, the direction for cumulative abnormal returns between CMR and MM is different. This leads back to the benchmark of the market model, and therefore the result is not robust. The negative rebalancing for future prices shows no significant results. For the spot prices, we detect significances only for negative rebalancing. These significances are on a 10% level and with different signs. Therefore, in our opinion, these results are spurious and not theory-enhancing.

Panel volume and open interest– Basic results					
Depending Variable	Weighting	Method	Eventday	CAR	P-values
Volume	Positive	CMR	-1 0 +1	0.0050 0.0971 0.0624	0.2567 0.0046*** 0.5934
Volume	Negative	CMR	-1 0 +1	0.0707 0.1414 0.0896	0.0521* 0.0210** 0.8800
Open interest	Positive	CMR	-1 0 +1	0.0024 0.0071 0.0109	0.3641 0.0180** 0.0254**
Open interest	Negative	CMR	-1 0 +1	0.0027 0.0169 0.0144	0.3820 0.0910* 0.0173**
Panel prices – Basic results Future and Spot prices					
Depending Variable	Weighting	Method	Eventday	CAR	P-values
Future prices	Positive	CMR	-1 0 +1	0.0027 0.0057 0.0002	0.0883* 0.0532* 0.9833**
Future prices	Negative	CMR	-1 0 +1	-0.0006 -0.0016 -0.0024	0.6847 0.4521 0.4402
Future prices	Positive	MM	-1 0 +1	0.0176 0.0355 0.0450	0.0768* 0.0681* 0.9554**
Future prices	Negative	MM	-1 0 +1	-0.0027 -0.0052 -0.0079	0.5874 0.5421 0.3482
Spot prices	Positive	CMR	-1 0 +1	0.0010 0.0022 -0.0008	0.3326 0.1365 0.7289
Spot prices	Negative	CMR	-1 0 +1	0.0034 0.0053 0.0089	0.1922 0.0786* 0.3840
Spot prices	Positive	MM	-1 0 +1	-0.0170 -0.0341 -0.0554	0.3094 0.1325 0.7021
Spot prices	Negative	MM	-1 0 +1	-0.0262 -0.0540 -0.0801	0.1950 0.0862* 0.3880

Table 3 shows all results for the basic analysis with an estimation window of 15 days, a gap of 35 days, and an event window of 3 days. The results cover the cumulative weighting for open interest and volume in the first panel. The second panel covers the results for prices (spot and future). Positive and negative means the rebalancing direction of the underlying commodities. The table shows the cumulative abnormal return (CAR) and the corresponding P-values for each day with the non-parametric test. The results show the real values, not percentage values. All results are rounded up to four decimal places. Significance level is *< 10%, ** < 5%, *** < 1%. The number of events N for all cases is 289 if the rebalancing for each commodity is one event. The results show significances for all settings in the first panel concerning the event day, including open interest for the day after the event for both settings. For the volume data, only the negative rebalancing the day before the event is shown. The results for the second-panel show significances for the future prices for the positive rebalancing for all days. For spot prices, the negative rebalancing shows low significances for the event day.

Our idea is to find impacts of financialization by covering the rebalancing process of commodity indices with three influencing factors—in particular volume, open interest, and the price (future and spot) of each commodity. Furthermore, this idea is based on proven index effects concerning major stock indices. Lynch and Mendenhall (1997) and Shleifer (1986), among others, can confirm an index effect for the S&P 500 as well as Steiner and Heinke (1997), Gerke et al. (2001), Elfakhani et al. (1998), and Karolyi (1996) for international indices. The general idea behind the compensation of a trading position in commodity markets is based on the concept of a consistent number of positions that have to be balanced. Positive rebalancing entails, therefore, an increase in financial-long positions, and negative rebalancing vice versa. Moreover, we would like to add that all financial positions can be non-financials, and combinations are also possible (Figure 1). Based on this idea, we draw three different possible modes of action, illustrated in Figure 1. In doing so, we can measure clear effects for volume and open interest data. The effect for volume data is also proven for the stock index studies described above. For the overall price effect, we think some traders may close their position for those rebalanced commodities contrary to both indices. It is also possible that the compensation of positions takes place between announcement and rebalancing day. This period of nearly six months is possibly long enough that no abnormal return is measurable. Besides, it is also possible that several effects overlap and make a clear result impossible. But we cannot support any effects concerning prices, as we find only weak evidence. Our results fit only for channels one and two but not for the third channel, as described in Figure 1, whereby we believe the link between futures and spot markets as proposed by Cheng and Xiong (2014) is interrupted. As Table 6 shows many rebalancing in different directions, we cannot say which effect is dominant.

Therefore, to avoid that negative and positive rebalancing in both indices cancel each other out, we now focus on rebalancing in the same direction for both indices. Table 4 shows the results for this setting. The results show significances for the event days for the positive and negative cases concerning the volume and open interest data. The day before the event is significant for the negative rebalancing concerning the volume data. For the open interest, we also measure significances for the day after the event. Whereas the height of the abnormal return is comparable to the case in Table 3, the significance level is due to the smaller dataset slightly lower. Nevertheless, with these results, we can confirm the basic results, and they fit the theory as well. The prices still show no clear significant results. Particularly, the direction of the abnormal return is now more in line with the theory, indicating that some of the uncertainties of the basic results are due to the aggregation of both indices. If rebalancing is in the opposite direction for both indices, index investors were forced to buy or sell a commodity depending on the commodity index they track. Hence, the net buying or selling pressure on the commodity future is unclear. Altogether we observe a clear abnormal return in case of volume and open interest, a weaker reaction for future returns, and nearly no reaction for prices.

Panel open interest and volume – Weighted in the same direction					
Depending Variable	Weighting	Method	Eventday	CAR	P-values
Volume	Positive	CMR	-1 0 +1	-0.0049 0.0538 0.0582	0.2794 0.0915* 0.2568
Volume	Negative	CMR	-1 0 +1	0.0441 0.1207 0.0717	0.0768* 0.0428** 0.8591
Open interest	Positive	CMR	-1 0 +1	0.0015 0.0058 0.0097	0.3283 0.0903* 0.0278**
Open interest	Negative	CMR	-1 0 +1	0.0004 0.0032 0.0079	0.4825 0.0791* 0.0134**
Panel prices – Weighted in the same direction Future and Spot prices					
Depending Variable	Weighting	Method	Eventday	CAR	P-values
Future prices	Positive	CMR	-1 0 +1	0.0037 0.0048 0.0022	0.0609* 0.1452 0.7636
Future prices	Negative	CMR	-1 0 +1	-0.0014 -0.0025 -0.0020	0.7733 0.3983 0.5766
Future prices	Positive	MM	-1 0 +1	0.0080 0.0134 0.0151	0.0609* 0.1452 0.7636
Future prices	Negative	MM	-1 0 +1	0.0027 0.0158 0.0106	0.7533 0.4596 0.5443
Spot prices	Positive	CMR	-1 0 +1	0.0039 0.0070 0.0015	0.0645* 0.0538* 0.9059*
Spot prices	Negative	CMR	-1 0 +1	-0.0022 -0.0011 -7.2256E-05	0.3910 0.1469 0.2088
Spot prices	Positive	MM	-1 0 +1	-0.0388 -0.0787 -0.1270	0.1654 0.2383 0.8895
Spot prices	Negative	MM	-1 0 +1	-0.0119 -0.0208 -0.0295	0.3542 0.1431 0.1800

Table 4 shows all results for the rebalancing in the same direction with an estimation window of 15 days, a gap of 35 days, and an event window of 3 days. Positive and negative means the rebalancing direction of the underlying commodities. The table shows the cumulative abnormal return (CAR) and the corresponding P-values for each day with the non-parametric test. The results show the real values, not percentage values. All results are rounded up to four decimal places. Significance level is *< 10%, ** < 5%, *** < 1%. The number of events N for all cases is 289 if the rebalancing for each commodity is one event. The results show significances concerning Vol and OI for the event days, which confirm the basic results. For the future and spot prices, only a few significances are measured. But the results for prices are not clear.

We are in line with the papers of Bohl et al. (2012), Brunetti et al. (2016), Harris and Buyuksahin (2009), Mutafoglu et al. (2012), and many others, which are not able to observe any impact on prices. Even if we use the non-cumulative effect and therefore test only rebalancing in the same direction, the results stay robust. Among others, Alquist and Gervais (2013), Buyuksahin and Harris (2011), and Sanders et al. (2004) find only small evidence concerning the financialization of commodity prices (spot and future). However, some studies find price effects concerning certain commodities or periods (Gilbert 2010b, 2010c; Mayer 2012; Robles et al. 2009). Because our approach cannot differentiate between commodities and periods, our results lean towards studies with a broader dataset in terms of commodities and periods. Here the majority of studies cannot reveal impacts on prices like described by Wimmer et al. (2020).

Like Henderson et al. (2014), who expected large issue volumes should be accompanied by large returns, we expect large rebalancing to coincide with large volume and open interest changes. Hence, Figure 6 shows the distribution of the relative changes of each underlying commodity (x-axis) and the abnormal return (CMR) on the event day (y-axis). For both results (volume and open interest), the trend line shows an increase from the third to the first quadrant. Therefore, it fulfills the expectation that traders have to adjust their positions by a larger amount if the rebalancing is larger and vice versa. Even with a winsorized data sample, the trend line remains constant.

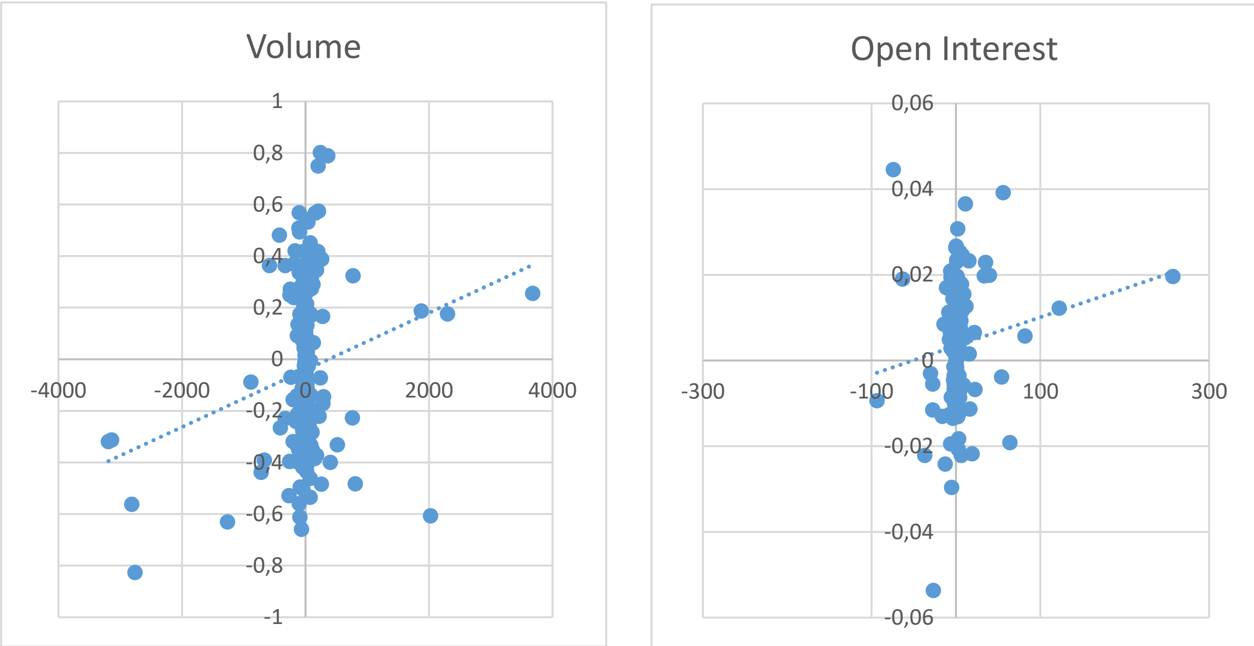

Figure 6: Scatter plot of the relative change of each underlying commodity related to the rebalancing along the x-axis and the abnormal return on the event day along the y-axis. The left picture is plotted for the volume dataset, and in the right figure, the same is plotted for the open interest data. In both cases, the trend line increases from the third to the first quadrant. With both results, the expectations are fulfilled.

We have an advantage over other studies like Mayer et al. (2017) with an unaggregated dataset. Therefore, the starting position is different from Henderson et al. (2014), but we cannot confirm the results. Besides all settings, a general point comes from critics concerning the methodology. Among others, Henderson Jr. (1990) discusses the issues and concludes that an event study produces reliable results even under less than perfect conditions despite problems with defining dates. Our main explanation for the different findings is related to various information processing. In the study of Henderson et al., the information is available to the market on the issuance day, thus complicating a comparison to ours in which the announcement of the rebalancing is known months before. This fact leads to three alternative explanations. First, the most straightforward reason is that there is simply no price effect because the amount of rebalancing is too small concerning the liquidity, or the prices are dominated by market fundamentals. In this case, there is no effect on the real economy, as discussed by Baur (2012). Second, if there is an effect, the market takes the new information into account between the announcement and the rebalancing day, or some trading is made OTC ("over the counter"). Third, the information might be available before the announcement date, or the rebalancing is endogenous. However, we can exclude endogeneity, which means that the indices are not an endogenous result. The rebalancing can be caused by economic influences based on the methodology. Therefore, less interest leads to less trading activity for each commodity. The changed trading activity (as well as price levels) is not the effect of the rebalancing but the effect of the former lower economic activity. Therefore, we make further analyses.

Further results and robustness tests

To consolidate the observed effects, we analyze further settings. First, we methodically adjust the event study settings (Figure 5) concerning the estimation and event window and the gap between both. The results are similar for the three groups (Vol, OI, and prices). With a growing event window and the increasing possibility of detecting more overlapping effects, the significant results decrease. That means no significances for price data and often only on a 10% level for OI and Vol, whose significances occur at much lower levels. Therefore, the only further effects detected are unknown. The decrease of significance can be seen for growing estimation windows as well as a bigger gap between both windows (estimation and event). The basic analysis isolates the effect well with its narrow setting around the event dates. For example, with too large settings, we detect the effects of the maturity of the front-month contract in the case of future prices.

Second, we use a normal t-test instead of the Corrado-rank-test. The results regarding the open interest and volume are very similar, but we find more significant results with mixed signs for the regression coefficients implying spurious statistics for the price data.

Third, we expand our analysis with a broader dataset for the BCOM from 2000 to 2021. Despite the longer timeline, the results for only one index stay mainly the same and therefore support our basic results with both indices.

Fourth, we test our results by shifting the event day from January to May to isolate unusual trading behavior. By doing so, we consider that a cyclicality in volume and open interest data can automatically force a significant result. But the results for the shifted days are different. We have no significant results for all three settings. These results confirm the unusual behavior of trading at the beginning of January.

Fifth, we also test the different commodity classes of each index separately. A problem with all subsamples is the decreasing number of commodities. Each group includes a small number for each test. The only subsample with enough commodities is agricultural commodities. The result for this subsample strengthens our basic results because it shows quite similar results concerning significances.

Sixth we analyze the results concerning a possible January-Effect by fitting a dummy variable into the market model for spot and future price settings. But we cannot detect changes in the results which would confirm such an effect.

But importantly, we analyze the announcement days of the rebalancing for each commodity index as event days. The period covers the years 2006 to 2021. The days for each year vary widely for the BCOM between July and November. For the S&P GSCI, they stay nearly the same over the years at the beginning of November. The results for this setting show no significances for volume and open interest, which can be based on many reasons. Among others, the market might react to one announcement because of the difference between both indices.

Furthermore, the new weightings become effective at the beginning of January, independent of the announcement day. Therefore, the market and its participants have time to implement the new information, and the new weightings are at the least calculated with public data and methodology. That means that although the announcement takes place on a certain day, the announced information is not new for the market. The results for the price data show no significances and hence fit our theory. Therefore, the following table sums up all settings and the following results:

Overview further results						
Title	Change	Result			Comment	Fitting to theory
		Vol	OI	Price		
Variation of event study settings[1]	Vary estimation-window	XXX	XXX	O	No further effects concerning basic results are detected.	Yes
	Vary gap	XXX	XX	O		Yes
	Vary event-window	XX	XX	O		Yes
Parametric test (t-test)	All settings tested with the t-test	XXX	XXX	XXX	Vol and OI results confirm basic results. Prices due to a lot of significances and wrong signs are unclear.	Yes
Longer timeline for BCOM	Timeline from 2000-2021	XXX	XX	O	Confirmation of the results; effects in the early years equal or weaker.	Yes
Theoretical Different Rebalancing Months May	Rebalancing dates shifted in a different month, but the same trading day	O	O	O	Other results for the days in May. Therefore clear evidence for unusual behavior in January.	Yes
Different commodity classes	Subgroup agricultural commodities	XX	X	O	No further effects, we confirm the basic results	Yes
Conspicuous trading behavior related to a January-Effect	Dummy for the market model concerning trading in January	-	-	O	The results stay constant. No results possible for Vol and OI because the dummy is only used in the market model.	Yes
Announcement days	Event days shifted to the announcement days of the indices	O	O	O	No effect concerning announcements.	Yes

Table 5: Shows an overview of the further results. It includes the kind of setting as well as different settings for the event study, the results, and the fitting to the theory of our study.[1] The estimation window has the values 25/15. The gap has the values 59/30/0, and the event window has the values 11/9/7/5. The significance level of the results represented by X< 10%, XX < 5%, XXX < 1% and O for else. The classification includes the event day and within each day the setting with the highest significance. The values are measured in the trading days for all settings. The different settings of the event study are based on different earlier mentioned studies. For all our further settings, we obtain consistent or similar results as described earlier, as well as a good fit for the theory.

Summarizing the results concerning an index effect, we can establish a direct effect for open interest and volume data, as Table 3 shows. In these cases, we can prove an effect for the event day itself and, in some cases, one day before or after the event. Our further results confirm the robustness with various settings, as Table 4 shows. However, in line with the interpretation above, we cannot observe an abnormal return in prices on the announcement day nor on the rebalancing date. In addition to cyclicality or recurring trading behavior, the study of Bessembinder et al. (2016) looked for trading around predictable dates and the influence on market liquidity. The case with the rolling of a large ETF and the dependent adjustment of positions is similar to the rolling period of commodity indices. The results of Bessembinder et al. that traders supply liquidity is in line with our results of a growing trading volume around the rebalancing dates of the commodity indices and, therefore, the significant results. The effects in our results are persistent even if we account for the cyclicality in volume and open interest of different commodities throughout the year. Additional to unique commodity characteristics, the rebalancing takes place in January. We also accounted for and contributed indirectly to the existence of cyclicality and turn of the year effect reported by Milonas (1991). To analyze the problem with a low level of trading around the turn of the year in more detail, we look as well at the index construction. These indices are based on average data over a period of time (normally five years) whereby for all commodities except agricultural commodities, a kind of "pork cycle" can be possible. This would imply that the increased weighting coincides with a low level in the last five years and vice versa. However, production data is only one of the multiple decisive factors for the indices. Besides, each commodity of the indices has a different affiliation in terms of production. Metal commodities, for example, which have no special harvest rhythm, can be mined over the whole year and follow a five-year cycle (Lutzenberger et al., 2017). In contrast, the harvest rhythm of agricultural commodities depends on the cultivation region, and finally, energy commodities are subject to market demand related to the time of year; for example, because in winter, demand for heating oil is higher. Last, the opposing rebalancing behavior shows that economic activity is a clear-cut determinant of the rebalancing, and therefore, of the changed volume on the rebalancing days. Consequently, we remain with the two preceding explanations for our findings that either there is no price effect or the price effect is not directly observable because the price change occurs slowly between the announcement day and the rebalancing day. A supporting document to this work shows all further results in detail.

6. Conclusion

To conclude this study, we examine the rebalancing effects of commodity indices on the underlying commodities using open interest, volume and price (future and spot) data. Based on existing literature in the area of financialization and changes in stock indices, we try to measure an index effect with the help of the rebalancing direction. We use an event study with 135 positive and 157 negative changes for the BCOM and 152 positives and 148 negative rebalancing positions for the S&P GSCI. The analyzed period covers the beginning of 2006 to the end of 2021 for both indices.

We can confirm regarding our open interest and volume data an index effect concerning the rebalancing date for both indices with abnormal returns for volume data up to 14.1% and open interest up to 1.69% (Table 3). Furthermore, concerning price data, we cannot confirm any index effect. The reason why we observe no or nearly no price effect is either due to an early adoption strategy of market participants or due to the dominance of market fundamentals in connection with liquid markets. Analysis with all kinds of clustering concerning the type of rebalancing, size of rebalancing, commodity groups, and different periods show no significant effect on the prices. On the other hand, the significant results regarding the trading volume and open interest are robust concerning changes in the commodity subsets of both inspected indices. Therefore, we firmly believe that, according to the theory presented, the non-commercial traders are forced to trade in case of rebalancing. The commercial and non-commercial traders with the opposite position respond to these forced trades leading to higher volume and open interest, which we can observe as an effect of financialization in the commodity market only for volume and open interest. For prices, we can conclude that the forced trades do not affect the market equilibrium, especially on the rebalancing day. We find that rebalancing does not affect the real economy, rejecting the idea of an index effect concerning prices.

Finally, the first approach concerning commodity indices leads to significant results for open interest and volume data. Nearly no effect is observable concerning prices, so we foster the literature stream with no effects. However, we can also observe precise volume and open interest effects. Following the benchmark indices results, the analysis of other indices or more accurate data relating to commercial and non – commercial traders to validate the results is necessary. Therefore, further research on the indices and the measured values has to be done.

7. Data Availability Statement

The data that support the findings of this study are available from Bloomberg (2022) and S&P (2022) for the index data as well as Thomson Reuters DataStream (2022) and Barchart (2022) for the future markets data (future prices, spot prices, volume data, and open interest data). Restrictions apply to the availability of the datasets, which were used under license for this study.

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Appendix

Commodities		Aluminum	Brent	Coffee	Copper	Corn	Cotton	Gasoline	Gold	Heating Oil	Kansas Wheat	Lean Hogs	Live Cattle	Natural Gas	Nickel	Silver	Soybeans	Sugar	Wheat	WTI	Zinc
2006/2007	S&P	-1.02%	-0.39%	-0.12%	-1.97%	1.40%	0.04%	-0.15%	0.08%	-0.45%	0.26%	0.15%	0.13%	-0.34%	0.38%	-0.09%	0.75%	-0.53%	1.09%	1.50%	-1.00%
	BCOM	-0.05%		0.09%	0.31%	-0.25%	-0.02%	0.00%	0.61%	-0.06%		-1.34%	0.05%	0.23%	0.06%	0.29%	-0.02%	0.15%	-0.06%	-0.06%	0.10%
2007/2008	S&P	-0.52%	-1.01%	-0.04%	-1.04%	0.57%	-0.05%	2.76%	0.01%	-0.70%	-0.32%	-0.23%	-0.33%	-0.19%	-0.76%	-0.02%	0.31%	0.10%	0.22%	2.14%	-0.52%
	BCOM	0.30%		-0.02%	0.85%	0.04%	-0.67%	-0.27%	0.57%	0.03%		-0.47%	-1.25%	-0.31%	0.08%	0.43%	-0.12%	0.06%	-0.01%	0.43%	0.23%
2008/2009	S&P	-0.08%	-0.83%	0.20%	0.34%	0.27%	0.26%	0.50%	1.07%	-0.88%	-0.11%	0.39%	0.76%	-2.05%	0.03%	0.11%	0.54%	1.14%	0.07%	-1.65%	0.15%
	BCOM	-0.11%		-0.03%	0.27%	0.06%	-0.21%	-0.07%	0.47%	-0.17%		-0.15%	-0.60%	-0.35%	0.09%	0.17%	-0.03%	-0.19%	0.09%	0.60%	0.11%
2009/2010	S&P	0.18%	1.36%	0.02%	0.59%	-0.36%	0.30%	-0.21%	-0.07%	0.22%	-0.15%	0.03%	-0.28%	-0.99%	0.15%	0.03%	-0.42%	-0.01%	-0.57%	-0.85%	0.04%
	BCOM	-1.25%		-0.41%	0.33%	1.37%	-0.27%	-0.18%	1.25%	-0.07%		-0.30%	-0.73%	-0.34%	-0.52%	0.40%	0.31%	-0.10%	-0.09%	0.59%	-0.12%
2010/2011	S&P	-0.18%	1.94%	0.18%	-0.23%	1.05%	0.27%	0.38%	-0.06%	0.55%	0.13%	-0.05%	-0.13%	-1.10%	-0.15%	0.16%	0.07%	-0.07%	-0.19%	-3.52%	-0.12%
	BCOM	-0.55%		-0.21%	-0.10%	-0.11%	0.00%	-0.03%	1.33%	-0.01%		-0.10%	-0.19%	-0.33%	-0.12%	0.00%	-0.06%	0.43%	-0.10%	0.37%	-0.17%
2011/2012	S&P	-0.29%	1.96%	-0.28%	-0.23%	0.32%	-0.61%	0.24%	0.12%	0.06%	0.14%	-0.04%	0.23%	-0.78%	-0.13%	-0.05%	0.37%	-0.40%	0.18%	-1.92%	-0.04%
	BCOM	0.67%	5.31%	0.22%	-0.48%	-0.31%	0.00%	-0.09%	-0.66%	-0.12%		0.11%	0.28%	-0.45%	0.33%	-0.52%	-0.77%	0.43%	0.36%	-5.02%	0.27%
2012/2013	S&P	-0.12%	3.84%	-0.20%	-0.15%	-0.79%	0.04%	0.91%	-0.47%	1.09%	-0.24%	0.16%	0.03%	0.65%	-0.07%	-0.11%	-0.15%	-0.33%	-0.07%	-4.47%	-0.01%
	BCOM	-0.96%	0.48%	-0.13%	0.21%	0.38%	-0.23%	0.06%	1.02%	0.06%	1.32%	-0.21%	-0.35%	-0.34%	-0.34%	1.13%	-1.59%	0.13%	-1.53%	-0.48%	-0.60%
2013/2014	S&P	-0.02%	1.27%	0.13%	-0.05%	-0.81%	-0.01%	-0.10%	-0.22%	-0.23%	0.01%	0.43%	0.33%	0.41%	0.05%	-0.05%	0.01%	-0.02%	-0.32%	-0.85%	0.06%
	BCOM	-0.19%	0.72%	-0.12%	0.23%	0.14%	-0.19%	0.16%	0.71%	0.20%	-0.11%	-0.03%	-0.01%	-0.98%	-0.19%	0.24%	0.19%	0.07%	-0.09%	-0.72%	-0.21%
2014/2015	S&P	2.92%	-14.76%	0.95%	7.67%	3.22%	-0.10%	-3.51%	6.79%	-3.78%	0.05%	-0.62%	-0.69%	5.67%	1.73%	2.41%	8.34%	0.88%	-0.09%	-14.17%	1.73%
	BCOM	-0.13%	0.65%	-0.11%	0.03%	0.05%	-0.07%	0.08%	0.37%	0.04%	-0.04%	0.07%	0.06%	-0.71%	0.07%	0.13%	0.00%	0.04%	-0.01%	-0.65%	0.09%
2015/2016	S&P	-1.98%	11.71%	-0.67%	-6.87%	-2.26%	0.24%	2.94%	-5.91%	2.95%	0.12%	0.85%	2.36%	-5.49%	-1.57%	-2.33%	-8.04%	-0.70%	0.70%	12.01%	-1.42%
	BCOM	0.01%	0.37%	0.08%	0.09%	0.11%	-0.02%	0.06%	-0.52%	-0.17%	-0.02%	0.12%	0.24%	-0.29%	0.24%	-0.06%	0.02%	-0.37%	0.00%	-0.37%	0.12%
2016/2017	S&P	0.37%	-3.94%	0.09%	0.21%	1.26%	0.35%	-0.91%	1.14%	-1.15%	0.21%	0.36%	0.30%	0.08%	-0.04%	0.14%	0.84%	0.87%	0.37%	-0.24%	0.12%
	BCOM	-0.03%	0.29%	0.08%	-0.04%	0.05%	-0.05%	0.02%	-0.21%	0.00%	0.03%	0.03%	0.41%	-0.47%	0.18%	-0.10%	0.13%	-0.23%	-0.01%	-0.29%	0.16%
2017/2018	S&P	0.38%	0.40%	-0.02%	0.37%	-0.51%	0.05%	-0.09%	-0.18%	-0.18%	0.03%	-0.44%	-1.02%	0.58%	0.03%	-0.03%	-0.13%	0.02%	-0.87%	1.90%	0.30%
	BCOM	-0.06%	-0.14%	0.23%	-0.43%	-1.28%	0.01%	-0.01%	0.77%	-0.16%	0.12%	-0.02%	0.33%	0.04%	0.22%	-0.44%	0.12%	0.14%	-0.06%	0.14%	0.41%
2018/2019	S&P	0.26%	1.72%	-0.29%	0.02%	-0.62%	-0.19%	-0.10%	-0.48%	0.57%	0.03%	-0.31%	-0.58%	-0.79%	0.08%	-0.10%	-0.52%	-0.94%	-0.26%	1.72%	-0.02%
	BCOM	-0.10%	-0.34%	-0.13%	0.16%	-0.24%	-0.03%	-1.46%	0.30%	-1.51%	-0.01%	-0.23%	-0.22%	0.25%	-0.05%	0.21%	0.07%	-0.39%	-0.12%	0.34%	0.11%
2019/2020	S&P	-0.20%	-0.20%	-0.07%	-0.09%	0.54%	-0.15%	0.05%	0.36%	-0.18%	0.11%	0.15%	0.42%	0.13%	0.04%	0.00%	-0.04%	-0.02%	0.08%	-1.11%	-0.16%
	BCOM	-0.09%	-0.33%	0.23%	-0.36%	-0.06%	0.07%	-0.04%	1.38%	-0.05%	0.19%	-0.07%	-0.07%	-0.30%	0.04%	-0.11%	-0.39%	-0.14%	-0.10%	0.33%	0.22%
2020/2021	S&P	0.33%	-2.31%	0.18%	0.61%	0.85%	0.01%	-0.83%	2.19%	-0.19%	0.23%	0.08%	0.56%	-0.44%	0.23%	0.18%	0.86%	0.28%	0.89%	-3.53%	0.01%
	BCOM	-0.12%	-0.15%	0.02%	-1.57%	-0.25%	0.02%	-0.08%	1.02%	-0.03%	0.09%	-0.05%	-0.17%	0.11%	-0.04%	0.58%	0.18%	-0.02%	-0.16%	0.15%	-0.18%

Table 6: Weighting behavior of S&P GSCI and BCOM 2006–2021

Table 6 shows the changes concerning the weightings of the underlying commodities—only for commodities, which are part of both indices—over the period 2006-2021 for BCOM and S&P GSCI. Green spaces mean a growing proportion for the commodity in the following year. Red spaces mean a decreasing proportion for the next year. White spaces mean that the commodity is not part of the index in the related year. The yellow spaces mean that the weighting is not changed for the following year. In each space, the size of the rebalancing is shown.

Commodities	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
	Differences between BCOM and S&P GSCI														
Aluminum	-1.07%	-0.22%	-0.19%	-1.07%	-0.73%	0.38%	-1.08%	-0.21%	2.79%	-1.97%	0.38%	0.34%	0.35%	0.32%	0.20%
Brent						7.27%	4.32%	1.99%	-14.11%	12.08%	-3.57%	-3.65%	0.69%	0.26%	1.58%
Coffee	-0.03%	-0.06%	0.17%	-0.39%	-0.03%	-0.06%	-0.33%	0.01%	0.84%	-0.59%	0.17%	0.18%	0.07%	0.21%	-0.06%
Copper	-1.66%	-0.19%	0.61%	0.92%	-0.33%	-0.71%	0.06%	0.18%	7.70%	-6.78%	0.30%	0.17%	0.33%	-0.06%	-0.41%
Corn	1.15%	0.61%	0.33%	1.01%	0.94%	0.01%	-0.41%	-0.67%	3.27%	-2.15%	1.37%	1.31%	-0.46%	-1.79%	-1.89%
Cotton	0.02%	-0.72%	0.05%	0.03%	0.27%	-0.61%	-0.19%	-0.20%	-0.17%	0.22%	0.33%	0.30%	0.01%	0.06%	-0.18%
Gasoline	-0.15%	2.49%	0.43%	-0.39%	0.35%	0.15%	0.97%	0.06%	-3.43%	3.00%	-0.85%	-0.89%	-0.07%	-0.10%	-0.11%
Gold	0.69%	0.58%	1.54%	1.18%	1.27%	-0.54%	0.55%	0.49%	7.16%	-6.43%	0.62%	0.93%	-0.39%	0.59%	0.29%
Heating Oil	-0.51%	-0.67%	-1.05%	0.15%	0.54%	-0.06%	1.15%	-0.03%	-3.74%	2.78%	-1.32%	-1.15%	-0.18%	-0.35%	0.41%
Kansas Wheat							1.08%	-0.10%	0.01%	0.10%	0.19%	0.24%	0.06%	0.15%	0.15%
Lean Hogs	-1.19%	-0.70%	0.24%	-0.27%	-0.15%	0.07%	-0.05%	0.40%	-0.55%	0.97%	0.48%	0.39%	-0.41%	-0.46%	-0.33%
Live Cattle	0.18%	-1.58%	0.16%	-1.01%	-0.32%	0.51%	-0.32%	0.32%	-0.63%	2.60%	0.54%	0.71%	-0.61%	-0.68%	-0.25%
Natural Gas	-0.11%	-0.50%	-2.40%	-1.33%	-1.43%	-1.23%	0.31%	-0.57%	4.96%	-5.78%	-0.21%	-0.39%	0.11%	0.62%	-0.75%
Nickel	0.44%	-0.68%	0.12%	-0.37%	-0.27%	0.20%	-0.41%	-0.14%	1.80%	-1.33%	0.20%	0.14%	0.21%	0.25%	0.30%
Silver	0.20%	0.41%	0.28%	0.43%	0.16%	-0.57%	1.02%	0.19%	2.54%	-2.39%	0.08%	0.04%	-0.13%	-0.47%	-0.54%
Soybeans	0.73%	0.19%	0.51%	-0.11%	0.01%	-0.40%	-1.74%	0.20%	8.34%	-8.02%	0.86%	0.97%	0.01%	-0.01%	-0.40%
Sugar	-0.38%	0.16%	0.95%	-0.11%	0.36%	0.03%	-0.20%	0.05%	0.92%	-1.07%	0.50%	0.64%	-0.21%	0.16%	-0.81%
Wheat	1.03%	0.21%	0.16%	-0.66%	-0.29%	0.54%	-1.60%	-0.41%	-0.10%	0.70%	0.37%	0.36%	-0.88%	-0.93%	-0.32%
WTI	1.44%	2.57%	-1.05%	-0.26%	-3.15%	-6.94%	-4.95%	-1.57%	-14.82%	11.64%	-0.61%	-0.53%	1.61%	2.04%	1.86%
Zinc	-0.90%	-0.29%	0.26%	-0.08%	-0.29%	0.23%	-0.61%	-0.15%	1.82%	-1.30%	0.24%	0.28%	0.47%	0.71%	0.39%

Table 7: Cumulative weighting behavior for BCOM and S&P GSCI between 2006 - 2021

Table 7 shows the cumulative changes concerning the underlying commodities' weightings – only for commodities, which are part of both indices – between 2006 and 2021 for BCOM and S&P GSCI. Green spaces mean a growing proportion for the commodity in the following year. Red spaces mean a decreasing proportion for the next year. Grey spaces mean that the commodity is not part of the index in the related year.