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# Characteristics of Japan's Commodities Index and its Correlation with Stock Index<sup>\*</sup>

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## Abstract

The commodity indexes associated with Japan's commodity-futures markets were formed in 2008 and publicized by the Tokyo Commodity Exchange and the Tokyo Grain Exchange. In this paper, I used these indexes to analyze the properties of Japan's commodity futures as portfolio investments, and could confirm that they possess investment characteristics that differ from stocks, and that commodity investors can enjoy favorable "diversified investment" effects if leveraged skillfully.

## 1. Introduction

In Europe and the U.S., private financial institutions and other organizations publish their own commodity indexes, which have been used in the real world as well as for research purposes. Some of these include the Goldman Sachs Commodity Index (GSCI), Dow Jones AIG Commodity Index (DJ-AIGCI), Deutsche Bank Liquid Commodity Index, Rogers International Commodity Index, Standard & Poor's Commodity Index, and the Reuters Commodity Research Bureau Index.

Conversely, in Japan there is little interest in commodity markets, and the notion of using a commodity index in terms of portfolio investment decision has never taken hold. The result has been a lack of popularity for commodity indexes on Japan's commodity-future markets, in sharp contrast to its stock markets, which have been using indexes for decades.<sup>1</sup> Nevertheless, the Tokyo

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<sup>\*</sup> In this paper, I owe a lot to the discussion at the Commodity Exchange Issue Research Conference held by the Japan Federation of Commodity Exchanges. Furthermore, this research receives the Science Research Grant-in-Aid (Challenging Exploratory Research).

<sup>1</sup> One exception is the commodity index published by the *Nikkei Shimbun*. This index covers not only commodities listed on the commodity futures markets, but a wider range of commodities.

Commodity Exchange and the Tokyo Grain Exchange started publishing their own commodity indexes in 2008.

In this paper I will introduce these indexes and analyze their co-movement with stock indexes in an effort to confirm the properties of commodity investments as an alternative investment vehicle.

## 2. The Tokyo Commodity Exchange's TOCOM Commodity Index<sup>2</sup>

### (1) Overview of the TOCOM Commodity Index (TOCOM\_INDEX)

The TOCOM Commodity Index is calculated based on the prices of all commodities based on the precious-metals, aluminum, crude-oil, and rubber markets listed on the Tokyo Commodity Exchange. It comprehensively shows the price level for all the markets of the Tokyo Commodity Exchange, and since June 2008 it has calculated all figures retroactively to May 31, 1986.

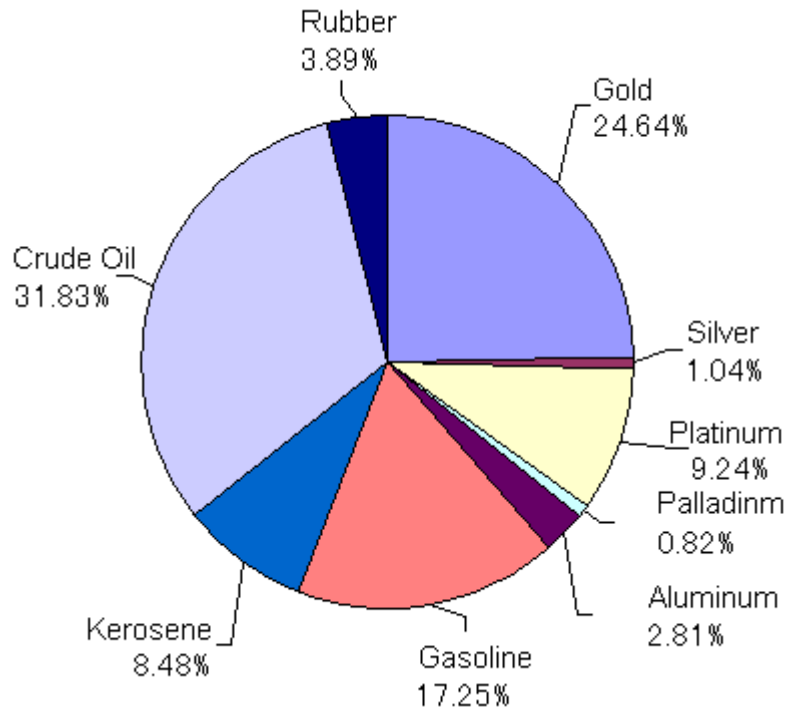
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<sup>2</sup> Based on the Tokyo Commodity Exchange for Industry website: [http://www.tocom.or.jp/jp/souba/tocom\\_index/index.html](http://www.tocom.or.jp/jp/souba/tocom_index/index.html)

The TOCOM\_INDEX changed its name on April 1, 2009, to the Nikkei-TOCOM Commodity Index. The period covered by the data used in this paper, however, is still under the old name.

Figure 1

Weight percentage (June 2009 to May 2010)



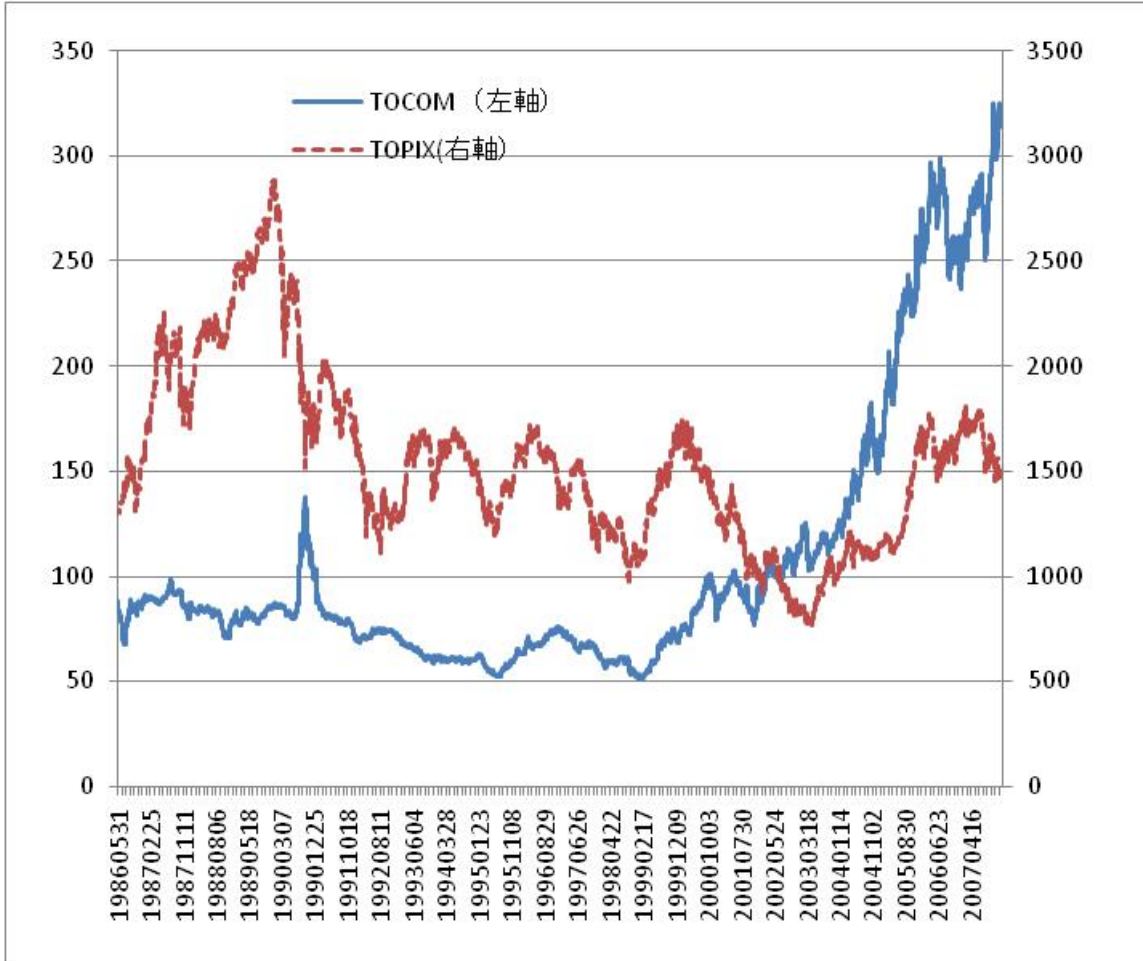
(2) Transition of the TOCOM\_INDEX and TOPIX

Previous research has indicated that commodity markets and stock markets do not demonstrate co-movement. Let's compare the TOCOM\_INDEX to a stock index (the Tokyo Stock Exchange's TOPIX).

The analysis covered the time period between May 31, 1986 and December 28, 2007, using 5,376 daily data published in the commodity index. First, the transition of the TOCOM\_INDEX and TOPIX is presented in Figure 2. We can see that the TOPIX (i.e., stock price) fluctuates far more than the TOCOM\_INDEX (i.e., commodity price).

Figure 1

Comparison of TOPIX and TOCOM\_INDEX



(3) Distribution of daily return of the TOCOM\_INDEX and TOPIX

In this paper, the daily return is defined as the difference between the natural logarithms of the indexes. With the index day  $t$  as  $X_t$  and index  $t-1$  day as  $X_{t-1}$ , the daily return of day  $t$  is  $\log(X_t)-\log(X_{t-1})$ .

The distribution is shown in Figure 3. The portion for TOCOM\_INDEX greater than 0 and 0.01 or less is the highest and, compared to TOPIX, the distribution is centered.

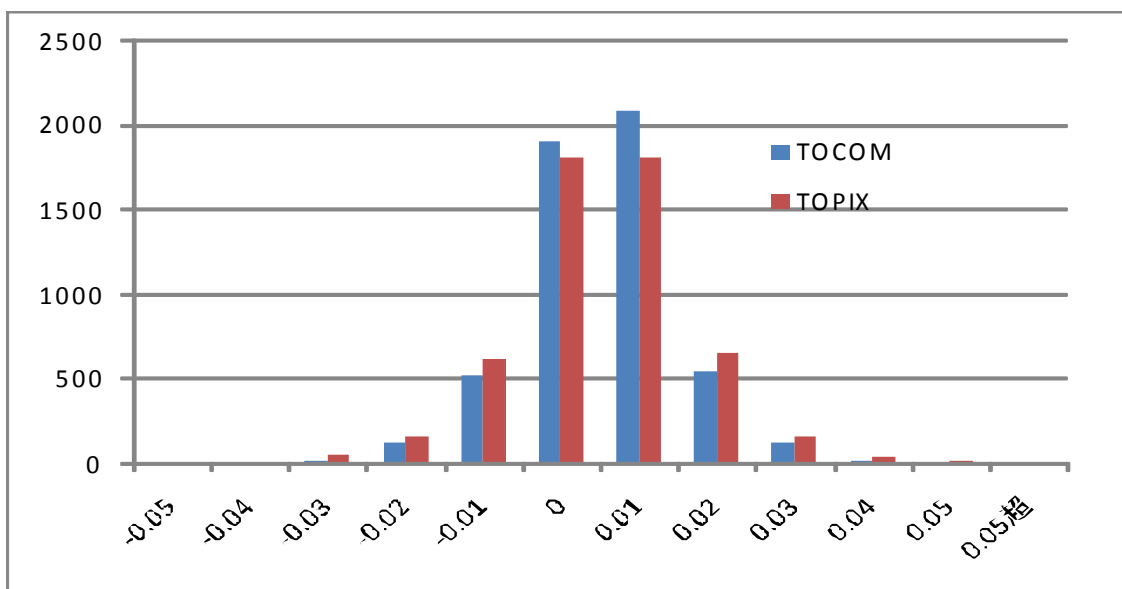
To confirm this point, I checked the basic statistical quantities; the results are as shown in Table 1. This reveals that the average value and median of TOCOM are larger than those of TOPIX; the standard deviation of TOPIX, however, is larger. In short, stocks have a lower return and larger volatility.

Since skewness is a measure that shows the extent to which the data is not distributed symmetrically around the average, it is zero for a normal distribution. Because both are negative values, it shows that both distributions are slanted to the right. But the degree is striking for TOPIX. In other words, very unfavorable circumstances are bound to happen with stocks.

Since kurtosis is a measure that shows the extent to which the data is collected around the average, a value higher than 3 would result in a distribution with fatter tails than a normal distribution. The TOPIX has a distribution with a fatter tail than the TOCOM\_INDEX.

**Figure 3**

Daily return distribution of the TOCOM\_INDEX and TOPIX



**Table 1**

Basic statistical quantity of the TOCOM\_INDEX and TOPIX daily returns

	TOCOM	TOPIX
Average	0.000245	0.000023
Median	0.000445	0.000068
Maximum	0.082186	0.091158
Minimum	-0.089858	-0.158102
Standard deviation	0.010227	0.012397
Skewness	-0.046834	-0.293312
Kurtosis	8.356623	11.51472
Number of samples	5375	5375

\*Covering a period from May 31, 1986 to December 28, 2007

## (4) Correlation between the daily returns of TOCOM\_INDEX and TOPIX

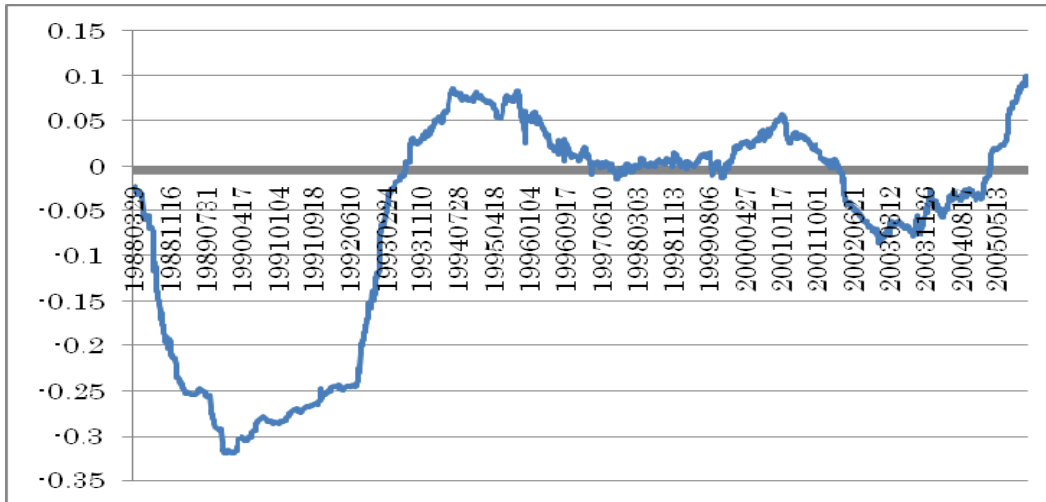
The correlation between the two indexes is crucial for the portfolio investment decision. A calculation of the correlation coefficient gives -0.0327, a negative correlation. Therefore, when commodities rise, stocks fall. Although this correlation is statistically significant, it is not that strong. The correlation coefficient may fluctuate depending on the sample period. I calculated the correlation coefficient for a period of 500 days before and after a certain day (for a total of 1001 days), that is, for the period from  $day_{t-500}$  to  $day_{t+500}$ . Then, I conducted the same for the next day.

The results (Figure 4) reveal that around 1993 the correlation coefficient drastically changed from minus to plus. Then, after a period during which it stayed close to positive 0.1, we see that from 1997 to 2000 there was almost no correlation. The correlation between 2002 and 2004 was negative; after 2005, it was positive.

In light of this, perhaps it is more appropriate to consider not a negative correlation but a weak correlation. Therefore, the important fact for the portfolio diversification is that commodity does not have a strong positive correlation with the stock market.

Figure 4

Transition of recursive correlation coefficients of the TOPIX and TOCOM\_INDEX



(5) Return of the TOCOM\_INDEX on a day of significant decline of the TOPIX

When looking to hedge downside risk, it is important to know how the prices of commodities fluctuate in times of great drops in stock prices. Therefore, I checked the TOCOM\_INDEX fluctuation on days when stocks fell considerably.

The most significant drop during the period of analysis is on October 20, 1987. The TOPIX fell close to 16% on that day, but the return of the TOCOM\_INDEX was positive. Of the five worst TOPIX decline days shown in Table 2, only on one day did the TOCOM\_INDEX also decline. On all of the three worst days, a positive return was recorded. This means that, compared to a portfolio with only stocks, having commodities in the portfolio softens the blows of great declines in those markets.

Conversely, the behavior of the TOPIX on days of great TOCOM\_INDEX declines is shown in Table 3. The most significant rate of decline was 9% on January 1, 1991. This period was marked by confusing information concerning the Gulf War, which caused stock prices to rise. Actually, on all five of TOCOM's worst days, the TOPIX was up.



**Table 2**

TOCOM\_INDEX return on worst five TOPIX days

	Closing price		Return	
	TOCOM	TOPIX	TOCOM	TOPIX
19871020	93.32	1793.90	0.00580	-0.15810
19900402	85.64	2069.33	0.00410	-0.07365
20010912	92.00	990.80	0.02811	-0.06574
20000417	72.02	1552.46	-0.01297	-0.06317
19900823	117.93	1829.25	0.04474	-0.05869

**Table 3**

TOPIX return on worst five TOCOM\_INDEX days

	Closing price		Return	
	TOCOM	TOPIX	TOCOM	TOPIX
19910118	88.28	1736.74	-0.08986	0.01427
19910117	96.58	1712.13	-0.07113	0.03844
19900828	111.86	1947.51	-0.06682	0.02228
19901022	115.75	1858.30	-0.05709	0.02287
19901203	105.65	1671.22	-0.05649	0.01156

## (6) Correlation between the stock price of individual companies and the TOCOM\_INDEX

Instead of trading directly by commodity futures, could one trade the stock of related companies to produce the same effect?

In an effort to find the correlation with TOCOM\_INDEX returns, I calculated the individual earnings ratio of stocks listed on the first section of the TSE that were traded on all the trading days between January 6, 1997 and December 28, 2007. I excluded those companies whose stock prices were discontinuous due to IPOs or mergers, as well as stocks not traded every day. Using this sample-selection rule resulted in 578 sample company stock prices to compare with the TOCOM\_INDEX in hopes of finding a correlation. Because there are those with correlation coefficients large and small, I listed the top ten companies in Table 4. The company with the largest correlation coefficient was Kanto Natural Gas Development Co., Ltd., an entity mainly engaged in the development and extraction of natural gas dissolved in water in Chiba Prefecture. As I predicted, the companies with the strongest correlation with the TOCOM\_INDEX are Cosmo Oil, Nippon Oil Corporation and Showa Shell Oil—all petroleum distributors. On the other hand, low correlations were seen with food companies, which all had negative correlation coefficients.

**Table 4**

Correlation between the TOCOM\_INDEX and individual company stocks

	Companies with little correlation		Companies with significant correlation	
1	-0.0531	Gunze	0.1282	Kanto Natural Gas
2	-0.0510	Morinaga Milk	0.1032	Cosmo Oil
3	-0.0477	Prima Meat	0.1029	Nippon Oil
4	-0.0403	Miyoshi Oil & Fat	0.0894	Showa Shell
5	-0.0355	Taiyo Ink	0.0850	Mitsui & Co.
6	-0.0349	Takara Holdings	0.0818	Olympus
7	-0.0328	Yamazaki Baking	0.0816	Mitsubishi Corporation
8	-0.0322	Mercian	0.0633	Hitachi Construction
9	-0.0315	Nisshinbo	0.0630	SMC
10	-0.0301	Nippon Valqua	0.0613	Yamaha Motor

\*Correlation coefficients from January 6, 1997 to December 28, 2007.

### 3. The Tokyo Grain Exchange's TG Index

#### (1) Overview of the Tokyo Grain Exchange's TG Index

The Tokyo Grain Exchange started publicizing its TG Index on June 16, 2008, in order to present fluctuations in domestic grain prices and serve as a benchmark for investments in grain. There are ten component commodities of the TG Index: eight listed commodities, such as corn and soybean, and two commodities, rice and wheat, whose listing is under consideration. Their weights are determined based on the domestic demand for grain, and yen-denominated futures prices are used as reference prices.

#### (2) Comparing the TG Index to the TOCOM\_INDEX and TOPIX

The Tokyo Grain Exchange has been compiling and publicizing the TG Index since March 31, 2003. Table 5 shows the correlation between the TG Index, TOCOM\_INDEX and the TOPIX from April 1, 2003 to December 28, 2007.

The correlation between the TG Index and the TOCOM\_INDEX is relatively high at 0.367. The correlation between the TG Index and the TOPIX is 0.148, which is higher than that between the TOCOM\_INDEX and the TOPIX. This shows that grain prices have a much stronger correlation

with industrial products, which are also traded in commodities markets, than with stock prices.

**Table 5**

Correlation between the returns of the TG Index, TOCOM\_INDEX and TOPIX

	TOCOM	TOPIX
TG Index	0.367	0.148
TOCOM		0.066

\*Correlation coefficients for April 1, 2003 to December 28, 2007.

(3) The TG Index when stocks plunge

Table 6 shows the TG Index and TOCOM\_INDEX on the largest decline days of the TOPIX between April 1, 2003 and December 28, 2007. On the worst stock-price day, May 10, 2004, the TG Index rose along with the TOCOM\_INDEX.

Table 7 shows the TG Index and TOPIX on the largest decline days of the TOCOM\_INDEX. There is a high correlation between the TOCOM and the TG Index, and when the TOCOM suffers great declines, the TG also goes down.

**Table 6**

TG Index and TOCOM\_INDEX during great declines of the TOPIX

	TG	TOCOM	TOPIX
20040510	0.0029	0.0066	-0.0254
20070817	-0.0156	-0.0160	-0.0248
20031023	0.0098	0.0031	-0.0236
20050418	-0.0050	-0.0095	-0.0158
20060118	-0.0046	0.0044	-0.0154

**Table 7**

TG Index and TOPIX during great declines of the TOCOM\_INDEX

	TG	TOCOM	TOPIX
20061004	-0.0024	-0.0164	-0.0043
20070817	-0.0156	-0.0160	-0.0248
20071112	-0.0099	-0.0160	-0.0112
20051216	-0.0095	-0.0148	-0.0008
20070305	-0.0115	-0.0143	-0.0151

#### (4) Comparison of the TG Index with stock prices of grain companies

I calculated the correlation between the TG Index and stocks of companies that are listed on the TSE in agricultural, fisheries, forestry, and food industry and whose stock prices are available on all trading days between April 1, 2003 and December 28, 2007. The results are shown in Table 8. Although the stocks of these industries are expected to have a relatively high correlation with the TG Index, the result reveals a slight 0.1 correlation, meaning that these stocks do not provide a sufficient hedge against agricultural-product price-fluctuation risk.

**Table 8**

Comparison of the TG Index with the stock of agricultural product companies

	Companies with little correlation				Companies with significant correlation			
		TG	TOCOM	TOPIX		TG	TOCOM	TOPIX
1	Ariake Japan	-0.026	-0.016	0.252	Nagatanien	0.096	0.027	0.395
2	JT	-0.024	-0.009	0.096	J Foods	0.096	0.034	0.294
3	House Foods	-0.023	0.024	0.472	Kyodo Shiryo	0.095	0.055	0.495
4	Fuji Oil	-0.017	-0.006	0.360	Miyoshi Oil & Fat	0.090	0.016	0.423
5	Toyo Suisan	-0.016	0.009	0.207	First Baking	0.085	0.013	0.347

#### 4. Conclusion

Although I believe that investments in commodities are desirable for a long-term individual portfolio, they are almost left unused in Japan. For this reason, the performance of commodities investments has never been adequately analyzed. Fortunately, the Tokyo Commodity Exchange and the Tokyo Grain Exchange have recently begun publicizing independent commodity indexes.

In this paper, using these indexes, I sought to define the properties that commodity futures have as an alternative investment. I was able to confirm that they have investment characteristics different from stock investments, and that if leveraged skillfully, they could be expected to provide favorable diversification effects to a stock-only portfolio.

However, the crash of the commodities markets in the fall of 2008 and beyond (in concert with the stock markets) may have altered their innate properties. This will be the subject of future research.