Commodity Futures: A Japanese Perspective*

Gary Gorton
The Wharton School, University of Pennsylvania
and National Bureau of Economic Research

Fumio Hayashi
University of Tokyo
and National Bureau of Economic Research

and

K. Geert Rouwenhorst
School of Management, Yale University

October 19, 2005

Abstract

We study the basic properties of an equally weighted index of U.S. commodities futures from the perspective of a Japanese investor. We find that the returns on the U.S. equally-weighted commodity futures index maintain their basic properties documented in Gorton and Rousenhorst (2005), when translated into Yen. In particular, looking at returns on Japanese stocks and bonds, the commodity futures index, translated into Yen, continues to display equity-like returns, but with slightly less volatility. In addition, the Yen-based commodity futures returns show essentially zero correlation with Japanese equities and negative correlation with bonds.

* We thank Dimitry Gupalo for research assistance, and AIG Financial Products and the Q-Group for financial support. Thanks to Kelley Kirklin for suggestions on the return calculation. We also thank Shigeyuki Hamori, Kenji Wada, and Nobuyoshi Yamori for their guide to the Japanese literature.

1. Introduction

The founding of the Osaka Rice Futures markets in the 18th century is considered by many to mark the origin of organized futures trading in commodities. Despite their long history, commodity futures have not been considered an investment choice until recently. In a recent paper, Gorton and Rouwenhorst (2005) show that there are good reasons for investors in the U.S. to consider adding commodity futures to their portfolios. Using an equally-weighted index constructed using data collected since 1959, they show that a portfolio of collateralized commodity futures has historically earned comparable returns to U.S. equities, yet commodity futures returns are uncorrelated with stock returns. Commodity futures have similar diversification properties for bond portfolios, but provide better returns in times of unexpected inflation than either stocks or bonds.

The current paper re-examines these empirical findings from the perspective of a Japanese investor. In particular we are interested in the question of whether commodity futures present an attractive complement to a portfolio that is invested in a combination of domestic Japanese benchmarks, such as the TSE value-weighted index and JGB. Unfortunately, a long data history of returns to commodity futures which settle locally in Japan is not readily available, and for this reason we decide to use the Gorton-Rouwenhorst (GR) index – translated into Yen – as our benchmark for commodities.

We find that the main conclusions of the U.S. study about the properties of commodities as an asset class translate readily to the Japanese context:

1. Commodity Futures have earned a return that is comparable to Stocks, but with slightly less volatility.
2. Commodity Futures are excellent diversifiers for traditional assets: the correlation of Commodity Futures with Stocks is close to zero and that with Bonds is negative.
3. Commodity Futures provide a better hedge against inflation than traditional assets classes such as Stocks and Bonds

The remainder of the paper is organized as follows. In the next section, Section 2, we review some basic concepts about commodity futures. Section 3 contains a brief description of existing research on the commodity futures markets in Japan and available data. Next we discuss in Section 4 the data used in this study and the calculation of futures returns. Section 5 describes our findings about the distribution of Yen versions of the return from the GR index. We then examine the portfolio properties of commodity futures by calculating correlations with Japanese Stocks and Bonds in Section 6. The role of commodity futures as an inflation hedge is discussed in Section 7. Section 8 then compares the performance of commodity futures in business cycle phases with that of Stocks and Bonds. Translating the returns on the index of U.S. commodity futures to Yen introduces currency risk. We will consider, in section 9, the Yen return from the GR index with a hedged position in a collateralized component of the return. The last section summarizes our conclusions.

2. Commodity Futures: Some Simple Definitions.

Commodity futures are exchange traded contracts whereby two parties agree to exchange an underlying amount of a commodity at a future date, at a price agreed upon at the origination of the agreement – the futures price. No cash changes hands at the inception of a futures contract, so the value of a futures contract is zero at origination. (Futures prices are set to ensure that this is the case.)

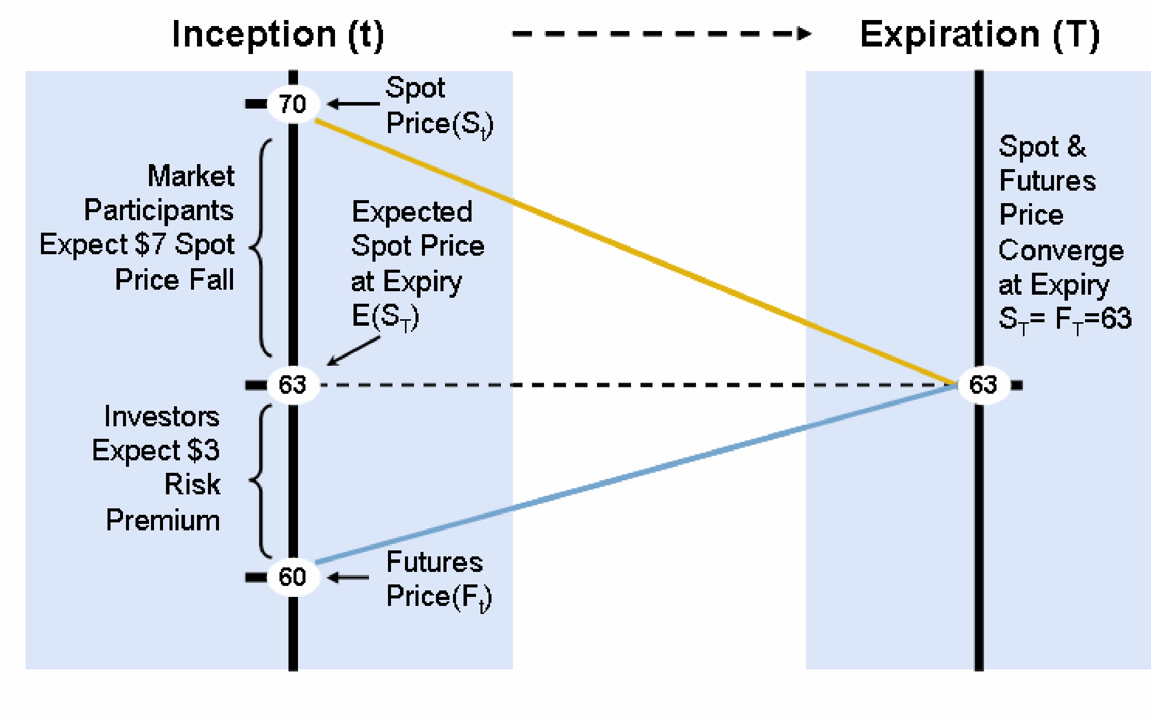
Futures contracts can act like insurance contracts for producers of commodities. For example, a rice farmer can reduce the uncertainty about the market value of his crop at harvest time by selling rice futures that mature around the time of his harvest. Whether it is attractive to do so will of course depend on the futures price. What determines the futures price? Because the farmer can always choose to wait until harvest time to sell his crops in the spot market, he will compare the current futures price to his beliefs about the future spot price that he expects to prevail at harvest time, when he considers selling futures. Likewise, a potential buyer of rice futures will consider the alternative of waiting to buy rice in the future spot market. In other words, futures prices will embed the expectations of both buyers and sellers about future spot market prices. If the future supply of rice is expected to be abundant, prices of rice for future delivery are likely to be low. By contrast, high expected demand relative to production will imply that supplies are likely to be tight and result in a high futures price.

Because expectations about the future spot price are embedded in the terms of a futures contract, anticipated trends in spot prices are not a source of a return to a futures investor. A buyer of futures will gain if spot prices at expiration of the futures contract exceed the market's expectations at the time of entering into the contract. Sellers of futures will gain when the spot price in the future falls short of market expectations. Unexpected spot price increases are, however, by definition not a systematic source of return to a futures investor – unless the investor has superior information, they should average out to zero over time.

What then is the rationale for investing in futures? Under what circumstances can investors in futures on average expect to make money? The answer hinges on the presence of a risk premium – defined as the difference between the expected spot price in the future, and the current futures price. If futures prices are on average set at a discount (i.e. below) expected future spot prices, a buyer of futures can on average expect to make money. If futures prices are on average set above future spot prices, sellers can expect to make money.

This is perhaps easiest to illustrate using a simple example taken from Gorton and Rouwenhorst (2005). Assume that the current spot price of oil is $70 per barrel and that market participants expect the price of oil to fall to $63 in three months. If the futures price is set at $60, the investor can expect to earn $3 over the life of the contract. To see this: if market expectations are realized, the buyer of futures would have locked oil at a price of $60, which subsequently turns out to be worth $63. The fact that the spot price of oil is expected to fall is not a factor in the return calculation of a futures investor, because this expectation is imbedded in the terms of the futures contract. What matters is whether the futures price is set at a discount relative to the expected spot price.

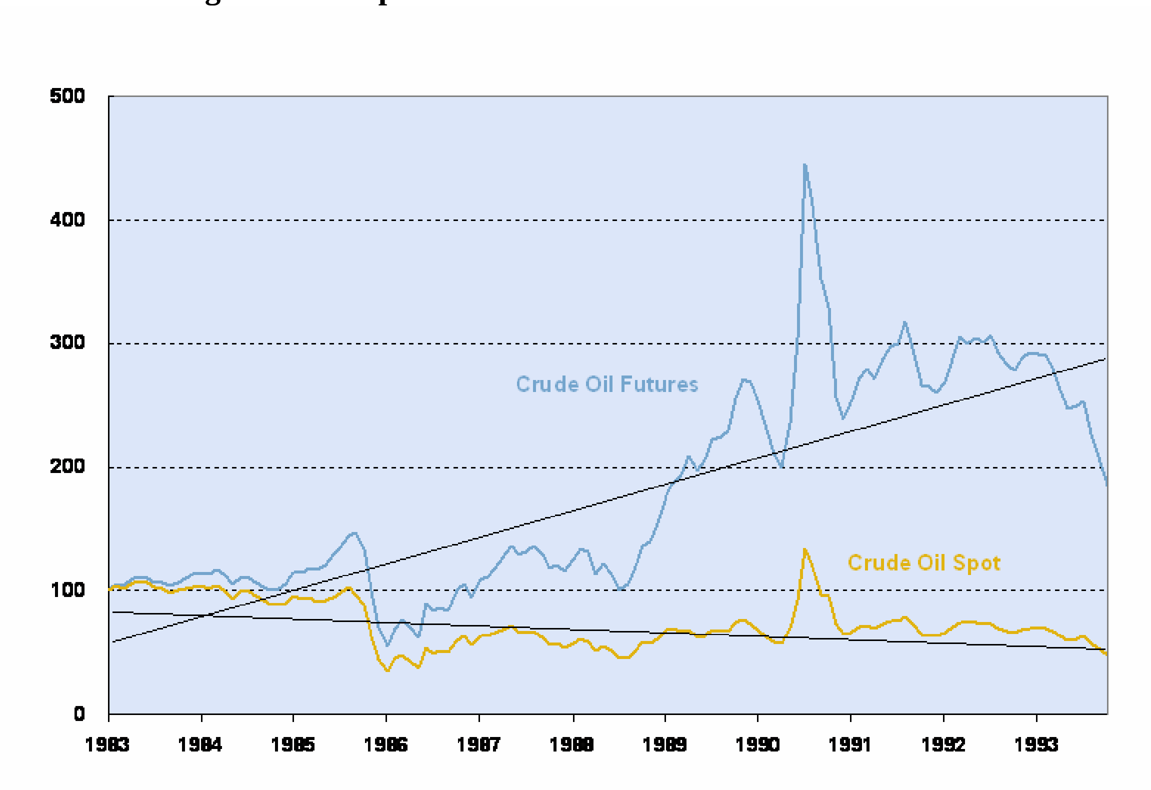
Figure 1: Futures versus Spot returns



This example also makes it easy to see how a buyer of futures gains from an unexpected appreciation of the spot market: if the spot price of oil turns out to be $64 – or $1 higher than originally expected – a long investor will earn a total of $4, the risk premium plus the unexpected spot price increase. In terms of the symbols in Figure 1, the return from holding a futures contract, $S_T - F_t$, consists of two parts, the risk premium $E(S_T) - F_t$ and an unexpected spot appreciation $S_T - E(S_T)$. This is the return the investor can reap at date T if he takes a long position in date t.

In the rest of the paper, we make the assumption that futures positions are fully collateralized by simultaneously purchasing U.S. Treasury bills (T-bills). The intuition is that unlike an investment in stocks and bonds, an investment in futures does not require a cash outlay and can potentially involve leverage. To ensure comparability with other assets, an assumption is needed about where to invest the cash and about the amount of leverage. It is common to assume an absence of leverage by matching the notional of the futures position to an equal investment in a risk-free asset. The total return between dates t and T earned by the investor with an investment of F_t dollars in date t, therefore, is: $r_t^{USD} F_t + [E(S_T) - F_t] + [S_T - E(S_T)]$, where r_t^{USD} is the interest rate on T-bills. The sum of the second term (the risk premium) and the third term (the unexpected spot appreciation) is the excess return, the return over the risk free return on an investment of F_t dollars.

Figure 2: Oil Spot and Collateralized Futures 1983 - 1994



This expression for the total return makes it clear that the expected appreciation of spot prices, $E(S_T) - S_t$, does not affect the total return. Figure 2 provides an illustration of the difference between an investment in spot oil and oil futures in a period of anticipated spot price decline. The lower line is the graph of the crude oil spot price, and measures the return to investing in physical oil excluding costs of storage, insurance, etc. The other graph, which has a positive trend, is the cumulative return from a fully collateralized investment in oil futures.[1] In 1983 there was a general perception in the market that spot oil prices had peaked. Led by Saudi Arabia, OPEC attempted to enforce relatively low production quota among member countries. The market consensus was that there was a large probability that the cartel might fail, and market participants predicted a gradual decline in the price of oil. This expectation was borne out: between 1983 and 1993, the spot price of crude oil dropped 53%. Was this also a bad time to invest in oil futures? Not necessarily. An anticipated decline in spot prices

---

[1] Therefore, in terms of the notation of Figure 1, the total rate of return from futures for month *t* is $\left(r_t^{USD} F_t + S_{t+1} - F_t\right) / F_t$, where *t* is the beginning of the month and r_t^{USD} is the 1-month T-bill rate. If the contract does not expire at the beginning of month *t*+1, we replace S_{t+1} by F_{t+1}, the price of the *same* futures contract that was held at *t* (the beginning of month *t*). If R_t is the gross total rate of return (one plus the rate of total return), it equals $r_t^{USD} + S_{t+1} / F_t$, the cumulative return from month 1 to month *T* is the product of R_1, R_2,… and R_T.

will lead to low prices for future delivery. As long as futures prices are set below (falling) future spot prices, the long side of a futures contract can anticipate earning a positive risk premium. Indeed, this is what happened: between 1983 and 1993, an investor in collateralized futures earned a return of 87%. The large difference between the spot and futures return strongly suggests that the price drop was anticipated. Had the decline been unanticipated instead, it would have affected the return to the futures and the spot market alike.

The existence and magnitude of this risk premium has been a much debated question among both academics and practitioners. Are there theoretical reasons to suggest that the risk premium either accrues to the buyer or the seller of a futures contract? The earliest theory about the risk premium in commodity futures dates back to Keynes (1930) and Hicks (1939). In his theory of *normal backwardation* Keynes envisioned a world of producers of commodities who would use the futures market to obtain price insurance – much like the rice farmer in our earlier example. The insurance would be provided by speculators (i.e. investors), who have no natural demand for rice, but who are willing to offer insurance (buy futures or go "long" futures) as long as they can expect to earn a positive profit. By discounting (i.e., "backwardating") the futures price relative to expected future spot prices, hedgers in effect reward speculators for providing insurance against price risk.

A test of the Keynesian theory of normal backwardation is complicated by the fact that the expected spot price – and hence the risk premium – is unobservable. But if futures prices are set at a discount at expected spot prices, repeatedly buying futures contracts over time should yield positive payoffs to a long futures investor. Bodie and Rosansky (1980), Fama and French (1987) and Gorton and Rouwenhorst (2005) provide empirical evidence that, consistent with Keynes' prediction, investors in commodity futures have historically earned a positive risk premium.

3. Commodity Futures in Japan

In our empirical results to be reported later, we will utilize the JPY return of the Gorton-Rouwenhorst index, not an index that could be constructed from prices on futures contracts traded on futures exchanges in Japan, as the benchmark for commodity futures. This is because there is no readily available database in Japan on futures prices dating back to 1959. Nevertheless, for the sake of completeness, we briefly review the literature on futures in Japan.

As early as in 1730, there existed an organized exchange with a standardized futures clearing system in the Dojima section of Osaka. The book by Miyamoto (1988) contains a detailed description of the organization of the Dojima exchange. It also is the first cliometric study, with a wealth of descriptive statistics and some statistical analysis based on mostly annual data from 1759 to 1859. Schaede (1989) is a very useful English language source on the market microstructure of the Dojima market. More recent work on the Dojima market by Ito (1993), Hamori *et. al.* (2001), and Wakita (1996, 2001) test the hypothesis that the futures price is an unbiased predictor of the future spot price (i.e., whether the risk premium mentioned above is zero). Recent work by Moridaira, Kogure, and Takatsuki (2005) uses daily (and sometimes intra-day) data between 1834 and 1864 to examine the co-movement of futures and spot prices.

Currently, there are about 51 commodity futures traded on seven exchanges in Japan. For some contracts, the volume is substantial. For example, the weight-adjusted volume for gold futures on the Tokyo Commodity Exchange (TOCOM) is of the same order of magnitude as that on the New York Mercantile Exchange (NYMEX).[2] Nikkei (a major newspaper comparable to the Wall Street Journal of the U.S.) has been publishing the Nikkei Commodity Futures Index since October 1, 1988. This index, however, cannot be used to calculate cumulative returns on a basket of futures contracts.[3] Most of the seven futures exchanges in Japan have a website for data downloading, but the data are available only since the early 1990s. To construct a Japanese index comparable to the GR index, we need a database on individual futures contracts from 1959. Constructing such a database is an agenda for future research.

Empirical studies on modern-day futures in Japan are available on selected commodities, but most of them are concerned with various renditions of the efficient market hypothesis.[4] Our concern, instead, is with the time-series properties of the total and excess returns from commodity futures. Studies focusing on this issue are rare, and the sample period is limited to the 1990s and after. Hamori and Hamori (2000) calculated daily excess returns (calculated as the log difference in the futures price) for four futures contracts, soybeans and corn on the Chicago Board of Trade (CBOT) and the Tokyo Grain Exchange (TGE), from January 1993 to July 1996. The average annualized percentage excess return is 8.3% for CBOT soybeans, 4.3% for TGE soybeans, 14.0% for CBOT corn, and 15.5% for TGE corn. Sasaki *et. al.* (2000) examined the linkage between CBOT and TGE soybeans from January 1995 to December 1996. They show that the two future prices and the JPY/USD exchange rate move together in the long run and that the co-movement is particularly strong when TGE contracts are matched with CBOT contracts that are two months shorter. They attribute this finding to the fact that it takes about 30 to 45 days to ship corn from the U.S. to Japan through the gulf of Mexico. Iihara *et. al.* (2002) examined monthly excess returns, from January 1993 to

[2] The volume in 2004 for gold futures was 14.96 million contracts at NYMEX and 17.39 contracts at TOCOM. The gold weight of a contract is 3.1035 kg at NYMEX and 1 kg at TOCOM.

[3] It is a geometric average of futures prices of various commodities. For each commodity, the futures price that goes into the index is for the longest existing contract (because the volume is largest for longest-maturity contracts in Japan). When a newer contract with a longer maturity enters the exchange, this new contract replaces the old one (which was the longest existing contract on the previous business day). Therefore, the cumulative gains and losses from holding the old contract are eliminated from the Nikkei index at the time of the turnover of contracts, and as a consequence the return on the futures contracts underlying the index cannot be calculated from the index. We thank Mr. Hiroshi Ono of Nikkei Media Marketing (the provider of the index) for confirming these points. He also confirms that Nikkei Media Marketing does not provide a documentation of the index.

[4] See, for example, Koyama (2004).

December 2001, on futures on silver, platinum, gold, and rubber traded on TOCOM, and corn, soybeans, sugar, and Azuki on TGE. The excess return is calculated as the logarithmic difference in the futures price. Probably due to the shortness of the sample, the mean is not significantly different from zero for any commodity. They also report that the excess returns are heavily influenced by the JPY/USD exchange rate for imported commodities and metals, but for Azuki (which is domestically produced).[5]

Tentative conclusions we can draw from studies on modern-day futures in Japan are the following. First, due to data limitations, no study has documented a statistically significant risk premium. Second, for imported commodities and metals, the link in futures prices between domestic exchanges and the U.S. exchanges is likely to be very strong because the yen-denominated futures prices are heavily influenced by the exchange rate.

4. Data Sources and Methodology

The equally-weighted commodity futures index constructed in Gorton and Rouwenhorst (2005) (the GR index) provides a 45 year performance history of commodity futures contracts in the United States from 1959 to 2004. The GR index provides the cumulative total return from investing in a basket of commodity futures contracts. For the details of the construction of the index, we refer the reader to their paper, but we summarize a number of its key features. At the end of each month, the index takes an equal position in all available commodity contracts. As new contracts are introduced, they are added to the index. The index is fully collateralized by U.S. Treasury bills, meaning that when the index takes a position of $1 in each of 25 commodity futures contracts, the index position will earn interest on $25. Therefore, the total return from the GR index consists of the T-bill return and the return from the equally-weighted portfolio of futures contracts. The latter component of the return is the excess return from the GR index.

We will compare the Yen denominated returns on the GR index of commodity futures to a representative basket of stocks and bonds in Japan. For stocks, we use the value-weighted monthly returns from the 1st section of the Tokyo Stock Exchange (TSE) obtained from the Japan Securities Research Institute. Total returns on bonds are calculated from the Nomura Bond Performance Index, which measures the holding period return (coupon plus capital gains) on a portfolio consisting of government and corporate bonds. Since this bond index is available only since 1965 (reflecting the virtual absence of the bond market in Japan until then), the period of our analysis is from 1965, not from 1959, if bond returns are to be considered. Further details on the data sources are in Appendix A.

[5] When the excess return is regressed on the logarithmic rate of change of the JPY/USD exchange rate, the coefficient on the exchange rate is 0.85 for silver, 0.91 for platinum, 0.83 for gold, 0.84 for rubber, 0.68 for corn, 0.71 for soybeans, and 1.02 for sugar. These coefficients are all highly significant. In contrast the exchange-rate coefficient for Azuki is –0.02.

The Yen denominated returns on the GR index is approximately equal to the sum of the return on the index in USD and the rate of Yen depreciation against the dollar. Therefore, the investor bears the currency risk on both the T-bill component and the excess return component of the total return on the GR index. Toward the end of the paper, we will also consider the Yen return, to be referred to as the hedged return, in which the T-bill component is currency-hedged. For details on how these unhedged and hedged returns are calculated, we refer the reader to Appendix B.

5. Risk and Returns of the Yen-Based Commodity Futures Index

We start our empirical analysis of commodity futures returns by summarizing the return distribution of the unhedged GR commodity index from the perspective of a US and a Japanese investor. The comparison illustrates the influence of exchange rates on the return distribution for Japanese investors in the index.

Table 1: Returns Commodity Futures in USD and JPY
Distribution of Annualized Percentage Returns 1959/7 – 2005/5

	Commodity Futures USD	Commodity Futures JPY	Exchange Rate JPY/USD
Average Return	10.67%	8.44%	-2.16%
Standard Deviation	12.02%	15.13%	9.60%
Skewness	0.70	0.52	-0.31

Looking at Table 1, several observations stand out:

1. The average return of the collateralized Commodity Futures return in JPY has been lower than the USD return by about 2% due to a depreciation of the USD against the JPY over the last 45 years.
2. Despite the substantial volatility in the JPY/USD exchange rate, the Commodity Futures return volatility in JPY has only been slightly higher than the volatility of the USD returns. Because the Commodity Futures returns in USD and the JPY/USD currency returns are almost uncorrelated (correlation coefficient: -0.04), much of the currency risk is effectively diversified away by the Commodity Futures volatility.
3. The positive skewness that characterizes Commodity Futures returns in USD is inherited by the JPY investor in the index.

The lower average return of the index in JPY does not necessarily imply that Commodity Futures are less attractive to a Japanese investor for several reasons. First, the return is before inflation adjustment. Second, the average return may be comparable to those of Japanese Stocks and Bonds. Third, Commodity Futures may be a good diversifier if their JPY returns are uncorrelated with Stocks and Bonds. We will consider these issues in turn below.

Figure 3: Stocks, Bonds, and Commodity Futures
Inflation Adjusted Performance 1965/1 – 2005/5

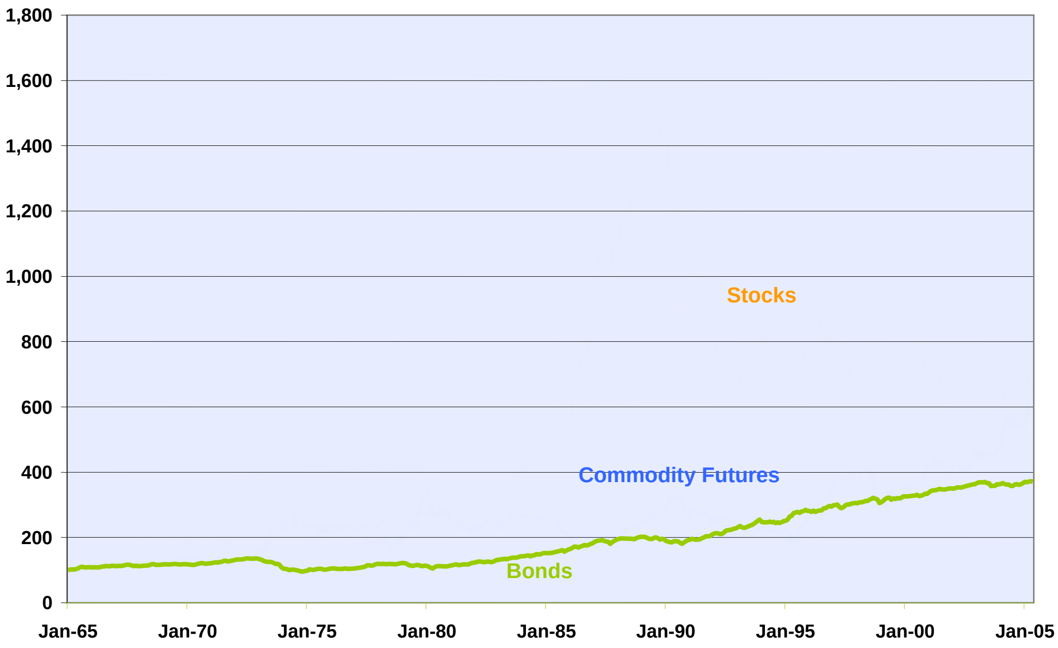


Figure 3 compares the cumulative returns of the Yen-based GR Commodity Futures index to those of Japanese Stocks (the value-weighted return from the first section of the Tokyo Stock Exchange) and Japanese Bonds (holding-period return on government and corporate bonds) in Japan over the last 40 years, from January 1965 to May 2005. All series have been deflated by the Japanese CPI, and therefore measure the inflation-adjusted performance of the three asset classes. While the graph dramatically emphasizes the spike in Japanese equity prices during the second half of the 1980s, it is perhaps surprising that, as in the U.S., Commodity Futures perform favorably against the two traditional asset classes. Over the last 40 years, the cumulative return to an investment in Commodity Futures has been comparable to an investment in Japanese Stocks, and higher than Bonds.

Table 2: Monthly Returns of Commodity Futures, Stocks and Bonds
Distribution of Percentage Annualized Returns 1965/1-2005/5

	Commodity	Stocks	Bonds	1-month

	Futures			rate
Average Return	9.06%	9.63%	6.77%	4.80%
Standard Deviation	15.80%	17.34%	3.45%	0.97%
Skewness	0.49	-0.11	-0.18	0.08
Kurtosis	3.47	1.14	4.20	-0.56

Table 2 displays the simple statistics of the monthly returns underlying the cumulative returns graphed in Figure 3 along with those of the one-month short term interest rate in Japan. Table 3 summarizes the distributions of the excess returns (over the one-month JPY riskless interest rate) of Stocks, Bonds, and Commodity Futures since 1965. The returns in these tables are raw or nominal returns, not adjusted for inflation. Three observations stand out:

1. As just mentioned and as shown in Table 2, despite large differences in short-term performance, Commodity Futures and Stocks have about the same average return over the full 40-year period. but the standard deviation of Stock returns is higher.
2. The return distribution of equities has negative skewness, while the distributions of Commodity Futures returns have positive skewness. Commodity Futures have less downside risk than Stocks or Bonds, as indicated by the opposite skewness of their return distributions.
3. Both Commodity Futures and Stocks have positive excess kurtosis, and are "fat-tailed" relative to the normal distribution.

In terms of excess returns, shown in Table 3, Commodities Futures have earned comparable excess returns to Stocks, with slightly lower volatility. As a consequence the Sharpe Ratio of Commodity Futures and Stocks are similar. Due to their low volatility, the Sharpe Ratio of Bonds has exceeded Stocks.

Table 3: Distribution of Excess Returns of Commodity Futures, Stocks and Bonds Annualized Monthly Returns 1965/1 – 2005/5

	Commodity Futures	Stocks	Bonds
Average	4.2%	4.8%	2.0%
Standard Deviation	15.8%	17.3%	3.4%

t-statistic	1.70	1.77	3.68
Sharpe ratio	0.27	0.28	0.58
% returns > 0	52	52	62

6. The Portfolio Properties of Commodity Futures

Gorton and Rouwenhorst (2005) point out that much of the attraction of Commodity Futures as an asset class stems from its portfolio properties. In particular, they show that Commodity Futures have near-zero correlation with Stocks, negative correlations with Bonds, and (at longer horizons) positive correlations with U.S. inflation. The latter is a particularly attractive feature for investors because Stocks and Bonds tend to be negatively exposed to inflation.

We find the same properties for Japan. Table 4 reports correlations between the returns from the GR commodity index with Stocks, Bonds, and Inflation in Japan. In addition to monthly returns, we examine overlapping returns over quarterly, annual, and 5-year investment horizons.[6] We note the following.

Table 4: Correlation of Commodity Futures Returns with Stocks, Bonds, and Inflation, Overlapping Return Data, 1959/7-2005/5

	Stocks	**Bonds**	**Inflation**
Monthly	0.03 (0.04)	-0.20*** (0.06)	0.11* (0.06)
Quarterly	0.01 (0.06)	-0.31*** (0.08)	0.16 (0.10)
1-year	0.02 (0.10)	-0.48*** (0.14)	0.38 (0.25)
5-year	0.10 (0.26)	-0.01 (0.18)	0.73* (0.40)

Note: Standard errors in parentheses. A “*” indicates the correlation is

[6] So, for example, a one-year return of the GR index from January 1965 to January 1966 is paired with the stock return over the same period, a one-year GR index return from February 1965 to February 1966 is paired with the stock return over the same period, and so forth. This means that for each asset the returns for horizons longer than a month are serially correlated even if the monthly return is not. The standard errors reported in the table takes this into account with the so-called Newey-West kernel. See, e.g., Hayashi (2000, Chapter 6) for details.

significant at 10%, "**" significant at 5%, and "***" significant at 1%. The standard errors are calculated taking account of the overlapping nature of returns (see footnote 6 for more details). For Bonds, the sample period is 1965/1 to 2005/5. The correlation coefficients for Stocks and Inflation are similar with slightly less significance if the sample period is from 1965/1 rather than 1959/7.

1. Commodity Futures returns are uncorrelated with Stocks over all horizons. Unlike in the U.S., the correlation does not turn negative at long horizons.
2. The correlation with inflation is positive, and rises steadily with the investment horizon. This is not surprising. The return from Commodity Futures is directly linked to commodity spot prices, and rise in dollar-denominated commodity prices should affect import prices and eventually raise the CPI.
3. The correlation with Bonds is negative and highly statistically significant – except at the 5-year horizon. Because bonds are nominally denominated assets, a prospect of higher inflation signalled by a rise in spot commodity prices hurts bond returns.

The near-zero correlation between Commodity Futures and Japanese Stocks holds up when Stock returns are extremely low --- a time when diversification is especially valuable. For the 1959-2005 period, during the 5% of the months of worst performance of Stocks (such as August 1971 and September 1990), when the equity return is on average -10.6% per month, Commodity Futures averaged -0.3% per month. For the worst 1% of Stocks returns, Stocks averaged -14.5% per month while commodities registered 0.9% per month.

7. Commodity Futures as an Inflation Hedge

Investors ultimately care about the real purchasing power of their returns, which means that the threat of inflation is a concern for investors. We have seen in the previous table that Commodity Futures can be a reasonable hedge against inflation. After all, commodity futures bet on the prices of physical commodities which – over long periods – can be expected to move with the level of aggregate prices. How do they compare with Stocks and Bonds on this score? For Bonds, as discussed above, we would expect that the correlation with inflation to be negative because they are nominal assets. For Stocks, because they represent claims against real assets, such as factories, equipment, and inventories, whose value can be expected to hold pace with the general price level, the correlation with inflation could be positive. However, firms also have contracts with suppliers of inputs, labor and capital, that are fixed in nominal terms and hence act very much like nominal bonds. So like Bonds, the correlation of Stocks with inflation would increase with the horizon but initially could be negative.

Table 5: Correlation of Stocks, Bonds and Commodities with Inflation,

Overlapping Return Data, 1959/7-2005/5

	Stocks	**Bonds**	**Commodity Futures**
Monthly	-0.01 (0.041)	-0.02 (0.057)	0.11* (0.061)
Quarterly	-0.04 (0.056)	-0.02 (0.079)	0.16 (0.098)
1-year	-0.05 (0.12)	0.08 (0.17)	0.38 (0.25)
5-year	0.24 (0.22)	0.50** (0.24)	0.73* (0.40)

Note: Standard errors in parentheses. A “*” indicates the correlation is significant at 10%, “**” significant at 5%, and “***” significant at 1%. For Bonds, the sample period is 1965/1 to 2005/5. The correlation coefficients for Stocks and Commodity Futures are similar if the sample period is from 1965/1 rather than 1959/7.

These expectations are born out in Table 5, which displays the correlation of Japanese Stocks, Japanese Bonds, and Commodity Futures with Japanese consumer price inflation. As before, correlations are computed over various investment horizons.

1. Unlike the U.S. we find that the longer-horizon correlations of Japanese Stocks and Bonds with Inflation are not as low.
2. However, the inflation correlation of Commodity Futures is higher than the correlation for the traditional asset classes

8. Commodity Futures Returns over the Business Cycle.

We have argued that much of the negative correlation between Japanese Bonds and Commodity Futures returns can be accounted for by their relation to inflation. We show here that Japanese Stocks and Commodity Futures respond differently to business cycles, thus providing a possible explanation for the lack of strong correlation between Stocks and Commodity Futures.

Figure 4: Business Cycle Phases

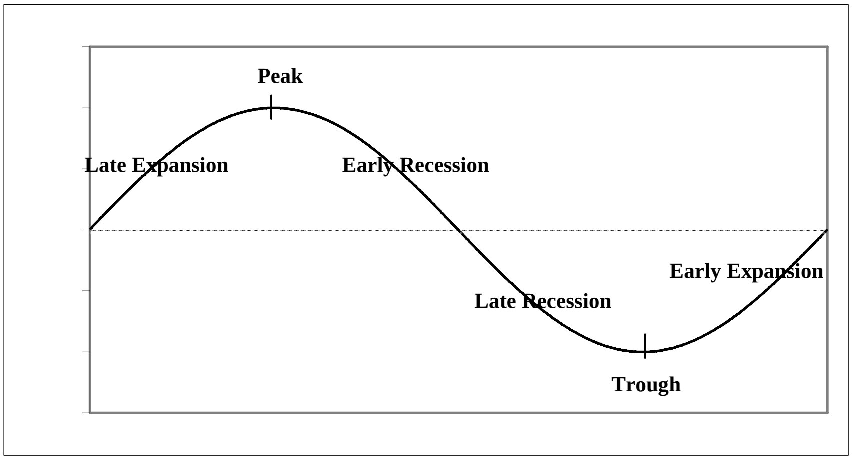


Figure 4 displays a stylized business cycle. We use the business cycle dating by the Cabinet Office of the Japanese government to identify peaks and troughs.[7] The four phases of the cycle are identified by dividing the number of months from peak to trough (trough to peak) into equal halves to indicate Early Recession and Late Recession (Early Expansion and Late Expansion). Clearly, the Early and Late Expansion phases correspond to an economic expansion, while the Early and Late Recession phases correspond to a recession.

Table 6 displays average returns of Stocks, Bonds, and Commodity Futures by phase of the business cycle. It shows that:

Table 6: Average Monthly Annualized Percebtage Returns by Phase of the Business Cycle, 1965/1 – 2005/5

	Stocks	Bonds	Commodity Futures
Expansion	12.9%	5.3%	15.8%
early	19.3%	6.7%	9.4%
late	6.5%	3.9%	22.2%
Recession	3.5%	9.5%	-3.3%
early	-2.5%	9.5%	1.4%
late	9.4%	9.4%	-8.0%

[7] See http://www.esri.cao.go.jp/jp/stat/di/041112hiduke.html for the dating of peaks and troughs by the Cabinet Office.

1. Stocks perform most poorly in the Early Recession phase, but register a positive return in the Late Recession phase, in anticipation of the coming Expansion. This pattern of Stocks leading the cycle is observed in the U.S. as well (see Gorton and Rouwenhorst (2005)).[8]
2. In contrast, Commodity Futures move in sync with the cycle. The average return is much lower in recessions than in expansions. This difference in the cyclical pattern of returns, which is statistically significant,[9] contributes to the lack of correlation between Stocks and Commodity Futures.
3. Unlike for the U.S., bond returns are not very sensitive to the business cycle in Japan (this may be due to the fact that Japanese Bonds here includes not only corporate bonds but also government bonds), although, as in the U.S., the average return is higher during recessions.

These results are purely descriptive, and do not imply a trading strategy, because business cycles are dated "after-the fact." However, the ex-post returns illustrate how Commodity Futures help to diversify traditional portfolios of stocks and bonds.

9. Hedging the Exchange Rate Risk of Commodity Futures

Thus far we have examined the JPY returns to the GR commodity index on an un-hedged basis. That is the returns were computed under the assumption that the Japanese investor would bear the currency risk associated with investing in a collateralized index of USD denominated commodity prices. This section will look at the investment on a hedged return basis. We refer the reader to Appendix B for the details of calculating hedged returns. The essence of currency hedging is the commodity index is to combine the investment in the USD denominated commodity index with a short position in the USD.

There is no a-priori reason to believe that currency hedging leads to either a return improvement or a risk (variance) reduction for investors. This will depend on the covariance between USD commodity prices and the JPY/USD exchange rate. For example assume that oil prices are set in world markets, and that energy prices were initially stable in all currencies including the JPY. If the USD were to unexpectedly appreciate against other currencies, energy prices would fall in USD. An unhedged investor would have seen the value of his position unchanged (JPY energy prices constant), but a hedged investor who has shorted the USD which unexpectedly

[8] The difference in the average stock return across the four phases of the business cycle is nearly significant at 5%. In the regression of monthly stock returns on the constant and three dummies corresponding to three of the four phases of the business cycle shows that the marginal significance of the three dummies as a whole is 5.1%. If the sample starts from 1959/7 rather than from 1965/1, the marginal significance is 2.3%.

[9] In the regression of the difference between Commodity Futures and Stocks on the constant and three dummies corresponding to three of the four phases of the business cycle shows that the three dummies as a whole are significant at 1%.

appreciated, would have earned lower returns and increased volatility because of the hedge.

Whether there are advantages of hedging international portfolios against currency risk is therefore an empirical matter. Table 7 compares the return distributions of commodity futures from an unhedged and a hedged perspective. Table 8 compares the portfolio correlation properties of the two indices with Stocks, Bonds and Inflation. We choose 1981 as the starting point of our return calculations, because it marks the beginning of the liberalization of Japan's foreign exchange markets.

Table 7: Monthly Returns of Commodity Futures
Distribution of Annualized Percentage Returns, 1981/1-2005/5

	Unhedged	**Hedged**
Average Return	5.58%	4.23%
Standard Deviation	14.32%	9.68%
Skewness	-0.07	-0.15
Kurtosis	0.63	0.48

Table 8
Correlation of Commodity Futures Returns with Stocks, Bonds, and Inflation, Overlapping Return Data, 1981/1-2005/5

Panel a: Unhedged Returns

	Stocks	**Bonds**	**Inflation**
Monthly	0.03	-0.20***	-0.06
Quarterly	0.03	-0.27***	-0.09
1-year	-0.01	-0.38***	-0.05
5-year	-0.41	-0.61***	-0.31*

Panel b: Hedged returns

	Stocks	Bonds	Inflation
Monthly	0.15**	-0.06	-0.01
Quarterly	0.18**	-0.12	-0.06
1-year	0.34**	-0.25*	-0.19
5-year	0.27*	-0.05	0.32

Note: Standard errors in parentheses. A "*" indicates the correlation is significant at 10%, "**" significant at 5%, and "***" significant at 1%.

Because inflation was very low and stable in the period since 1981, it is difficult to estimate correlation with the inflation rate precisely. This can explain the lack of correlation between inflation and the Commodity Futures returns. Two observations stand out from Tables 7 and 8:

1. A currency hedged Commodity Futures index has historically underperformed an unhedged index, and has experienced lower volatility.

2. Hedged returns have higher correlations with Stocks and Bonds. Currency hedging has historically lowered the diversification benefits of Commodity Futures for Japanese investors.

10. Summary

This paper provides evidence on the long-term properties of an investment in collateralized commodity futures contracts from the point of view of a Japanese investor. Because there currently is no commodity futures index based on futures contracts traded in Japan, we examined the question by translating the Gorton-Rouwenhorst GR (equal-weighted) index to Yen. Our basic conclusion is that many of the attractive properties of Commodity Futures that are displayed in USD are maintained. In particular, returns to the GR index in Yen show equity-like returns compared to Japanese equity returns. Moreover, Commodity Future returns are essentially uncorrelated with Japanese equity and negatively correlated with Bond returns.

In addition to offering high returns, the historical risk of an investment in Commodity Futures translated into Yen has been relatively low --- especially if evaluated in terms of its contribution to a portfolio of stocks and bonds. A diversified investment in Commodity Futures has slightly lower risk than stocks --- as measured by standard deviation. And because the distribution of commodity returns is positively skewed relative to equity returns, commodity futures have less downside risk

References

(References in English)

Bodie, Zvi and Victor Rosansky. 1980. "Risk and Return in Commodity Futures." *Financial Analysts Journal*, vol. 36, no. 3 (May/June): 27-39.

Fama, Eugene F. and Kenneth R. French. 1987. "Commodity Futures Prices: Some Evidence on Forecast Power, Premiums, and the Theory of Storage." *Journal of Business*, vol. 60, no. 1 (January): 55-73.

Gorton, Gary B., and K. Geert Rouwenhorst, 2005. "Facts and Fantasies About Commodity Futures," Financial Analysts Journal, forthcoming.

Hamori, S., N. Hamori, and D. Anderson, 2001. "An Empirical Analysis of the Efficiency of the Osaka Rice Market During Japan's Tokugawa Era", *Journal of Futures Markets*, vol. 21, no. 9 (September), pp. 861-874.

Hayashi, Fumio, 2000, *Econometrics*, Princeton University Press.

Hoshi, Takeo, and A. Kashyap, 2001, *Corporate Financing and Governance in Japan*, MIT Press.

Hicks, John R. 1939. *Value and Capital*. Cambridge, England: Oxford University Press.

Keynes, John M. 1930. *A Treatise on Money, vol. 2*. London: Macmillan.

Shaede, Ulrike, 1989. "Forwards and Futures in Tokugawa-Period Japan: A New Perspective on the Dojima Rice Market", *Journal of Banking and Finance*, vol. 13, pp. 487-513.

Wakita, Shigeru, 2001. "Efficiency of the Dojima Rice Futures Market in Tokugawa-Period Japan", *Journal of Banking and Finance*. vol. 25, No. 3 (March), pp. 535-544.

(References in Japanese)

Hamori, S. and N. Hamori, 2000. "Time-Series Properties of Returns from Futures: a U.S.-Japan Comparison in Volatility" (in Japanese), *Sakimono Torihiki Kenkyu*, vol. 4, no. 2 (March).

Iihara, Y, H. Kato, and T. Tokunaga, 2002. "On the Co-movements of Commodity Futures" (in Japanese), *Sakimono Torihiki Kenkyu*, vol. 7, no. 11 (December).

Ito, Takatoshi, 1993. "On the Market Efficiency of the Dojima Rice Futures Market in the 18th Century" (in Japanese), *Keizai Kenkyu*, vol. 44, no. 4.

Koyama, Ryo, 2004. *Introduction to Futures with Emphasis on Commodity Futures* (in Japanese), Kindai Bungei Sha, Tokyo.

Miyamoto, Mataro, 1988. *Market Economy in Premodern Japan: Osaka Rice Market* (in Japanese), Yuhikaku, Tokyo.

Moridaira, S, A. Kogure, and Y. Takatsuki, 2005. "Hedging in the Dojima Rice Futures Market: 1834-1864" (in Japanese), mimeo., Department of Policy Studies, Keio University.

Sasaki, J., T. Nakatani, and K. Demura, 2000. "Empirical Analysis of Linkages between Exchanges: TOCOM and CBOT Soybean Futures" (in Japanese), *Sakimono Torihiki Kenkyu*, vol. 5, no. 1 (September).

Wakita, Shigeru, 1996. "Market Efficiency in the Dojima Rice Futures Market" (in Japanese), *Keizai Kenkyu*, vol. 47, no. 3.

Appendix A: Data Sources

Japanese Stock Returns
As the JPY return from stocks, we use the value-weighted monthly total returns from the 1st section of TSE (Tokyo stock exchange). The data source is JSRI (Japan Securities Research Institute). The returns incorporate capital changes (such as stock splits, stock dividends, etc).

Japanese Bond Returns
The market for Japanese government bonds (JGBs) didn't fully develop until the mid 1970s when the Japanese Ministry of Finance was compelled to open a secondary market. The development of the market for corporate bonds lagged behind the JGB market. The first non-collateralized straight corporate bond was issued in 1985.[10] Therefore, before the mid 1970s, the collection of long-term securities a Japanese investor could buy was quite limited, consisting mainly of the bond issued by the Japanese Telephone and Telegraph Corporation and debentures issued by long-term credit banks and trust banks.

Our measure of the JPY total bond return is from the BPI (Bond Performance Index) constructed by Financial and Economic Research Center of Nomura Securities . The Nomura BPI is based on total returns from a portfolio of all Japanese publicly issued fixed income securities with the minimum remaining maturity of one year and the minimum par amount outstanding of 1 billion yen. The portfolio includes JGBs, bank debentures, and corporate bonds. More details on the Nomura BPI can be found at http://qr.nomura.co.jp/QR/index/BPI/nribpi_info.html. The return for the month is calculated as the rate of change of this index from the last business day of the previous month to the last business day of the current month.

Japanese Consumer Price Inflation
The month-to-month inflation rate is calculated from the Japanese CPI (consumer price index) downloadable from http://www.stat.go.jp/data/cpi/longtime/index.htm. The index excludes imputed rent and is not seasonally adjusted.

JPY/USD Exchange Rate
The JPY/USD exchange rate at the beginning of the month is the mid value of the bid and ask interbank rates during the last business day of the previous month on the Tokyo Foreign Exchange Market. The data source is the monthly statistics published by the Bank of Japan.

JPY/USD Spot-Forward Spread

[10] For more details, see Chapter 7 of Hoshi and Kashyap (2001).

The 1-month spread is defined as the difference between the one-month forward exchange rate and the spot rate. The rate we use is the interbank rate in the Tokyo Foreign Exchange market. The data source is the Bank of Japan.

One-month JPY Interest Rate

There is no consistent series on the one-month riskless rate in Japan comparable to the one-month T-bill rate in the U.S., because the open market for short-term government securities did not fully develop until very recently. There is, however, a close substitute for the T-bill rate in Japan: the rate on repurchase agreements. The rate is known as the repo rate or Gensaki rate in Japan. The one-month Gensaki rate is available from the Bank of Japan since January 1977. For February 1977 to the end of the sample period, we take the 1-month riskless rate for the month to be the Gensaki rate on the last business day of the previous month. It is the rate offered to clients by security companies. The data source is the Japan Association of Security Companies. Before January 1977, the only open market for short-term funds was the Call market, the interbank market for loans comparable to the Federal Funds market of the U.S. For January 1960-Jaunary 1977, we use the collateralized overnight Call rate as the short-term interest rate. For July 1959-January 1960, we set the rate at the Call rate on January 31, 1960 (of 8.4% per year). The data on the Call rates are available from the Bank of Japan.

The GR (Gorton-Rouwenhorst) Total Return Index

The monthly GR series is from Gorton and Rouwenhorst (2005) and can be downloaded from http://www.nber.org/data/. If Z_t is this GR index at the end of month *t*, then one plus the return on the index is given by Z_t / Z_{t-1}.

Appendix B: Definitions of JPY Commodity Futures Returns

There are two versions of the JPY Commodity Futures returns. The first is the return from the unhedged strategy. The unhedged return strategy is determined as follows:

- At the beginning of each month, a Japanese investor converts JPY into USD and buys a 1-month U.S. Treasury bill;
- The investor then uses the 1-month Treasury bill as collateral to invest in the USD-denominated commodity futures portfolio underlying the GR index for a month;
- At the end of the month, the investor settles the position and collects returns in USD; this total return consists of the return from the Treasury bill and the return from the uncollateralized Commodity Futures;
- The USD total return is then converted into JPY at the spot exchange rate at the end of the month.

Therefore, one plus the unhedged JPY Commodity Future return for the month is given by:

$$1 + \text{unhedged JPY return from commodity futures} = \frac{Z_t}{Z_{t-1}} \times \frac{X_t}{X_{t-1}},$$

where X_t is the exchange rate (JPY per USD) on the last business day of month *t*, Z_t is the GR total return index on the last day of month *t*. The whole USD return is thus exposed to the foreign exchange risk.

The second version of the JPY return differs from the first in that the U.S. Treasury bill component of the total return is hedged by the investor by selling USD forward at the beginning of the month. The GR excess return is defined as the GR total return minus the return on the collateral (the T-bill rate):

$$\text{GR excess return for month } t = \frac{Z_t}{Z_{t-1}} - \left(1 + r_t^{USD}\right),$$

where r_t^{USD} is the 1-month riskless USD rate of return (the U.S. 1-month T-bill rate) during month *t*. The JPY return from the hedged strategy is defined as

$$1 + \text{hedged JPY return from commodity futures} = \left(1 + r_t^{USD}\right) \times \left(1 + \frac{P_{t-1}}{X_{t-1}}\right) + (\text{GR excess return}) \times \frac{X_t}{X_{t-1}},$$

where P_{t-1} is the one month spot-forward spread on the last business day of month *t*-1.