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Linkages among precious metals commodity futures prices: evidence from Tokyo

Yoichi Tsuchiya
State University of New York at Buffalo

Abstract

We investigate whether long-term co-movements among the prices of precious metals commodity futures contracts can be observed. The past literature on agricultural commodity futures prices obtains the mixed results. We find that there is no long-term interdependence among the prices of the four non-agricultural commodity products traded at the Tokyo Commodity Exchange. The finding provides new evidence against interdependence of commodity futures prices.

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1. Introduction

Pindyck and Rotemberg (1990) demonstrate that the prices of several commodities such as wheat, cotton, copper, gold, crude oil, lumber and cocoa are likely to move together. They suggest that the co-movement of the commodity prices is caused in part by herd behavior of traders in the financial markets. The phenomenon is called the excess co-movement hypothesis (ECMH).

Malliaris and Urrutia (1996) examine the notion that the futures prices of six agricultural commodities traded at the Chicago Board of Trade (CBOT) move independently to attest the ECMH. The six agricultural commodities are corn, wheat, oats, soybean, soybean meal and soybean oil and the sample period is from January 1981 to October 1991. Their hypothesis is rejected and the empirical results show a long-term relationship among the six commodity futures contracts, which is consistent with the ECMH. On the other hand, Booth and Ciner (2001) find that the prices of the four agricultural commodities traded at the Tokyo Grain Exchange (TGE) move independently. The data starts from July 1993 to March 1998. Bhar and Hamori (2006) also analyze the interdependence of the futures prices of the four commodities traded at the TGE using a more recent data set, which cover the period from August 1994 to December 2003. Their finding indicates that the prices of the agricultural products move independently for the total sample period. It is also implied with the use of sub-samples that there is price co-movement among the four products from 2000 to 2003, while there is no price co-movements in 1990s. Dawson and White (2002) show that there is no interdependence among soft commodities such as barley, cocoa, coffee, sugar, and wheat at the London International Financial Futures Exchange (LIFFE).

The purpose of this paper is to investigate whether or not prices of non-agricultural commodities move independently in the long run using Johansen's cointegration analysis as the previous works. Although linkages among the agricultural commodity futures prices have been examined since the finding of Pindyck and Rotemberg (1990), not much attention has been paid to non-agricultural commodity futures prices. In particular, we use the price indexes for four precious metals commodity futures contracts traded at the Tokyo Commodity Exchange (TOCOM).

As a result, we find that the prices of the four precious metals futures contracts move independently. It also suggests that there is no long-term relationship among the four futures contracts.

The rest of the paper is organized as follows. Section 2 describes our data. Section 3 presents the empirical results with brief explanation of statistical method. Section 4 summarizes our findings.

2. Data

We use the Nikkei-TOCOM Sub Commodity Indexes[1] for four precious metals futures contracts traded at the TOCOM: gold, palladium, platinum and silver. Each commodity listed at the TOCOM has its Sub Index. Each Sub Index is the figure of the fluctuation rates of the daily settlement prices in the core contract-month (fifth or sixth contract-month[2]), from base date (May 31, 2002, on which the Index price is set at 100) to the applicable date. The sample period covers the end of May 2002 to the end of

[1] The Nikkei-TOCOM Commodity Index is the aggregated figure of all the Sub Index, multiplied by a weight percentage for each component.

[2] This is because those contract-month are the most active. Unlike the Japanese futures contracts, the nearest contracts are usually the most active in the US futures contracts.

May 2010. The data comprise a total of 1958 observations for each contract with no observations missing.

3. Results

First, we test stationarity for the level and first difference of the natural logarithm of the precious metals futures prices. We use two tests to see the robustness of the result: the augmented Dickey-Fuller (ADF) unit root tests and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) unit root tests. Then, we test cointegration for long-term interdependence among the prices of the four non-agricultural commodity products.

3.1 Unit root test

Table 1 shows the results of the ADF tests for the level and first difference of the natural logarithm of the precious metals futures prices. The ADF test[3] tests the null hypothesis that a variable contains a unit root against the alternative that a variable contains no unit root. We employ three specifications for the test: the auxiliary regression includes a constant and time trend (I); auxiliary regression includes a constant (II); auxiliary regression includes none (III). For the price level, the ADF tests indicate that the futures price contains a unit root in every case. For the first difference of price, the tests indicate that there is no unit root in all cases.

Table 2 shows the results of the KPSS tests for the level and first difference of the natural logarithm of the precious metals futures prices. Unlike the ADF test, the KPSS test[4] tests the null hypothesis that a variable contains no unit root against the alternative that a variable contains a unit root. We employ two specifications for the test: the auxiliary regression includes a constant and time trend (I); auxiliary regression includes a constant (II). For the price level, the KPSS tests indicate that the futures price contains a unit root in every case. For the first difference of price, the tests indicate that there is no unit root in all cases.

We obtain consistent results from the ADF and KPSS tests. Therefore, it leads to the conclusion that the prices of the four precious metals futures contracts are integrated of order one, $I(1)$. This validates our cointegration analysis discussed below.

3.2 Cointegration test

We use Johansen's full information maximum likelihood cointegration analysis to test for long-run co-movements. Johansen (1991) develops two likelihood ratios to test for the number of cointegration vectors in an unrestricted vector autoregression (VAR) model: the maximum eigenvalue test and the trace test. The former tests the null hypothesis of r cointegrating vectors against the alternative hypothesis of $r+1$ cointegrating vectors. The latter tests the null hypothesis of r cointegrating vectors at most against the alternative hypothesis of more than r vectors. Neither test has a standard asymptotic distribution, however, Monte Carlo simulations based critical values exist. The critical values are obtained from Osterwald-Lenum (1992).

To see the robustness of our findings, we employ the lag intervals for 1 to 2, and three specifications of the deterministic trends since the results of a cointegration test depend on the two factors. The specifications are as follows: the cointegrating equations have no intercepts and the level data have no deterministic trends (I); the cointegrating

[3] See Dickey and Fuller (1979).

[4] See Kwiatkowski *et al.* (1992).

equations have intercepts but the level data have no deterministic trends (II); both the cointegrating equations and the level data have linear trends (III).

The results are reported in Table 3 and indicate no cointegration among the time series of precious metals futures prices. This implies that the prices of the four precious metals products move independently and there is no evidence of herding behavior among the traders at the TOCOM. The results are robust to the selection of the deterministic trend and lag structure specification. Our finding is consistent with Bhar and Hamori (2006), Booth and Ciner (2001) and Dawson and White (2002), but differs from Malliaris and Urrutia (1996).

4. Conclusion

We examine long-term price relationships among four precious metals commodity futures contracts traded at the TOCOM using Johansen's cointegration analysis. In conclusion, cointegration tests indicate that the prices of the four commodity futures do not move together in the long-run. Our result is consistent with the findings of Bhar and Hamori (2006), Booth and Ciner (2001) and Dawson and White (2002), but in contrast to Malliaris and Urrutia (1996).

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Table 1: Augmented Dickey-Fuller test

Commodity	Specification	Lag length	Test statistics
Noble metal futres price levels			
Gold	I	23	-2.23
	II	23	-0.68
	III	23	2.21
Palladium	I	1	-1.98
	II	1	-1.81
	III	1	-0.09
Platinum	I	21	-2.04
	II	21	-2.02
	III	21	1.17
Silver	I	2	-2.20
	II	10	-1.10
	III	10	1.18
First difference of noble metal futres prices			
Gold	I	22	-10.62*
	II	22	-10.63*
	III	22	-10.37*
Palladium	I	1	-30.00*
	II	1	-30.00*
	III	1	-30.01*
Platinum	I	20	-9.40*
	II	20	-9.38*
	III	20	-9.26*
Silver	I	9	-14.67*
	II	9	-14.67*
	III	9	-14.61*

Note: The auxiliary regression includes a constant and time trend (I), a constant (II), and none (III). Lag length is chosen using AIC with maximum lag being 30. * indicates that the null hypothesis can be rejcted at the 5% significance level.

Table 2: KPSS test

Commodity	Specification	Test statistics
Precious metals futures price levels		
Gold	I	1.33*
	II	20.65*
Palladium	I	1.41*
	II	2.10*
Platinum	I	2.77*
	II	15.00*
Silver	I	2.82*
	II	18.16*
First difference of precious metals futures prices		
Gold	I	0.043
	II	0.048
Palladium	I	0.096
	II	0.154
Platinum	I	0.056
	II	0.126
Silver	I	0.061
	II	0.063

Note: The auxiliary regression includes a constant and time trend (I) and a constant (II). * indicates that the null hypothesis can be rejected at the 5% significance level.

Table 3: Cointegration tests

	Trace test			Maximal Eigenvalue test		
	I	II	III	I	II	III
Lag = 1						
r = 0	14.52	15.68	19.83	30.77	36.22	47.51
r ≤ 1	12.20	13.01	13.38	16.24	20.54	27.67
r ≤ 2	3.13	4.74	11.20	4.04	7.53	14.30
r ≤ 3	0.91	2.80	3.10	0.91	2.80	3.10
Lag = 2						
r = 0	16.52	17.16	21.12	33.49	38.59	50.90
r ≤ 1	12.15	13.35	14.91	16.97	21.44	29.78
r ≤ 2	3.62	4.85	11.26	4.82	8.09	14.88
r ≤ 3	1.20	3.24	3.62	1.20	3.24	3.62

Note : I: The cointegrating equations have no intercepts and the level data have no deterministic trends;
II: The cointegrating equations have intercepts but the level data have no deterministic trends;
III: Both the cointegrating equations and the level data have linear trends.
* indicates that the null hypothesis can be rejected at the 5% significance level.