Volume Title: Commodity Prices and Markets, East Asia Seminar on Economics, Volume 20

Volume Author/Editor: Takatoshi Ito and Andrew K. Rose, editors

Volume Publisher: University of Chicago Press

Volume ISBN: 0-226-38689-9
ISBN13: 978-0-226-38689-8

Volume URL: http://www.nber.org/books/ito_09-1

Conference Date: June 26-27, 2009

Publication Date: February 2011

Chapter Title: The Relationship between Commodity Prices and Currency Exchange Rates: Evidence from the Futures Markets

Chapter Authors: Kalok Chan, Yiuman Tse, Michael Williams

Chapter URL: http://www.nber.org/chapters/c11859

Chapter pages in book: (47 - 71)

2

The Relationship between Commodity Prices and Currency Exchange Rates
Evidence from the Futures Markets

Kalok Chan, Yiuman Tse, and Michael Williams

2.1 Introduction

We examine relationships among currency and commodity futures markets based on four commodity-exporting countries' currency futures returns and a range of index-based commodity futures returns. These four commodity-linked currencies are the Australian dollar, Canadian dollar, New Zealand dollar, and South African rand. We find that commodity/currency relationships exist contemporaneously, but fail to exhibit Granger-causality in either direction. We attribute our results to the informational efficiency of futures markets. That is, information is incorporated into the commodity and currency futures prices rapidly and simultaneously on a daily basis.

There are a few studies on the relationship between currency and commodity prices. A recent study by Chen, Rogoff, and Rossi (2008) using quarterly data finds that currency exchange rates of commodity-exporting countries have strong forecasting ability for the spot prices of the commodities they export. The authors argue that the currency market is price efficient and can incorporate useful information about future commodity price movements. In contrast, the commodities spot market is far less developed than

Kalok Chan is the Synergis-Geoffrey Yeh Professor of Finance and Director of the Centre for Fund Management at the Hong Kong University of Science and Technology, Hong Kong, China. Yiuman Tse is professor of Finance at the University of Texas at San Antonio and a U.S. Global Investors, Inc., research fellow. Michael Williams is a doctoral student at the University of Texas at San Antonio.

We appreciate the comments of Taka Ito, Tokuo Iwaisako, Andy Rose, Doo Yong Yang, and the participants of the 2009 NBER-EASE Conference in Hong Kong. Tse acknowledges the financial support from a summer research grant of U.S. Global Investors, Inc., and the College of Business at the University of Texas at San Antonio.

the exchange rate market. Therefore, exchange rates contain forward-looking information beyond what is already reflected in commodity prices.

However, Chen, Rogoff, and Rossi (2008) use commodity prices from either the spot market or the forward market, both of which are less price efficient than the currency spot market. As a result, their evidence cannot be interpreted as absolute superior information processing ability in the currency exchange market over the commodity market. In this chapter, we extend Chen and colleagues by employing futures market data. Relative to the commodity spot market, the futures market offers more convenient, lower cost trading due to its high liquidity, transparent pricing system, high leverage, and allowance of short positions. We, therefore, expect a higher level of informational efficiency for the futures market.

Another advantage of studying the futures market is that we can use higher-frequency data. Most previous literature examines commodity/currency relationships using lower-frequency data (e.g., Chen, Rogoff, and Rossi [2008] use quarterly data). This allows the previous literature to examine commodity/currency relationships based on business transactions. Using daily data allows us to examine the fast dynamics between commodity prices and currency rates in terms of the information transmission brought about by informed and speculative transactions.

Literature studying commodity/currency relationships began with the Meese-Rogoff Exchange Rate Puzzle, which states that fundamentals-based currency forecasting models cannot outperform random walk benchmarks (Meese and Rogoff 1983). The puzzle thus suggests that no economic fundamental-to-exchange rate relationship exists. An extensive literature following Meese and Rogoff, however, finds contradictions to the Exchange Rate Puzzle (e.g., MacDonald and Taylor 1994; Chinn and Meese 1995; MacDonald and Marsh 1997; Mark and Sul 2001; Groen 2005; and others).

Previous studies often cite three explanations for fundamentals-to-currency relationships in general, and commodity-to-currency relationships in particular. The sticky price model states that commodity price increases lead to inflationary pressures on a commodity-exporting country's real wages, nontraded goods prices, and exchange rate. However, wages and nontraded goods prices are upwards sticky, leading only commodity price increases to impact the country's exchange rate. The efficient relative price between traded and nontraded goods is then restored by the currency appreciation.

The portfolio balance model states that a commodity-exporting country's exchange rate is heavily dependent on foreign-determined asset supply and demand fluctuations. Thus, commodity price increases lead to a balance of payments surplus and an increase in foreign holdings of the country's currency. Both of these factors, in turn, lead to an increase in the relative demand for the country's currency, leading to positive currency returns (see

Chen and Rogoff [2003]; Chen [2004]; and Chen, Rogoff, and Rossi [2008] for further detailed discussions).

The third explanation for commodity-to-currency relationships states that commodity price changes proxy exogenous shocks in a commodity-exporting country's terms-of-trade (Cashin, Cespedes, and Sahay 2003; Chen and Rogoff 2003). Terms-of-trade shocks then lead to a shift in the relative demand for an exporter's currency, which, in turn, leads to changes in that exporter's exchange rate (Chen 2004; Chen, Rogoff, and Rossi 2008).

Currency-to-commodity relationships are explained by changes in macroeconomic expectations embedded within currency prices being incorporated into commodity price changes (Mark 1995; Sephton 1992; Gardeazabal, Regulez, and Vasquez 1997; Engel and West 2005; Klaassen 2005). This is made possible given that exchange rates are forward-looking while commodity prices are based on short-term supply and demand imbalances (Chen, Rogoff, and Rossi 2008). Under this framework, economic expectations embedded within currency prices contain information regarding a commodity exporter's capacity to meet supply expectations. Thus, expectations regarding future commodity conditions can lead to hedging or hoarding behavior, which, in turn, leads to commodity price changes.

Each of the previous models assumes that economic agents adjust their commodity (or currency) holdings based on business activities (i.e., hedging). Additionally, economic agents are capable of capturing incoming commodity/currency information, accurately interpreting that information in light of their business-specific conditions, and then acting according to their needs. While these assumptions likely hold over longer periods of time, it is questionable whether they hold for frequencies as low as one day.

Our study examines short-horizon commodity/currency relationships using two types of restriction-based causality tests as well as a rolling, out-of-sample forecasting methodology. We find no evidence of cross-asset causality or predictive ability in either direction. These results suggest that commodity returns information is rapidly incorporated into currency returns (and vice versa) on a daily level. In light of previous literature, our results also suggest that economic expectations embedded in currency returns are rapidly incorporated into a country's terms-of-trade, which are embedded in commodity returns (and vice versa).

We suggest that daily commodity/currency relationships within futures markets are facilitated by relatively informed speculators and these markets' ability to rapidly incorporate information shocks into prices. As a result, commodity/currency lead-lag relationships are not found over daily horizons given that asymmetric information profits have already been captured by informed speculators.

Many studies provide evidence that the previous explanation is aided by futures markets having an important role in the price discovery process. Specifically, futures prices represent unbiased estimates of future spot prices when markets are efficient. While we do not suggest that markets are perfectly efficient, we do recognize that futures markets provide a large proportion of forward-looking price discovery. As such, market participants look to futures prices for information regarding future spot prices. Note that our analysis is not predicated on futures prices being unbiased estimates of future spot prices. Rather, our analysis is based on a much less restrictive assumption that futures markets provide forward-looking price discovery for spot markets.

Chan (1992) and many others show that futures lead stock index movements. In commodity futures markets, Schwarz and Szakmary (1994) report that futures prices lead spot prices in petroleum markets such as crude oil, heating oil, and unleaded gasoline. Bessler and Covey (1991) find that cattle futures prices provide more price discovery than cattle cash prices. Thus, futures markets provide higher levels of price discovery than spot markets.

Futures markets offer individual and institutional investors the opportunity to trade (for hedging and speculation) in assets that they may not easily access in commodity spot and forward markets. Investors can also readily trade simultaneously in the commodity and currency futures markets on a real time basis. Accordingly, commodities and currencies are more closely linked and more responsive to one another in the futures market than in the spot market.

We continue in section 2.2 with a description of the study's data set and empirical methodology. Section 2.3 reports the study's results while section 2.4 summarizes the study's findings and provides concluding remarks.

2.2 Data and Methodology

We collect daily commodity and currency futures data from Commodity Systems Inc.'s (CSI) database spanning a maximum range from July 28, 1992 to January 28, 2009. We use the active nearby futures contracts where prices are denominated in U.S. dollars. A separate analysis is performed on data denominated in euros. Our results remain qualitatively unchanged, indicating that dollar denomination and dollar effects do not impact our study's results. We avoid using forward contracts because commodity forward contracts are notoriously illiquid. Prior research has reported that currency and commodity futures contracts traded on the Chicago Mercantile Exchange (CME) are liquid and efficient. Moreover, we do not face nonsynchronous trading problems in our analysis given that all CME futures contracts used in this study trade within one hour of each other.

We calculate returns throughout our analysis using the difference in log prices for both commodities and currencies. Given that our data originate from the futures markets, these returns actually represent the excess returns made possible by securing a futures position. Futures contracts do not generally necessitate an initial monetary outlay in order to secure a position (beyond, of course, exchange-specific margin requirements). As such, any gains or losses incurred by a trader are free and clear of additional transactions costs associated with funding requirements and opportunity loss. Any individual or index return mentioned throughout the chapter should be considered as an excess return.

Note that multiple contracts may trade simultaneously in futures markets depending on contract maturity. To determine a contract's price, we select the price of the most active nearby contract before that contract's last trading day. This is done in a "rolling" fashion throughout each contract's data span. We calculate returns for each contract prior to rolling over to the next contract. See, for example, Bessembinder and Chan (1992) and Tse and Booth (1996).

Most previous studies examine commodity/currency relationships using lower-frequency data. Using lower-frequency data allows the previous literature to examine these relationships in the context of business transactions. We use daily data to capture fast dynamics occurring within the futures markets and to focus on the impact of informed and other speculative activity on commodity/currency relationships.

We employ two broad commodity index futures, the S&P GSCI (formerly Goldman Sachs Commodity Index) and the Reuters/Jefferies Commodity Research Bureau (CRB) commodity indices that began trading on July 28, 1992 and March 6, 1996, respectively. While the GSCI contract is more popular than the CRB contract, we include both due to differing index coverage. Among the currency futures, the Japanese yen is the most active contract, followed by the Canadian dollar, Australian dollar, New Zealand dollar, and South African rand.

Investors may not have easy access to many commodity spot markets and, as discussed in Chen, Rogoff, and Rossi (2008), many commodities lack liquid forward markets. However, most of the commodity and currency futures contracts used in this study are actively traded by individual and institutional investors. Thus, our study avoids infrequent trading and liquidity biases that may exist in forward and spot commodity markets.

Rosenberg and Traub (2008) and many others point out that futures markets' wide range of participants (from hedge funds to corporate hedgers and retail traders), centralized location, anonymous trading, and highly transparent trading systems suggest that futures prices can aggregate rich sources of private information. As a result, price discovery is much faster in futures markets. More importantly, daily futures settlement prices are readily available from various futures exchanges and news media. Daily settlement prices are determined by the futures exchange near the close of trading in order to calculate daily profits and losses on investors' positions. These profits and losses are both realized (resulting from actual purchases and sales) and unrealized (resulting from daily marking-to-market revaluations).

Table 2.1 **Sample beginning dates**

	AD	CD	RA	NZ	JY
S&P GSCI Commodity Index	7/29/1992	7/29/1992	5/08/1997	5/08/1997	7/29/1992
CRB Commodity Index	3/07/1996	3/07/1996	5/08/1997	5/08/1997	3/07/1996
Country specific indices	7/29/1992	7/29/1992	5/08/1997	5/08/1997	

Notes: The table reports the beginning dates for each currency/commodity pair. Abbreviations AD, CD, NZ, RA, and JY refer to the Australian dollar, Canadian dollar, New Zealand dollar, South African rand, and Japanese yen, respectively.

All but three futures contracts are traded on the CME Group (Chicago Mercantile Exchange/Chicago Board of Trade/New York Mercantile Exchange Company) based in the United States. The CRB commodity index futures are traded on ICE Futures U.S. (formerly named the New York Board of Trade). Using data predominantly from one exchange has the benefit of avoiding different trading platform and exchange bias.

Lead and zinc futures used to construct country-specific commodity return indices are traded on the London Metals Exchange (LME). We include the two non-U.S. traded commodity futures into these indices given that each contribute a small percentage to the indices' composition. For robustness purposes, we test our results after omitting lead and zinc futures. We find that our results (available on request) are virtually the same, indicating that our results are not affected by multiple exchange bias.

As previously discussed, unlike other studies that employ data of lower frequencies, we use daily data as in Sephton (1992) to account for commodity/currency relationships being sensitive to time aggregation (Klaassen 2005). As shown in table 2.1, there is a variation of the data period for different commodity/currency combinations due to data reporting limitations. In addition to the full sample, we also base our analyses on two subsamples. The first subsample ranges from July 28, 1992 to June 29, 2007, and represents the prefinancial crisis period. The second subsample ranges from July 1, 2007 to January 28, 2009, which covers conditions during the financial crisis. We find that the two subsamples' results are qualitatively similar to the full sample results (see appendix table 2A.1). Examining the subsamples relative to the full sample ensures that our results are not biased by the recent financial crisis that began with the Bear Stearns hedge fund collapse in July 2007.

Australian, Canadian, New Zealand, and South African currencies are often referred to as "commodity currencies," reflecting that the underlying countries are large commodity exporters. According to the World Bank's World Development Indicators database in 2007, commodities contributed a 68 percent share of Australia's total exports, 43 percent for Canada, 71 percent for New Zealand, and 49 percent for South Africa. Raw commodities comprise a significant percentage of these countries' exports such that an increase in commodity prices may directly increase their currency prices. It is worth noting that these countries are still price takers in world markets for most of their commodity exports (Chen and Rogoff 2003).

Given their strong dependence on commodity exports and data availability, we include the aforementioned countries in our analysis. Note that we do not include Chile in our analysis as in Chen, Rogoff, and Rossi (2008), even though Chile is a raw commodity exporter. We omit Chile from the analysis given that peso futures are not available on the CME, and that including non-CME peso futures could introduce exchange bias into the results.

Both the S&P GSCI and Reuters/Jefferies CRB commodity index futures track various commodity sectors including energy, agricultural, livestock, precious metal, and industrial metal products. The GSCI is relatively concentrated in energy commodity futures (approximately 68 percent in May 2009), whereas the CRB is more commodity diverse (39 percent invested in energy futures). Consistent results between the two indices indicate that our results are not sensitive to index basket diversity or focus.

In addition to the two broad commodity indices, we construct daily "country commodity" return indices that proxy changes in a commodity-exporting country's terms-of-trade (Cashin, Cespedes, and Sahay 2003; Chen and Rogoff 2003; Chen 2004). This process begins by identifying commodity series from the CSI database whose export shares are known (IMF Global Financial Database from appendix 1, table-A1 of Chen, Rogoff, and Rossi [2008]). From there, country-specific returns are calculated as the export share-weighted average of individual commodity returns.

In some cases, early sample data are not fully available for a given country returns index. We use export share reweighting in these cases to compensate for the missing series and to prevent return attenuation. Using the post-weights found in table 2.2, the country commodity futures return series for country i at time t consisting of j commodities during unavailable data dates is calculated as follows:

$$\text{Country Commodity Return}_{it} = \sum_j \text{Individual Commodity Return}_{jt} * \left(\frac{w_{ij}}{\sum_j w_{ij}} \right)$$

where the commodity-specific weights (w_{ij}) are reweighted according to data availability.

It is important to note that several futures contracts do not have long data histories. In particular, coal contracts are important components in the Australian and South African country indices, but whose futures data are unavailable until July 12, 2001. Thus, these country indices can only replicate 46.3 percent and 78.0 percent of the true Australian and South African indices, respectively. Moreover, aluminum futures contracts are important components in both the Australian and Canadian indices, yet

Table 2.2 **Export shares**

Australia	Pre	Post
Coal	24.4	34.5
Gold	9.4	13.3
Wheat	8.3	11.7
Aluminum	8.1	11.5
Beef	7.9	11.2
Natural Gas	4.8	6.8
Cotton	2.8	4.0
Copper	2.8	4.0
Zinc	1.5	2.1
Lead	0.7	1.0
Total	70.7	
New Zealand	**Pre**	**Post**
Beef	9.4	36.4
Aluminum	8.3	32.2
Lumber	8.1	31.4
Total	25.8	
Canada	**Pre**	**Post**
Crude Oil	21.4	29.4
Lumber	13.6	18.7
Natural Gas	10.7	14.7
Beef	7.8	10.7
Aluminum	5.0	6.9
Wheat	3.4	4.7
Gold	2.3	3.2
Zinc	2.3	3.2
Copper	2.0	2.7
Coal	1.8	2.5
Hogs	1.8	2.5
Corn	0.5	0.7
Silver	0.3	0.4
Total	72.9	
South Africa	**Pre**	**Post**
Gold	48.0	48.0
Platinum	30.0	30.0
Coal	22.0	22.0
Total	100	

Notes: The table reports pre- and post-weighting export shares for four commodity exporting countries. The pre-weighting column refers to International Monetary Fund (IMF) export shares reported in Chen, Rogoff, and Rossi (2008). The post weighting column refers to IMF export shares that are reweighted based on data availability in the CSI data set. Note that the CSI data set does not include a futures contract on beef. As such, beef returns are proxied by an average of live cattle and feeder cattle returns.

only begin to have consistent data coverage on May 14, 1999. Therefore, our country commodity indices may underrepresent the true indices under full information.

All commodity futures contracts in table 2.2 have consistent trade data after July 12, 2001 for the Australian, Canadian, and South African commodity return indices and after May 14, 1999 for the New Zealand commodity returns index. After these corresponding trading dates, country commodity indices contain an average 70.7 percent, 72.9 percent, and 100 percent of the available commodities for Australia, Canada, and South Africa, respectively. For robustness purposes, we conduct our analyses on a data set that begins on July 29, 1992, as well as a second data set that begins on July 12, 2001 for the Australian, Canadian, and South African return indices, and May 14, 1999 for the New Zealand returns index. We find that the results (i.e., no significant causality and forecasting improvement in all countries) are similar across samples. We summarize these results in appendix tables 2A.2 and 2A.3.

Due to data availability, the New Zealand commodity returns index comprises only 25.8 percent of New Zealand commodity exports. While some New Zealand futures data are available from the Australian Securities Exchange, the twelve-hour lag between U.S. and Australian futures trading may introduce nonsynchronous trading problems. These omitted futures comprise a large percentage of New Zealand's total exports, implying that nonsynchronous bias could be large if these components are included. As such, we trade off likely exchange bias in favor of possible index construction bias.

Unlike previous literature, we use currency futures data to mitigate the impacts of overnight currency transaction interest payments. Specifically, spot rate changes are only one component of currency trading profit. Interest earned (paid) on long (short) currency transactions must be included to accurately estimate profits in currency spot markets. Levich and Thomas (1993), Kho (1996), and many others use currency futures to eliminate the need for overnight interest rate accounting.

Pukthuanthong-Le, Levich, and Thomas (2007) point out the computational advantages of using futures over spot data in forecasting currency returns. Specifically, price trends and returns can be measured simply by the log difference of futures prices given that futures prices reflect contemporaneous interest differentials between a foreign currency and the U.S. dollar. Thus, using futures data allows us to conveniently measure currency returns.

We use two separate analyses to assess causality between commodity and currency returns, which is equivalent to testing semistrong form (cross-asset) efficiency for a given futures contract. The first analysis uses coefficient restriction tests on the following two models to examine currency-to-commodity and commodity-to-currency causal relationships, respectively:

(1) $$\text{Comm}_{j,t} = \alpha_{j,0} + \sum_{k=1}^{5} \beta_{j,k}\text{Comm}_{j,t-k} + \sum_{l=1}^{5} \gamma_{j,l}\text{Curr}_{i,t-l} + \varepsilon_{j,t}$$

(2) $$\text{Curr}_{i,t} = \alpha_{i,0} + \sum_{k=1}^{5} \beta_{i,k}\text{Curr}_{i,t-k} + \sum_{l=1}^{5} \gamma_{i,l}\text{Comm}_{j,t-l} + \varepsilon_{i,t},$$

where $\text{Curr}_{i,t}$ are daily log returns for the *i*th currency at time *t* and $\text{Comm}_{j,t}$ are daily log returns for the *j*th commodity at time *t*.

While our study's aim is cross-asset predictability, we include own-autoregressive lags in both models. This is done for the sake of consistency, as well as the fact that exchange rates can exhibit nontrivial, own serial dependence (Klaassen 2005). Further, including five lags for each variable allows the tests to account for semistrong form (cross-asset) efficiency violations spanning more than one trading day and up to one trading week.

The models shown earlier are estimated using ordinary least squares (OLS) with the Newey-West heteroskedasticity and autocorrelation consistent covariance matrix. For coefficient testing, two restriction tests are employed on the cross-market coefficients, γ, as follows:

$$H_{O,1} : \gamma_1 = \ldots = \gamma_5 = 0$$
$$H_{O,2} : \gamma_1 + \ldots + \gamma_5 = 0.$$

The first test assumes that all cross-market coefficients are jointly equal to zero. The second test assumes that the sum of all cross-market coefficients is equal to zero. In addition, the magnitude (sign) of summed coefficients indicates economic significance (relationship directionality).

Note that our commodity/currency samples span an average of 2,000 to 4,000 trading days. Given such large sample sizes, we use the 1 percent statistical significance level as the significance benchmark, while we also discuss results significant at the 5 percent level. Doing so frees our inferences from concluding that significant commodity/currency relationships exist when, in fact, they do not.

Our second analysis involves comparing rolling out-of-sample forecasts between models 1 and 2 against their respective own-autoregressive benchmark forecasts. Specifically, models 1 and 2 and the following benchmark models are estimated using the first half of each available sample:

(3) $$\text{Comm}_{j,t} = \alpha_{j,0} + \sum_{k=1}^{5} \beta_{j,k}\text{Comm}_{j,t-k} + \varepsilon_{j,t}$$

(4) $$\text{Curr}_{i,t} = \alpha_{i,0} + \sum_{k=1}^{5} \beta_{i,k}\text{Curr}_{i,t-k} + \varepsilon_{i,t}.$$

A one-step ahead, out-of-sample forecast is then computed using the initial estimation. From there, both the beginning and the end of the estimation sample are advanced by one time period while a second one-step ahead, out-of-sample forecast is made. This process continues until the holdout sample is exhausted.

After computing the out-of-sample returns forecasts, Root Mean Square Error (RMSE) percentage differences are calculated as follows:

$$\frac{RMSE_{Model} - RMSE_{Benchmark}}{RMSE_{Benchmark}},$$

where negative (positive) values indicate that a given augmented (benchmark) model provides superior forecasting power relative to a given benchmark (augmented) model. Significant negative values also indicate that a given commodity (currency) return series has predictive power for a given currency (commodity) return series.

Note that other fundamental information exists that may help in explaining exchange rate and commodity price movements, as well as the interlinkages between them. Examples could include economy size (real gross domestic product), export basket diversity, country commodity supply elasticities, and commodity production efficiency measures. However, like Chen, Rogoff, and Rossi (2008), our focus is solely on cross-asset returns predictability at daily intervals. Thus, including other macroeconomic fundamental information would be beyond the scope of our work and would make estimation difficult given that most macroeconomic information is of lower-than-daily frequency.

2.3 Results

2.3.1 Contemporaneous Correlations

Figure 2.1 illustrates monthly futures price movements of the two broad commodity indices and five currencies from July 1992 through January 2009. There is evidence of comovement between the commodity indices and the currencies, although these relationships are less obvious for the South African rand and Japanese yen. We also notice that the commodity and currency futures prices have become more volatile since the second half of 2007.

Panel A of table 2.3 reports cross-asset contemporaneous correlations for the full sample. We find that all commodity-exporting countries' currency returns are contemporaneously correlated with both broad commodity index as well as each respective country-commodity index returns. All correlation coefficients are significantly positive, indicating that commodity price increases are associated with positive currency returns. Australian dollar futures returns are generally more correlated with the broad commodity indices (0.250 with S&P GSCI and 0.412 with CRB) than are other currency futures returns. All other full-sample futures returns also have coefficients

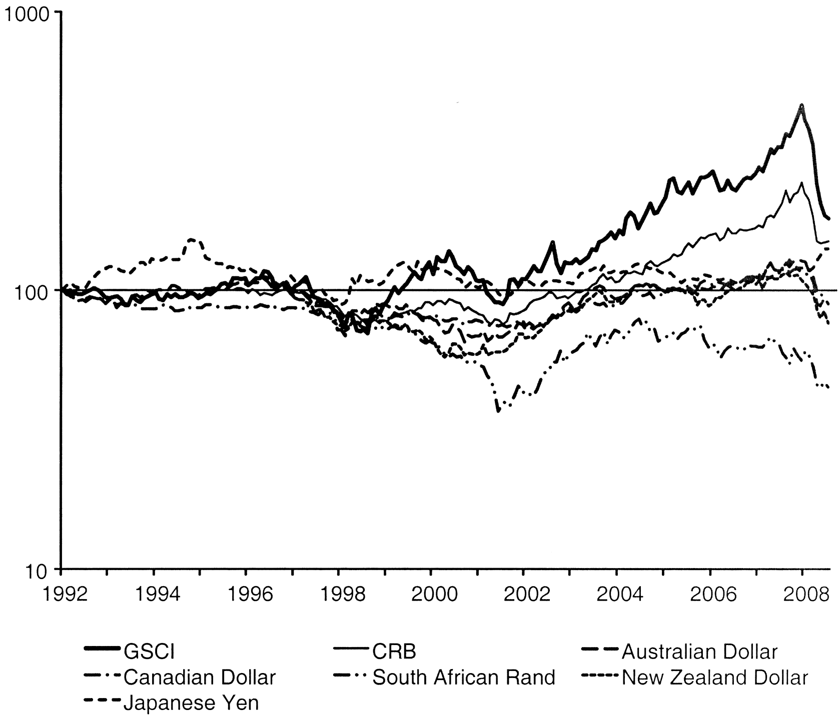

Fig. 2.1 Monthly futures prices, July 1992–January 2009

Notes: This figure reports end-of-the-month futures prices (log scale), each with a scaled starting value of 100 in July 1992. The price series are the S&P GSCI commodity index, CRB commodity index, AD (Australian dollar), CD (Canadian dollar), AR (South African rand), NZ (New Zealand dollar), and JY (Japanese yen).

larger than 0.20 with both indices, except for the relationship between the rand and GSCI (0.162).

We also find that yen returns are not correlated with the two broad commodity index returns (0.001 and 0.055). One may wonder why little correlation exists for the yen given that Japan is heavily dependent on commodity imports. One explanation for this is that the yen was used in the carry trade over the past decade and is a "safe harbor" currency during times of crisis. Thus, the yen being linked to significant nonimport price pressures may reduce its comovement with commodity prices. A second explanation may be that contemporaneous commodity/currency relationships only exist for heavy commodity exporters as opposed to importers.

Of particular note is the fact that while statistically significant, the correlation magnitude for the New Zealand dollar and its country-commodity returns index (0.163) is lower than for the other pairs (0.319 for Australia, 0.225 for Canada, and 0.225 for South Africa). The low correlation for New

Table 2.3 Contemporaneous correlations

	AD	CD	RA	NZ	JY
	A. Full sample (7/29/1992 or later to 1/28/2009)				
S&P GSCI Commodity Index	0.250	0.261	0.162	0.214	0.001
CRB Commodity Index	0.412	0.375	0.266	0.349	0.055
Country specific indices	0.319	0.225	0.225	0.163	
	B. Sub-sample (7/29/1992 or later to 6/29/2007)				
S&P GSCI Commodity Index	0.133	0.136	0.073	0.102	0.056
CRB Commodity Index	0.290	0.239	0.178	0.237	0.157
Country specific indices	0.213	0.122	0.185	0.074	

Notes: The tables report contemporaneous correlations between various commodity and currency returns. Abbreviations AD, CD, RA, NZ, and JY refer to the Australian dollar, Canadian dollar, South African rand, New Zealand dollar, and Japanese yen currency return series, respectively. All correlations are statistically different from zero at the 1 percent significance level except for the full sample GSCI/JY pair.

Zealand may be a result of index construction. As seen in table 2.2, our New Zealand commodity returns index comprises only 25.8 percent of the IMF export shares.

The GSCI and CRB commodity indices are highly cross-correlated (0.710). The significance of this relationship can be explained by both indices tracking the same major commodity categories. The lack of perfect correlation suggests that different index allocations lead each index to reflect different commodity return aspects. This latter fact affirms that our use of the two indices is not an exercise in redundancy.

Panel B shows that the correlation coefficients between commodity and currency returns decrease substantially during the subsample, although the results are still significant at the 1 percent level. For instance, the correlation coefficient between the Australian dollar and the GSCI index is 0.133, 0.290 for the CRB, and 0.213 for the Australian commodity index returns. These results suggest that the financial crisis had some marginal, but not statistically significant, impact on commodity/currency relationships.

It is also worth noting that correlations between the currency futures and the country-specific commodity return indices are generally higher if the sample starts from the day when all of the component commodities have started trading (i.e., July 12, 2001 for Australia, Canada, and South Africa and May 14, 1999 for New Zealand; see panel A of table 2A.2 in the appendix). Given that correlations are still significant, these results indicate that data availability only impacts country index construction in a marginal, nonsignificant manner.

2.3.2 Currency-to-Commodity Lead-Lag Relationships

Table 2.4 reports the results of cross-market coefficient restriction tests on currency-to-commodity return relationships. Panels A and B report zero-

Table 2.4 **Currency-to-commodity Granger causality tests**

	AD	CD	RA	NZ
A. P-values of cross-market zero-coefficient tests, full sample				
S&P GSCI Commodity Index	0.721	0.654	0.477	0.780
CRB Commodity Index	0.419	0.551	0.378	0.957
Country specific indices	0.847	0.407	0.979	0.258
B. P-values of cross-market zero-coefficient tests, subsample				
S&P GSCI Commodity Index	0.381	0.784	0.661	0.900
CRB Commodity Index	0.065	0.309	0.434	0.731
Country specific indices	0.362	0.645	0.393	0.874
C. Sum of cross-market coefficients, full sample				
S&P GSCI Commodity Index	0.152	0.009	0.138	0.009
CRB Commodity Index	0.104	0.069	0.087	0.019
Country specific indices	0.056	0.044	0.030	0.073
D. Sum of cross-market coefficients, subsample				
S&P GSCI Commodity Index	0.153	0.004	0.066	0.102
CRB Commodity Index	0.121**	0.096	0.056	0.030
Country specific indices	0.079	0.094	–0.034	0.040

Notes: The tables report coefficient restriction tests on the following OLS estimated model:

$$\text{Comm}_{j,t} = \alpha_{j,0} + \sum_{k=1}^{5} \beta_{j,k}\text{Comm}_{j,t-k} + \sum_{l=1}^{5} \gamma_{j,l}\text{Curr}_{i,t-l} + \varepsilon_{j,t}$$

In each panel, AD, CD, RA, and NZ refer to the Australian dollar, Canadian dollar, South African rand, and New Zealand dollar return series, respectively. The sample period starts on July 29, 1992 (or later depending on data availability; see Table 2.1, Panel A) and ends on January 28, 2009 for the full sample (June 29, 2007 for the subsample). *P*-values are reported for the cross-market zero-coefficient results while the sum of cross-market coefficients are reported for the coefficient-sum results.

***Significant at the 1 percent level.

**Significant at the 5 percent level.

coefficient restriction test *p*-values for the full and subsamples, respectively. We find that no significant currency-to-commodity relationships exist. The lowest *p*-value is 0.065 for the subsample Australian dollar-CRB index relationship.

Panels C and D report the sum of cross-market coefficients for the full and subsamples, respectively. Again, we find little evidence of currency-to-commodity relationships for commodity-exporting countries. The only exception to this finding is the Australian dollar-to-CRB index relationship. This sum is 0.121 and is significant at the 5 percent, but not 1 percent level.

Note that the previous relationships are reexamined using ten lags for both commodities and currencies. We find that results throughout the chapter remain qualitatively unchanged between the two model specifications (results available on request). This finding indicates that the results in table 2.4 are robust to lag specification.

Table 2.5 **Currency-to-commodity forecasting results**

	AD (%)	CD (%)	RA (%)	NZ (%)
A. RMSE percentage differences, full sample				
S&P GSCI Commodity Index	–0.06	–0.20	0.85	1.06
CRB Commodity Index	0.88	1.35	0.80	1.05
Country specific indices	0.27	0.04	0.29	–0.09
B. RMSE percentage differences, subsample				
S&P GSCI Commodity Index	–1.33	–1.25	0.06	0.97
CRB Commodity Index	–0.66	0.16	–1.10	–0.24
Country specific indices	0.14	–0.02	0.26	0.29

Notes: The tables report RMSE percentage differences between a currency-augmented commodity forecasting model

$$\text{Comm}_{j,t} = \alpha_{j,0} + \sum_{k=1}^{5} \beta_{j,k}\text{Comm}_{j,t-k} + \sum_{l=1}^{5} \gamma_{j,l}\text{Curr}_{i,t-l} + \varepsilon_{j,t},$$

and an own-autoregressive forecasting model

$$\text{Comm}_{j,t} = \alpha_{j,0} + \sum_{k=1}^{5} \beta_{j,k}\text{Comm}_{j,t-k} + \varepsilon_{j,t}.$$

Each model is estimated using OLS with the first half of available data while rolling, out-of-sample forecasts are computed for the remaining half. Negative (positive) values indicate that the currency-augmented commodity (benchmark) forecasting model is superior to the benchmark (currency-augmented commodity) forecasting model. In each panel, AD, CD, RA, and NZ refer to the Australian dollar, Canadian dollar, South African rand, and New Zealand dollar return series, respectively. The sample period starts on July 29, 1992 (or later, depending on data availability) and ends on January 28, 2009 for the full sample and June 29, 2007 for the subsample.

Table 2.5 compares out-of-sample forecasting accuracy between currency-augmented commodity forecasting models and their own-autoregressive commodity forecasting benchmarks. Panels A and B report RMSE percentage differences for the full and subsamples, respectively. We find that RMSE percentage differences are mixed with respect to sign, but are all economically insignificant. The greatest forecasting improvement is still less than 5 percent. Insignificant differences suggest that currency returns are not capable of forecasting future commodity returns. In other words, daily currency returns do not possess causal relationships with commodity returns.

Chen, Rogoff, and Rossi (2008) find that currency returns are able to predict future broad commodity index returns at quarterly frequencies. Based on the present-value model of exchange rate determination (Campbell and Shiller 1987; Engel and West 2005), they argue that the currency exchange rate can predict economic fundamentals because the currency rate reflects expectations of future changes in its fundamentals. Specifically, currency rates are forward-looking while commodity prices are focused on short-run supply and demand conditions. As a result, forward-looking currency exchange rates can predict commodity prices.

A refinement of their explanation for currency-to-commodity relationships may be in macroeconomic expectations leading to changes in a country's terms-of-trade. Currency returns' forward-looking nature suggest that they contain economic expectations information (Mark 1995; Sephton 1992; Gardeazabal, Regulez, and Vazquez 1997; Engel and West 2005; Klaassen 2005). Commodity returns, on the other hand, contain information regarding a commodity exporter's terms-of-trade, given that commodity price shocks originate from exogenous, international markets and that these exporters are world-price takers (Cashin, Cespedes, and Sahay 2003; Chen and Rogoff 2003; Chen 2004).

Under the aforementioned framework, economic expectations embedded within currency returns contain information regarding a commodity exporter's capacity to meet exporting expectations. While this exporter is likely a price taker, commodity market elasticity conditions imply that small supply imbalances induce high price responses (Chen, Rogoff, and Rossi 2008). Thus, expectations regarding future commodity conditions could lead to commodity transactions and, therefore, commodity price changes.

We suggest that the incorporation of economic expectations into trade terms takes place over intervals shorter than what economic agents need to alter their commodity positions after an exchange rate shock. These short-run intervals are, however, of sufficient length for commodity speculators to profit from economic expectations information embedded in currency prices. These speculators have greater information interpretation abilities relative to the average economic agent and, therefore, are able to capture asymmetric information profits. Given commodity futures markets' ability to rapidly incorporate information, speculative activity brings about rapid currency (economic expectations) to commodity (terms-of-trade) comovement.

Note that our explanation does not contradict previous findings of long-horizon commodity/currency relationships. Rather, we make a distinction between speculative versus business commodity transactions. The former transaction takes place over daily frequencies in liquid futures markets and involves informed traders profiting from superior information collection and processing skills. The latter transaction takes place over much longer time frames, and involves relatively uninformed agents adjusting commodity positions according to their economic outlooks.

2.3.3 Commodity-to-Currency Lead-Lag Relationships

Table 2.6 reports cross-market coefficient restriction causality tests for commodity-to-currency return relationships. Panels A and B report zero-coefficient restriction test p-values for the full and subsamples, respectively. We find little evidence that commodities cause currency returns. Two pos-

Table 2.6 **Commodity-to-currency granger causality tests**

	AD	CD	RA	NZ
A. P-values of cross-market zero-coefficient tests, full sample				
S&P GSCI Commodity Index	0.196	0.029	0.817	0.258
CRB Commodity Index	0.264	0.098	0.671	0.260
Country specific indices	0.011	0.043	0.828	0.995
B. P-values of cross-market zero-coefficient tests, subsample				
S&P GSCI Commodity Index	0.167	0.738	0.396	0.088
CRB Commodity Index	0.433	0.288	0.188	0.052
Country specific indices	0.070	0.590	0.704	0.823
C. Sum of cross-markets coefficients, full sample				
S&P GSCI Commodity Index	0.033	0.045***	–0.016	0.019
CRB Commodity Index	0.077	0.057	–0.070	0.066
Country specific indices	0.130***	0.052***	–0.031	0.019
D. Sum of cross-markets coefficients, subsample				
S&P GSCI Commodity Index	0.011	0.019	–0.008	–0.021
CRB Commodity Index	0.011	–0.007	–0.083	0.000
Country specific indices	0.095**	0.020	–0.050	–0.018

Notes: The tables report coefficient restriction tests on the following OLS estimated model:

$$\text{Curr}_{i,t} = \alpha_{i,0} + \sum_{k=1}^{5} \beta_{i,k}\text{Curr}_{i,t-k} + \sum_{l=1}^{5} \gamma_{i,l}\text{Comm}_{j,t-l} + \varepsilon_{i,t}.$$

In each panel, AD, CD, RA, and NZ refer to the Australian dollar, Canadian dollar, South African rand, and New Zealand dollar return series, respectively. The sample period starts on July 29, 1992 (or later, depending on data availability) and ends on January 28, 2009 for the full sample and June 29, 2007 for the subsample. *P*-values are reported for the cross-market zero-coefficient results while the sum of cross-market coefficients are reported for the coefficient-sum results.

***Significant at the 1 percent level.

**Significant at the 5 percent level.

sible exceptions to this finding are the Australian returns index-to-Australian dollar and the Canadian returns index-to-Canadian dollar relationships. While these relationships are significant at the 5 percent level in the full sample (*p*-values of 0.011 and 0.043 for the Australian-index and Canadian-index, respectively), they are not significant in the subsample (*p*-values of 0.070 and 0.590, respectively).

Panels C and D report the sum of cross-market coefficients. There is no evidence of significant daily lead-lag, commodity-to-currency relationships. Neither broad nor country-specific commodity returns can consistently explain future currency returns. The sums of coefficients are generally economically insignificant. Two exceptions are, again, the Australian returns index-to-Australian dollar and the Canadian returns index-to-Canadian dollar causal relationships. Both of these relationships are significant at the 1 percent level in the full sample, but only the former relationship is significant

Table 2.7 **Commodity-to-currency forecasting results**

	AD (%)	CD (%)	RA (%)	NZ (%)
A. RMSE percentage differences, full sample				
S&P GSCI Commodity Index	0.32	–0.02	0.22	0.21
CRB Commodity Index	0.54	0.05	0.34	0.50
Country specific indices	–0.29	–0.07	0.14	0.14
B. RMSE percentage differences, sub-sample				
S&P GSCI Commodity Index	0.59	0.00	–0.23	–0.55
CRB Commodity Index	–0.17	–0.49	–1.10	–0.72
Country specific indices	–0.04	0.00	0.15	0.17

Notes: The tables report RMSE percentage differences between a commodity-augmented currency forecasting model

$$\text{Curr}_{i,t} = \alpha_{i,0} + \sum_{k=1}^{5} \beta_{i,k}\text{Curr}_{i,t-k} + \sum_{l=1}^{5} \gamma_{i,l}\text{Comm}_{j,t-l} + \varepsilon_{i,t},$$

and an own-autoregressive forecasting model

$$\text{Curr}_{i,t} = \alpha_{i,0} + \sum_{k=1}^{5} \beta_{i,k}\text{Curr}_{i,t-k} + \varepsilon_{i,t}.$$

Each model is estimated using OLS with the first half of available data while rolling, out-of-sample forecasts are computed for the latter half. Negative (positive) values indicate that the commodity-augmented currency (benchmark) forecasting model is superior to the benchmark (commodity-augmented currency) forecasting model. In each panel, AD, CD, RA, and NZ refer to the Australian dollar, Canadian dollar, South African rand, and New Zealand dollar return series, respectively. The sample period starts on July 29, 1992 (or later, depending on data availability) and ends on January 28, 2009 for the full sample and June 29, 2007 for subsample.

at the 5 percent level in the subsample. Moreover, only the Australian returns index-to-Australian dollar results are moderately economically significant given that the sum of cross-asset coefficients is 0.130 and 0.095 for the full and subsamples, respectively.

Table 2.7 reports forecasting accuracy results between commodity-augmented currency return models and own-autoregressive currency benchmarks. We find that commodity returns are rarely capable of increasing out-of-sample forecasting accuracy for currency returns, relative to own-autoregressive models. Like the currency-to-commodity forecasting results in table 2.5, no improvement for the commodity-to-currency forecasting is larger than 5 percent. In other words, we find evidence that commodity returns do not lead currency returns at relatively short time intervals. Our results are consistent across sample selection, indicating that these results are robust to both index construction and the effects of the financial crisis.

For comparison purposes, we repeat the causality and forecasting analyses on Japanese yen-to-broad commodity index returns to assess if currency-to-commodity relationships exist for a noncommodity exporting country. As in the correlation analysis, we find no significant links between the yen and broad commodity index returns. Again, these results are not surprising given that Japan is not a major raw commodity exporter, and that the yen is used for both carry trade and risk mitigation purposes.

The commodity-to-currency causality and forecasting results in tables 2.6 and 2.7 indicate the efficient information transmission between the commodity and currency markets. This market efficiency also suggests that the terms-of-trade information embedded within commodity returns is rapidly incorporated into the economic expectations embedded in a commodity-exporting country's currency returns.

Theoretical models discussed in the introduction suggest the causal relationship between commodity prices and currency exchange rates. While these models (particularly the sticky price model and portfolio balance model) provide adequate commodity-to-currency explanations over longer time frames, they likely do not hold over shorter intervals in liquid futures markets. The reason for this is that each model requires economic agents to make currency transactions in response to exogenous stimuli. However, the average economic agent will not likely recognize and incorporate economic expectations into their business decisions over very short time intervals.

The lack of commodity-to-currency causal relationships at daily intervals does not, however, preclude rapid information transfers between asset classes as we suggest. In this case, speculators in futures markets rapidly incorporate terms-of-trade information into economic expectations over intraday time frames, while other economic agents cause long-horizon commodity-to-currency relationships through their business-necessitated activity.

Overall, we do not find significant causality and forecasting power between the currency and commodity futures markets in both directions and in both the full and subperiods. If anything, the Australian commodity returns index Granger-causes the Australian dollar in the full period analysis, while we find no forecasting improvement. All pairs of commodity and currency futures are significantly and contemporaneously correlated.

In the context of a broader literature, our findings have implications on the present-value model of exchange rate determination. The present-value model states that a given exchange rate can be represented as the discounted sum of its expected (exogenous) fundamentals. Chen, Rogoff, and Rossi (2008) find Granger-causal relationships from exchange rates to commodity prices over quarterly intervals using spot market data. We, however, find no Granger-causality between the commodity and currency markets using daily futures data. Thus, we provide preliminary evidence that the present-value model of exchange rate determination may not hold for daily durations in the highly efficient exchange rate futures markets.

2.4 Conclusions

We examine short-run commodity/currency relationships in four commodity-exporting countries (Australia, Canada, New Zealand, and South Africa) using restriction-based causality tests and a rolling out-of-sample forecasting analysis. We use daily futures prices from July 1992 through January 2009. While investors do not have easy access to many commodity spot and forward markets, they can readily trade in futures markets. They can even speculate on the commodity and currency futures prices simultaneously on a real time basis.

We find that commodity exporting countries' currency returns are contemporaneously correlated with both broad and country-specific commodity return indices. In contrast, commodity returns do not share causal relationships with currency returns, nor are commodity returns capable of predicting future daily currency returns (and vice versa). These results show that commodity prices and currency exchange rates are closely related, but the lead-lag relationship disappears within a day. In light of previous literature, we conclude that commodity-exporting countries' terms-of-trade information embedded in commodity returns is rapidly incorporated into these countries' economic expectations, which are embedded in their exchange rates (and vice versa).

Our results are different from Chen, Rogoff, and Rossi (2008) who use quarterly spot data. They find that currency exchange rates can remarkably forecast commodity prices, suggesting that currency rates contain information beyond what has been reflected in commodity prices. However, their findings may be a result of the less informationally efficient commodity spot markets.

In our chapter, the rapid information transmission between the commodity and currency markets is a result of informed traders using futures markets to profit from expectations/trade-term information. Previous literature notes that futures markets in general, and commodity futures markets in particular, take price leadership roles with respect to spot markets. This is because futures markets are active, transparent, of low transaction costs, have no short-selling constraints, and allow traders the ability to speculate simultaneously in both commodity and currency futures contracts. Thus, the very nature of futures markets allows informed traders the ability to rapidly incorporate economic expectations (currency return information) into commodity-exporting countries' trade-terms (commodity returns, and vice versa).

For future research, we suggest examining individual commodity futures to individual currency futures relationships. Of particular interest among practitioners is the relationship between the Australian dollar and gold, and the relationship between the Canadian dollar and crude oil (see Lien 2008). Another avenue for further study is how monetary policy and real interest rates impact commodity/currency relationships. Frankel (2005, 2006) and Blanch (2008) note that U.S. monetary policy has significant impacts on commodity prices. It would also be interesting to examine whether investor psychology motivates commodity/currency relationships. An example would be whether increased investor opportunism or risk appetite entices investors into both the commodity and high-yielding currency futures markets. All this warrants future research.

Appendix

Table 2A.1 Contemporaneous correlations, restriction and forecasting accuracy tests for the crisis only sample

		Currency-to-Commodity			Commodity-to-Currency		
	Rho	Zero-Coef.	Sum-Coef.	RMSE % Diff	Zero-Coef.	Sum-Coef.	RMSE % Diff
AD							
S&P GSCI	0.509***	0.907	0.186	3.16	0.666	0.096	2.49
CRB	0.590***	0.939	0.045	4.04	0.696	0.235	2.42
Country index	0.518***	0.820	–0.027	4.42	0.304	0.235	–0.56
CD							
GI	0.537***	0.244	–0.122	–0.82	0.070	0.142**	0.01
CRB	0.586***	0.240	–0.130	2.88	0.312	0.188	2.34
Country index	0.508***	0.450	–0.099	–0.39	0.073	0.178	–0.14
RA							
GI	0.390***	0.426	0.338	0.54	0.868	–0.086	6.04
CRB	0.451***	0.544	0.155	2.26	0.854	–0.117	5.85
Country index	0.338***	0.537	0.198	–2.85	0.938	–0.008	4.36
NZ							
GI	0.459***	0.958	–0.060	2.22	0.100	0.144	–1.15
CRB	0.548***	0.948	–0.129	4.26	0.557	0.212	1.52
Country index	0.429***	0.141	0.052	–0.59	0.541	0.132	0.46

Notes: The table reports contemporaneous correlations (rho), zero-sum coefficient restriction test *p*-values, summed cross-asset coefficients, and RMSE percentage differences for currency-to-commodity and commodity-to-currency relationships for the crisis only period. This sample spans July 1, 2007 to January 28, 2009. Abbreviations AD, CD, RA, and NZ refer to the Australian dollar, Canadian dollar, South African rand, and New Zealand dollar return series, respectively.

***Significant at the 1 percent level.

**Significant at the 5 percent level.

Table 2A.2 Contemporaneous correlations and currency-to-commodity sample robustness

	AD	CD	NZ	RA
A. Sample ranges and contemporaneous correlations between currency and country Index				
Sample A				
Beginning	7/12/2001	7/12/2001	5/14/1999	7/12/2001
Ending	1/28/2009	1/28/2009	1/28/2009	1/28/2009
Corr. coeff.	0.393	0.332	0.265	0.161
Sample B				
Beginning	7/12/2001	7/12/2001	5/14/1999	7/12/2001
Ending	6/29/2007	6/29/2007	6/29/2007	6/29/2007
Corr. coeff.	0.239	0.193	0.230	0.063
B. P-values of cross-market zero-Coefficient tests				
Country indices (sample A)	0.746	0.433	0.976	0.287
Country indices (sample B)	0.331	0.408	0.641	0.405
C. Sum of cross-markets coefficients				
Country indices (sample A)	0.015	0.025	0.046	0.019
Country indices (sample B)	0.031	0.132	–0.008	0.027
D. RMSE percentage differences				
Country indices (sample A)	–1.31%	–0.32%	0.25%	–1.71%
Country indices (sample B)	–5.60%	–2.36%	0.20%	–1.48%

Notes: The tables report robustness results for currency-to-commodity relationships across two samples not included in the previous discussions. Panel A reports sample date ranges. Panel B reports cross-market zero-coefficient Granger Causality test *p*-values, while Panel C reports the summed coefficients of cross-market variables as well as indicators of statistical significance. Panel D reports RMSE percentage differences of currency-augmented commodity forecasting models relative to own-autoregressive commodity benchmarks. In each panel, AD, CD, RA, and NZ refer to the Australian dollar, Canadian dollar, South African rand, and New Zealand dollar return series, respectively. The beginning date of each sample corresponds to when a given country-commodity return index's individual commodity components were all trading. The end of Sample B corresponds to the (approximate) beginning of the world financial crisis.

Table 2A.3 **Commodity-to-currency sample robustness**

	AD	CD	NZ	RA
	A. Sample Date Ranges			
Sample A				
Beginning	7/12/2001	7/12/2001	5/14/1999	7/12/2001
Ending	1/28/2009	1/28/2009	1/28/2009	1/28/2009
Sample B				
Beginning	7/12/2001	7/12/2001	5/14/1999	7/12/2001
Ending	6/29/2007	6/29/2007	6/29/2007	6/29/2007
	B. P-values of Cross-market Zero-Coefficient Tests			
Country index (sample A)	0.038	0.019	0.891	0.956
Country index (sample B)	0.118	0.603	0.841	0.932
	C. Sum of cross-markets coefficients			
Country index (sample A)	0.148**	0.083	–0.051	0.029
Country index (sample B)	0.083	0.020	–0.092	–0.011
	D. RMSE percentage differences			
Country index (sample A)	–0.33%	0.17%	0.68%	0.44%
Country index (sample B)	1.66%	0.86%	0.80%	0.40%

Notes: The tables report robustness results for commodity-to-currency relationships across two samples not included in the previous discussions. Panel A reports sample date ranges. Panel B reports cross-market zero-coefficient Granger Causality test *p*-values, while Panel C reports the summed coefficients of cross-market variables as well as indicators of statistical significance. Panel D reports RMSE percentage differences of commodity-augmented currency forecasting models relative to own-autoregressive currency benchmarks. In each panel, AD, CD, RA, and NZ refer to the Australian dollar, Canadian dollar, South African rand, and New Zealand dollar return series, respectively. The beginning date of each sample corresponds to when a given country-commodity return index's individual commodity components were all trading. The end of Sample B corresponds to the (approximate) beginning of the world financial crisis.

***Significant at the 1 percent level.

**Significant at the 5 percent level.

References

Bessembinder, H., and K. Chan. 1992. Time-varying risk premia and forecastable returns in futures markets. *Journal of Financial Economics* 32 (2): 169–94.

Bessler, D. A., and T. Covey. 1991. Cointegration: Some results on U.S. cattle prices. *Journal of Futures Markets* 11 (4): 461–74.

Blanch, F. 2008. Insight: Commodities rally driven by fundamentals, not speculators. *Financial Times,* June 24. Available at: http://www.ft.com.

Campbell, J. Y., and R. J. Shiller. 1987. Cointegration and tests of present value models. *Journal of Political Economy* 95 (5): 1062–88.

Cashin, P., L. Cespedes, and R. Sahay. 2003. Commodity currencies: Developing countries reliant on commodity exports see the fate of their exchange rates tied to fickle commodity markets. *Finance and Development* 40 (1): 45–8.

Chan, K. 1992. A further analysis of the lead-lag relationship between the cash market and stock index futures market. *Review of Financial Studies* 5:123–52.

Chen, Y. 2004. Exchange rates and fundamentals: Evidence from commodity econo-

mies. Unpublished Working Paper. University of Washington, Department of Economics. Unpublished Working Paper.
Chen, Y., and K. Rogoff. 2003. Commodity currencies. *Journal of International Economics* 60:133–60.
Chen, Y., K. Rogoff, and B. Rossi. 2008. Can exchange rates forecast commodity prices? NBER Working Paper no. 13901. Cambridge, MA: National Bureau of Economic Research, March.
Chinn, M. D., and R. A. Meese. 1995. Banking on currency forecasts: How predictable is change in money? *Journal of International Economics* 38:161–78.
Engel, C., and K. D. West. 2005. Exchange rates and fundamentals. *Journal of Political Economy* 113:485–517.
Frankel, J. 2005. How interest rates cast a shadow over oil. *Financial Times,* April 14. Available at: http://www.ft.com.
———. 2006. The effect of monetary policy on real commodity prices. In *Asset prices and monetary policy,* ed. John Campbell, 291–334. Chicago: University of Chicago Press.
Gardeazabal, J., M. Regulez, and J. Vazquez. 1997. Testing the canonical model of exchange rates with unobservable fundamentals. *International Economic Review* 38:389–404.
Groen, J. J. J. 2005. Exchange rate predictability and monetary fundamentals in a small multi-country panel. *Journal of Money, Credit, and Banking* 37:495–516.
Kho, B.-C. 1996. Time-varying risk premia, volatility, and technical trading rule profits: Evidence from foreign currency futures markets. *Journal of Financial Economics* 41:249–90.
Klaassen, F. 2005. Long swings in exchange rates: Are they really in the data? *Journal of Business and Economic Statistics* 23:87–95.
Levich, R. M., and L. R. Thomas III. 1993. The significance of technical trading rules in the FX market: A bootstrap approach. *Journal of International Money and Finance* 12:451–74.
Lien, K. 2008. *Day trading and swing trading the currency market: Technical and fundamental strategies to profit from market moves* (2nd ed.). Hoboken, NJ: Wiley Trading.
MacDonald, R., and I. W. Marsh. 1997. On fundamentals and exchange rates: A Casselian perspective. *Review of Economics and Statistics* 79:655–64.
MacDonald, R., and M. P. Taylor. 1994. The monetary model of exchange rate: Long-run relationships, short-run dynamics and how to beat a random walk. *Journal of International Money and Finance* 13:276–90.
Mark, N. C. 1995. Exchange rates and fundamentals: Evidence on long-horizon predictability. *American Economic Review* 85:201–18.
Mark, N. C., and D. Sul. 2001. Nominal exchange rates and monetary-fundamentals: Evidence from a small post-Bretton Woods sample. *Journal of International Economics* 53:29–52.
Meese, R. A., and K. Rogoff. 1983. Empirical exchange rate models of the seventies: Do they fit out-of-sample? *Journal of International Economics* 14:3–24.
Pukthuanthong-Le, K., R. M. Levich, and L. R. Thomas III. 2007. Do foreign exchange markets still trend? *Journal of Portfolio Management* 34:114–18.
Rosenberg, J. V., and L. G. Traub. 2008. *Price discovery in the foreign currency futures and spot market.* Federal Reserve Bank of New York Staff Reports no. 262. New York.
Schwarz, T. V., and A. C. Szakmary. 1994. Price discovery in petroleum markets: Arbitrage, cointegration, and time interval of analysis. *Journal of Futures Markets* 14:147–67.

Sephton, P. S. 1992. Modeling the link between commodity prices and exchange rates: The tale of daily data. *Canadian Journal of Economics* 25:156–71.
Tse, Y., and G. G. Booth. 1996. Risk premia in foreign currency futures: A reexamination. *Financial Review* 31:521–34.

Comment Tokuo Iwaisako

Present value formulation of exchange rates is impeccable as a theory. However, its practical importance has always been questioned, because it seems to be nearly impossible to address the issue of simultaneity between the exchange rate and fundamentals in a persuasive manner. The recent paper by Chen, Rogoff, and Rossi (2008, hereafter CRR) tackles this issue using world commodity prices as an exogenous variable with which to cut through macroeconomics where endogeneity is normally considered to be a problem. Chen, Rogoff, and Rossi present surprisingly strong evidence that foreign exchange values of commodity exporting countries ("commodity currencies") help to predict the prices of the commodities they export in spot/forward markets.

Two chapters in this volume, the chapter by Chan, Tse, and Williams, and the chapter by Groen and Pesanti, ask if the finding in CRR (2008) is really robust. In particular, Chan, Tse, and Williams argue that the predictability that CRR (2008) reports disappears if data on commodity futures are used. However, they also find that contemporaneous correlations between commodity prices and commodity currencies are generally very strong.

At first glance, the contrast between the empirical results in CRR (2008) and Chan, Tse, and Williams seems stark. However, once we realize the different natures of spot, forward, and futures markets of commodities, the difference between the two empirical results is not so surprising. While spot and forward commodity markets are dominated by transactions directly related to the transaction of real goods, commodity futures markets are essentially financial markets, dominated by investors/speculators. Hence, the arbitrage mechanism is expected to work more effectively in futures markets than in the other two types of commodity markets.

While I believe that the main findings by Chan, Tse, and Williams are persuasive and robust, we have to be careful in accepting their empirical results. First, there are some important differences between this chapter's data and those of other studies. While this chapter uses daily data, CRR and Groen and Pesanti use lower-frequency data. Also, the authors use a sample period

Tokuo Iwaisako is the principal economist of the Policy Research Institute, Ministry of Finance, Government of Japan, and a visiting researcher at the Institute of Economic Research, Hitotsubashi University.