The Volatility Transmission of Gold around the World

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Abstract

This paper studies how one gold market affects another gold market in a different time zone, using the daily data from the Hong Kong, London, and New York markets over the period 2000-2005. When using the variable of intraday returns in regressions, we find that the Hong Kong market does not affect the London market, which has no impact on the New York market, which, in turn, does not affect the Hong Kong market. This finding is consistent with the theory of market efficiency because the intraday performance of one gold market cannot predict the intraday performance of another gold market that trades subsequently. However, when using the variable of intraday return volatility in regressions, we find that the Hong Kong market positively affects the London market, that the London market positively affects the New York market, and that the New York market positively affects the Hong Kong market. This new evidence contributes to the existing literature in financial market integration by suggesting that there are high degrees of volatility linkages between the Hong Kong, London, and New York gold markets.

I. Introduction

Academics, practitioners, and regulators have long been interested in the degree to which national financial markets are interrelated. Studies of this topic typically focus on the examinations of portfolio diversification, the co-movements of equity prices, or the lead-lag relationships among national stock market indexes. Earlier research on the synchronization among equity prices across different countries [e.g., Grubel 1968; Levy and Sarnat 1970; Agmon 1972; Ripley 1973; Hilliard 1979; and others] explores the benefits of international diversification in reducing portfolio risk. Using weekly or monthly return data, most studies find that return correlations across countries are low or statistically insignificant.

Research in the 1980s on market interdependence examines the linkages of international equity markets using higher-frequency data. Jaffe and Westerfield (1985), using daily closing prices for five countries, find that return correlations between the U.S. and four other national markets are generally positive and significant for each day of the week. Schollhammer and Sand (1985) study the co-movements of stock market indices of major European countries and the U.S. Contrary to the findings of previous research, a significant degree of interdependence is found between the stock prices of Germany, the UK, the Netherlands, and Switzerland. In addition, a change in the US stock price index normally leads to a same-direction change of all the European markets except Italy. Eun and Shim (1989) use the vector autoregression (VAR) methodology to investigate cross-country price transmissions of nine national stock markets and detect a high degree of linkage among these national stock markets. They also find that the U.S. market is the most important information producer, often affecting other national stock markets unilaterally.

More recently, Becker, Finnerty, and Gupta (1990), using the opening price to the closing price returns of the Japanese and U.S. stock markets, find that the U.S. market Granger-causes the Japanese market, while the Japanese market has only a small impact on

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the U.S. market. Campbell and Hamao (1992) find evidence of common movements in expected excess stock returns between the Japanese and U.S. financial markets, suggesting a high degree of integration between the long-term capital markets of these two countries. In addition, Chiou (2011) finds strong evidence that Tokyo, London and New York stock markets are significantly interdependent in terms of equity return volatility.

Overall, previous research on the interactions and integration of financial markets shows that the degree of interdependence among national stock markets increases over time, as suggested by Koch and Koch (1991). They examine the relationships between daily closing index prices of eight national stock markets for the years 1972, 1980, and 1987. This evidence is consistent with the increased trade and capital flows across country borders in the past 50 years.

Based upon theoretical foundations and empirical findings of prior research on international market linkages, this paper extends the existing literature by examining how national gold markets interact. We study how the gold prices in different time zones (Hong Kong, London, and New York) affect one another. Gold is one of the most invested commodities and is traded in a lot of national financial markets. Therefore, it is suitable to use gold to investigate price transmission around the world. Some interesting questions arise. First, do the gold prices in the three major markets behave similarly in return and return volatility? Second, what are the causality relationships in the gold prices between these three markets?

The present paper is different from most of previous studies in three important ways. First, while we investigate the linkages between national gold markets, most previous papers research the topic using national equity markets. Second, unlike many previous studies that use close-to-close return data (i.e., 2 days' closing prices are used), we use open-to-close return data (i.e., same-day opening and closing prices are used) in three major gold markets (Hong Kong, London, and New York). Close-to-close returns tend contain noises over a 24-hour period that may distort the true performance of a financial market in a trading day. In contrast, open-to-close returns make direct tests of market efficiency easier. Finally, we focus on how a change in return volatility in one gold market affects the change in return volatility in another gold market. Prior research normally studies how a change in the index return in one stock market affects the change in the index return in another stock market. The focus on return volatility is interesting and important because return volatility is one key variable determining the price of an option contract.

We find no evidence that three gold markets are significantly interdependent, using the variable of the intraday return. This result is not consistent with those of prior papers that examine market integration, using the close-to-close returns of national equity markets. When using the variable of the intraday return volatility, we find that the Hong Kong market positively affects the London market, that the London market positively affects the New York market, and that the New York market positively affects the Hong Kong market. This new evidence contributes to the existing literature by suggesting that there are high degrees of volatility linkages between the Hong Kong, London, and New York gold markets.

The remainder of this paper is organized as follows. Section II briefly discusses the selection of three gold markets. In Section III, we describe the data and methodology. Section IV presents and discusses empirical results. We summarize and conclude in Section V.

II. Selection of Three Gold Markets

Gold is traded around the clock and in many countries. With so many forms, gold trading ranges from the spot contract to the abstractions of futures contracts and to the solid tangibility of bracelets and rings.

The spot contract of gold is normally traded in an over the counter (OTC) market. This means an exchange does not match buyers and sellers, who, instead, come together on their own terms. The spot price of gold is the prevailing rate for a direct transfer of gold for cash. In normal situations, the spot price of a gold contract is lower than the futures price of a comparable contract because of the additional cost associated with storing the gold until delivery and the effect of speculation.

To examine the volatility transmission of gold prices across Asia, Europe, and North America, we selected Hong Kong, London (UK), and New York (the U.S.) as the representative markets for each of three continents. Because these three markets are in different time zones, they can be used for studying international linkages of financial markets. Also, we chose these three markets (Hong Kong, London, and New York) because they are consistently among the most active in the world in terms of market size, breadth, depth, liquidity, and foreign participation.

III. Data and Methodology

We obtained the daily opening and closing prices of spot gold contracts for the Hong Kong, London, and New York markets from a Wall Street firm over the period March 2000-July 2005 (65 months). All of these prices are expressed in local currency units.

Because holidays in Hong Kong, the UK, and the U.S. differ, we first aligned the opening and closing prices by the calendar date for these three markets. To examine the pricing transmission of the spot gold contract, we then calculated the intraday return (= (close - open)/open) for each day and for each of the three markets. We deleted the dates in which at least one market did not trade.

Table 1 shows the summary statistics of intraday (open-to-close) returns over the 65-month period for each of three markets. During the sample period, the New York market has the highest average return (0.016%) while the London market has the lowest average return (-0.038%). Interestingly, the New York market also has the highest standard deviation (0.0225%), followed by London and Hong Kong. When we compare the return distributions, we find that the return distribution of the Hong Kong market is more left-skewed (the largest negative skewness) and more peaked (the largest kurtosis) than those of London and New York.

Table 1

Summary statistics of the intraday returns of spot gold contracts in Hong Kong, London, and New York over the period March 2000-July 2005
Spot contracts (in local currency units)

	Hong Kong	London	New York
Sample size	1265	1265	1265
Mean (%)	-0.0038	-0.0384	0.0161
Standard Dev (%)	0.0225	0.0139	0.0224
Max (%)	2.726	5.224	3.674
Min (%)	-4.054	-3.901	-4.728
Skewness	-3.395	0.777	-0.028
Kurtosis	45.028	14.871	2.261

Because our focus is on how the gold price transmits continually from one gold market to another, the simple regression model, as used in Becker, Finnerty, and Gupta (1990), is appropriate for capturing the pricing transmission. Specifically, we use simple regression models to examine the causal relationships between Hong Kong, London, and New York, using the daily open-to-close intraday returns and return volatility.

IV. Empirical Findings and Interpretations

On a typical business day, the chronological trading sequence is as follows: (1) Hong Kong opens; (2) Hong Kong closes; (3) London opens; (4) New York opens (a few hours before London's close); (5) London closes; and (6) New York closes. There is a trading-hour overlap between London and New York. To investigate the causal relationship between two gold markets, all regression models in this paper are in the sequence of Hong Kong, London, and New York.

Table 2 presents the regression results using intraday returns in regression models. Panel A shows that only 0.011% of the variability of the London intraday return can be explained by the variability of the Hong Kong intraday return, with an insignificant coefficient of the independent variable. Panel B shows that only 0.06% of the variability of the New York intraday return can be explained by the variability of the London intraday return, with an insignificant coefficient of the independent variable. Similarly, Panel C shows that only 0.016% of the variability of the Hong Kong intraday return can be explained by the variability of the New York intraday return, with an insignificant coefficient of the independent variable. It is surprising that in terms of the intraday return, there are no significant relationships in each of three pairs of gold markets. However, these results indicate market efficiency in that one market's intraday performance cannot predict another market's intraday performance.

Table 2

The results of causality tests using the intraday return in egression models
Regression variable = intraday return of spot gold prices = (close- open)/open
Time period = March 2000 to July 2005
* Significant at the 5% level; ** Significant at the 1% level
HK = Hong Kong; LN = London; NY = New York
Panel A: # of observations = 1,265
LN = -0.0383 + 0.0152(HK)
R^2 = 0.01%; t-value of the X variable coefficient = 0.377
Panel B: # of observations = 1,265
NY = 0.018 + 0.0394(LN)
R^2 = 0.059%; t-value of the X variable coefficient = 0.865
Panel C: # of observations = 1,264
HK = -0.0037 + -0.0054(NY)
R^2 = 0.016%; t-value of the X variable coefficient = -0.447

Table 3 exhibits the regression results using the volatility of intraday returns in regression models. Panel A shows that about 8.38% of the variability of the London intraday return volatility can be explained by the variability of the Hong Kong intraday return volatility, with the slope coefficient significant at the 1% level. Panel B shows that about 18.85% of the variability of the New York intraday return volatility can be explained by the variability of the London intraday return volatility, with the slope coefficient significant at the 1% level. Similarly, Panel C shows that only 11.85% of the variability of the Hong Kong intraday return volatility can be explained by the variability of the New York intraday return volatility, with the slope coefficient significant at the 1% level. These results are interesting in that in terms of the intraday return volatility, the Hong Kong market affects the London market positively and significantly, the London market affects the New York market positively and significantly, and the New York market affects the Hong Kong market positively and significantly.

Table 3
The results of causality tests using the volatility of intraday returns in regression models
Regression variable = volatility of intraday returns
Time period = March 2000 to July 2005
* Significant at the 5% level; ** Significant at the 1% level
HK = Hong Kong; LN = London; NY = New York
Panel A: # of observations = 1,235
LN = 6.08 + 0.275(HK)
R^2 = 8.39%; t-value of the X variable coefficient = 10.62**
Panel B: # of observations = 1,235
NY = 7.74 + 0.61(LN)
R^2 = 18.85%; t-value of the X variable coefficient = 16.93**
Panel C: # of observations = 1,234
HK = 1.62 + 0.257(NY)
R^2 = 11.85%; t-value of the X variable coefficient = 12.87**

The findings of this paper have at least four important implications. First, the finding that the intraday return of one gold market cannot predict the intraday return of another gold market trading subsequently is consistent with the theory of market efficiency. It implies that formulating a profitable trading strategy to explore the inefficiencies between two gold markets may be challenging. Second, portfolio theory shows that when the correlation between two assets is lower, all else being equal, the portfolio risk is reduced. If national gold markets are weakly correlated (in terms of intraday returns), then international diversification of gold investments can reduce the portfolio risk. Third, because our key variable in regressions is return volatility that is one key element in option pricing, the strong interactions of gold markets may imply the integration of gold option markets if they exist. Finally, national regulators and policy makers should be concerned about the volatility linkages between financial markets. They need to have a good understanding of world financial markets, watch these markets closely, and be prepared to handle adverse situations such as financial crises.

VI. Summary and Conclusions

This paper studies the lead-lag relationships between three major gold markets over the period 2000-2005, using the intraday return variable and return-volatility variable, which are different from earlier papers. In terms of the intraday return variable, we find no evidence that three markets are significantly interdependent. This result is not consistent with those of prior papers that examine market integration, using the close-to-close returns of national equity markets. When using the variable of the intraday return volatility, we find that the Hong Kong market positively affects the London market, that the London market positively affects the New York market, and that the New York market positively affects the Hong Kong market.

The findings of this paper have important implications for trading strategies, portfolio management, option markets, and policy making. First, because the intraday return of one gold market cannot predict the intraday return of another gold market that trades subsequently, exploring the inefficiencies between two gold markets to profit may be challenging. Second, when national gold markets are weakly correlated (in terms of intraday returns), international diversification of gold investments can reduce the portfolio risk. Third, one key element in option pricing is return volatility, which is our key variable in regressions. The strong interactions of gold markets, in terms of return volatility, may imply the integration of gold option markets if they exist. Finally, national regulators and policy makers should be concerned about the volatility linkages between financial markets. They need to have a good understanding of how world financial markets interact, watch these markets closely, and be prepared to handle adverse situations such as financial crises.

Overall, this paper extends the existing literature in market integration by using intraday returns and return volatility to test how one gold market affects another gold market. Our new evidence suggests that there are high degrees of volatility linkages between the Hong Kong, London, and New York markets.

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