Information and Volatility in Futures and Spot Markets: The Case of the Japanese Yen

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INTRODUCTION

This article investigates the relative intraday reactions in the Japanese yen futures and spot markets to scheduled U.S. macroeconomic announcements. The primary motive of the article is to investigate the extent to which the spillover of volatility between futures and spot markets is information driven. If some or all of the volatility spillover from futures to spot markets is a result of incoming information, regulation or even elimination of futures markets will not lessen spot market volatility. This article is directed not only at the debate on whether futures markets cause spot market volatility, but also to the broader question of whether regulation of futures markets will lead to less volatile spot markets.

There are two major lines of research in futures markets that motivate this study. The first explores the possibility that futures trading increases volatility in the prices of underlying assets (SEC, 1988; Brady Commission, 1988; Harris, 1989; Bessembinder and Seguin, 1992). Research interest on the issue can be attributed generally to trader and public concern that excessive speculation in futures has a deleterious

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impact on cash market volatility. Increased volatility is thought to lead to misallocation of resources among traders and to higher costs of capital and greater heading costs for corporations. The evidence on whether futures trading increases spot market volatility has been mixed, especially for equity indices such as the S&P 500 (Santoni, 1987; Edwards, 1988; Harris, 1989; Darrat and Rahman, 1995). In contrast, the evidence on the impact of currency futures trading has generally been unfavorable (Clifton, 1985; Grammatikos and Saunders, 1986; Chatrath, Ramchander, and Song, 1996). The issue of the impact of futures trading remains important, as can be gauged by the continuing debate on whether or not futures markets need further regulation.

The second line of research that motivates this study examines whether the price movements in futures markets lead the price movements in cash markets, i.e., whether futures markets discover spot prices in the short run. Several studies including Ng (1987), Kawaller, Koch, and Koch (1987), Stoll and Whaley (1990), and Cheung and Ng (1990) have found that futures price changes lead cash price changes from a few seconds to several hours. Other researchers including Stoll and Whaley (1990), Chan (1992), and Chan, Chan, and Karolyi (1991) find that price changes in either the cash or the futures market can lead those in the other. Nonetheless, those studies found generally stronger evidence that futures price changes lead cash prices, supporting the contention that futures markets play a price discovery role.

This article extends the work of Crain and Lee (1995) (henceforth C&L). C&L examine issues relating to the relative efficiency of futures and spot markets following macroeconomic announcements. The authors compare the price adjustment process in the Eurodollar and deutsche mark futures and spot markets. They also present results for futures-spot causality across announcement and no-announcement days. While the response of exchange rates to macroeconomic announcements has been the subject of study for some time [see, e.g., Cornell (1982), Engle and Frankel (1984), and Ederington and Lee (1993, 1994)], C&L's paper stands out as one that offers a comparison of currency futures and spot market reactions to news releases.

This study differs from that of C&L in three respects. First, it focuses more specifically on examining the role of information arrival on the lead–lag relationship between the futures and spot markets. According to Ross (1989), if information arrives first in the futures markets, one should see volatility spillover from these markets to the spot markets. Several parametric and nonparametric tests are constructed to differentiate between potential information effects and volatility spillover effects between futures and spot markets. Then, a model is proposed that takes into account the serial dependencies commonly found in exchange rate data (Hsieh, 1989), while allowing for the possibilities of intermarket volatility spillover and time-varying covariance among spot and futures markets. Third, dollar/Japanese yen exchange rate (henceforth JY) data are employed. These data have an advantage in that they correspond to the trading hours in the U.S. market and the nontrading hours for the Japanese markets. The influence of Japanese announcements is already reflected in the JY rate at the market's open in the United States, so that the potential for biases from not controlling for foreign announcements is reduced. Moreover, there is prior evidence that, between the macroeconomic announcements in the United States and Japan, the U.S. announcements have the greater influence on the JY rate (Ito and Roley, 1987).

The results of this study support the notion that information plays an important role in the volatility spillover between futures and spot markets. Specifically, the evidence of volatility spillover from the JY futures to the JY spot market diminishes when a set of macroeconomic announcements are controlled for. The findings at least partly explain why futures market regulation (via measures such as margin requirements) has failed to reduce spot market volatility.[1]

The next section describes the data employed in the investigation. The subsequent sections present the empirical evidence relating to the major hypotheses examined. A concluding section summarizes the findings and discusses the implications of the article.

DATA

Intraday futures and quoted spot rates of Japanese yen (Chicago Mercantile Exchange) for the interval from 2 January 1992 through December 1995 are used.[2] The rates are sampled hourly between 8:20 AM eastern time (market's open) and 3:00 PM eastern time. The futures rates are for the nearby contract until the last day of the preexpiration month when the series shifts to the next nearby contract. There are 6947 price observations and 6012 intraday price changes in the series. To maintain conformity in the sampling interval, price changes for the 8:20–9:00 AM interval are adjusted to an hourly basis as in C&L.

Table I provides summary statistics for the JY futures and spot returns, given by $\Delta \ln F_t = (\ln f_t - \ln f_{t-1})^* 100$ and $\Delta \ln S_t = (\ln s_t -$

[1]For instance, Schwert (1989) and Hsieh and Miller (1990), among others, fail to find a convincing relationship between futures margin requirements and volatility.

[2]The data are obtained from Futures Industry Institute, Washington, DC. The spot rates at hour t are the average of the bide and ask prices.

TABLE I

Descriptive Statistics for JY Futures and Spot Rate Changes

	A. Summary Statistics	
	Δlnf	*Δlns*
Mean	0.0471	0.0481
SD	0.2281	0.2174
Skewness	2.95[c]	2.16[c]
Kurtosis	35.62[c]	22.50[c]
$Q(24)$	57.98[c]	130.70[c]
$Q^2(24)$	44.12[c]	620.09[c]
ADF()	−1.58	−1.89
ADF(Δ)	−9.18[c]	−8.70[c]
	B. Cointegration Tests (*lnf,lns*)	
	Without Trend	*With Trend*
Phillips	−74.05[c]	−61.49[c]
DF	−11.49[c]	−9.60[c]

Notes: The results are for hourly data from 2 January 1992 through 29 December 1995; 6947 price observations are employed to arrive at 6012 intraday return observations. Δln*f*(*S*) is the differenced natural log of futures (spot) multiplied by 100. Q_{24} is the Ljung-Box-Pierce (LBP) test statistic (chi-square) for serial correlation of the return series. Q^2_{24} is the LBP statistic for the squared return series. ADF is the augmented Dickey-Fuller statistic (*t*) that tests the null of nonstationarity of the series. ADF statistics are from the model with time trend (model without trend provided similar results). DF and Phillips are the Dickey-Fuller and Phillips *t*-statistics that test for the null hypothesis of cointegration of the ln*f* and ln*s* series (see Engle and Granger, 1987; Phillips, 1987). Lags for ADF and DF regressions are based on the Schwarz information criterion [ADF model lags: 29 for ln*f* and 21 for ln*s*; ADF*Δ*() model lags: 20 for Δln*f* 22 and 20 for Δln*s*; DF model lags: 39 for model without trend and 30 for model with trend]. The Phillips test employs a lag length of 1 and corrects for serial correlation in the cointegrating (residual) equation in the manner proposed by Phillips (1987). For comparison of data, all significance levels are presented in Tables I–VIII.
[a]Significance level of 0.10.
[b]Significance level of 0.05.
[c]Significance level of 0.01.

$\ln s_{t-1})*100$, respectively. Both series are positively skewed and leptokurtic, as indicated by the skewness and excess kurtosis statistics. The series exhibit linear and nonlinear dependencies, as indicated by the significant Ljung-Box-Pierce (LBP) $Q(24)$ and $Q^2(24)$ statistics. The augmented Dickey-Fuller (ADF) t-statistics for the log of the futures and spot rates are not significant, while the statistics for the differenced (return) series are significant at the 0.01 level. These results indicate that the level series contain one unit root, or in other words, the JY rate series require first differencing to achieve stationarity. Finally, the Dickey-Fuller (DF) and Phillips t-statistics indicate that the ($\ln f_t$, $\ln s_t$) series are cointegrated, so that there exists an error-correction mechanism (ECM) in a bivariate representation of the return series (Engle and Granger, 1987).[3]

The study considers 20 sets of macroeconomic announcements over the sample period whose scheduled release is reported in "The Week Ahead" section of *Business Week*. The reports are provided to reporters approximately 30 minutes prior to the scheduled release time. The reporters are not permitted to transmit the nature of the announcements until the release time. At the release time, the reports appear on the screens on the floor of the futures exchange.[4] The announcements, along with their frequencies, are listed in the Appendix of this paper. With the exception of the National Association of Purchasing Managers (NAPM) Survey, the announcements are made by U.S. government agencies.

To investigate the relative price adjustment process in the futures and spot markets, this paper examines the intraday return and volatility behavior over announcement and no-announcement periods. The measure of unconditional volatility used is $\sigma_t = | P_t - P_{t-1}|/P_{t-1}$, where P_t is the futures (spot) rate at time t. Variations of this measure are widely employed in the finance literature [see, e.g., Karpoff (1987), Garcia, Leuthold, and Zapata (1986), Holthausen, Leftwich, and Mayers (1987), and Chan and Chung (1993)].[5] In light of the evidence of autocorrelation in Table I, and given the prior evidence on the success of autoregressive conditional heteroskedasticity (ARCH)-type models in capturing the dependencies in exchange rates (e.g., Baillie and Bollerslev, 1989; Hsieh, 1988, 1989), a proxy for conditional volatility is deployed in this analysis.

A set of conditional volatility series (h_t) is constructed through the generalized ARCH (GARCH) (1,1) model with robust standard errors [see, e.g., Bollerslev (1986)]. The standardized residuals from this model are free of linear and nonlinear dependencies, as measured by LBP $Q(24)$ or $Q^2(24)$ statistics. Moreover, the comparison of high-order ARCH models and the GARCH model, facilitated by the evaluation of the log-likelihood functions [see Akgir (1989) for details], suggests that the latter model better characterizes the changes in the JY rates. The correlation between the traditional measure of volatility, σ, and the conditional variance measure is 0.74 for the futures series and 0.85 for the spot series.

[3]Alternate tests for cointegration, Johansen trace and maximum eigenvalue statistics, also provide strong evidence of cointegration between the two series.

[4]See Ederington and Lee (1993) for further details on the report-release procedure.

[5]Others, including C&L, employ standard deviation of returns as the measure of volatility. The results are qualitatively unchanged when using the standard deviation measure.

TABLE II

Impact of Announcements on JY Futures and Spot Volatility

	Futures	*t*	*Spot*	*t*
Constant	$0.16e^{-2}$[c]	26.66	$0.18e^{-2}$[c]	26.71
Employment (8:30)	$0.25e^{-2}$[c]	3.68	$0.23e^{-2}$[c]	3.05
Merchandise Trade Deficit (8:30)	$0.16e^{-2}$[c]	3.30	$0.14e^{-2}$[c]	2.77
Gross Domestic Product (8:30)	$0.25e^{-2}$[c]	2.84	$0.15e^{-2}$	1.53
Leading Indicators (8:30)	$0.21e^{-2}$[a]	1.84	$0.22e^{-2}$[b]	2.36
Employment Costs (8:30)	$0.20e^{-2}$[a]	1.66	$0.19e^{-2}$	1.44
Initial Unemployment Claims (8:30)	$0.40e^{-2}$[c]	4.69	$0.31e^{-2}$[b]	2.49
Producer Price Index (8:30)	$0.21e^{-2}$[c]	3.04	$0.15e^{-2}$[b]	2.03
Retail Sales (8:30)	$0.11e^{-3}$	1.37	$0.75e^{-3}$	0.87
Consumer Price Index (8:30)	$0.15e^{-3}$[a]	1.70	$0.14e^{-2}$	1.22
Housing Starts (8:30)	$0.32e^{-3}$[b]	2.19	$0.28e^{-2}$[a]	1.75
Durable Goods Orders (8:30)	$0.21e^{-2}$[b]	2.33	$0.19e^{-2}$[b]	2.06
Existing-Home Sales (8:45)	$0.41e^{-3}$	0.29	$0.40e^{-3}$	0.22
Industrial Production (9:15)	$-0.26e^{-3}$	-0.38	$-0.50e^{-3}$	-0.65
Construction Spending-NAPM (10:00)	$-0.52e^{-3}$	-0.72	$-0.66e^{-3}$	-0.82
Factory Inventories (10:00)	$-0.22e^{-3}$	-0.40	$-0.36e^{-3}$	-0.58
Personal Income (10:00)	$-0.12e^{-3}$	-0.02	$-0.39e^{-3}$	-0.48
New Single Family Home Sales (10:00)	$-0.18e^{-3}$	-0.22	$0.31e^{-3}$	0.34
Consumer Confidence (10:00)	$0.32e^{-3}$	0.35	$-0.30e^{-3}$	-0.29
Federal Budget (2:15)	$-0.19e^{-3}$	-0.96	$-0.24e^{-3}$	-0.84
Adjusted R^2	0.033		0.021	

Notes: The results are from OLS regressions of JY futures and spot intraday volatility (the standardized absolute price change) on a constant and a set of 19 dummy variables that take on the value of 1 if there is an announcement at $t - 1$, and 0 otherwise. The Construction Spending and NAPM announcements are represented by one dummy variable.
[a]Significance level of 0.10.
[b]Significance level of 0.05.
[c]Significance level of 0.01.

INFORMATION AND RELATIVE PRICE ADJUSTMENTS

To evaluate the influence of the macroeconomic announcements on the JY futures and spot markets, the volatility measures are regressed on an intercept and a set of dummy variables that take on the value of 1 if there is a particular announcement at hour $t - 1$, and 0 otherwise.[6] The results from the unconditional volatility regressions are reported in Table II.[7] Similar to the evidence for the deutsche mark rate in C&L, only the 8:30 AM announcements are found to influence the JY futures and spot markets. Moreover, the impact of individual announcements seems to be more pronounced in the futures market, as can be gauged by the generally larger announcement coefficients and the larger R^2 coefficient. However,

[6]The Construction Spending and NAPM announcements almost always overlap, so that only one dummy variable represents these two announcements.
[7]The conditional volatility regressions yield very similar results.

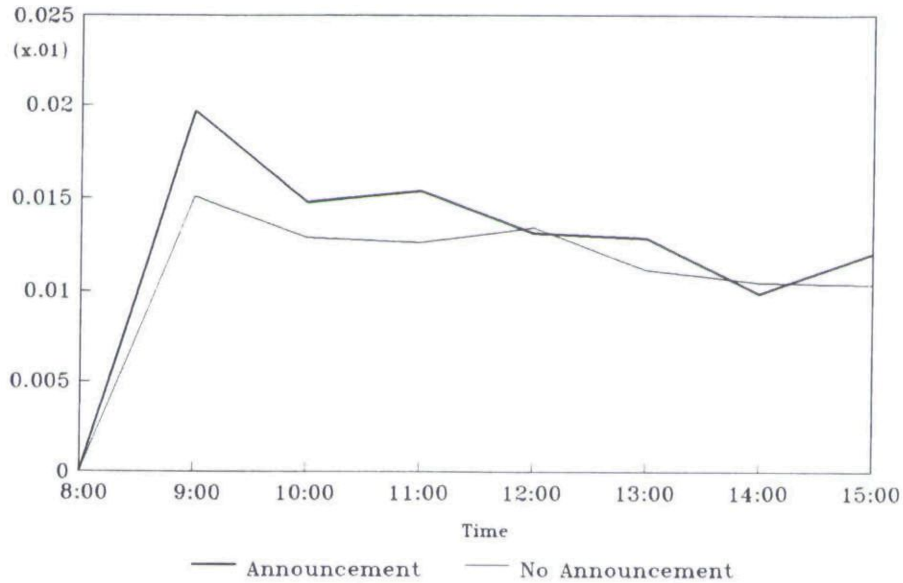

FIGURE 1
Japanese yen futures volatility.

two announcements, Employment and Trade Deficit, are consistently significant at the 0.01 level. Other announcements that significantly impact both the JY futures and spot market are Leading Indicators, Initial Unemployment Claims, Producer Price Index (PPI), Housing Starts, and Durable Goods Orders.

Figures 1–4 graph the futures and spot volatility and conditional volatility measures over announcement and no-announcement days in the framework of C&L and Ederington and Lee (1994).[8] In each of the figures, volatility is found to be most pronounced over the 8:00–9:00 AM period for announcement as well as no-announcement days. As expected, the volatility on the markets' open on announcement days is significantly higher than that on no-announcement days. C&L provide similar evidence for the deutsche mark futures and spot markets. Moreover, the pattern of higher volatility on announcement days persists until 11:00 AM. Figures 1–4 also support the existence of a U-shaped volatility curve for the Japanese yen. There is a notable upward trend in volatility for the 2:00–3:00 PM time period over announcement days. However, there is no consistent pattern of rising or falling volatility in the closing hour of no-announcement days. The documentation of a U-shaped volatility curve for announcement days (and not for no-announcement days) sup-

[8]The figures in Figures 1 and 2 are values times 10^2.

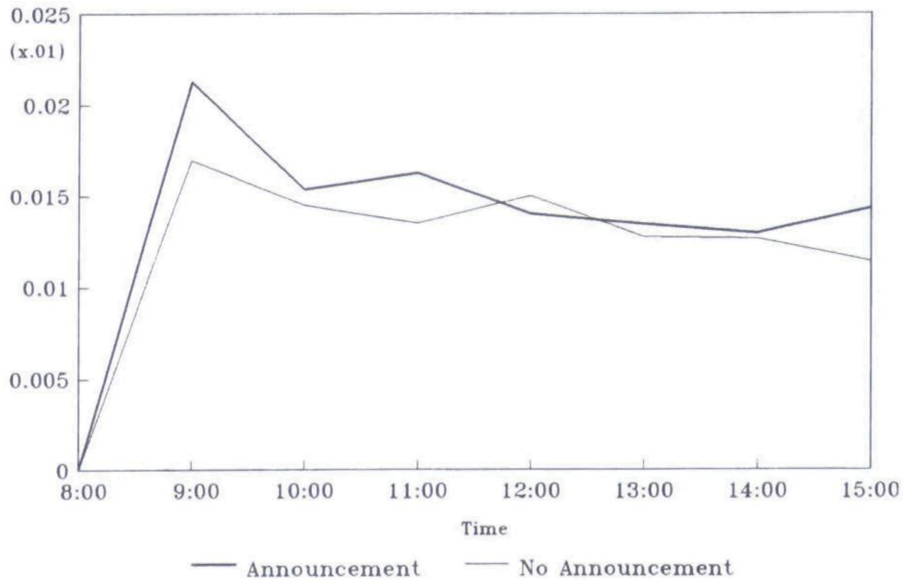

FIGURE 2
Japanese yen spot volatility.

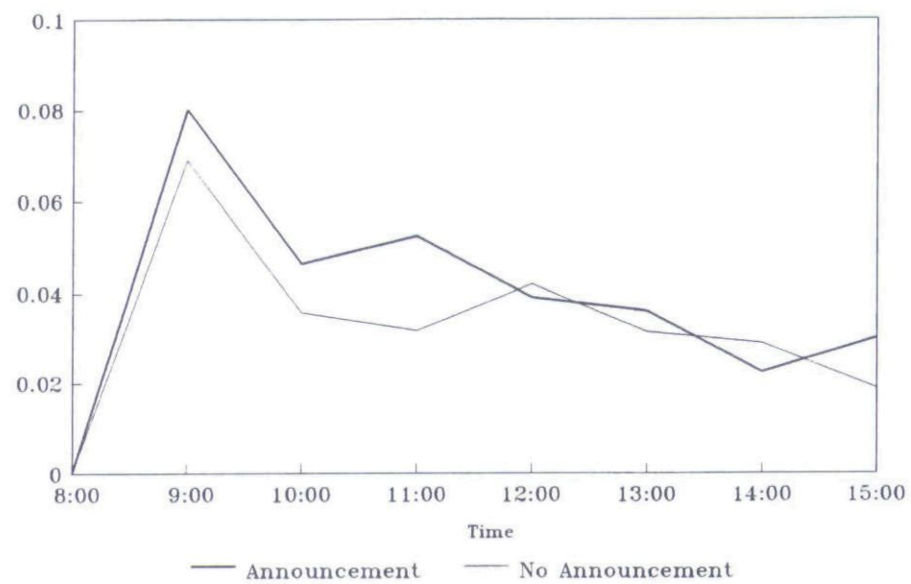

FIGURE 3
Japanese yen futures conditional volatility.

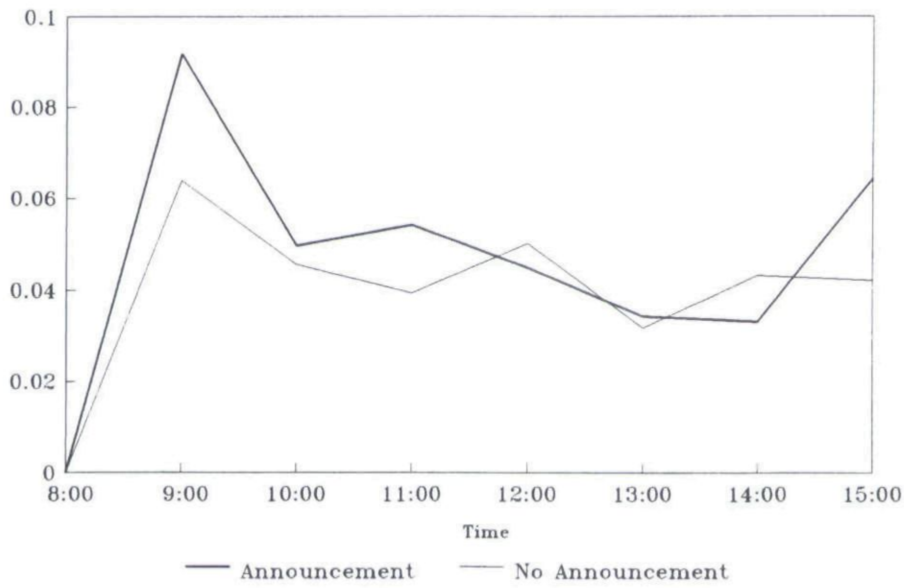

FIGURE 4
Japenese yen spot conditional volatility.

ports the notion that such a pattern (widely documented in other markets) has an information-based explanation [see, e.g., Admati and Pfleiderer (1988) and Becker, Finnerty, and Kopecky (1993)].

Table III presents results pertaining to the relative intraday volatility over announcement and no-announcement days with 8:30 announcements (169 trading days). Days on which there were 10:00 AM and 2:15 AM announcements are dropped from the sample for this analysis. This exclusion is motivated by the need to more accurately gauge the persistence of volatility following the initial announcement. Only the data on 8:30 announcements allow an investigation of the reaction of futures and spot rates over a seven-hour intraday period.

The results support the trends observed in Figures 1–4. The figures reported in the first four columns of Table III suggest that the volatility during announcement days is greater than during no-announcement days over the first three hours of trading (more clearly so in Table IIIB). Moreover, the relative volatility is significantly elevated for the 2:00–3:00 PM period, in line with the earlier allusion to the role of information in the U-shape of the trend in intraday volatility. The persistence of volatility beyond the first hour following the announcement suggests that JY markets either overreact or underreact to the new information. The fifth and seventh columns of Table III report the ratio of futures volatility to spot volatility during announcement and no-announcement days, respectively.

TABLE III

Relative Volatility Persistence for the Japanese Yen Following 8:30 Announcements

Time	A. Relative Volatility							
	$\sigma_{f,a}/\sigma_{f,na}$	F $(Ho{:}\sigma_{f,a} = \sigma_{f,na})$	$\sigma_{s,a}/\sigma_{s,na}$	F $(Ho{:}\sigma_{s,a} = \sigma_{s,na})$	$\sigma_{f,a}/\sigma_{s,a}$	F $(Ho{:}\sigma_{f,a} = \sigma_{s,a})$	$\sigma_{f,na}/\sigma_{s,na}$	F $(Ho{:}\sigma_{f,a} = \sigma_{s,a})$
8:00–9:00	1.371	5.66[c]	1.267	8.38[c]	0.925	0.77	1.071	0.27
9:00–10:00	1.145	2.92	1.061	0.55[c]	0.959	0.32	0.889	3.48
10:00–11:00	1.222	8.45[c]	1.204	6.77[c]	0.947	0.44	0.933	1.25
11:00–12:00	0.981	0.28	0.930	0.91	0.934	0.68	0.880	2.60
12:00–1:00	1.151	2.95	1.056	0.58	0.953	0.61	0.926	3.68
1:00–2:00	0.942	0.45	1.020	0.09	0.787	6.47[c]	0.825	4.51
2:00–3:00	1.162	5.15[c]	1.257	5.59[c]	0.858	2.59	0.913	2.00

Time	B. Relative Conditional Volatility							
	$h_{f,a}/h_{f,na}$	F $(Ho{:}h_{f,a} = h_{f,na})$	$h_{s,a}/h_{s,na}$	F $(Ho{:}h_{s,a} = h_{s,na})$	$h_{f,a}/h_{s,a}$	F $(Ho{:}h_{f,a} = h_{s,a})$	$h_{f,na}/h_{s,na}$	F $(Ho{:}h_{f,a} = h_{s,a})$
8:00–9:00	1.162	3.61[b]	1.437	3.92[b]	0.879	0.48	1.080	0.28
9:00–10:00	1.301	4.28[b]	1.088	0.16	0.938	0.11	0.782	1.69
10:00–11:00	1.658	8.31[c]	1.379	3.85[b]	0.963	0.02	0.804	1.81
11:00–12:00	0.928	0.79	0.792	0.93	0.894	0.23	0.750	1.82
12:00–1:00	1.161	0.17	1.079	0.20	1.063	0.06	0.970	0.04
1:00–2:00	0.792	0.89	0.696	0.79	0.669	2.23	0.618	1.87
2:00–3:00	1.532	9.15[c]	1.338	3.62[b]	0.615	2.94	0.662	1.45

Notes: σ_t represents the standardized absolute price change between hour $t-1$ and t. h_t represents the conditional variance.
[a]Significance level of 0.10.
[b]Significance level of 0.05.
[c]Significance level of 0.01.

It is notable that there is no indication that futures volatility is greater than spot volatility over announcement or no-announcement days.[9]

INFORMATION AND VOLATILITY SPILLOVER

Results pertaining to the lead–lag relationship between futures and spot rates of the JY, and the role of information in this relationship are presented in this section. First, however, results are presented from pooled cross-sectional regressions in a framework similar to the vector autoregressive (VAR) models commonly employed in tests for Granger causality between variables (see C&L). Days are pooled into two groups: days with 8:30 announcements and days with no announcements. Then, spot (futures) volatility at 3:00 PM on an announcement day is regressed on the spot and futures volatility at 2:00 PM, 1:00 PM, . . . 9:00 PM of the *same* day. Similar pooled regressions are carried out for volatility at 2:00 PM and 1:00 PM. For comparative purposes, sets of regressions are run also for no-announcement days.

Tables IV and V present a summary of the results (F-values and adjusted R^2s) from the regressions for the volatility and conditional volatility measures, respectively. The results provide evidence that the volatility in the JY futures market leads the volatility in the JY spot market during announcement days: the F-values for the null that spot volatility is not caused by futures volatility are rejected for two of three regressions in Table IVB and one of three regressions in Table VB. The null that futures volatility is not caused by spot volatility for announcement days is not rejected for either the volatility measure (Table IVA) or the conditional volatility measure (Table VA).[10]

For no-announcement days, the evidence of the leadership of futures volatility is weaker: the null that futures volatility leads spot volatility is rejected only once (Table IV). Also note that the adjusted R^2 coefficient for the models is relatively lower for no-announcement days. In sum, there is evidence that volatility spillover between futures and spot markets is information driven.[11]

[9]The return serial correlation of spot and futures markets following the 8:30 announcements is examined also. The data suggest a prolonged adjustment process following these announcements. Negative correlation between the first hour returns and the second and third hour returns is detected in the futures market, and negative correlation between the first hour returns and third hour returns in the spot market. These results are symptomatic of overreaction in the JY market (also see C&L).

[10]VAR models are estimated also for the entire sample and for the return variables. These results are even stronger in indicating that futures markets lead spot markets, with no feedback effects. For instance, the F-value for the null that futures (spot) returns cause spot (futures) returns is 126.29 (0.03). The significance levels of these statistics are unaltered when an error correction term is appended to the VAR representation.

[11]The Granger causality test results are robust to regressions with different lags of the variables involved.

TABLE IV

Causality Results: Futures-Spot Volatility over Announcement/ No-Announcement Days

A. Dependent Variable Is Futures Volatility

Dependent Variable	Days with 8:30 Announcements				No-Announcement Days			
	$Ho:\sigma^s \to \sigma^f$	$Ho:\sigma^f \to \sigma^f$	*df*	Adjusted R^2	$Ho:\sigma^s \to \sigma^f$	$Ho:\sigma^f \to \sigma^f$	*df*	Adjusted R^2
$\sigma^f_{3:00}$	0.09	12.56[c]	156	0.07	0.25	3.37[a]	150	0.06
$\sigma^f_{2:00}$	1.05	9.53[c]	158	0.18	0.16	4.82[b]	152	0.18
$\sigma^f_{1:00}$	2.15	9.03[c]	160	0.12	0.41	3.10[a]	154	0.03

B. Dependent Variable Is Spot Volatility

Dependent Variable	Days with 8:30 Announcements				No-Announcement Days			
	$Ho:\sigma^s \to \sigma^s$	$Ho:\sigma^f \to \sigma^s$	*df*	Adjusted R^2	$Ho:\sigma^s \to \sigma^s$	$Ho:\sigma^f \to \sigma^s$	*df*	Adjusted R^2
$\sigma^s_{3:00}$	16.31[c]	5.73[b]	156	0.35	1.28	0.04	150	0.04
$\sigma^s_{2:00}$	3.93[b]	0.08	158	0.31	0.92	3.37[a]	152	0.14
$\sigma^s_{1:00}$	0.52	2.68[a]	160	0.08	0.10	2.97	154	0.04

Notes: σ^s represents the standardized absolute spot price changes between hour $t-1$ and t; σ^f represents the standardized absolute futures price changes between hour $t-1$ and t. $Ho:\sigma^s \to \sigma^f$ represents the null hypothesis: spot volatility does not lead futures volatility; $Ho:\sigma^f \to \sigma^s$ represents the null hypothesis: futures volatility does not lead spot volatility. The results are from pooled cross-sectional regressions. For instance, for the $\sigma^f_{3:00}$ regression, the futures volatility at 3 PM on a particular announcement day regressed on the spot and futures volatility at 2 PM, 1 PM, . . . , and 9 AM of that announcement day. The F-value tests the null that the lagged coefficients are 0, $F\sim(1, N-K)$, where $K = 6$ for the $\sigma_{3:00}$ regressions, $K = 5$ for the $\sigma_{2:00}$ regressions, etc.

[a]Significance level of 0.10.

[b]Significance level of 0.05.

[c]Significance level of 0.01.

The preceding regression analysis of volatility spillover between futures and spot markets has several limitations. First, the measures for volatility employed so far do not suitably account for the volatility clustering and persistence often documented in exchange rate series (Hsieh, 1989). Second, the above methodology does not simultaneously allow for volatility covariance and spillovers between the futures and spot series. While financial series may exhibit high persistence in the variance of their univariate representations, the persistence may be common across the series, so that linear combinations of the variables show lesser persistence. Further, the OLS regressions may fail to adequately incorporate the joint distribution of futures and spot rates, which is implied when the series are cointegrated (as indicated in Table I).

In light of these limitations, models are estimated that assume that the second moments of $\Delta \ln f_t$ and $\Delta \ln s_t$ can be parameterized by an error-

TABLE V

Causality Results: Futures-Spot Conditional Volatility over Announcement/No-Announcement Days

A. Dependent Variable Is Futures Conditional Volatility

Dependent Variable	Days with 8:30 Announcements				No-Announcement Days			
	$Ho{:}h^s \rightarrow h^f$	$Ho{:}h^f \rightarrow h^f$	df	Adjusted R^2	$Ho{:}h^s \rightarrow h^f$	$Ho{:}h^f \rightarrow h^f$	df	Adjusted R^2
$h^f_{3:00}$	0.26	4.36[b]	156	0.07	0.12	0.40	150	0.08
$h^f_{2:00}$	0.14	5.97[c]	158	0.22	0.05	1.65	152	0.13
$h^f_{1:00}$	3.50	6.75[c]	160	0.10	0.05	2.49	154	0.03

B. Dependent Variable Is Spot Conditional Volatility

Dependent Variable	Days with 8:30 Announcements				No-Announcement Days			
	$Ho{:}h^s \rightarrow h^s$	$Ho{:}h^f \rightarrow h^s$	df	Adjusted R^2	$Ho{:}h^s \rightarrow h^s$	$Ho{:}h^f \rightarrow h^s$	df	Adjusted R^2
$h^s_{3:00}$	7.66[c]	2.59[a]	156	0.38	1.65	1.19	150	0.07
$h^s_{2:00}$	1.76	1.10	158	0.34	0.52	2.11	152	0.18
$h^s_{1:00}$	0.14	2.04	160	0.04	0.24	1.74	154	0.09

Notes: h^s and h^f represent spot and futures conditional variance from the GARCH (1, 1) model; $Ho{:}h^s \rightarrow h^f$ represents the null hypothesis: spot volatility does not lead futures volatility; $Ho{:}h^f \rightarrow h^s$ represents the null hypothesis: futures volatility does not lead spot volatility. The results are from pooled cross-sectional regressions. For instance, for the $h^f_{3:00}$ regression, the volatility in futures price at 3 PM on a particular announcement day is regressed on spot and futures volatility at 2 PM, 1 PM, . . . , and 9 AM of that announcement day. The F-value tests the null that lagged coefficients are 0, F- (1, $N - K$), where $K = 6$ for the $\sigma_{3:00}$ regressions, $K = 5$ for the $\sigma_{2:00}$ regressions, etc.
[a]Significance level of 0.10.
[b]Significance level of 0.05.
[c]Significance level of 0.01.

correction bivariate GARCH model with time-varying covariance between the two variables.[12] A variation of the models estimated is

$$\Delta \ln F_t = \alpha_0 + \sum_{i=1}^{n} \alpha_i \Delta \ln F_{t-i} + \sum_{i=1}^{n} \beta_i \Delta \ln S_{t-i} + \delta_f Z_{t-1} + \eta_f D_t + \varepsilon_{ft} \quad (1)$$

$$\Delta \ln S_t = \gamma_0 + \sum_{i=1}^{n} \gamma_i \Delta \ln F_{t-i} + \sum_{i=1}^{n} \gamma_i \Delta \ln S_{t-i} + \delta_s Z_{t-1} + \eta_s D_t + \varepsilon_{st} \quad (2)$$

$$\left.\begin{matrix}\varepsilon_{ft}\\ \varepsilon_{st}\end{matrix}\right| \Omega_{t-1} \sim N(0, H_t) \quad (3)$$

[12]For similar applications of this model, see Chan et al. (1991).

$$H_t = \begin{pmatrix} h_{f,t} \\ h_{s,t} \\ h_{sf,t} \end{pmatrix} = \begin{pmatrix} \alpha_{10} \\ \alpha_{20} \\ \alpha_{30} \end{pmatrix} + \begin{pmatrix} \alpha_{11} & 0 & 0 \\ 0 & \alpha_{21} & 0 \\ 0 & 0 & \alpha_{31} \end{pmatrix} \begin{pmatrix} \varepsilon^2_{f,t-1} \\ \varepsilon^2_{s,t-1} \\ \varepsilon^2_{f,t-1}\varepsilon^2_{s,t-1} \end{pmatrix}$$

$$+ \begin{pmatrix} \beta_{11} & 0 & 0 \\ 0 & \beta_{21} & 0 \\ 0 & 0 & \beta_{31} \end{pmatrix} \begin{pmatrix} h_{f,t-1} \\ h_{s,t-1} \\ h_{fs,t-1} \end{pmatrix} + \begin{pmatrix} \beta_{12} & 0 & 0 \\ 0 & \beta_{22} & 0 \\ 0 & 0 & 0 \end{pmatrix} \begin{pmatrix} \varepsilon^2_{s,t-1} \\ \varepsilon^2_{f,t-1} \\ 0 \end{pmatrix}$$

$$+ \begin{pmatrix} \beta_{13} & 0 & 0 \\ 0 & \beta_{23} & 0 \\ 0 & 0 & \beta_{33} \end{pmatrix} (D_t) \qquad (4)$$

where Z_t is the error-correction term given by $\ln f_t - \ln s_t$, Ω_{t-1} is the information set at hour $t - 1$, and D_t is a dummy variable which takes on a value of 1 if there is an announcement at hour $t - 1$, and 0 otherwise. For comparative purposes, the above model is also estimated without D_t in the return and variance equations.[13]

Equations (1) and (2) describe the mean equations where returns are regressed on past returns, and the information dummy, and the error-correction term introduced to account for the cointegration in futures and spot prices. The coefficients on the error-correction variable also serve to provide an insight as to whether one of the markets leads the other. If $\delta_f < 0$ and $\delta_s = 0$, the burden of futures-spot rate convergence falls on the futures market. The opposite is true if $\delta_f = 0$ and $\delta_s > 0$.

Equation (3) specifies the joint distribution of the error terms in the mean equation. Equation (4) defines the functional form of the variance and covariance of the error terms. The lagged ε_s^2 and ε_f^2 terms have been added to the h_f and h_s equations, respectively, to analyze the spillover of volatility between the two markets. For instance, if $\beta_{12} > 0$ in the h_f equation, spot price shocks induce increased volatility in futures markets. The impact of information on the lead–lag relationship in futures and spot volatility is gauged by analyzing the sensitivity of the β_{12} and β_{22} coefficients to the introduction of the information dummy.

Table VI presents the results from the GARCH model with and without the information dummy variable. Table VIA reports the coefficients from the return equation. The return lag length of one produces standardized residuals that do not exhibit significant autocorrelation, as indicated by the Q-statistics in Table VIC. The shallow lag structure also minimizes the parameters estimated in the bivariate system and serves to improve its convergence properties. As in the OLS regression results,

[13]The off-diagonals are excluded from the equations to enhance the convergence properties of the model.

TABLE VI

Bivariate GARCH Results with and without News

	Without News	*With News*
	A. Return Equations	
α_0	0.0060[a]	0.0058[a]
α_1	−0.0706[c]	−0.0603[c]
β_1	0.0219	0.0229
δ_f	−0.0012	−0.0012
η_f	—	0.0002
ψ_0	0.0030	0.0029
ψ_1	0.3350[c]	0.2351[c]
λ_1	−0.2942[c]	−0.2490[c]
δ_s	0.0212[c]	0.0212[c]
η_s	—	0.0015[a]
	B. Variance Equations	
α_{10}	0.0269[c]	0.0213[c]
α_{11}	0.0743[c]	0.0790[c]
β_{11}	0.2235[c]	0.2042[c]
β_{12}	0.0260[c]	0.0153[c]
β_{13}	—	0.0109[c]
α_{20}	0.0278[c]	0.0257[c]
α_{21}	0.0849[c]	0.0788[c]
β_{21}	0.2123[c]	0.1959[c]
β_{22}	0.1144[c]	0.0293[c]
β_{23}	—	0.0084[c]
α_{30}	0.0235[c]	0.0091[c]
α_{31}	0.2344[c]	0.1973[c]
β_{31}	0.1579[c]	0.1310[c]
β_{33}	—	0.0033[c]
$LR\chi^2$ ($Ho{:}\beta_{12} = \beta_{22}$)	29.04[c]	21.17[c]
	C. Diagnostics	
$Q_{24}(z_f)$	21.44	21.40
$Q^2_{24}(z_f)$	4.74	1.71
$Q_{24}(z_s)$	19.44	22.94
$Q^2_{24}(z_s)$	16.62	16.80
LL	15,320.79	15,339.15
$LR\chi^2$	—	36.72[c]

Notes: The coefficients are from the model:

$$\Delta \ln F_t = \alpha_0 + \alpha_1 \Delta \ln F_{t-1} + \beta_1 \Delta \ln S_{t-1} + \delta_f Z_{t-1} + \eta_f D_t + \varepsilon_{ft}$$
$$\Delta \ln S_t = \psi_0 + \psi_1 \Delta \ln F_{t-1} + \lambda_1 \Delta \ln S_{t-1} + \delta_s Z_{t-1} + \eta_s D_t + \varepsilon_{st}$$

$$H_t = \begin{pmatrix} h_{f,t} \\ h_{s,t} \\ h_{sf,t} \end{pmatrix} = \begin{pmatrix} \alpha_{10} \\ \alpha_{20} \\ \alpha 3_0 \end{pmatrix} + \begin{pmatrix} \alpha_{11} & 0 & 0 \\ 0 & \alpha_{21} & 0 \\ 0 & 0 & \alpha_{31} \end{pmatrix} \begin{pmatrix} \varepsilon^2_{f,t-1} \\ \varepsilon^2_{s,t-1} \\ \varepsilon^2_{f,t-1}\varepsilon^2_{s,t-1} \end{pmatrix} + \begin{pmatrix} \beta_{1,}6 & 0 & 0 \\ 0 & \beta_{21} & 0 \\ 0 & 0 & \beta_{31} \end{pmatrix} \begin{pmatrix} h_{f,t-1} \\ h_{s,t-1} \\ h_{fs,t-1} \end{pmatrix}$$
$$+ \begin{pmatrix} \beta_{12} & 0 & 0 \\ 0 & \beta_{22} & 0 \\ 0 & 0 & 0 \end{pmatrix} \begin{pmatrix} \varepsilon^2_{s,t-1} \\ \varepsilon^2_{f,t-1} \\ 0 \end{pmatrix} + \begin{pmatrix} \beta_{13} & 0 & 0 \\ 0 & \beta_{23} & 0 \\ 0 & 0 & \beta_{33} \end{pmatrix} (D_c)$$

where Z_t is the error-correction term, ($\ln f_t - \ln s_t$), and D_t is a dummy variable for 20 sets of macroeconomic announcements and takes on the value of 1 if an announcement falls on hour $t - 1$, and 0 otherwise. The "without news" model excludes the dummy variable. $Q_{24}Z$ and $Q^2_{24}Z$ statistics are the LBP statistics for serial correlation of the standardized residuals, $Z = \varepsilon_t/\sqrt{h_t}$. LL and LR are the log-likelihood function and likelihood-ratio values, respectively.

[a]Significance level of 0.10.

[b]Significance level of 0.05.

[c]Significance level of 0.01.

there is evidence that the JY futures market leads the JY spot market. The β_1 coefficient is insignificant, while the Y_1 coefficient is significant across the two estimations. Further, the δ_s coefficient is positive, indicating that the burden of convergence between the two markets lies with the spot market.

Table VIB reports the coefficients from the variance and covariance equations. The β_{13}, β_{23}, and β_{33} coefficients are positive, indicating that news plays a significant role in the conditional volatility and covariance of the two markets. However, it is noteworthy that the β_{13} coefficient is greater than the β_{23} coefficient, suggesting that futures prices are relatively more sensitive to the selected set of announcements. In either column, the β_{12} and β_{22} coefficients are positive, suggesting that shocks in one market feed into the other. As shown in the table, the likelihood-ratio test rejects the null hypothesis $\beta_{12} = \beta_{22}$, suggesting that β_{22} is significantly larger than β_{12}. The fact that $\beta_{12} < \beta_{22}$ is consistent with the notion that the futures market has the larger impact of the two.

The results in Table VIB also indicate the role of information in the volatility spillover between the futures and spot markets. The β_{12} and β_{22} coefficients fall when the information dummy is introduced into the equations. The magnitude of the drop is dramatic. The coefficient β_{12} drops from 0.0260 to 0.0153, more than a 40% drop, while the coefficient β_{22} drops from 0.1144 to 0.0293, more than a 70% drop. While the coefficients remain statistically significant in the second column, the results do suggest that information plays an important role in the volatility spillover across markets.[14] These results are consistent with the general conclusions reached by Ederington and Lee (1994).

Unfortunately, however, the differences in β_{22} across the two estimations are not directly testable across the two models. To further evaluate the differences in the spillover of volatility across announcement days and no-announcement days, the regression is estimated:

$$h_{s,t} = \omega_0 + \omega_1 A \cdot \varepsilon^2_{f,t-1} + \omega_2 NA \cdot \varepsilon^2_{f,t-1} + u_t \tag{5}$$

where A (NA) takes on the value of 1 if hour $t - 1$ falls on an announcement (no-announcement) day, and 0 otherwise, and $\varepsilon^2_{f,t}$ and $h_{s,t}$ are derived from estimating eqs. (1)–(4) without the volatility spillover and information dummy variables. The regression equation is similar to the news-impact curves estimated in Engle and Ng (1993) and Bae and Karolyi

[14]Furthermore, the log-likelihood ratio test (LR test) presented in Table VIC is significant, indicating an improvement in fit when the information dummy is included in the model.

TABLE VII

Futures Return Shocks and Spot Variance: OLS Results

Sample (Hour)	*Constant*	$A \cdot \varepsilon^2_{f,t-1}$	$NA \cdot \varepsilon^2_{f,t-1}$	*Adjusted* R^2	*F*
10:00	0.44e−5c (17.13)	0.265c (16.90)	0.002 (0.12)	0.24	279.30c
11:00	0.39e−5c (21.93)	0.196c (10.47)	0.096c (5.70)	0.16	5.83c
12:00	0.39e−5c (34.56)	0.183c (11.57)	0.160c (10.55)	0.20	2.44
1:00	0.38e−5c (28.13)	0.182c (10.21)	0.189c (19.45)	0.25	1.37
2:00	0.40e−5c (40.69)	0.135c (6.53)	0.023c (4.27)	0.07	14.16c
3:00	0.36e−5c (20.13)	0.190c (5.25)	0.0912 (1.32)	0.12	4.97c
Intraday	0.40e−5c (62.07)	0.204c (11.92)	0.042c (5.66)	0.16	16.10c

Notes: The coefficients are from the news-impact regression:

$$h_{s,t} = \omega_0 + \omega_1 A \cdot \varepsilon^2_{f,t-1} + \omega_2 NA \cdot \varepsilon^2_{f,t-1} + u_t$$

where $\varepsilon_{F,t-1}$ and $h_{s,t}$ are the lagged (intraday) futures return shock and spot conditional variance, respectively, and A (NA) takes on the value of 1 if t falls on an announcement day (no-announcement day), and 0 otherwise. The futures shock and spot conditional variance are derived from estimating eqs. (1)–(4) without the volatility spillover and information dummy variables. The F-value tests the null hypothesis $A \cdot \varepsilon^2_{f,t-1} = NA \cdot \varepsilon^2_{f,t-1}$.

[a]Significance level of 0.10.

[b]Significance level of 0.05.

[c]Significance level of 0.01.

(1994).[15] If volatility spillover is information driven, then ω_1 will be larger than ω_2. The regression is estimated for the entire sample, and for each hour from 10:00 AM to 3:00 PM. The results presented in Table VII clearly indicate the significance of the relationship between information and volatility spillovers from the futures market to the spot market. The F-value rejects the equality of ω_1 and ω_2 for four of the six cross-sectional regressions and for the regression involving the entire intraday sample.

UNEXPECTED EMPLOYMENT AND TRADE DEFICITS AND VOLATILITY

An additional bivariate GARCH model is implemented with the view that the test results in Table VI may be biased in that the information dummy may be capturing some market-opening effect (as in the U-shaped vola-

[15]Those authors evaluated the relationship between h_t and ε^2_{t-1} from GARCH models under the presumption that the lagged shock variables reflect the impact of the news.

tility patterns) rather than acting as a control variable for information. The concern is reenforced by the fact that most of the announcements investigated are released at 8:30 PM, corresponding approximately to the markets' opening.

The alternate model employs the unexpected components of three important announcements, Employment, Merchandise Trade Deficits, and Inflation, rather than the information dummy. The former two announcements are found to have a significant impact on the JY futures and spot markets (Table II). Theory dictates that an inflation announcement might explain exchange rate volatility. The unexpected trade deficit (*utd*), unexpected employment (*ue*), and unexpected inflation (*ui*) data are used to construct a series as follows: $utd_t = (E(td_t) - td_t)$, $ue_t = (E(e_t) - e_t)$, and $ui_t = (E(i_t) - i_t)$, where *td, e,* and *i* represent the actual (released) trade deficit, unemployment, and inflation figures, respectively, and $E(\cdot)$ represents the expected values of these figures.[16]

Table VIII reports the results from the bivariate GARCH model that employs the three announcement shocks as mixing variables. The β_{13}, β_{23}, and β_{33} coefficients, and the β_{14}, β_{24}, and β_{34} coefficients are significant, suggesting that shocks in unemployment and trade deficits have a positive impact on futures and spot volatility and on the covariance between futures and spot volatility. As in Table VI, the results suggest that information has a positive role in the volatility spillover between futures and spot markets. The β_{12} and β_{22} coefficients are smaller in Table VIII relative to those in the first column of Table VI. This is particularly so for the β_{22} coefficient, which drops from 0.1144 to 0.0344, suggesting that much of the futures leadership in volatility is attributable to information arrival.

Another test is conducted over the concern that the 8:20–9:30 AM price adjustments alluded to in the "Data" section may bias the results in the study. The empirical tests in Table II–VIII are conducted without this adjustment. No changes are noted in the findings of the study: The data continue to exhibit a U-shaped volatility pattern for event days, the OLS results support the evidence that futures market volatility leads spot market volatility on event days more than on nonevent days, and the GARCH model results indicate that a large portion of the volatility spillover between markets is explained by the investigated announcements.

[16]The actual series and their forecasted (expected) values for trade deficits and employment are supplied by the Money Market Service (MMS) Corporation. Recently, Aggarwal, Mohanty, and Song (1995) examined the efficiency of survey forecasts of the MMS data. The expected values of the trade deficit and employment series are shown to be rational.

TABLE VIII

Bivariate GARCH Results with Trade Deficit, Unemployment, and Inflation Shocks

Return Equations		*Variance Equations*	
α_0	0.0058[a]	α_{10}	0.0229[c]
α_1	−0.0612[c]	α_{11}	0.3127[c]
β_1	0.0231	β_{11}	0.1315[c]
δ_f	−0.0012	β_{12}	0.0202[c]
η_{f1}	−0.0047[b]	β_{13}	0.0376[b]
η_{f2}	0.0011[b]	β_{14}	0.0171[c]
η_{f3}	0.0009	β_{15}	0.0014
ψ_0	0.0030	α_{20}	0.0270[c]
ψ_1	0.2151[c]	α_{21}	0.1138[c]
λ_1	−0.2479[c]	β_{21}	0.1731[c]
δ_s	0.0207[c]	β_{22}	0.0344[c]
η_{s1}	−0.0033[c]	β_{23}	0.0409[b]
η_{s2}	0.0005[a]	β_{24}	0.0142[b]
η_{s3}	0.0003	β_{25}	0.0011
		α_{30}	0.0167[c]
		α_{31}	0.1721[c]
		β_{31}	0.1318[c]
Diagnostics		β_{33}	0.0272[c]
		β_{34}	0.0343[c]
$Q_{24}(z_f)$	23.42	β_{35}	0.0029
$Q^2_{24}(z_f)$	4.56		
$Q_{24}(z_s)$	24.84	$LR\chi^2$ $(Ho{:}\beta_{12} = \beta_{22})$	20.94[c]
$Q^2_{24}(z_s)$	14.68		
LL	15,344.21		
$LR\chi^2$	46.84[c]		

Notes: The coefficients are from the model:

$$\Delta \ln F_t = \alpha_0 + \alpha_1 \Delta \ln F_{t-1} + \beta_1 \Delta \ln S_{t-1} + \delta_f Z_{t-1} + \eta_{f1} utd_t + \eta_{f2} ue_t + \eta_{f3} ui_t + \varepsilon_{ft}$$

$$\Delta \ln S_t = \psi_0 + \psi_1 \Delta \ln F_{t-1} + \lambda_1 \Delta \ln S_{t-1} + \delta_d Z_{t-1} + \eta_{s1} utd_t + \eta_{s2} ue_t + \eta_{s3} ui_t + \varepsilon_{st}$$

$$H_t = \begin{pmatrix} h_{f,t} \\ h_{s,t} \\ h_{sf,t} \end{pmatrix} = \begin{pmatrix} \alpha_{10} \\ \alpha_{20} \\ \alpha_{30} \end{pmatrix} + \begin{pmatrix} \alpha_{11} & 0 & 0 \\ 0 & \alpha_{21} & 0 \\ 0 & 0 & \alpha_{31} \end{pmatrix} \begin{pmatrix} \varepsilon^2_{f,t-1} \\ \varepsilon^2_{s,t-1} \\ \varepsilon^2_{f,t-1}\varepsilon^2_{s,t-1} \end{pmatrix} + \begin{pmatrix} \beta_{11} & 0 & 0 \\ 0 & \beta_{21} & 0 \\ 0 & 0 & \beta_{31} \end{pmatrix} \begin{pmatrix} h_{f,t-1} \\ h_{s,t-1} \\ h_{fs,t-1} \end{pmatrix}$$

$$+ \begin{pmatrix} \beta_{12} & 0 & 0 \\ 0 & \beta_{22} & 0 \\ 0 & 0 & 0 \end{pmatrix} \begin{pmatrix} \varepsilon^2_{s,t-1} \\ \varepsilon^2_{f,t-1} \\ 0 \end{pmatrix} + \begin{pmatrix} \beta_{13} & 0 & 0 \\ 0 & \beta_{23} & 0 \\ 0 & 0 & \beta_{33} \end{pmatrix} (|ue_t|) + \begin{pmatrix} \beta_{14} & 0 & 0 \\ 0 & \beta_{24} & 0 \\ 0 & 0 & \beta_{34} \end{pmatrix} (|utd_t|) + \begin{pmatrix} \beta_{15} & 0 & 0 \\ 0 & \beta_{25} & 0 \\ 0 & 0 & \beta_{35} \end{pmatrix} (|ui_t|)$$

where Z_t is the error-correction term, $(\ln f_t - \ln s_t)$, and utd_t, ue_t, and ui_t are, respectively, the differences between expected and actual trade deficit, unemployment, and inflation figures released at $t - 1$. LL and LR are the log-likelihood function and likelihood-ratio test statistics, respectively.

[a]Significance level of 0.10.

[b]Significance level of 0.05.

[c]Significance level of 0.01.

CONCLUSIONS

This article examines the intraday behavior of the Japanese yen spot and futures rates following news releases and investigates the role of information in the relationship between the volatility in futures and spot markets. The results suggest that the evidence of one market leading to greater volatility in the other is at least partly driven by information. The implication is that empirical evidence that futures markets *cause* spot market volatility may be a reflection of futures markets' reacting more efficiently to new information. This in turn implies that regulation or elimination of futures market (for the Japanese yen, in this case) will not necessarily result in lower volatility in the spot market.

This study employs a set of scheduled U.S. macroeconomic announcements in its investigation. It is likely that even more conclusive evidence of the role of information in the volatility relationship across futures and spot markets would be determined by examining a more comprehensive set of relevant announcements (e.g., one that includes international news) and employing a data set sampled at finer intervals. For now, the article serves to highlight the importance of considering the role of futures markets in price discovery before arriving at any meaningful conclusions over the role of futures markets in cash price volatility. To provide a more complete picture of the implications of futures trading, research on volatility spillover has the daunting task of separating (i) the futures-spot volatility relationship that arises from information arrival from (ii) the futures-spot volatility relationship that arises from other factors (speculation, arbitrage, expiration effects, etc.).

APPENDIX

Macroeconomic Announcements (February 1992–December 1995)

Announcement	*Time*	*Reporting Agency*	*Number of Announcements*
Employment	8:30	Bureau of Labor Statistics	44
Merchandise Trade Deficit	8:30	Bureau of Census	46
Gross Domestic Product	8:30	Bureau of Economic Analysis	30
Leading Indicators	8:30	Bureau of Economic Analysis	42
Employment Costs	8:30	Bureau of Labor Statistics	17
Initial Unemployment Claims	8:30	Bureau of Labor Statistics	32
Producer Price Index	8:30	Bureau of Labor Statistics	48
Retail Sales	8:30	Bureau of Census	47
Consumer Price Index	8:30	Bureau of Labor Statistics	47
Housing Starts	8:30	Bureau of Census	48
Durable Goods Orders	8:30	Bureau of Census	44
Existing-Home Sales	8:45	Bureau of Census	8
Industrial Production	9:15	Federal Reserve Board	46
Construction Spending	10:00	Bureau of Census	43
Factory Inventories	10:00	Bureau of Census	79
Personal Income	10:00	Bureau of Economic Analysis	45
New Single Family Home Sales	10:00	Bureau of Census	46
NAPM Survey	10:00	National Association of Purchasing Managers	46
Consumer Confidence	10:00	Bureau of Economic Analysis	30
Federal Budget	2:15	Department of Treasury	48

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