Transmission of Information across International Equity Markets

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This article provides evidence of information transmission from the United States and Japan to Korean and Thai equity markets. *Information* is defined as important macroeconomic announcements in the United States, Japan, Korea, and Thailand. Using high-frequency intraday data, I find a large and significant association between developed-economy macroeconomic announcements and emerging-economy equity volatility and trading volume at short time horizons. Previous studies' findings of at most weak evidence of transmission from developed to emerging economies may be due to their use of lower frequency data and their focus on developed-economy financial market innovations as a proxy for information. (*JEL* E44, G14, G15)

An extensive literature has explored the transmission of information across global financial markets, but only weak evidence of transmission from developed-economy equity markets to emerging-economy equity markets has been found [e.g., Bekaert and Harvey (1997) and Ng (2000)].[1] This result is surprising because most emerging economies rely heavily on international trade, and such trade is predominantly with developed economies (especially the United States and Japan). Information regarding macroeconomic fundamentals of developed economies should significantly influence emerging-economy fundamentals and thus

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[1] Studies focusing on information transmission among developed markets include Eun and Shim (1989), Hamao, Masulis, and Ng (1990), Engle, Ito, and Lin (1990), King and Wadhwani (1990), Lin and Ito (1994), Karolyi (1995), Becker, Finnerty, and Friedman (1995), Karolyi and Stulz (1996), Connolly and Wang (2002), Kim (2003), and Andersen, Bollerslev, Diebold, and Vega (2004). Studies focusing on transmission from developed markets (mainly the United States and Japan) to emerging markets include Cheung, He, and Ng (1994), Kim and Rogers (1995), Bekaert and Harvey (1997), and Ng (2000). Among these papers, Becker, Finnerty, and Friedman (1995), Connolly and Wang (2002), Kim (2003), and Andersen, Bollerslev, Diebold, and Vega (2004) used macroeconomic announcements to proxy for information.

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emerging equity market returns and volatility. For example, Bekaert and Harvey (1997) found that, during the mid-1970s and the early 1990s, world factors on average can explain only about two (three) percent of Korean (Thai) equity return volatility, while international trade was about seventy (sixty) percent of gross domestic product. Such fundamental linkages should be material even when capital controls are in place.

The weakness of existing evidence may be attributable to the nature of information proxies used in existing studies and to their use of low-frequency data. Existing studies have focused on the impact of innovations from asset pricing models or of volatility changes in one market on returns or volatility in another market. The underlying information arrivals that drive such innovations in a developed market are likely to be of varying importance for an emerging market. Thus, the impact of information about developed-economy fundamentals that is material for the emerging market might be masked by the use of information proxies that include information that is material for developed markets but that is approximately noise for the emerging market.

Studies of information transmission that use low-frequency data also may fail to detect impacts that are incorporated very quickly and other short-run dynamic effects. Recent research that uses macroeconomic announcements to proxy for information and focuses mainly on developed markets has shown that the impact of information on volatility is short-lived [e.g., Ederington and Lee (1993), Andersen and Bollerslev (1998), Fleming and Remolona (1999), and Balduzzi, Elton, and Green (2001)].

This article is the first to study international transmission of economic fundamental information from developed economies to emerging economies using high-frequency data. I study information transmission from the United States and Japan to Korea and Thailand during 1995 through 2000. *Information* is defined as important macroeconomic announcements in the United States, Japan, Korea, and Thailand. Using minute-by-minute intraday equity market data, macroeconomic announcements, and expectations about such announcements, I investigate the impact of U.S. and Japanese announcements on intraday return volatility and trading volume for Korea and Thailand, controlling for announcements made in Korea and Thailand. I estimate two-factor stochastic models for volatility and trading volume in which the short-run component is allowed to vary with information. Empirical measures of information are dummy variables for each announcement, the size of announcement surprises (measured as the absolute value of the difference between realizations and expectations), and the dispersion of announcement expectations (measured as the cross-sectional standard deviation of all analysts' expectations for each announcement). Because the sources of information are identifiable, problems of noise and spurious relationships which may influence results when financial market innovations are used to proxy for information are avoided.

I find that announcements of U.S. Nonfarm Payrolls (EMPNF) and the Japanese Industrial Production Index (IPI) induce large but short-lived increases in Korea and Thailand return volatility. In addition, U.S. inflation data and Japanese Monetary Policy Meeting (MPM) decisions also have a large but short-lived effect on Korean market volatility. On average, these short-lived effects last about 30 minutes. Such short-lived effects are consistent with behavior in developed markets. For example, U.S. macroeconomic announcements have been found to be associated with short-lived bursts of volatility in various U.S. financial markets [e.g., Ederington and Lee (1993) and Fleming and Remolona (1999)].

The impact of information on intraday trading volume is also assessed.[2] I find that announcements that affect Thailand's volatility (U.S. EMPNF and Japanese IPI), as well as U.S. Federal Open Market Committee (FOMC) decisions, induce large and significant short-lived increases in trading volume for Thailand. As for the Korean market, the same announcements that affect volatility (U.S. inflation data and Japanese MPM and IPI) also are associated with large and significant short-lived increases in trading volume. These effects last about 45 minutes on average. An examination of trading volume is helpful because it sheds light on the nature of reactions to information that is not revealed by examining return volatility alone. Some macroeconomic announcements are expected by an average market participant (implying no measured announcement surprises), but the expectations of individual market participants may be dispersed. When announcements are made, uncertainty is resolved and individuals may rebalance portfolios, with the volume of rebalancing positively related to the dispersion of expectations. The evidence is consistent with theoretical models put forward by Karpoff (1986), Kim and Verrecchia (1991), Shalen (1993), and Harris and Raviv (1993).

Although short-lived effects on volatility and volume are not in themselves of great economic importance, such effects are indirect evidence of an impact of international transmission of information on returns, which might be quite important economically. Unfortunately, direct examination of the impact of announcements on returns cannot provide convincing evidence in an international context because the sign of the return innovation is unpredictable for most announcements. Announcements affect a variety of economic variables, including trade flows, capital flows, and exchange rates, and the net implication of any given announcement for emerging-economy equity returns can differ with circumstances.

[2] Several studies have examined the impact of information on trading volume within a single country, for example, Li and Engle (1998), Fleming and Remolona (1999), and Balduzzi, Elton, and Green (2001). To my knowledge, Lin and Ito (1994) is the only article which studies the impact of information from one market on trading volume in another market, and they study only developed markets.

Thus, any of a negative, zero, or positive unconditional average reaction of returns to announcements could be consistent with economically important international financial linkages. Conditioning on circumstances would require taking a position about the details of a structural international macroeconomic model, and such models remain in flux at this time.

In contrast, the effects of announcements on volatility and volume are predictable, which motivates this article's empirical focus. Although it is logically possible that substantial volume effects could occur even if announcements *always* have only a small impact on returns, it seems more likely that agents trade more in the wake of announcements because asset prices *often* are finding a new level. Moreover, because volatility is measured as absolute return deviations, the finding of significant volatility is also a finding that prices move significantly in response to information. Thus, I regard this article as providing evidence of economically important information transmission from developed economies to emerging-economy equity markets.

The remainder of the article is organized as follows. Section 1 describes data sources. In Section 2, results from using daily data are presented as background. Intraday volatility and trading volume models and estimation methods are described in Section 3. Section 4 presents the main empirical results. Finally, Section 5 concludes and discusses directions for future research.

1. Data Description

1.1 Equity market data

Intraday minute-by-minute Korea total market index values and trading volume are from the Korea Stock Exchange and cover the period from January 3, 1995, through December 26, 2000. During this period, the Korea Stock Exchange operated under four different sets of trading hours. Different trading-hour regimes are labelled as Subsample I, II, III, and IV (see Figure 1). Intraday minute-by-minute Thailand total market index values and trading volume are from the Stock Exchange of Thailand and cover the period from January 3, 1995, through December 29, 2000. The trading hours are shown in Figure 1.

In order to mitigate the nonsynchronous trading problem for component securities in an index [Lo and MacKinlay (1990)], I compute returns at 15-minute intervals.[3] To minimize the stale prices problem, the opening

[3] A 15-minute return interval minimizes the average intraday return autocorrelation. I compared autocorrelations for 1-minute, 5-minute, 10-minute, 15-minute, 20-minute, and 30-minute periods. Korea Subsample I and Thailand 15-minute return intraday autocorrelations are –0.02 and 0.06, respectively. The mean 15-minute returns for Korea and Thailand are very close to zero. Other results are available on request.

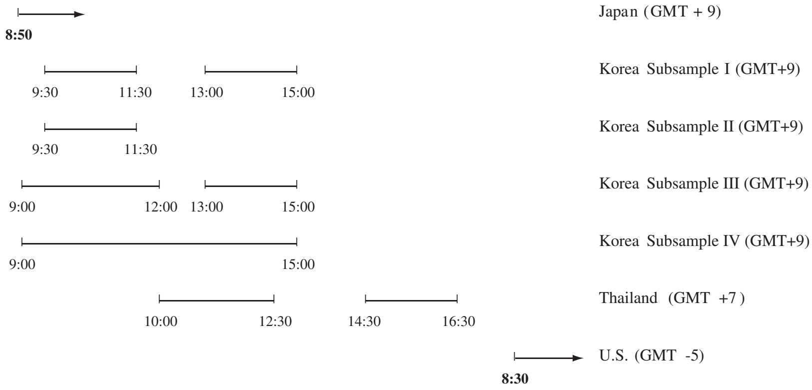

Figure 1
Trading hours for Korea and Thailand
The figure shows trading hours for Korea and Thailand. All times are local. GMT represents Greenwich Mean Time. *Japan* represents the most up-to-date scheduled time for most Japanese macroeconomic announcements as of this writing. See further detail in Table 1 for earlier periods. *Korea Subsample I* is weekdays during the period from January 3, 1995, through December 5, 1998. *Korea Subsample II* is Saturdays during the period from January 3, 1995, through December 5, 1998. *Korea Subsample III* is weekdays during the period from December 7, 1998, through May 19, 2000. *Korea Subsample IV* is weekdays during the period from May 22, 2000, through December 26, 2000. *Thailand* is weekdays during the period from January 3, 1995, through December 29, 2000. *U.S.* represents the time for most of the U.S. macroeconomic announcements.

prices are taken after the market has been open for 15 minutes. The first return of each day is computed from yesterday's closing price and today's opening price (the price 15 minutes after the true open). Volatility is measured as absolute return deviation: $|R_{t,n} - \bar{R}_{t,n}|$, where $R_{t,n}$ is the return for interval n in day t, and $\bar{R}_{t,n}$ is the expected return for interval n in day t. The expected return is computed as the sample average of returns across all days, t, for a given time interval, n. Trading volume is computed as the number of shares traded over any 15-minute interval.

As is often encountered in high-frequency data, there are days when returns and trading volume are contaminated by recording errors, and such days are dropped from the sample. Such errors often manifest themselves as either sequences of zeros in the total market index and trading volume or sequences of negative values in trading volume. I removed days when the sequences are longer than an hour (23 days from Korea and 3 days from Thailand). The usable sample for Thailand is 1,471 days and 26,478 15-minute intervals. Sizes of Subsamples I, II, III, IV for Korea are 947, 191, 352, and 148 days and 15,152, 1,528, 7,040, and 3,552 15-minute return observations, respectively.

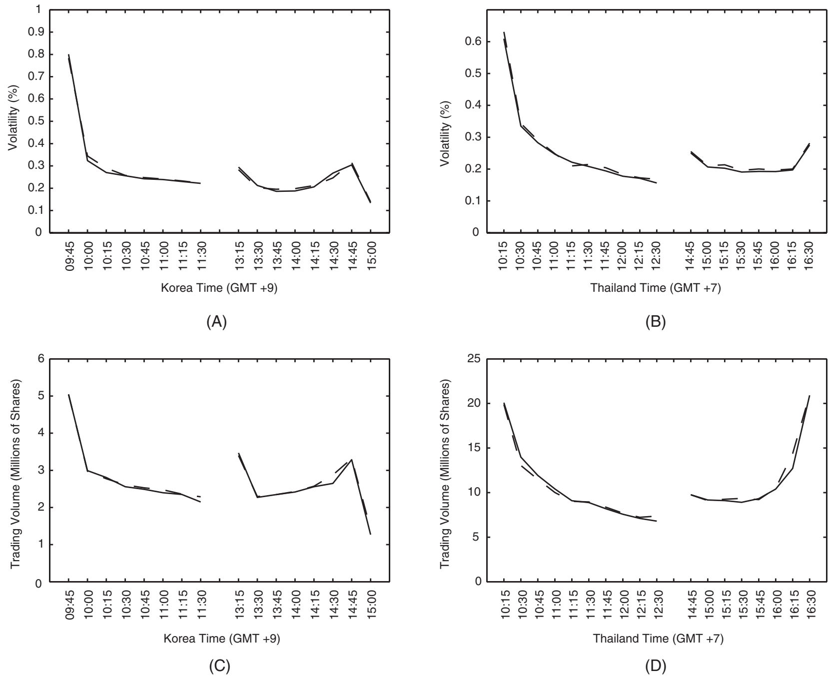

Figure 2
Average intraday volatility and trading volume
Panels (A) and (B) show the intraday volatility pattern for Korea Subsample I and Thailand, respectively. Panels (C) and (D) show the intraday trading volume pattern for Korea Subsample I and Thailand, respectively. The open space in the middle of each panel represents the market's lunch break. The *solid lines* in panels (A) and (B) are averages of intraday volatility, and the *dashed lines* are the averages of fitted intraday volatility. The *solid lines* in panels (C) and (D) are averages of intraday trading volume, and the *dashed lines* are the averages of fitted intraday trading volume.

Figure 2 plots average intraday volatility (panels A and B) and trading volume (panels C and D) for Korea Subsample I and for Thailand.[4] The spike in the middle of the day is due to high activity when the market reopens after the lunch-time break. The sharp decreases of the Korean market's volatility and volume in the last trading period are due to the use of a batch auction in the last 10 minutes to arrive at closing prices. During this batch auction period, all bids and offers are considered as having been submitted simultaneously. Ignoring the lunch-time break and the batch auction in the Korean market, intraday volatility and trading volume in Korean and Thai markets exhibit similar U-shaped patterns, which resemble what has been documented in the literature for

[4] To conserve space, I only report results for Korea Subsample I. Results for other Korean subsamples are qualitatively similar and are available on request.

U.S. equity markets [Tauchen and Pitts (1983), Karpoff (1987), and Foster and Viswanathan (1993)].

Due to the time difference between the United States and Asia, the impact of U.S. announcements appears during the first trading period of the following day. This delay might lead to a problem in differentiating the impact of U.S. macroeconomic announcements from other overnight information. To minimize this problem, I use the absolute value of the daily *net of announcement effect* return on the U.S. S&P 500 index (sometimes called *volatility spillover* below) to control for other overnight information that may impact Asian markets. The *net of announcement effect* return is computed as the return during the U.S. trading day (open-to-close) minus the return over the 30 minutes following the announcement in the U.S.[5] In addition, I also use dummy variables to control for the first trading period, Monday morning, and mornings after holidays. Use of high-frequency intraday data for Korean and Thai stocks trading in New York as American Depository Receipts (ADRs) [see Karolyi and Stulz (1996) for the case of Japan] or country funds [see Cohen and Remolona (2000) for the case of Southeast Asian countries] would eliminate this problem. However, there are only a few ADRs and country funds listed on the New York Stock Exchange.[6] In addition, these stocks are not actively traded and do not track the underlying assets well.[7] Thus, the benefit of using intraday domestic total market data outweighs the cost. As for Japanese announcements, they impact Korean and Thai equity markets at various times during trading hours. Table 1 provides specific times for each announcement.

Daily data are used for two purposes: to compute long-run volatility, and to produce some model results in order to put the high-frequency results into perspective. For long-run volatility, the sample for Korea is from January 3, 1990, through December 26, 2000, for a total of 3,081 observations. The Thailand sample period is from July 2, 1987, through December 29, 2000, for a total of 3,284 observations. When producing model results, the samples are restricted to begin in 1995 for comparability with high-frequency sample periods.

[5] With the exception of FOMC meeting announcements, all U.S. announcements used in this article are released at 8:30 Eastern Time, before the U.S. equity market opens at 9:30. Net of announcement effect trading day returns on days with an announcement (except the FOMC announcements) are computed from 10:00 to 16:00, whereas returns on days with no announcement are computed from 9:30 to 16:00.

[6] As of December 29, 2000, there were five Korean stocks and no Thai stocks listed as ADRs. As for country funds, there were three Korean funds and two Thai funds traded on the New York Stock Exchange.

[7] Korean ADRs sometimes trade at a premium because of ownership limits.

Table 1
Macroeconomic announcements

Announcement	Total	Monday	Tuesday	Wednesday	Thursday	Friday	Time (Local)	Source
U.S.								
Employment Report (EMP)	72	0	0	0	3	69	8:30	Bureau of Labor Statistics
Unemployment Rate (EMPU)								
Nonfarm Payrolls (EMPNF)								
Producer Price Index (PPI)	72	0	6	11	21	34	8:30	Bureau of Labor Statistics
Consumer Price Index (CPI)	72	0	24	17	15	16	8:30	Bureau of Labor Statistics
Federal Open Market Committee Meeting (FOMC)	49	0	32	15	2	0	14:15	Federal Reserve Board
Total days with at least one announcement	257	0	58	40	40	119		
Japan								
Gross Domestic Product (GDP)	24	6	4	1	5	8	15:30/8:50[a]	Economic Planning Agency
Industrial Production Index (IPI)	72	12	8	19	16	17	15:30/13:30/8:50[b]	MITI
Wholesales Price Index (WPI)	71	18	16	8	17	12	17:30/11:00/8:50[c]	Bank of Japan
Tankan Business Survey (TK)	24	8	2	7	2	5	14:00/11:00/8:50[d]	Bank of Japan
Monetary Policy Meeting (MPM)	57	7	8	7	15	20	No fixed time	Bank of Japan
Total days with at least one announcement	234	49	37	38	52	58		
Korea								
Gross Domestic Product (GDP)	24	2	6	7	9	0	13:00	Bank of Korea
Industrial Production Index (IPI)	72	18	9	15	13	17	12:00	National Statistical Office
Consumer Price Index (CPI)	72	15	13	12	15	17	12:00	Ministry of Finance and Economy
Trade Balance (TB)	71	21	9	11	10	20	No fixed time	MTIE
Total days with at least one announcement	205	48	31	39	41	46		
Thailand								
Gross Domestic Product (GDP)[e]	8	6	1	1	0	0	11:00	NESDB
Consumer Price Index (CPI)	71	26	13	13	10	9	No fixed time	Ministry of Commerce
Trade Balance (TB)	72	5	10	4	35	18	15:00	Bank of Thailand
Total days with at least one announcement	148	37	23	17	44	27		
Grand total days with at least one announcement	667	111	118	106	136	196		

The table shows the sources, day distribution, and time of each announcement. All times are local. U.S. time is GMT -5. Japan and Korea times are GMT +9. Thailand time is GMT +7. MITI represents the Ministry of International Trade and Industry. MTIE represents the Ministry of Trade, Industry, and Energy. NESDB represents the National Economic and Social Development Board. [a]The Japanese GDP announcement time was changed to 8:50 on September 9, 1999. [b]The Japanese Industrial Production Index announcement time was changed to 13:30 on January 29, 1997, and to 11:00 on October 29, 1997. [c]The Japanese Wholesale Price Index announcement time was changed to 11:00 on August 9, 1996, and to 8:50 on December 9, 1996. [d]The Japanese Tankan Business Survey announcement time was changed to 11:00 on August 28, 1996, and to 8:50 on November 27, 1996. [e]The first available announcement date and time was on March 30, 1999. All announcements are made on a monthly basis except U.S. FOMC (every six weeks), Japanese MPM (bimonthly), and Japanese, Korean, and Thai GDP (quarterly).

1.2 Macroeconomic announcement data

Table 1 shows details on all announcements used in this article and their mnemonic abbreviations. The data include the date, time, median of analysts' expectations about each macroeconomic announcement, and the standard deviation of all analysts' expectations for each announcement. The announcement sample covers the period from January 1995 through December 2000.

U.S. macroeconomic announcements include the Employment Report (EMP), the Producer Price Index (PPI), the Consumer Price Index (CPI), and FOMC decisions. I separate components of the Employment Report into two parts that include the Unemployment Rate (EMPU) and Nonfarm Payrolls (EMPNF). This separation is possible when I measure the information with the absolute value of announcement surprises (the sample correlation of the absolute value of surprises for the two components is 0.07). I focus on these five announcements because they have been shown in the literature to be the most important releases that capture real economic activity (EMPU and EMPNF), prices (PPI and CPI), and monetary policy (FOMC). These announcements have a robustly large and significant impact on U.S. financial markets [e.g., Ederington and Lee (1993), Andersen and Bollerslev (1998), and Jones, Lamont, and Lumsdaine (1998)].[8] Data for U.S. announcements are from the government agency that published them. Market expectations are from Money Market Services (MMS).[9]

Japanese macroeconomic announcements include Gross Domestic Product (GDP), the Industrial Production Index (IPI), the Wholesale Price Index (WPI), the Tankan Business Survey (TK), and Monetary Policy Meeting (MPM) decisions. These announcements are chosen based on coverage in the major Japanese financial newspaper (*Nikkei Kin-yu Shimbun*) and on conversations with a Bank of Japan officer. The Japanese Monetary Policy Committee was set up in 1998, with the U.S. FOMC as its model. The Japanese monetary committee meets twice a month.

[8] I also investigated the impact of 19 other U.S. macroeconomic releases on Korean and Thai equity markets. These releases have been found to be significant in some contexts, but their effect is not as broadly robust or significant as the releases that are the focus of this article. These releases include GDP advance, GDP preliminary, GDP final, retail sales, industrial production, capacity utilization, personal income, new home sales, personal consumption expenditures, durable goods orders, factory orders, construction spending, business inventories, trade balance, consumer confidence index, NAPM index, housing starts, index of leading indicators, and initial jobless claims. I found evidence that GDP (advance and preliminary) and retail sales releases significantly impacted Korean and Thai return volatility in some subsample periods. However, I found only weak evidence of the impact of these 19 releases on trading volume and no evidence of the impact of GDP and retail sales releases on trading volume. Detailed results are available on request.

[9] Kuttner (2001) and Faust, Swanson, and Wright (2004) have shown that expectations of FOMC decisions are better captured with federal funds futures contracts. I choose to use MMS data because it provides a measure of market dispersion of expectations (the standard deviation of all analysts' expectations). The sample correlation of the median of expectations and expectations derived from federal funds futures contracts is 0.99.

Korean announcements include GDP, IPI, CPI, and Trade Balance (TB). Thai macroeconomic announcements include GDP, CPI, and TB. The official trade balance is reported by the Bank of Thailand in an end-of-month *Press Release on Economic and Monetary Conditions*. This release includes manufacturing production, private consumption, government cash balance, CPI and PPI (which are first reported by the Ministry of Commerce at the beginning of the month), trade balance, liquidity conditions in financial markets, and the exchange rate. I choose to focus on the trade balance because it represents the most important macroeconomic factor among those in the Press Release.[10]

For all Asian macroeconomic announcements, the announcement data are from the government agency that published them. For some announcements for which data from the agency do not provide both date and time, I identified date and time as those when news of the announcement first appeared on either Bloomberg News or the Dow Jones Interactive Database. Market expectations are from *Consensus Economics: Asia Pacific Consensus Forecasts* and Bloomberg News and are available from 1997. These expectations are measured monthly but are reported as a year-on-year growth rate. Wongswan (2003) discusses assumptions and methodologies used to convert year-on-year growth rate expectations to monthly expectations.

I use three empirical measures of information. First, announcement occurrences are captured with dummy variables for the full sample for all countries. Second, I use standardized announcement surprises (available for the full sample for the United States and from 1997 for Japan, Korea, and Thailand). Standardized surprises are computed by dividing announcement surprises by the standard deviation of surprises across the sample [Balduzzi, Elton, and Green (2001)]. This standardization is useful in comparing the responses to different economic announcements which have different units of measurement. It affects neither the statistical significance of the estimated responses nor the explanatory power of the model. Finally, I use the dispersion of announcement expectations (full sample for the United States and from 1997 for Japan, Korea, and Thailand). This measure is intended to capture the dispersion or disagreement of agents' beliefs, which can be viewed as capturing the amount of uncertainty that is resolved when information arrives. Disagreement among agents is used widely in microstructure theory to explain trading volume, volatility, and the positive relationship between the two [e.g., Karpoff (1987), Kim and Verrecchia (1991), and Shalen (1993)].

[10] Different versions of the Thai trade balance are published independently by the Ministry of Finance (Customs Department), Ministry of Commerce (Department of Foreign Trade), and Bank of Thailand. However, the statistic from the Bank of Thailand is considered the official one.

2. Preliminary analysis

As noted previously, studies using low-frequency data and using developed-economy financial market innovations as the measure of information find little evidence of information transmission from developed markets to emerging markets. Most such studies have used weekly or monthly data. However, other studies imply that the impact of information (macroeconomic announcements) on volatility is very short-lived, making it unlikely that daily data will support sufficiently powerful tests. I begin by examining daily data in order to obtain benchmark results against which results based on higher-frequency data may be compared. Results are obtained for both volatility and volume.

To examine the impact of macroeconomic announcements on volatility, I estimate an AR(1)-GARCH(1,1) model in which volatility is allowed to vary when information arrives. GARCH(1,1) models are known to provide reasonably good approximations of volatility dynamics [e.g., Hansen and Lunde (2005)]. Daily asset returns are modeled as

$$R_t = \phi_0 + \phi_1 R_{t-1} + \epsilon_t \tag{1}$$

$$h_t = \omega + \alpha\epsilon_{t-1}^2 + \beta h_{t-1} + \sum_{k=1}^{N_A} \psi_k I_t^k + \sum_{i=1}^{N_D} \varphi_i D_t^i + \kappa |R_{t-1}^{US}| \tag{2}$$

where ϵ_t is an error term with mean zero and conditional variance h_t, I^k is a dummy variable for the kth variety of macroeconomic announcement, the D^i are dummy variables for days of the week and days after holidays, and R_{t-1}^{US} is the net-of-announcement-effect return on the U.S. S&P 500 index over the previous trading day. The model is estimated by quasi-maximum likelihood. The estimation results, based on daily data from 1995 through 2000, are shown in the first two columns of Table 2 (labelled Additive volatility). These results are consistent with previous studies' findings of no information transmission, in that none of the announcement-dummy coefficients are significantly different from zero. However, the tests may have low power for two reasons apart from data frequency. The first issue relates to geometric decay in volatility autocorrelation implied by the standard GARCH model. Andersen and Bollerslev (1997) point out that the standard GARCH model cannot capture strong regular seasonal patterns (e.g., macroeconomic announcement and day-of-the-week effects). To incorporate the seasonal patterns, I modify the standard GARCH model to the following form

$$R_t = \phi_0 + \phi_1 R_{t-1} + \sqrt{S_t}\epsilon_t \tag{3}$$

Table 2
Daily volatility and trading volume regressions

	Additive volatility		Multiplicative volatility		Trading volume	
	Korea	Thailand	Korea	Thailand	Korea[a]	Thailand[b]
Intercept	−0.037	−0.066	−0.032	−0.077		−27.367*
	(0.036)	(0.047)	(0.044)	(0.045)		(7.904)
AR(1)	0.137*	0.163*	0.132*	0.157*	0.614*	0.708*
	(0.029)	(0.030)	(0.022)	(0.028)	(0.042)	(0.045)
ω	0.983*	0.687*	0.149*	0.256*		
	(0.196)	(0.292)	(0.061)	(0.072)		
α	0.112*	0.150*	0.083*	0.088*		
	(0.018)	(0.025)	(0.033)	(0.035)		
β	0.812*	0.719*	0.985*	0.988*		
	(0.023)	(0.031)	(0.109)	(0.175)		
Tuesday	−1.453*	−1.702*	−0.335*	−0.578*	8.570*	28.395*
	(0.355)	(0.480)	(0.126)	(0.107)	(3.484)	(8.517)
Wednesday	−0.588*	0.241	−0.204	0.094	14.863*	35.198*
	(0.251)	(0.380)	(0.140)	(0.188)	(3.455)	(8.275)
Thursday	−1.086*	−1.392*	−0.329*	−0.421*	9.081*	39.395*
	(0.265)	(0.374)	(0.118)	(0.104)	(3.387)	(9.431)
Friday	−0.855*	−0.489	−0.320*	−0.311	7.858*	42.169*
	(0.293)	(0.413)	(0.141)	(0.163)	(3.400)	(9.941)
Saturday	−1.693*		−0.406*		−8.068*	
	(0.264)		(0.128)		(4.072)	
After holiday	−0.033	0.699	0.063	0.173	2.068	35.379*
	(0.223)	(0.399)	(0.104)	(0.143)	(4.916)	(15.210)
U.S. volatility spillover	0.341*	0.467*	0.031*	0.065*		
	(0.087)	(0.122)	(0.014)	(0.033)		
U.S. announcements						
Employment Report	0.180	0.371	−0.021	−0.134	−5.545	−1.451
	(0.199)	(0.274)	(0.107)	(0.139)	(4.926)	(13.842)
Producer Price Index	−0.174	−0.072	−0.025	−0.196	−3.534	10.993
	(0.206)	(0.359)	(0.131)	(0.151)	(4.713)	(13.804)
Consumer Price Index	0.403	0.851	0.130	0.268	−7.613	−0.903
	(0.277)	(0.562)	(0.179)	(0.215)	(4.627)	(12.320)
FOMC Meeting	−0.405	−0.073	−0.120	0.224	0.173	45.278
	(0.248)	(0.376)	(0.173)	(0.277)	(5.566)	(24.201)
Japanese announcements						
GDP	−0.285	−0.118	−0.101	−0.155	−5.382	19.555
	(0.238)	(0.433)	(0.155)	(0.165)	(7.684)	(19.659)
Industrial Production Index	−0.751	0.682	−0.181	−0.008	−4.241	−17.768
	(0.461)	(0.438)	(0.168)	(0.195)	(5.156)	(10.990)
Wholesale Price Index	−0.341	−0.114	0.082	0.211	−1.158	4.689
	(0.243)	(0.393)	(0.171)	(0.162)	(4.608)	(13.047)
Tankan Survey	−0.653	−0.768	−0.148	−0.155	−4.842	−19.130
	(0.430)	(0.483)	(0.175)	(0.141)	(7.743)	(13.959)
Monetary Policy Meeting	1.792	2.964	0.231	0.457	−22.116	−10.929
	(1.025)	(1.735)	(0.172)	(0.251)	(15.275)	(21.664)
Korean announcements						
GDP	−0.056	−0.846	0.006	−0.108	1.580	−27.101
	(0.284)	(0.489)	(0.194)	(0.140)	(7.668)	(14.432)
Industrial Production Index	0.311	0.006	0.024	0.333	−2.378	−4.072
	(0.294)	(0.451)	(0.149)	(0.253)	(5.252)	(9.282)
Consumer Price Index	0.180	−0.226	−0.003	−0.090	2.880	5.695
	(0.185)	(0.136)	(0.222)	(0.182)	(5.185)	(16.621)
Trade Balance	0.098	0.842	0.056	0.292	5.436	6.687
	(0.248)	(0.606)	(0.207)	(0.307)	(5.672)	(11.964)

Table 2
(continued)

	Additive volatility		Multiplicative volatility		Trading volume	
	Korea	Thailand	Korea	Thailand	Korea[a]	Thailand[b]
Thai announcements						
GDP	1.219	−2.807	−0.026	−0.283	−18.682	8.083
	(1.854)	(1.949)	(0.319)	(0.220)	(13.422)	(25.829)
Consumer Price Index	−0.019	0.534	−0.011	0.273	5.912	−12.033
	(0.195)	(0.487)	(0.153)	(0.225)	(5.096)	(10.625)
Trade Balance	0.397	0.337	0.196	−0.040	−1.907	23.177
	(0.311)	(0.477)	(0.192)	(0.159)	(5.190)	(13.013)

The table shows estimates of the impact of macroeconomic announcements on daily volatility and volume for Korea and Thailand. *Additive volatility* shows regression results for a GARCH model with additive macroeconomic announcement dummies [Equation (2)]. *Multiplicative volatility* shows regression results for a GARCH model with multiplicative macroeconomic announcement dummies [Equations (4) and (5)]. *Volume* shows regression results for trading volume using macroeconomic announcement dummies, with the coefficients on the model's ARMA terms, except an AR(1) coefficient, omitted to save space. [a]Parameters on ARMA(10,2) terms, the time-trend, and intercepts for the two sample periods are not shown (see further details in note 12). [b]Parameters on ARMA(9,0) terms and the time-trend are not shown. *AR(1)* is the coefficient for the model's first AR term. *U.S. Volatility Spillover* is the absolute value of the previous trading day *net of announcement effect* return (see Section 1.1). The sample period for Korea is from January 3, 1995, through December 26, 2000. The sample period for Thailand is from January 3, 1995, through December 29, 2000. Robust standard errors are in parenthesis. Standard errors for volatility models are Bollerslev and Wooldridge (1992) robust quasi-maximum likelihood standard errors, and those for trading volume models are Newey and West (1987) robust standard errors. *indicates the estimate is significant at the 95% confidence level.

$$S_t = 1 + \sum_{k=1}^{N_A} \psi_k I_t^k + \sum_{i=1}^{N_D} \varphi_i D_t^i + \kappa |R_{t-1}^{US}| \tag{4}$$

$$h_t = \omega + \alpha \epsilon_{t-1}^2 + \beta h_{t-1} \tag{5}$$

where S_t measures seasonal patterns (including information arrivals).[11]

Here the dummy variables enter multiplicatively into the volatility equation, as opposed to additively in Equation (2). Moreover, when there are no seasonal patterns, this modified GARCH model reduces to the standard GARCH model. The estimation results are shown in the middle columns of Table 2 (labelled Multiplicative volatility). Again there is no evidence of information transmission. It is interesting to note that the coefficient on U.S. volatility spillover ($|R_{t-1}^{US}|$) is highly significant across the two model specifications for both countries, similar to the

[11] Andersen and Bollerslev (1997) introduced this modeling concept for the case of high-frequency intraday seasonal patterns (see Section 3.1). Applications on daily data were implemented in Jones, Lamont, and Lumsdaine (1998), Li and Engle (1998), and Flannery and Protopapadakis (2002).

empirical evidence of standard U.S. volatility spillovers to Asian markets documented in Ng (2000).

The second issue relates to the efficiency of the GARCH model. It is well known that a long sample period is required if precise GARCH parameter estimates are to be obtained. The most efficient way to achieve precision here is to estimate jointly Equation (3) through Equation (5) for the full sample of daily data (1990 through 2000 for Korea and 1987 through 2000 for Thailand), but unfortunately, announcement data for all four countries are only available from 1995. Instead of using data only from 1995, I employ a two-step procedure to estimate the impact of announcement dummies on volatility. This procedure permits information in the dynamics of the pre-1995 data to be incorporated. First, daily volatility is estimated from an AR(1)-GARCH(1,1) model with no announcement dummies using the full sample of daily data. In the second step, I run a simple ordinary least squares (OLS) regression of fitted volatility estimates from the GARCH model in step one on dummies for macroeconomic announcements and other control variables used earlier for a sample from 1995 through 2000. The results show no evidence of information transmission (not shown in tables). As a robustness check, I run a regression of absolute return on dummy variables for macroeconomic announcements, day-of-the-week, and days after holidays and the absolute value of the previous day's U.S. net-of-announcement-effect return, which also shows no evidence of information transmission (not shown in tables).

The right columns of Table 2 (Trading volume) show results for OLS regressions of ARMA models of daily volume in which volume is allowed to vary with macroeconomic announcements, days of the week, and days after holidays.[12] Again there is no evidence of an impact of macroeconomic information.

To sum up, tests using daily data show no evidence of information transmission, even using macroeconomics announcements as the measure of information. This may arise because there is no information transmission from the United States and Japan to Korea and Thailand, or because tests based on daily data have low power because information effects are very short-lived.

[12] ARMA models are used to control for persistence in the trading volume time series. The model for Korea is an ARMA(10,2) with a time-trend and two intercepts. The two intercepts are for pre- and post-complete lifting of foreign investment restrictions in Korean equity markets (May 25, 1998). The model for Thailand is an ARMA(9,0) with a time-trend and an intercept. Specification tests of these two models show that they can capture the persistence of trading volume well. I failed to reject the null hypothesis of no autocorrelation up to lag 15, 20, and 25 for Korean and Thai trading volume innovations at the 95% confidence level.

3. High-Frequency Methodology

3.1 Impact of information on intraday volatility

Recent studies of price dynamics suggest that a two-factor model of volatility is appropriate, including long-run (persistent) and short-run (mean-reverting) factors [e.g., Alizadeh, Brant, and Diebold (2002)].[13] However, it is difficult to estimate a conventional stochastic volatility model in high-frequency data because of computation costs and noise in the data series. Andersen and Bollerslev (1997) propose a simple way to model both volatility factors in a high-frequency setting.[14] The asset return is decomposed into three parts as follows:

$$R_{t,n} - \bar{R}_{t,n} = \sigma_{t,n} S_{t,n} Z_{t,n} \tag{6}$$

where $\bar{R}_{t,n}$ is the expected 15-minute return for interval n in day t, n denotes the 15-minute interval within a day ($n = 1, 2, \ldots, 16$ for Korea Subsample I and $n = 1, 2, \ldots, 18$ for Thailand), $Z_{t,n}$ is an error term with mean zero and unit variance, $S_{t,n}$ represents the pattern effect (calendar, scheduled announcement, and potentially a short-run or mean-reverting volatility factor), and $\sigma_{t,n}$ is the remaining part (potentially a long-run or persistent volatility factor). Squaring Equation (6) and taking logs yields:

$$2\log[|R_{t,n} - \bar{R}_{t,n}|] - \log \sigma^2_{t,n} = c + 2\log S_{t,n} + u_{t,n} \tag{7}$$

where $c = E[\log Z^2_{t,n}]$ and $u_{t,n} = \log Z^2_{t,n} - E[\log Z^2_{t,n}]$.

To make the estimation tractable, three assumptions are imposed. First, the expected return $\bar{R}_{t,n}$ is assumed constant across all sample days, but is permitted to vary within each day. Second, to demonstrate robustness, the persistent factor, $\sigma^2_{t,n}$, is computed three ways, using: integrated volatility [Andersen, Bollerslev, Diebold, and Labys (2001)], a GARCH model, and the unconditional variance. Lastly, the parametric function for $E[\log S_{t,n}]$ is assumed to be of the form $f(\theta; t, n)$

[13] See, for example, Gallant, Hsu, and Tauchen (1999), Engle and Lee (1999), and Chernov, Gallant, Ghysels, and Tauchen (2003). Alternatively, many papers add a jump component to price dynamics [e.g., Andersen, Benzoni, and Lund (2002), Pan (2002), Eraker, Johannes, and Polson (2003)]. It should be noted that both the two-factor model and the one-factor model with a jump component imply observationally indistinguishable price dynamics. Which model is the correct specification remains an open question and is beyond the scope of this article. However, I prefer the two-factor model, because the impact of information on volatility persists for a short time as opposed to a single period.

[14] The methodology in this section is based primarily on Andersen and Bollerslev (1997, 1998).

$$f(\theta;t,n)=\sum_{j=0}^{J}\sigma_t^j\left[\mu_{0j}+\mu_{1j}n+\mu_{2j}n^2+\sum_{k=1}^{D}\lambda_{kj}I_k(t,n)+\lambda_{USj}|R_{t-1}^{US}|\right.$$
$$\left.+\sum_{p=1}^{P}(\gamma_{pj}\cos\frac{p2\pi}{N}n+\delta_{pj}\sin\frac{p2\pi}{N}n)\right] \tag{8}$$

where $I_k(t,n)$ represents an indicator for the event k during interval n on day t. Where appropriate, the impact of event k can be modeled as persisting for more than one period by using $I_k(t,n+i)$, where $i=0,\dots,N_k$, and N_k is the number of intervals during which event k persists. To allow for the dynamic response with parsimonious and efficient estimates, I model the response as an order-p polynomial specification [Andersen and Bollerslev (1998)],

$$\lambda_k(i)=c_0+c_1\cdot i+\dots+c_p\cdot i^p \tag{9}$$

where $\lambda_k(i)$ is the response of event k after i interval and $i=0,\dots,N_k$. When $i=0$, it represents the initial impact from event k. I impose a restriction that event k persists for N_k periods, $\lambda_k(N_k+1)=0$. This removes one parameter from the p-order polynomial.[15] The number of parameters used to model the dynamic response of event k is equal to p. Indicators for time-of-the-day effects, day-of-the-week effects, macroeconomic announcements, and important economic events may be included.[16] As noted previously, several different measures of macroeconomic announcement information are used, including dummy variables, standardized announcement surprises, and the dispersion of announcement expectations. The dynamic response to U.S. volatility spillover ($|R_{t-1}^{US}|$) follows the same specification as those of event indicators. When $J=0$, $D=0$, and $\lambda_{US}=0$, $f(\theta;t,n)$ reduces to a standard Flexible Fourier Functional form [Gallant (1981)]. This functional form is both simple and able to capture intraday patterns. Given the assumptions, we can rewrite Equation (7) as

$$\hat{x}_{t,n}\equiv 2\log[|R_{t,n}-\bar{R}_{t,n}|]-\log\hat{\sigma}_{t,n}^2=\hat{c}+f(\theta;t,n)+\hat{u}_{t,n} \tag{10}$$

[15] Imposing that $\lambda_k(N_k+1)=0$, I solve for c_p, then substitute c_p back into $\lambda_k(i)$; $\lambda_k(i)=c_0\cdot[1-(\frac{i}{N_k+1})^p]+c_1\cdot[1-(\frac{i}{N_k+1})^{p-1}]\cdot i+\dots+c_{p-1}\cdot[1-(\frac{i}{N_k+1})]\cdot i^{p-1}$.

[16] I control for five major economic events: the Thai currency crisis (July 2, 1997), the Korean currency crisis (November 17, 1997), the Russian crisis (August 17, 1998), the Long-Term Capital Management (LTCM) crisis (September 24, 1998), and the Brazilian crisis (January 13, 1999). The date and time for each event is that of the first news that appeared on the Bloomberg News monitor. The modeling of these events can be viewed as controlling for outlying observations.

where $\hat{c} = E[\log Z_{t,n}^2] + E[\log \sigma_{t,n}^2 - \log \hat{\sigma}_{t,n}^2]$ and $\hat{u}_{t,n} = (\log S_{t,n}^2 - E[\log S_{t,n}^2]) + (\log \sigma_{t,n}^2 - \log \hat{\sigma}_{t,n}^2 - E[\log \sigma_{t,n}^2 - \log \hat{\sigma}_{t,n}^2]) + (\log Z_{t,n}^2 - E[\log Z_{t,n}^2])$.

To estimate the model, Andersen and Bollerslev (1998) suggest a two-step estimation procedure. In the first step, $\bar{R}$ is calculated, $\hat{\sigma}_{t,n}^2$ is estimated, and a lag length is specified for the intraday pattern [Equation (8)]. The second step is an OLS regression of $\hat{x}_{t,n}$ on an intraday pattern function [Equation (10)]. Although the two-step estimation is not efficient, it is consistent.

There are several possible ways of estimating $\hat{\sigma}_{t,n}^2$ for use in the first stage. This component is intended to capture the persistent volatility factor. I use three different measures. First, as in Andersen, Bollerslev, Diebold, and Labys (2001), when using high-frequency data, we can measure daily volatility and treat it as observable, which they denote *integrated volatility*. However, integrated volatility consists of both long-run and short-run factors. In order to extract a long-run component, I compute a one-day ahead forecast from a time series model fitted on daily integrated volatility. The intraday estimate is

$$\hat{\sigma}_{t,n} = \frac{\hat{\sigma}_t^{Int}}{\sqrt{N}} \tag{11}$$

where $\hat{\sigma}_t^{Int}$ is a one-day ahead forecast of integrated volatility, $\hat{\sigma}_t^{Int}$ is computed from an ARMA(1,1) model of integrated volatility (σ_t^{Int}), and integrated volatility is computed from

$$\sigma_t^{Int} = \sqrt{\sum_{n=1}^{N} R_{t,n}^2} \tag{12}$$

Here the ARMA(1,1) is sufficient to capture autocorrelation in σ_t^{Int}.

The second method is to estimate a GARCH(1,1) model using a full sample of daily data, $\hat{\sigma}_t^{GARCH}$. The intraday estimate is

$$\hat{\sigma}_{t,n} = \frac{\hat{\sigma}_t^{GARCH}}{\sqrt{N}} \tag{13}$$

Lastly, to check robustness, I assume that $\sigma_{t,n}$ is constant by equating it to the unconditional standard deviation of equity returns. The intraday estimate is

$$\hat{\sigma}_{t,n} = \frac{\bar{\sigma}}{\sqrt{N}} \tag{14}$$

where $\bar{\sigma}$ is the unconditional standard deviation.

To appraise the economic significance of announcements, I transform estimated coefficients into measures of the impact on market volatility by converting Equation (10) to

$$|R_{t,n} - \bar{R}_{t,n}| = \frac{\hat{\sigma}_t}{\sqrt{N}} \exp\left(\frac{f(\theta; t, n)}{2}\right) \exp\left(\frac{\hat{u}_{t,n}}{2}\right) \tag{15}$$

where $\hat{\sigma}_t$ is the daily estimated standard deviation obtained from Equation (11), (13), or (14). The impact can be computed directly from Equation (15) as

$$M(k) = \sum_{i=0}^{N_k} \left[\exp\left(\frac{\lambda_k(i)}{2}\right) - 1\right] \tag{16}$$

where $M(k)$ is the cumulative response from event k, and $\lambda_k(i)$ is the response of market volatility to event k after an interval of duration i.

3.2 Impact of information on intraday trading volume

To study the impact of information on trading volume, normal intraday patterns in volume must be distinguished from information effects. Panels C and D of Figure 2 show that intraday volumes exhibit a U-shaped pattern. Following the same modeling strategy as for intraday volatility, I model volume as consisting of long-run and short-run components. The decomposition is analogous to Equation (6); that is, intraday volume is modeled the same way as absolute returns:

$$V_{t,n} = V_{t,n}^{LR} S_{t,n} Z_{t,n} \tag{17}$$

where $V_{t,n}$ is trading volume for time interval n in day t, $Z_{t,n}$ is an error term with mean zero and unit variance, $S_{t,n}$ represents the pattern effect (calendar effects and scheduled announcements), and $V_{t,n}^{LR}$ is the remaining part (potentially a long-run factor).

Taking the log of Equation (17) yields

$$\log V_{t,n} - \log V_{t,n}^{LR} = c + \log S_{t,n} + u_{t,n} \tag{18}$$

where $c = E[\log Z_{t,n}]$, $u_{t,n} = \log Z_{t,n} - E[\log Z_{t,n}]$. $V_{t,n}^{LR}$ is computed as a one-step ahead forecast from ARMA models based on daily volume (see note 12). $E[\log S_{t,n}]$ is modeled using a parametric function of the form $f(\theta; t, n)$ similar to Equation (8) but with no U.S. volatility spillover term. Under this specification, short-run trading volume is allowed to vary with information. The economic significance of announcements can be evaluated in a manner similar to evaluation of the results on volatility, Equations (15) and (16).

4. Empirical Results

As noted previously, results are obtained for three different empirical measures of macroeconomic information: dummy variables for announcements, standardized announcement surprises, and the dispersion of announcement expectations. Each measure, used one at a time, is allowed to impact the short-run components of volatility and trading volume through $I_k(t,n)$ in Equation (8). In addition, I also allow the direct impact of information to persist over different numbers of 15-minute time intervals, as modeled in Equation (9).

I begin with the full model, deleting information variables and re-estimating the model until all retained information measures are significant. Table 3 shows volatility results for Korea Subsample I and Thailand 1995–2000 when announcement dummies are the measure of information. Coefficients on controls for daily and intraday patterns appear in the early rows, then coefficients on announcement dummies, and finally coefficients on dummies that control for crises. Newey and West (1987) robust standard errors with 18 lags, which are sufficient to correct for intraday autocorrelation when there are 16 and 18 15-minute time intervals in a day for Korea and Thailand, respectively, are shown in parentheses. The first column of each panel displays results for the full model, including all announcements, whereas the second column reports results for the final model after insignificant announcement dummies are dropped. The third and fourth columns report results when alternative measures of the long-run volatility factor ($\hat{\sigma}_{t,n}$) are used (GARCH and unconditional standard deviation, respectively). Leaving aside the information variables, which are discussed below, the significance of coefficients on many terms in Equation (8) is evidence that volatility exhibits strong intraday and day-of-week patterns. In addition, the significance of the coefficient on U.S. volatility spillover ($|R_{t-1}^{US}|$) is consistent with evidence of standard U.S. volatility spillovers to Asian markets, similar to the results in Section 2. The fact that results are qualitatively robust to use of different measures of long-run volatility implies that, at high frequencies, the short-run component of volatility dominates, similar to the results for foreign exchange found in Andersen and Bollerslev (1998).

Table 4 reports results for trading volume. To save space, only the preferred specification is reported, and only coefficients on announcement dummies and crisis dummies are shown. However, results for other control variables are qualitatively similar to those for volatility in that volume also exhibits strong intraday and day-of-week seasonality.

Turning to results for the impact of macroeconomic announcements, as noted previously, several different measures of information are used for both Korea and Thailand and for several Korean subsamples associated with different market operating hours. To conserve space, results are

Table 3
Intraday volatility regressions

	Korea				Thailand			
	Full system	Int. vol.	GARCH	Std	Full system	Int. vol.	GARCH	Std
Intercept	−0.289	−0.335	0.082	−0.915*	2.660*	3.103*	2.908*	2.515*
	(0.423)	(0.415)	(0.410)	(0.431)	(0.602)	(0.340)	(0.338)	(0.346)
μ_1	−0.754*	−0.740*	−0.780*	−0.643*	−1.347*	−1.434*	−1.472*	−1.412*
	(0.130)	(0.128)	(0.128)	(0.131)	(0.160)	(0.097)	(0.097)	(0.099)
μ_2	0.046*	0.045*	0.047*	0.040*	0.067*	0.072*	0.073*	0.071*
	(0.008)	(0.008)	(0.008)	(0.007)	(0.008)	(0.005)	(0.005)	(0.005)
γ_1	−0.721*	−0.703*	−0.736*	−0.627*	−1.591*	−1.708*	−1.736*	−1.696*
	(0.174)	(0.172)	(0.172)	(0.175)	(0.232)	(0.160)	(0.160)	(0.161)
δ_1	0.206*	0.210*	0.185*	0.273*	−0.425*	−0.484*	−0.522*	−0.460*
	(0.071)	(0.069)	(0.069)	(0.072)	(0.102)	(0.054)	(0.054)	(0.055)
γ_2					−0.405*	−0.422*	−0.420*	−0.426*
					(0.048)	(0.043)	(0.042)	(0.043)
δ_2					−0.062	−0.086*	−0.092*	−0.082*
					(0.046)	(0.031)	(0.031)	(0.032)
Monday morning	0.621*	0.606*	0.608*	0.607*	0.638*	0.510*	0.488*	0.548*
	(0.190)	(0.187)	(0.185)	(0.198)	(0.168)	(0.157)	(0.155)	(0.165)
First morning trading	0.802*	0.827*	0.821*	0.849*	0.083			
	(0.161)	(0.144)	(0.145)	(0.145)	(0.172)			
First afternoon trading	0.563*	0.565*	0.564*	0.572*	0.596*	0.601*	0.602*	0.602*
	(0.087)	(0.084)	(0.084)	(0.084)	(0.073)	(0.072)	(0.071)	(0.072)
Last trading	−2.341*	−2.331*	−2.343*	−2.299*				
	(0.157)	(0.156)	(0.156)	(0.158)				
After holiday	−0.447*	−0.433*	−0.311	−0.509*	0.057			
	(0.188)	(0.185)	(0.184)	(0.167)	(0.100)			
Tuesday	0.235*	0.235*	0.198*	0.205*	0.089			
	(0.080)	(0.080)	(0.076)	(0.102)	(0.065)			
Wednesday	0.229*	0.230*	0.181*	0.180	0.138			
	(0.086)	(0.086)	(0.079)	(0.118)	(0.070)			
Thursday	0.272*	0.270*	0.219*	0.204	0.150*			
	(0.083)	(0.082)	(0.078)	(0.111)	(0.070)			
Friday	0.225*	0.221*	0.156	0.188	0.144*			
	(0.091)	(0.091)	(0.085)	(0.108)	(0.068)			
U.S. volatility spillover	0.404*	0.397*	0.292*	0.670*	0.281*	0.276*	0.131	0.362*
	(0.080)	(0.081)	(0.072)	(0.102)	(0.087)	(0.086)	(0.082)	(0.094)
U.S. announcements								
Employment Report	0.924*	1.111*	0.502*	1.367*	0.664*	0.639*	0.738*	0.670*
	(0.418)	(0.371)	(0.255)	(0.475)	(0.316)	(0.275)	(0.272)	(0.300)
Producer Price Index	−0.157				0.306			
	(0.540)				(0.261)			
Consumer Price Index	0.004				0.187			
	(0.345)				(0.299)			
FOMC Meeting	0.209				0.446			
	(0.387)				(0.303)			
Japanese announcements								
GDP	−0.377				−0.656			
	(0.813)				(0.745)			
Industrial Production Index	0.543				−0.878			
	(0.427)				(0.523)			
Wholesale Price Index	0.045				0.056			
	(0.405)				(0.298)			
Tankan Survey	−0.391				−1.162			
	(0.818)				(0.783)			
Monetary Policy Meeting	1.853*	1.843*	1.431*	2.497*	0.510			
	(0.382)	(0.377)	(0.397)	(0.409)	(0.299)			

Table 3
(continued)

	Korea				Thailand			
	Full system	Int. vol.	GARCH	Std	Full system	Int. vol.	GARCH	Std
Korean announcements								
GDP	0.448				−0.857			
	(0.518)				(0.622)			
Industrial Production Index	−0.205				0.576			
	(0.350)				(0.352)			
Consumer Price Index	0.097				−0.586			
	(0.322)				(0.339)			
Trade Balance	0.009				−0.047			
	(0.255)				(0.310)			
Thai announcements								
GDP					−0.371			
					(0.753)			
Consumer Price Index	0.112				0.382			
	(0.245)				(0.292)			
Trade Balance	−0.575				0.597*	0.570*	0.543*	0.444*
	(0.386)				(0.222)	(0.216)	(0.198)	(0.233)
Crisis episodes								
Thai	2.456*	2.551*	2.696*	2.262*	4.093*	4.064*	3.312*	4.465*
	(0.253)	(0.135)	(0.126)	(0.155)	(0.324)	(0.225)	(0.230)	(0.223)
	−1.094*	−1.164*	−1.096*	−1.281*				
	(0.325)	(0.186)	(0.175)	(0.211)				
Korean	4.151*	4.158*	3.533*	4.458*	1.318*	1.177*	0.198	1.236*
	(0.252)	(0.250)	(0.276)	(0.247)	(0.235)	(0.236)	(0.273)	(0.234)
	−4.638*	−4.637*	−5.034*	−4.140*				
	(0.284)	(0.286)	(0.369)	(0.187)				
Russian	3.404*	3.413*	3.321*	3.107*	4.446*	4.350*	3.912*	4.845*
	(0.211)	(0.210)	(0.207)	(0.222)	(0.203)	(0.195)	(0.178)	(0.209)
					−0.539*	−0.586*	−0.777*	−0.371*
					(0.274)	(0.272)	(0.250)	(0.272)
LTCM	3.413*	3.422*	2.955*	2.857*	3.692*	3.730*	3.737*	3.716*
	(0.196)	(0.193)	(0.195)	(0.196)	(0.241)	(0.235)	(0.228)	(0.247)
					0.969*	0.993*	0.730*	1.135*
					(0.198)	(0.198)	(0.196)	(0.203)
Brazilian					2.840*	2.871*	2.435*	2.962*
					(0.105)	(0.097)	(0.086)	(0.101)
					−0.379*	−0.375*	−0.560*	−0.335*
					(0.088)	(0.086)	(0.087)	(0.086)

The table shows estimates of intraday volatility regressions for Subsample I for Korea and the full sample for Thailand. *U.S. volatility spillover* is the absolute value of the previous trading day *net of announcement effect* return (see Section 1.1). *Full system* is a regression of intraday volatility that includes all macroeconomic announcements. *Int. vol.* is a preferred regression of intraday volatility that estimates long-run volatility from an ARMA(1,1) model on integrated volatility. *GARCH* is a preferred regression of intraday volatility that estimates long-run volatility from a GARCH model. *Std* is a preferred regression of intraday volatility that estimates long-run volatility as an unconditional standard deviation of returns. The dynamic specifications for Korean *Int. vol., GARCH*, and *Std* models are: U.S. volatility spillover $N_k = 3$ and $p = 1$, U.S. EMP $N_k = 1$ and $p = 1$, Japanese MPM $N_k = 1$ and $p = 1$, Thai Crisis $N_k = 3$ and $p = 2$, Korean Crisis $N_k = 3$ and $p = 2$, Russian Crisis $N_k = 2$ and $p = 1$, and LTCM Crisis $N_k = 2$ and $p = 1$. The dynamic specifications for Thai *Int. vol., GARCH*, and *Std* models are: U.S. volatility spillover, U.S. EMP $N_k = 1$ and $p = 1$, Thai Trade Balance $N_k = 1$ and $p = 1$, Thai Crisis $N_k = 3$ and $p = 1$, Korean Crisis $N_k = 2$ and $p = 1$, Russian Crisis $N_k = 3$ and $p = 2$, LTCM Crisis $N_k = 4$ and $p = 2$, and Brazilian Crisis $N_k = 4$ and $p = 2$. For each event that $p = 2$, the first parameter is c_0, and the second is c_1. Newey and West (1987) robust standard errors with 18 lags are in parentheses. *indicates the estimate is significant at the 95% confidence level. See Table 1 for a list of the macroeconomic announcements' abbreviations.

Table 4
Intraday trading volume regressions

	Korea	Thailand
Macroeconomic announcements		
U.S. Employment Report		0.220*
		(0.073)
Japanese Monetary Policy Meeting	0.197*	
	(0.098)	
Crisis episodes		
Thai	0.554*	0.991*
	(0.021)	(0.035)
		0.096*
		(0.012)
Korean	0.176*	−0.411*
	(0.033)	(0.063)
		0.310*
		(0.058)
Russian	0.495*	1.711*
	(0.022)	(0.024)
		−0.769*
		(0.027)
LTCM	0.517*	1.189*
	(0.031)	(0.114)
		0.126*
		(0.046)
Brazilian		1.009*
		(0.021)
		−0.490*
		(0.017)

The table shows estimates from intraday volume regressions for Korea Subsample I and Thailand, with most variables omitted to save space. The dynamic specifications for Korea are: Japanese MPM $N_k = 1$ and $p = 1$, Thai Crisis $N_k = 3$ and $p = 1$, Korean Crisis $N_k = 3$ and $p = 1$, Russian Crisis $N_k = 6$ and $p = 1$, and LTCM Crisis $N_k = 6$ and $p = 1$. The dynamic specifications for Thailand are: U.S. EMP $N_k = 2$ and $p = 1$, Thai Crisis $N_k = 7$ and $p = 2$, Korean Crisis $N_k = 3$ and $p = 2$, Russian Crisis $N_k = 3$ and $p = 2$, LTCM Crisis $N_k = 7$ and $p = 2$, and Brazilian Crisis $N_k = 4$ and $p = 2$. For each event that $p = 2$, the first parameter is c_0, and the second is c_1. Newey and West (1987) robust standard errors with 18 lags are in parentheses. *indicates the estimate is significant at the 95% confidence level. See Table 1 for a list of the macroeconomic announcements' abbreviations.

reported only in summary form for each country, in Table 5 for volatility and Table 6 for volume. The tables list the macroeconomic announcements for which estimated coefficients are significantly different from zero at the 95% confidence level. The format of these two tables is similar in that the label on top of each column shows the type of information measure used, whereas rows differ by subsample. The top panel of each table shows results for Korea, and the bottom panel shows results for Thailand. Since Asian macroeconomic expectations are only available after 1997, I divide the sample that starts before 1997 into the full period of that subsample and the remaining period from 1997 of that subsample [i.e., Korea Subsample I and Korea Subsample I (from 1997)].

Table 5
Summary empirical results on intraday volatility

Sample period	Dummy variables	Announcement surprises	Dispersion of announcement expectations
Korea			
Subsample I	U.S. Employment Report Japanese MPM	U.S. Nonfarm Payrolls U.S. Producer Price Index Japanese MPM[a]	Japanese MPM[a]
Subsample I (from 1997)	U.S. Producer Price Index Japanese MPM	U.S. Nonfarm Payrolls U.S. Producer Price Index Japanese Industrial Production Index Korean GDP Japanese MPM[a]	U.S. Producer Price Index Japanese MPM[a]
Subsample II	Japanese MPM	Japanese MPM[a]	Japanese MPM[a]
Subsample II (from 1997)	Japanese MPM	Japanese MPM[a]	Japanese MPM[a]
Subsample III	–	U.S. Consumer Price Index	U.S. Consumer Price Index
Subsample IV	U.S. Consumer Price Index	U.S. Nonfarm Payrolls U.S. Consumer Price Index	U.S. Nonfarm Payrolls U.S. Consumer Price Index
Thailand			
1995–2000	U.S. Employment Report Thai Trade Balance	U.S. Nonfarm Payrolls U.S. FOMC Meeting Thai Trade Balance[a]	U.S. Nonfarm Payrolls Thai Trade Balance[a]
1997–2000	Thai Trade Balance	U.S. Nonfarm Payrolls Japanese Industrial Production Index Thai GDP Thai Trade Balance	Thai Trade Balance

The table summarizes results for the impact of macroeconomic announcements on Korean and Thai volatility. *Dummy variables* denotes the use of dummy variables to capture macroeconomic announcements [$I_k(t,n)$ in Equation (8)]. *Announcement surprises* denotes the use of standardized announcement surprises [$I_k(t,n)$ in Equation (8)]. The standardized surprise is defined as the absolute value of the difference between the actual announcement and the median of analysts' expectations divided by the standard deviation of surprises across the sample period. *Dispersion of announcement expectations* denotes the use of the standard deviation of analysts' expectations just before the announcement [$I_k(t,n)$ in Equation (8)]. [a]denotes the use of dummy variables to capture macroeconomic announcements.

It is evident from Table 5 and Table 6 that there is some variation across subsamples and countries in which announcements have significant impact. This could be due to the fact that the announcements which are viewed by market participants as most important change over time, perhaps with the state of the business cycle, or because of changes in monetary or fiscal regimes. Another possible reason for variation in announcement significance is that statistical power varies across subsamples because the number of announcements occurring within each subperiod differs. For example, for many announcement types, Korea Subsample I has more than twice as many announcements as the other Korea subsamples. See Wongswan (2003) for details.

Table 6
Summary empirical results on intraday trading volume

Sample period	Dummy variable	Announcement surprises	Dispersion of announcement expectations
Korea			
Subsample I	Japanese MPM	Japanese MPM[a]	U.S. FOMC Meeting Japanese MPM[a]
Subsample I (from 1997)	Japanese Industrial Production Index Korean Trade Balance	Japanese Industrial Production Index Korean GDP Korean Consumer Price Index Korean Trade Balance	Japanese Industrial Production Index Korean Consumer Price Index
Subsample II	Japanese MPM	Japanese MPM[a]	Japanese MPM[a]
Subsample II (from 1997)	Japanese MPM	Japanese MPM[a]	Japanese MPM[a]
Subsample III	Japanese MPM	U.S. Producer Price Index Korean Industrial Production Index Japanese MPM[a]	Korean Trade Balance Japanese MPM[a]
Subsample IV	Japanese MPM	Korean GDP Japanese MPM[a]	Korean GDP Japanese MPM[a]
Thailand			
1995–2000	U.S. Employment Report	U.S. Nonfarm Payrolls	U.S. Nonfarm Payrolls U.S. FOMC Meeting
1997–2000	U.S. Employment Report	Japanese Industrial Production Index Thai GDP	U.S. Nonfarm Payrolls U.S. FOMC Meeting

The table summarizes results for the impact of macroeconomic announcements on Korean and Thai trading volume. *Dummy variables* denotes the use of dummy variables to capture macroeconomic announcements [$I_k(t,n)$ in Equation (8)]. *Announcement surprises* denotes the use of standardized announcement surprises [$I_k(t,n)$ in Equation (8)]. The standardized surprise is defined as the absolute value of the difference between the actual announcement and the median of analysts' expectations divided by the standard deviation of surprises across the sample period. *Dispersion of announcement expectations* denotes the use of the standard deviation of analysts' expectations just before the announcement [$I_k(t,n)$ in Equation (8)]. [a]denotes the use of dummy variables to capture macroeconomic announcements.

4.1 Impact of information on intraday volatility

The general conclusion from Table 5 is that U.S. EMPNF and Japanese IPI induced significant increases in Korean and Thai equity return volatility. In addition, U.S. inflation data (CPI and PPI) and Japanese MPM decisions also have a large but short-lived effect on Korean volatility. On average, these impacts persist for about 30 minutes. The sizes of these impacts, as measured by the size of coefficients when information is measured as standardized surprises, are much larger than the sizes of impacts of Korean and Thai announcements on their own return volatilities. The U.S. Nonfarm Payrolls (EMPNF) has also been shown previously to be the most important announcement in the U.S. financial markets [e.g., Ederington and Lee (1993), Andersen and Bollerslev (1998), Jones, Lamont, and Lumsdaine (1998), Flannery and Protopapadakis (2002), and Andersen, Bollerslev, Diebold, and Vega (2003)]. Such importance is likely due to its timeliness and to the perception that it is a good indicator of the state of U.S. economy (thus, it also may contain information that would help forecast the future direction of monetary policy).

It is puzzling that Japanese MPM decisions only affect the Korean market, while U.S. FOMC decisions only affect the Thai market. The Japanese MPM decisions only impacted Korea's volatility during 1998. This finding might be attributed to the fact that the Monetary Policy Committee was set up in 1998 with a strong apparent commitment from the Japanese government (they passed a new law). Initially, market participants may have attached some credibility to the new policy. However, after a year of implementation, market participants did not observe any progress in revitalizing the Japanese economy, which may have led to diminished credibility and thus a reduction of the impact of MPM decisions. I inspected the impact on intraday returns for individual meeting announcements and found that 15-minute returns in Korea reacted strongly following the first four meetings. Returns were 30 times higher than the same time interval on days with no announcement. However, return reactions on average, both positive and negative, were more limited later in the sample. Because market expectations data are not available for the MPM announcements, I cannot link announcement surprises to return reactions. The weak results for the impact of U.S. FOMC decisions on Thailand's return volatility likely are due to time variation in the surprise component of U.S. monetary policy. Although I do not find a significant impact on volatility during the 1997 to 2000 period, that period contains few surprises. During the full sample (1995–2000), there were 49 FOMC meetings but only four decisions that surprised the markets, and these occurred mostly prior to 1997.

The economic significance of announcements can be evaluated through Equations (15) and (16). For example, consider the case of Korea Subsample I when dummy variables are the measure of information arrival (Table 3). The impact of U.S. EMP on Korean volatility is restricted to follow the first-order polynomial ($p = 1$) and to persist for 30 minutes ($N_k = 1$); the dynamic structure follows λ_{k0} and $\lambda_{k1} = \frac{\lambda_{k0}}{2}$ (see dynamic structures for each event in the note of Table 3). Thus, this dynamic structure implies an increase in Korean market volatility of 74% $(\exp(\frac{1.111}{2}) - 1)$ for the first 15 minutes (initial impact) and 32% $\left(\exp\left(\frac{1.111\cdot(1/2)}{2}\right) - 1\right)$ for the next 15 minutes relative to baseline periods without macroeconomic announcements. In terms of volatility level, the initial impact is an increase of 0.59% (an initial jump of 74% times mean first-interval volatility of 0.80%) and an increase of 0.10% in the second interval. Such increases are indicative of transmission of economically significant information from developed to emerging economies. Panel A

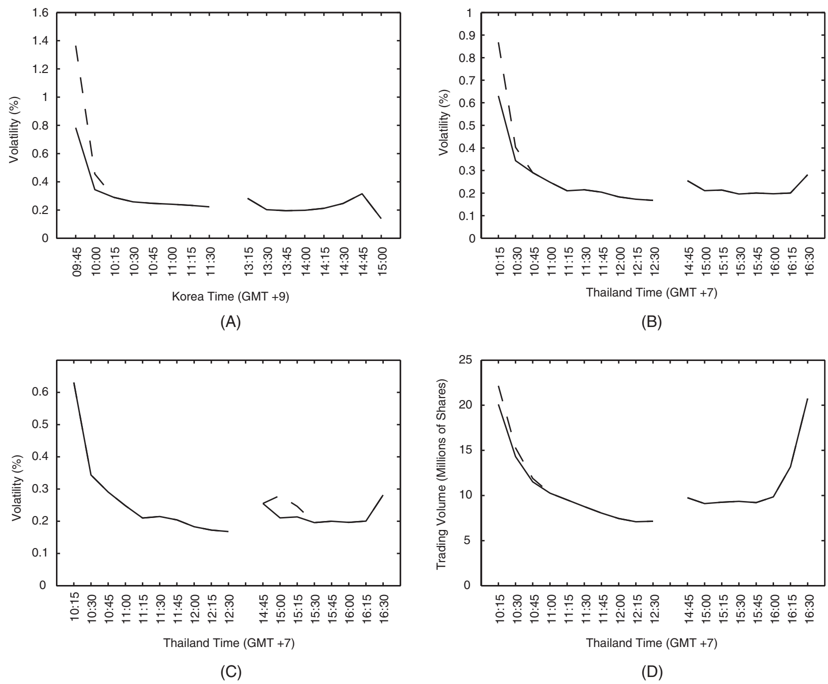

Figure 3
Intraday volatility and trading volume responses to macroeconomic announcements
The panels show Korean and Thai equity return volatility and trading volume responses to macroeconomic announcements. The open space in the middle of each panel represents the market's lunch break. The *solid lines* show the averages of fitted intraday volatility or trading volume. The *dashed lines* show the averages of fitted intraday volatility or trading volume on days in which the specified announcement occurred. Panel (A) shows Korean Subsample I volatility response to U.S. Employment Report. Panels (B) and (D) show Thai volatility and trading volume responses to U.S. Employment Report, respectively. Panel (C) shows Thai volatility response to Thai Trade Balance.

of Figure 3 shows the response of Korean return volatility to U.S. EMP, and panels B and C show the responses of Thai return volatility to the U.S. EMP and Thai TB, respectively.[17]

The economic importance of major economic events (see note 16) can also be evaluated through Equations (15) and (16). The bottom panel of Table 3 gives estimates of the impact of these events. It is evident from the magnitude of estimated coefficients that the impacts are very large and persistent. For example, the Korean crisis led to a statistically large

[17] Such short-lived bursts of volatility are consistent with other studies using developed markets data [e.g., Ederington and Lee (1993) and Becker, Finnerty, and Friedman (1995)], but are different from results in Kim (2003). Using open-to-close prices, Kim (2003) finds that several macroeconomic announcements led to permanent decreases in volatility. However, he models announcements by allowing them to enter the daily volatility model additively [closely resembling Equation (2) in this article], which imposes that announcements have a permanent effect on volatility.

increase in Korean volatility that persists for an hour ($N_k = 3$) and follows the second-order polynomial ($p = 2$) dynamic structure (see note 15 on the implied responses for each interval, given estimates of c_0 and c_1). More specifically, volatility jumped 700% for the first 15-minute interval, 23% in the second interval but, surprisingly, decreased 53% and 56% in the third and fourth intervals, respectively, relative to baseline periods without macroeconomic announcements and economic crises. In terms of the volatility level, the initial impact is an increase of 5.60% (an initial jump of 700% times mean first-interval volatility of 0.80%), 0.07% in the second interval, and decreases of 0.14% and 0.15% in the third and fourth intervals, respectively. The total cumulative response is 5.38% in an hour. It is worth noting that, because I identified each event by its first appearance on the Bloomberg News monitor, the impacts of these events are transmitted to Korea and Thailand very rapidly, consistent with other findings of this article that information transmission is likely to be most apparent in high-frequency data.

To evaluate the performance of the model, I take an unconditional expectation of Equation (15). Panels A and B of Figure 2 show the average intraday volatility (solid lines) for Korea and Thailand and the fitted average intraday volatility (dashed lines). Bearing in mind that I estimate intraday patterns of log volatility, it is evident that the model does a good job of capturing average intraday volatility patterns.

4.2 Impact of information on intraday trading volume

It is well established that information affects both volatility and volume [e.g., Tauchen and Pitts (1983), Karpoff (1987), and Andersen (1996)]. Thus, this article's results for trading volume can be used as a robustness check of the results for volatility. In addition, studying volume sheds light on the role of information in resolving heterogeneity in agents' beliefs, which I approximate empirically with the dispersion of announcement expectations.

Table 6 shows that the Japanese IPI significantly affects both Korean and Thai equity market trading volume, consistent with the result on volatility. As for the U.S. EMPNF, it only affects Thailand's trading volume, though the effect is robust to different measures of announcement. The U.S. inflation data also induces a significant increase in Korean trading volume. On average, these impacts persist for about 45 minutes. These results lend extra support to the existence of information transmission from developed to emerging economies. Overall, these results are consistent with the positive relationship between volatility and trading volume observed by other researchers [Tauchen and Pitts (1983), Admati and Pfleiderer (1988), Foster and Viswanathan (1990), and Andersen (1996)].

The puzzling effect of foreign monetary policy decisions also carries over to trading volume. More specifically, the Japanese MPM only affects Korean trading volume, but the effect is significant for the whole sample period from 1998, as compared to the significant effect only in 1998 for volatility. The impact of U.S. FOMC decisions on Thailand's trading volume uncovers an interesting relationship between the degree of heterogeneity in agents' beliefs and trading volume. I find a positive relationship between volume and the dispersion of expectations about U.S. FOMC decisions. Although I only find a significant impact of U.S. FOMC decisions on volatility for the full sample (1995–2000), I find a significant and robust positive relationship between the dispersion of expectations and trading volume in different subsamples. A difference in power may arise because volume relates to the *dispersion* of agents' beliefs, whereas volatility relates to an *average* agent's expectation [e.g., Karpoff (1986), Kim and Verrecchia (1991), Shalen (1993), and Harris and Raviv (1993)]. While most FOMC announcements are expected by an average market participant (implying no measured announcement surprises), the expectations of individual market participants may be dispersed for many announcements.[18]

To evaluate the economic impact of announcements on volume, I follow the methodology described previously in Equations (15) and (16). Panel D of Figure 3 shows the response of Thailand's trading volume to the announcement of U.S. EMP. It is interesting to note that the impact of macroeconomic announcements and important economic events on volume are more persistent than the impact on volatility, consistent with a role of private information in price discovery similar to the empirical results documented in Fleming and Remolona (1999).[19]

The performance of the model is evaluated by comparing average intraday volume with average fitted values. Panels C and D of Figure 2 show the comparison for Korea Subsample I and Thailand when announcement dummies are used to control for information flow. As in the case of volatility, the model does well in capturing patterns of intraday volume.

4.3 Impact of information on intraday return

The results for information transmission from the United States and Japan to Korean and Thai equity return volatility and trading volume are indirect evidence of an impact on returns. As mentioned previously, the sign of the impact on returns is unpredictable in the absence of a

[18] As noted previously, there were only four FOMC surprises, but there were 24 announcements in which analysts had dispersed expectations.

[19] The extra persistence of effects on volume relative to effects on volatility is not economically large for macroeconomic announcements but is material for crisis events.

structural model of the macroeconomy and the asset markets of each country. I estimated the impact of announcements and major economic crises on returns and allowed each event to have a separate impact. I measure information as announcement surprises, as opposed to the absolute value of surprises used in volatility and volume equations. Major economic crises are represented by dummy variables. For each type of announcement, I cannot reject the null hypothesis of an average (unconditional) zero impact of announcement surprises. As for major economic crises, I find significantly large negative impacts on returns in Korean and Thai equity markets, as we would expect.

One possible explanation of the insignificant average impact of macroeconomic announcements on returns could be that the sign of the return response is time-varying [see, for example, McQueen and Roley (1993) and Boyd, Hu, and Jagannathan (2005) for the case of U.S. equity markets]. There are several instances in the data of announcements that affect both volatility and volume that support this hypothesis. For example, following the November 7, 1997, U.S. Nonfarm Payrolls release, which came in 74,000 *higher* than market expectations, the first 15-minute return in the Thai market was about 20 times higher than the average return on days with no announcements, while the Nonfarm Payrolls release on June 4, 1999, which was 209,000 *below* market expectations, elicited an almost identical positive return reaction, not a negative return reaction as a hypothesis of a constant relationship would imply. One possible explanation for the difference is that market participants expected different FOMC policy responses in 1997, because the FOMC was very concerned about financial market liquidity in 1997 but less so in 1999. Another example is the 0.2% lower-than-expected U.S. PPI release on July 13, 1995, which was associated with a 15-minute Korean market return that was six times more *positive* than the average on days with no announcement, whereas the PPI release on January 8, 1998, also 0.2% lower-than-expected, was associated with a Korean market return 19 times more *negative* than usual.

5. Conclusion

Using high-frequency measures of volatility, I find that macroeconomic information announcements in developed countries (the United States and Japan) have an economically and statistically significant impact on emerging-economy (Korean and Thai) equity market volatility. This is evidence of the value of information in emerging markets and of important economic links between developed and emerging markets. As such, the results support one of the main themes of financial economics, the linkage between macroeconomic fundamentals and asset price dynamics. The fact that the impact of announcements is short-lived, lasting only about 30 minutes on average, likely explains why previous studies based on lower-frequency data have generally been unable to find evidence of such linkages.

Unlike most previous studies, which only investigate the impact of information on return volatility, this article evaluates the impact of developed-economy announcements on intraday volume as well. The results show strong and significant evidence of information transmission through this channel, but here again, the effects are short-lived (on average, they last about 45 minutes). This is consistent with reasonably efficient absorption of information even in emerging markets.

Although the results for volatility and trading volume are not exactly the same, in the subsample with the longest duration (and thus perhaps the best power), announcements of the Japanese Industrial Production Index and Japanese Monetary Policy Meeting decisions impact both volatility and volume in the Korean market. In Thailand, U.S. Nonfarm Payrolls and the Japanese Industrial Production Index affect both volume and volatility. Other results are also reasonably robust when sample composition and institutional factors are taken into account.

It might be surprising that there is not much evidence of an impact of domestic Korean (Thai) announcements on domestic Korean (Thai) financial markets. One plausible explanation is that, on many occasions, announcements were leaked before the official release was made. I searched Bloomberg News and Dow Jones News Retrieval databases and found several occasions when high-level government officials accidentally announced information early.

Several issues merit further exploration. For example, it would be interesting to investigate the impact of U.S. and Japanese macroeconomic announcements on other international equity markets. If a similar set of announcements affects many markets similarly, such variables might constitute good candidates for identifying risk factors for inclusion in international asset pricing models.

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