THE UNIVERSITY OF TEXAS AT SAN ANTONIO, COLLEGE OF BUSINESS

Working Paper SERIES

March 11th, 2009

Wp# 0063FIN-257-2009

Where does Volatility and Return Come From?
The Case of Asian ETFs

Yiuman Tse
Department of Finance
The University of Texas at San Antonio
One UTSA Circle
San Antonio, TX 78249, USA
Email: yiuman.tse@utsa.edu
Tel: 210-458-5314

Jose A. Gutierrez
The University of Texas at San Antonio
One UTSA Circle
San Antonio, TX 78249, USA

Valeria Martinez
Fairfield University
Fairfield, CT 06824, USA

Department of Finance,
University of Texas at San Antonio,
San Antonio, TX 78249, U.S.A

COLLEGE OF BUSINESS KNOWLEDGE FOR A NEW WORLD
ONE UTSA CIRCLE
SAN ANTONIO, TEXAS 78249-0631
210 458-4317 | BUSINESS.UTSA.EDU

Where Does Return and Volatility Come From?

The Case of Asian ETFs

Jose A. Gutierrez [a], Valeria Martinez [b], Yiuman Tse [c,1]

[a] *University of Texas at San Antonio, San Antonio, TX 78249, United States*

[b] *Fairfield University, Fairfield, CT, 06824, United States*

[c] *University of Texas at San Antonio, San Antonio, TX 78249, United States*

We analyze return and volatility of Asian iShares traded in the U.S. The difference in trading schedules between the U.S. and Asia offers a unique market setting that allows us to distinguish various return and volatility sources. We find Asian ETFs have higher overnight volatility than daytime volatility, explained by public information released during each local market's trading session. Local Asian markets also play an important role in determining each Asian ETF return. Nonetheless, returns for these funds are highly correlated with U.S. markets, indicative of the effects of investor sentiment and location of trade. Finally, returns in the U.S. market Granger-cause returns in all six Asian markets analyzed.

March 2009

JEL Classification: F30; G15

Keywords: International ETF; iShares; returns; variance; diversification

---

[1] Correspondence author: Yiuman Tse, One UTSA Circle, College of Business, The University of Texas at San Antonio, San Antonio, TX 78249. Phone: (210) 458-5314. Fax: (210) 458-6320. Email: yiuman.tse@utsa.edu. We are grateful to three anonymous reviewers and the participants at the 2008 FMA meeting in Dallas for valuable comments and suggestions. We would also like to thank Barclays Global Investors for providing the iShares data. Tse acknowledges the financial support from a summer research grant of U.S. Global Investors, Inc. and the College of Business at The University of Texas at San Antonio.

1. Introduction

Where does volatility come from? In previous work, volatility is explained by public information, private information, or noise trading.[2] Because in most markets all three effects take place at the same time, determining which of these is the source of volatility can be a difficult task. There have been various attempts to disentangle these effects by taking advantage of existing market characteristics. For example, Fleming, Kirby, and Ostdiek (2006) analyze volatility for weather sensitive agricultural and energy markets. Under their assumptions, if public information that affects these markets is released at regular intervals throughout the day, then trading and non-trading variances should be equal per unit of time. If there is higher variance during the trading hours then it can be attributed to private information and noise.

If trading period variance is normally higher than non-trading period variance, and the difference between these drops during the weather sensitive season, then we can attribute the higher variance to public information. Nonetheless, if the private information flow also rises in the weather sensitive season, then it may be difficult to disentangle these two effects.

We extend the work in Fleming et al. (2006), and add value to existing work by analyzing volatility sources for index-tracking Asian Exchange-Traded Funds (ETFs). According to Chordia, Roll, and Subrahmanyam (2002, pg 128), private information is unlikely to be prevalent at the index level. Public information should also be considerably more important than noise

---

[2] For more information, see Oldfield and Rogalski (1980), French and Roll (1986), Amihud and Mendelson (1987), Barclay, Litzenberger, and Warner (1990), Stoll and Whaley (1990), Harvey and Huang (1991), Chang, Fukuda, Rhee, and Takano (1993), Chan and Chan (1993), and Fung, Lien, Tse, and Tse (2005).

trading in the index market.[3] This notion, coupled with the 12-hour difference in schedule between the U.S. and Asian markets, enables us to isolate the effects of public information. In addition to volatility, we also analyze Asian ETF returns. Various authors such as Froot and Dabora (1999) find returns are not only determined by the underlying assets they represent but are also influenced by the international market in which they trade.

Our results show that Asian ETFs have higher overnight volatility than daytime volatility. We attribute this finding to the release of public information which primarily occurs during each of the local market's trading session. Intraday returns for the Asian ETFs are significantly Granger-caused by the U.S. market returns, but not the reverse. A closer look at ETF volatilities shows significant bi-directional Granger causality between the U.S. and all Asian markets used in this study, with a much stronger volatility spillover from the U.S. to the Asian ETFs. We also find that Asian local markets play an important role in determining Asian ETF returns; however, returns for these funds are highly correlated with U.S. market returns. Overall, the impact of public information in local Asian markets has a significant impact on ETF returns. However the U.S. market plays a determinant role in explaining Asian ETF returns and volatilities, suggesting the effects of investor sentiment and location of trade.

2. Literature Review

There are numerous studies explaining the sources of volatility observed in different markets. Stoll and Whaley (1990) argue that volatility of daytime returns is related to the release of public information during the day. Jones, Kaul, and Lipson (1994a), find that volatility is

[3] Most previous studies incorporating variance ratio tests do not consider the noise trading component a significant source of volatility.

higher on days when exchanges are open than when exchanges are closed, even if no trades occur during open trading time. French and Roll (1986) posit that the greater trading period variance is due to more private information released during this time period, since traders are more likely to obtain this information and act on it during trading hours. Barclay, Litzenberger, and Warner (1990) attribute the higher weekend volatility on the Tokyo stock exchange to the release of private information. Chan, Fong, Kho, and Stulz (1996) discover that volatility patterns for Asian and European stock are consistent with the arrival of public information, but not private information. Hoque, Kim, and Pyun (2007) use variance ratio tests in eight Asian emerging stock markets and conclude that six of the eight are mean-reverting, suggesting that these markets are not weak-form efficient. Barclay and Hendershott (2003) find that, for NASDAQ stocks, the ratio of private to public information is higher during the day than it is during after-hours trading, when there tend to be fewer informed trades and more liquidity trades.

By taking advantage of the natural characteristics of different financial instruments we are able to isolate the different volatility sources and better understand the origin of volatility in financial markets. Such is the case of Fleming et al. (2006), which analyzes volatility for weather-sensitive agricultural and energy markets. This market setting allows the authors to differentiate between the different sources of volatility. While private information and noise trading are more likely to occur during the trading session, public information on these products is evenly distributed throughout the day. Fleming et al. find that there is a strong relationship between prices and public information that cannot be explained by pricing errors or changes in trading activity. Thus volatility in these markets is driven by public information.

In the current analysis, we take advantage of the trading schedule differences for international investments, to isolate the public information of local foreign markets from private information released during the U.S. trading session. However, when it comes to the analysis of foreign investments that trade outside their home country, there are other factors that come into play. Many of these investments not only reflect public information from their home country, but also display characteristics of the international market in which they trade. This phenomenon is commonly referred to as location of trade or investor sentiment. Evidence of the investor sentiment effect is found in the work of Bodurtha, Kim, and Lee (1995), Froot and Dabora (1999), Chan, Hamed, and Lau (2003), and Wang and Jiang (2004).

Bodurtha et al. (1995) find that the premiums for the different international closed-end funds tend to move together, reflecting the varying sentiment of U.S. investors. Froot and Dabora (1999) study the trading of various company stocks that trade in multiple markets. After adjusting for exchange rates, they conclude the same stock trades at different prices in different markets, attributing their results to country specific investor sentiment. Cha and Ho (2000) examine the relationship between developed equity markets and four Asian emerging equity markets. The authors conclude that the links between developed and emerging markets have strengthened considerably since the crash of 1987. Chan et al. (2003) analyze the trading activity of the Hong Kong based company Jardine Group before and after the stock was de-listed from the Hong Kong Exchange in 1994. After delisting, the core business of the group is maintained in Hong Kong and mainland China, while most of the group's trading takes place in Singapore. They discover that after delisting the group's stock from the Hong Kong market, returns are more correlated with the Singapore market and less correlated with the Hong Kong market, consistent with country-specific investor sentiment. Wang and Jiang (2004) analyze Chinese companies that issue A shares in mainland China and H Shares in Hong Kong markets. They find H shares have significant exposure to Hong Kong market factors and behave more like Hong Kong stock than mainland China stock.

Given the results of prior literature, we attempt to answer the following two questions for the case of Asian ETFs which are traded in U.S. markets: Does volatility come from private information, or pubic information? Are returns characterized by location of trade or the underlying assets they represent?

3. Data Description

Exchange-traded funds (ETFs) are diversified security portfolios that track a stock or bond market index. They can be traded like stock throughout the day using market orders, limit orders, stop orders, margin purchases etc. They trade in both national and regional U.S. exchanges.

ETFs have become very popular due to their positive features such as ease of trading, diversification benefits, low expense fees, and potential tax advantage. The potential tax advantage arises from the fact that, in contrast to open-end funds where the creation or destruction of shares results in a taxable event, ETF investors are not subject to tax consequences as a result of investor demand or liquidations. ETFs create and destroy shares through “in kind transactions or transfers of securities” which are a non-taxable event for the fund. The process is as follows: every day market makers receive information on the demand for (excess of) securities needed to create (destroy) a particular ETF’s shares. Market makers then buy (sell) these securities in the capital markets and deposit (redeem) them with the custodian who then issues (destroys) the appropriate number of ETF shares.

iShares where created by Barclays Global Investors in 1996[4]. Since then, the dollar value invested in ETFs has grown to approximately $417 billion, and at the end of 2006, there were nearly 400 different ETF funds. International iShares funds track the Morgan Stanley Capital Indexes which encompass about 85% of each country's market capitalization. Although the ETFs closely track the index they represent, they do not fully replicate the index. As a result, the ETF and the underlying index will not move in lockstep.[5] As reported by Lauricella and Gullapalli (2007), ETF prices are not only determined by fundamental information of the assets they represent, but also by supply and demand in the U.S. market in which they trade. In addition, due to the trading schedule difference between local Asian markets and U.S. markets, prices in each market will not reflect the same amount of information. Since the U.S. market opens and closes at a later time during the day, on any given trading day the U.S. markets can incorporate additional information beyond that released during the Asian trading hours. Rules and regulations for ETFs, may also affect how closely they track the index. For example, the IRS single issue rule points out that an ETF cannot hold a single position that represents more than 25% of their portfolio. Based on this rule, an ETF that tracks any country index that holds a single position of more than 25% of its portfolio will not be able to fully replicate the index.

In this study we use daily and intraday data from January 2002 through December 2007 for the following six Asian iShares funds: Hong Kong (EWH), Japan (EWJ), Malaysia (EWM) , Singapore (EWS), Taiwan (EWT), South Korea (EWY), and for the S&P500 (IVV) iShares

---

[4] For more information on iShares, see Tse and Martinez (2007).

[5] For the sample of funds used in this analysis the correlation between the ETF daytime returns and corresponding local index returns ranges from 27% to 61%.

fund. Daily price data and local market index futures prices come from Commodity Systems Incorporated (CSI). We also use intraday trade data from the Trade and Quote database (TAQ). Initially listed on the AMEX, the iShares used in this analysis migrated to the NYSE in November 2005.

Daytime returns are estimated as the log difference between the closing (CL_t) and opening (OP_t) prices on day t. Overnight returns are the log difference between the opening price on day t (OP_t) and the closing price on day $t-1$ (CL_{t-1}). 24-hour returns are estimated as the log difference between the closing price on day t (CL_t) and the closing price on day $t-1$ (CL_{t-1}) for each ETF.

$$\text{Daytime returns} = \log(CL_t) - \log(OP_t) \quad (1)$$

$$\text{Overnight returns} = \log(OP_t) - \log(CL_{t-1}) \quad (2)$$

$$\text{24-hour returns} = \log(CL_t) - \log(CL_{t-1}) \quad (3)$$

Panel A of Table 1 shows average daily daytime, overnight, and 24-hour returns, as well as standard deviations for each Asian ETF and the U.S. ETF. Consistent with market efficiency, daytime returns and overnight returns are both insignificantly different from zero. For all Asian markets, overnight volatility is greater than daytime volatility, but for the U.S. market, daytime volatility is greater than overnight volatility. Daily average dollar volume measured in shares indicates that the three most active ETFs are Japan (136.85 million), U.S. (118.95 million), and Korea (33.33 million).

[Insert Table 1 Here]

Panel A provides the daily realized volatility, measured at five-minute intervals, for each ETF. Andersen, Bollerslev, Diebold, and Labys (2001) and Andersen, Bollerslev, Diebold, and Ebens (2001) improve daily volatility estimates by using high-frequency, intraday returns to construct daily realized volatility. The authors define realized volatility as the square root of the sum of intraday squared returns, and show that this is a consistent estimator of actual, but unobservable, volatility. Based on this estimate, all six Asian ETFs have higher volatility (1.742 average) than the U.S. ETF (0.797). These results are comparable if we use the standard deviation of the 24-hour return (reported in Panel A) or the standard deviation of the five-minute return (reported in Panel B).

4. Empirical Results

We explore the source of Asian ETFs return and variance by analyzing volatility ratios, return and volatility correlations, location of trade and public information impact on returns, and Granger causality in returns and volatilities.

4.1 Volatility Ratios

We construct volatility ratios for each ETF and compare daytime to overnight return volatility using daily data. Panel A of Table 2 presents the volatility ratios for each market with (VR1) and without (VR2) the local holiday effects. VR1 shows that all Asian volatility ratios are less than one, and range from 0.905 (Malaysia and Singapore) to 0.519 (Japan). Volatility ratios less than one indicate higher overnight volatility than daytime volatility. By applying the Bartlett test for homogeneity of variances, we conclude that the differences between the Asian daytime and overnight variances are statistically significant at the 1% level for Hong Kong, Japan, Taiwan, and Korea. The higher overnight volatility for Asian ETFs is consistent with the release of public information during the trading hours of each of the local Asian markets. The Asian variance ratios contrast with the U.S. ratio which has a value of 3.339, indicating higher daytime than overnight variance. The higher daytime volatility is consistent with the release of public information during trading hours in the U.S. market.

To further strengthen these results, we compare daytime and overnight volatilities excluding holidays for each respective Asian market. When Asian holidays are excluded, we expect the observed difference between daytime and overnight volatility to increase which would reduce the values of the observed variance ratios.

The results are in line with our hypothesis. When we exclude local Asian holidays, variance ratios drop across the board in all Asian markets, indicating a greater volatility difference between daytime and overnight returns. It should be noted, however, that the difference between the volatility ratios when Asian holidays are included and excluded is economically insignificant.

[Insert Table 2 Here]

At an index level, it is unlikely that private information would be the driving force, according to Chordia et al. (2002). Thus, the results support the notion that the observed volatility difference in returns is driven by public information released in each local Asian market.

4.2 Correlation Analysis

Most studies that analyze the relationship between world markets attribute high levels of correlation to the location of trade and to world market integration. Bodurtha et al. (1995), Froot and Dabora (1999), Chan et al. (2003) determine that prices can be influenced by location of trade. Bosner-Neal, Brauer, Neal, and Wheatley (1990), Patro (2001), Olienyk, Schwebach and Zumwalt (1999), and Pennathur, Delcoure, and Anderson (2002), find that the more world markets are integrated, the higher the correlation between U.S. and foreign investments, which translates into less diversification benefits from foreign investments.

We analyze daily and intraday correlation between the Asian and the U.S. S&P 500 ETF returns and volatilities. As shown in Panel B of Table 2, Asian funds have a daily return correlation with the S&P 500 fund of at least 36%, ranging up to a maximum of 68%. For the period of our analysis, the Asian fund with the highest daily return correlation with the U.S. market is Japan, followed by Hong Kong, Taiwan, Korea, Singapore, and Malaysia, with correlation coefficients of 0.688, 0.586, 0.577, 0.573, 0.480, and 0.364 respectively. In terms of realized volatility (Panel C), the highest correlation with the U.S. is found in Japan (0.709), Hong Kong (0.696), and Taiwan (0.596), and the Asian market with the lowest realized volatility correlation with the U.S. is Malaysia (0.266). The high correlation values suggest that Asian ETFs have limited diversification benefits.

4.3 Asymmetric Comovement

We examine the asymmetry in Asian ETF comovement with the direction of the U.S. market returns in the following market index model:

$$r_{Asia,t} = \alpha_{Asia} + \beta^{+}_{Asia} r^{+}_{US,t} + \beta^{-}_{Asia} r^{-}_{US,t} + \varepsilon_{Asia,t} \qquad (4)$$

where $r_{Asia,t}$ and $r_{US,t}$ are the close-to-close log daily returns for each respective Asian ETF and the S&P 500 ETF respectively. The + and – superscripts denote U.S. up and down markets, respectively. Equation 4 distinguishes positive from negative U.S. returns and allows for a different coefficient against each in order to identify any asymmetry in comovement. See, for example, Lo (2001).[6]

[Insert Table 3 Here]

For each Asian ETF, Table 3 shows that both β^{+} and β^{-} are each individually significant, and are not statistically different from one another. For example, for the Hong Kong ETF (EWH), $\beta^{+} = 0.953 \;\; (t = 10.99)$ and $\beta^{-} = 0.956 \;\; (t = 13.42)$, and the null hypothesis that $\beta^{+} = \beta^{-}$ is not rejected with $t = -0.03$. Hence, the Asian ETFs correlate with the U.S. market, but there is no asymmetric comovement between them.

4.4 Location of Trade vs. Release of Public Information

To further study the source of Asian iShare returns, we use a simple regression analysis of contemporaneous variables. We regress each Asian ETF's daytime return against the S&P 500 iShare daytime return and the local market's overnight return, represented by the local index's nearest futures contract.

$$r_{Asia,t} = \alpha_0 + \beta_1 r_{US,t} + \beta_2 r_{Index,t} + \beta_3 Holiday_{Asian,t} + \varepsilon_t \qquad (5)$$

where $r_{Asia,t}$ is the daytime return for each Asian iShare, $r_{US,t}$ is the daytime return for the S&P 500 iShare, $r_{Index,t}$ is the overnight return for each Asian market's most representative market index futures contract, $Holiday_{Asian,t}$ is a dummy variable equal to one when there is a holiday in that particular Asian market and zero otherwise, and ε_t is the error term.

[6] Based on this index model, Lo (2001) finds that emerging markets have an up-market beta of 0.16 but a down-market beta of 1.49, indicating an asymmetric correlation with the U.S. market.

Table 4 shows that for Hong Kong, Japan, Singapore, Taiwan, and Korea, U.S. market returns explain a greater portion of Asian ETF returns than do the returns from the local market, as measured by the β_1 and β_2 coefficients, respectively. For example, in the case of Hong Kong, $\beta_1 = 0.516$ $(t = 10.68)$ and $\beta_2 = 0.359$ $(t = 7.83)$. In the case of Malaysia, however, the above does not hold. For Malaysia, the local market explains more of the ETF returns, as measured by $\beta_1 = 0.192$ $(t = 4.59)$ and $\beta_2 = 0.501$ $(t = 7.31)$.

[Insert Table 4 Here]

The significant contribution of U.S. market returns to international investment returns is consistent with the importance of location of trade and world market integration in explaining foreign investment returns. Moreover, the important contribution of a local market returns to the corresponding Asian ETF indicates that public information released in each local market also plays an important role in explaining these ETFs' returns. It is worth noting that these results are qualitatively the same after controlling for the foreign exchange rate between the U.S. and the local Asian market. Furthermore, holidays do not have a significant effect on returns for any Asian country.

4.5 Granger Causality in Returns and Volatilities

In Table 5, we analyze the intraday lead-lag relationship in returns and volatilities between the U.S. market and each Asian market, measured at five-minute intervals. For the six Asian iShares, as well as for the U.S. iShare, we run the following autoregressive return models:

$$r_{Asia,t} = a_{Asia} + b_{Asia} DOpen_t + c_{Asia} DClose_t + \sum_{j=1}^{24} w_{Asia,j} r_{US,t-j} + \sum_{j=1}^{24} x_{Asia,j} r_{Asia,t-j} + \varepsilon_{Asia,t} \quad \text{(6a)}$$

$$r_{US,t} = a_{US} + b_{US} DOpen_t + c_{US} DClose_t + \sum_{j=1}^{24} w_{US,j} r_{US,t-j} + \sum_{j=1}^{24} x_{US,j} r_{Asia,t-j} + \varepsilon_{US,t} \qquad (6b)$$

where $r_{Asia,t}$ is the five-minute return for each Asian iShare at time t, $r_{US,t}$ is the five-minute return for the S&P 500 iShare, $DOpen_t$ is a dummy variable equal to one during the first 30 minutes of trading and zero otherwise, $DClose_t$ is a dummy variable equal to one during the last 30 minutes of trading and zero otherwise, $\varepsilon_{Asia,t}$ and $\varepsilon_{US,t}$ are both error terms. The 24 lagged returns are used as regressors to estimate any short-term movement in conditional expected returns. The regression errors are corrected for heteroskedasticity and autocorrelation by the Newey-West method.

Analogous to the Jones, Kaul, and Lipson (1994b) approach, we then define volatility as the absolute value of the residuals taken from equations 6a and 6b.

$$|\varepsilon_{Asia,t}| = \alpha_{Asia} + \beta_{Asia} DOpen_t + \gamma_{Asia} DClose_t + \sum_{j=1}^{24} y_{Asia,j} |\varepsilon_{USt-j}| + \sum_{j=1}^{24} z_{Asia,j} |\varepsilon_{Asia,t-j}| + \eta_{Asia,t} \qquad (7a)$$

$$|\varepsilon_{US,t}| = \alpha_{US} + \beta_{US} DOpen_t + \gamma_{US} DClose_t + \sum_{j=1}^{24} y_{US,j} |\varepsilon_{USt-j}| + \sum_{j=1}^{24} z_{US,j} |\varepsilon_{Asia,t-j}| + \eta_{US,t} \qquad (7b)$$

where $|\varepsilon_{Asia,t}|$ and $|\varepsilon_{US,t}|$ are the absolute value residual from equations 6a and 6b, respectively, $DOpen_t$ and $DClose_t$ are defined identically as they were in the return models above, coefficients $y_{Asia,j}$ and $y_{US,j}$ measure the persistence in the volatility of the U.S. iShare, coefficients $z_{Asia,j}$ and $z_{US,j}$ measure the persistence in the volatility of each respective Asian iShare, and $\eta_{Asia,t}$ and $\eta_{US,t}$ are both error terms. Adding day-of-week dummy variables to equations (6) and (7) yield comparable results.

[Insert Table 5 Here]

Panel A of Table 5 shows the results of Granger causality in returns between each Asian market and the U.S., using five-minute intervals. U.S. ETF returns cause returns for all Asian markets at any conventional significance level. In contrast, only Japan causes U.S. returns at the 5% level. These results are consistent with those observed in Table 4, highlighting the importance of the U.S. market, in which these ETFs trade.

Panel B presents the results of Granger causality in volatility. We find significant bi-directional causality between the U.S. and all Asian markets, with a much stronger volatility spillover from the U.S. to the Asian ETFs.

To address whether these results are sensitive to the chosen five-minute interval, we replicate the results with 10-minute interval intraday data. As presented in Table 6, the results do not change qualitatively.

[Insert Table 6 Here]

5. Summary of Findings

By taking advantage of the trading schedule difference between the U.S. and Asian markets, coupled with the notion that private information is not likely to be of any significance at an index level, we are able to distinguish between different return and volatility sources for Asian iShares.

We observe higher overnight than daytime volatility, which we accredit to the release of public information in each local market. Asian ETF returns are explained by both U.S. returns (location of trade) and local Asian market returns. The location of trade and investor sentiment effects are further supported by the high return correlation between Asian and U.S. ETFs.

Granger causality analysis of intraday returns shows that the U.S. causes returns in all Asian markets. We also find bi-directional Granger causality in volatility between the U.S. and the six Asian markets analyzed, while the volatility spillover is much stronger from the U.S. to the Asian ETFs. Overall, local market information and returns play an important role in explaining Asian ETF volatility and returns. Nonetheless, returns and volatilities are heavily influenced by the U.S. market where they trade.

6. References

Amihud, Y., & Mendelson, H., (1987). Trading mechanisms and stock returns: An empirical investigation. *Journal of Finance* 42, 533-553.

Andersen, T.G., Bollerslev, T., Diebold, F.X., & Ebens, H., (2001). The distribution of realized stock return volatility. *Journal of Financial Economics* 61, 43-73.

Andersen, T.G., Bollerslev, T., Diebold, & Labys, P., (2001). The distribution of realized exchange rate volatility. *Journal of the American Statistical Association* 96, 453, 42-55.

Barclay, M.J., Litzenberger R.H., & Warner, J.B., (1990). Private information, trading volume and stock return variances. *Review of Financial Studies* 3, 233-253.

Barclay, M.J., & Hendershott, T., (2003). Price discovery and trading after hours. *Review of Financial Studies* 16, 1041-1073.

Bodurtha, J.N., Kim, D.S., & Lee, C.M.C., (1995). Closed-end country funds and U.S. market sentiment. *Review of Financial Studies* 8, 879-918.

Bonser-Neal, C., Brauer, G., Neal, R., & Wheatley, S., (1990). International investment restrictions and closed-end country fund prices. *Journal of Finance* 45, 523-547.

Cha, B., & Oh, S., (2000). The relationship between developed equity markets and the Pacific Basin's emerging equity markets. *International Review of Economics and Finance* 9, 299-322.

Chan, K., & Chan, Y.C., (1993). Price volatility in the Hong Kong stock market: A test of the information and trading noise hypothesis. *Pacific-Basin Financial Journal* 1, 189-202.

Chan, K., Fong, W.M., Kho, B.C., & Stulz, R.M., (1996). Information trading and stock returns: Lessons from dually-listed securities. *Journal of Banking and Finance* 20, 1161-1187.

Chan, K., Hamed, A., & Lau, S.T., (2003). What if trading location is different from business location? Evidence from the Jardine Group. *Journal of Finance* 58, 1221-1246.

Chang, R.P., Fukuda, T., Rhee, S.G., & Takano, M., (1993). Interday and intraday return behavior of the TOPIX. *Pacific-Basin Financial Journal* 1, 67-95.

Chordia, T., Roll, R., & Subrahmanyam, A., (2002). Order imbalance, liquidity, and market returns. *Journal of Financial Economics* 65, 111-130.

Fleming, J., Kirby, C. & Ostdiek, B., (2006). Information, trading and volatility: Evidence from weather-sensitive markets. *Journal of Finance* 61, 2899-2930.

French, K.R., & Roll, R., (1986). Stock return variances: The arrival of information and the reaction of traders. *Journal of Financial Economics* 17, 5-26.

Froot, K.A., & Dabora, E.M., (1999). How are stock prices affected by the location of trade? *Journal of Financial Economics* 53, 189-216.

Fung, J.K.W., Lien, D., Tse, Y., & Tse, Y.K., (2005). Effects of electronic trading on the Hang Seng Index futures market. *International Review of Economics and Finance* 14, 415-425.

Harvey, C.R., & Huang, R.D., (1991). Volatility in the foreign currency futures market. *Review of Financial Studies* 4, 543-569.

Hoque, H.A.A.B., Kim, J.H., & Pyun, C.S., (2007). A comparison of variance ratio tests of random walk: A case of Asian emerging stock markets. *International Review of Economics and Finance* 16, 488-502.

Jones, C.M., Kaul, G. & Lipson, M.L., (1994a). Information trading and volatility. *Journal of Financial Economics*, 36 127-154.

Jones, C.M., Kaul, G. & Lipson, M.L., (1994b). Transactions, volume, and volatility. *Review of Financial Studies* 7, 4, 631-651.

Lauricella, T., & Gullapalli, D., (2007). Fast Money Crowds Embrace ETFs, adding risk for individual investors. *The Wall Street Journal*.

Lo, A., (2001). Risk management for hedge funds: Introduction and overview. *Financial Analysts Journal* 57, 16-33.

Oldfield, S., & Rogalski, R., (1980). A theory of common stock returns over trading and non-trading periods. *Journal of Finance* 35, 729-751.

Olienyk, J.P., Schwebach, R.G., & Zumwalt, J. K., (1999). WEBS, SPDRs, and country funds: An analysis of international cointegration. *Journal of Multinational Financial Management* 9, 217–232.

Patro, D.K., (2001). Market segmentation and international asset prices: Evidence from the listing of world equity benchmark shares. *Journal of Financial Research* 24, 83-98.

Pennathur, A.K. Delcoure, N., & Anderson, D., (2002). Diversification benefits of iShares and closed-end funds. *Journal of Financial Research* 25, 541-557.

Stoll, H., & Whaley, R., (1990). Stock market structure and volatility. *Review of Financial Studies* 3, 37-71.

Tse, Y., & Martinez, V., (2007). Price discovery and informational efficiency of international iShares funds. *Global Finance Journal* 18, 1-15.

Wang, S.S., & Jiang, L., (2004). Location of trade, ownership restrictions, and market illiquidity: Examining Chinese A- and H- shares. *Journal of Banking and Finance* 28, 1273-1297.

Table 1
Descriptive Statistics

Daytime returns are estimated as the log difference between the U.S. market's closing and opening price for each ETF. Daytime returns = $\log(CL_t) - \log(OP_t)$. Overnight returns are estimated as the log difference between the U.S. market's opening price and the previous day's closing price for each ETF. Overnight returns = $\log(OP_t) - \log(CL_{t-1})$. 24-hour returns are estimated as the log difference between the U.S. market's closing price and the previous day's closing price for each ETF. 24-hour returns = $\log(CL_t) - \log(CL_{t-1})$. Daily volume, returns, standard deviation of returns, and realized volatility are obtained using data from January 2002 to December 2007. Realized volatility is obtained by taking the square root of the sum of the squared intra-day returns sampled at five-minute intervals.

Panel A: Daily

	Avg Return (%)			Std Dev of Return (%)			Volume	Realized
	Daytime	Overnight	24-hour	Daytime	Overnight	24-hour	($m)	Volatility
Hong Kong	-0.059	0.117	0.058	1.149	1.305	1.517	21.33	1.833
Japan	0.034	0.003	0.036	0.774	1.074	1.347	136.85	1.066
Malaysia	-0.023	0.083	0.059	0.975	1.025	1.283	8.66	1.625
Singapore	-0.043	0.109	0.066	1.239	1.302	1.588	10.97	2.194
Taiwan	-0.149	0.171	0.022	1.431	1.663	2.010	29.39	2.002
Korea	-0.107	0.193	0.086	1.319	1.705	1.956	33.33	1.733
U.S.	-0.006	0.023	0.017	0.904	0.495	1.015	118.95	0.797

Panel B: five-minute Interval

	Avg Return(%)	Std Dev Return(%)
Hong Kong	-0.0008	0.2449
Japan	0.0006	0.1318
Malaysia	-0.0004	0.2051
Singapore	-0.0006	0.2856
Taiwan	-0.0019	0.2615
Korea	-0.0014	0.2256
U.S.	-0.0003	0.1039

Table 2
Variance Ratios and Correlations

Panel A shows the variance ratios estimated as the ratio of daytime return variance divided by overnight return variance. VR1 is the variance ratio of daytime to overnight return variance of each Asian and U.S. iShares. VR2 is the variance ratio of daytime to overnight return variance of each iShares excluding holidays in each respective Asian market. The test statistic (Bartlett's Test of Homogeneous Variances) is distributed as $\chi^2(1)$. Panels B and C show return and volatility correlations respectively, between the local Asian market ETF and the U.S. S&P 500 ETF. Daytime returns are estimated as the log difference between the closing and opening price on day t. Daytime returns = $\log(CL_t) - \log(OP_t)$. Overnight returns are calculated as the log difference between the opening price on day t and the closing price on day t-1. Overnight returns = $\log(OP_t) - \log(CL_{t-1})$. Intraday return and volatility correlations are estimated using five-minute intraday interval returns. The sample period is January 2002 through December 2007.

Panel A: Variance Ratios

	VR1	Daytime	Overnight	χ^2		VR2	Daytime	Overnight	χ^2	
Hong Kong	0.776	1.320	1.702	24.29	**	0.729	1.327	1.821	36.07	**
Japan	0.519	0.599	1.154	159.30	**	0.495	0.612	1.237	173.04	**
Malaysia	0.905	0.951	1.051	3.78		0.868	0.968	1.115	7.22	**
Singapore	0.905	1.534	1.695	3.76		0.889	1.538	1.730	5.10	*
Taiwan	0.740	2.047	2.766	34.03	**	0.674	2.026	3.006	55.05	**
Korea	0.803	1.483	1.846	18.06	**	0.570	1.747	3.066	112.04	**
U.S.	3.339	0.818	0.245	518.60	**					

* and ** Statistical significance at 5% and 1% levels respectively

Panel B: Return Correlations

	Daytime	Overnight	CL-to-CL	Five-Min
Hong Kong	0.586	0.423	0.639	0.093
Japan	0.688	0.475	0.580	0.205
Malaysia	0.364	0.292	0.387	0.072
Singapore	0.480	0.394	0.536	0.071
Taiwan	0.577	0.405	0.594	0.095
Korea	0.573	0.439	0.592	0.114

all statistically significant at the 0.01% level

Panel C: Volatility Correlations

	Absolute CL-to-CL	Absolute Five-Min	Realized Volatility
Hong Kong	0.471	0.117	0.696
Japan	0.340	0.199	0.709
Malaysia	0.234	0.042	0.266
Singapore	0.423	0.070	0.539
Taiwan	0.414	0.092	0.596
Korea	0.435	0.109	0.470

all statistically significant at the 0.01% level

Table 3
Asymmetric Comovement

The table shows the results from the regression: $r_{Asian,\,t} = \alpha_{Asia} + \beta^{+}_{Asia}\, r^{+}_{US,\,t} + \beta^{-}_{Asia}\, r^{-}_{US,\,t} + \varepsilon_{Asia,\,t}$, where $r_{Asian,\,t}$ is the log close-to-close return for each Asian iShare, $r^{+}_{US,\,t}$ is positive close-to-close return for the S&P500 iShare, $r^{-}_{US,\,t}$ is negative close-to-close return for the S&P500 iShare, and ε_t is the error term. T-statistics are presented in parenthesis below the coefficients. Regression errors are corrected for heteroskedasticity and autocorrelation by the Newey-West method. The sample period is January 2002 through December 2007.

	Hong Kong		Japan		Malaysia		Singapore		Taiwan		Korea	
α	0.043		0.017		0.078		0.060		0.086		0.107	
	(0.92)		(0.41)		(1.73)		(1.14)		(1.37)		(1.86)	
β^{+}	0.953	**	0.779	**	0.453	**	0.829	**	1.061	**	1.085	**
	(10.99)		(12.39)		(6.98)		(9.28)		(9.66)		(12.23)	
β^{-}	0.956	**	0.761	**	0.525	**	0.848	**	1.290	**	1.196	**
	(13.42)		(12.42)		(6.17)		(9.83)		(14.09)		(13.43)	
R^2 Adj.	0.41		0.34		0.15		0.29		0.35		0.35	
H_0: $\beta^{+} = \beta^{-}$	(-0.03)		(0.18)		(-0.60)		(-0.14)		(-1.38)		(-0.77)	

* and ** Statistical significance at 5% and 1% levels respectively

Table 4
Location of Trade vs. Release of Public Information

The table shows the results from the regression: $r_{Asian,\,t} = \alpha_0 + \beta_1\, r_{US,\,t} + \beta_2\, r_{Index,\,t} + \beta_3\, Holiday_{Asian,\,t} + \varepsilon_t$, where $r_{Asian,\,t}$ is the daytime return for each Asian iShare, $r_{US,\,t}$ is the daytime return for the S&P500 iShare, $r_{Index,\,t}$ is the overnight return for each Asian market's most representative market index futures contract, $Holiday_{Asian,\,t}$ is a dummy variable equal to one when there is a holiday in that particular Asian market and zero otherwise, and ε_t is the error term. T-statistics are presented in parenthesis below the coefficients. Regression errors are corrected for heteroskedasticity and autocorrelation by the Newey-West method. The sample period is January 2002 through December 2007.

	Hong Kong		Japan		Malaysia		Singapore		Taiwan		Korea	
α_0	-0.001	*	0.000		0.000		0.000		-0.002	**	-0.001	**
	(-2.04)		(1.53)		(-1.39)		(-1.33)		(-5.11)		(-3.54)	
β_1	0.516	**	0.461	**	0.192	**	0.559	**	0.757	**	0.581	**
	(10.68)		(17.78)		(4.59)		(9.40)		(9.67)		(11.39)	
β_2	0.359	**	0.247	**	0.501	**	0.176	**	0.232	*	0.297	**
	(7.83)		(8.75)		(7.31)		(2.64)		(2.36)		(6.93)	
β_3	0.000		0.000		-0.001		-0.001		0.000		-0.001	
	(-0.51)		(-1.07)		(-1.19)		(-1.26)		(-0.11)		(-1.02)	
R^2 Adj.	0.37		0.51		0.19		0.24		0.34		0.39	

* and ** Statistical significance at 5% and 1% levels respectively

Table 5
Granger Causality Between U.S. and Asian Markets at five-minute Intervals

The table shows Wald coefficient tests for Granger causality between the U.S. ETF and each Asian ETF, from January 2002 through December 2007. Panel A shows causality in returns and Panel B shows causality in volatilities. Chi-squared p-values are presented in parentheses below the coefficients. P-value coefficients for 12 and 24 lag Q-statistics on residual autocorrelation are presented at the foot of each panel. Results are generated using two-equation VAR systems with 24 lags for return models and 24 lags for volatility models, sampled at five-minute intervals. Regression errors are corrected for heteroskedasticity and autocorrelation by the Newey-West Method.

Panel A: Causality in Returns

	Hong Kong		Japan		Malaysia		Singapore		Taiwan		Korea	
U.S. Granger-causes Asia												
	536.3	**	1,383.8	**	341.7	**	379.1	**	490.2	**	688.8	**
	(0.00)		(0.00)		(0.00)		(0.00)		(0.00)		(0.00)	
Q(12)	1.000		1.000		1.000		1.000		1.000		1.000	
Q(24)	1.000		1.000		1.000		0.974		1.000		1.000	
Asia Granger-causes U.S.												
	28.1		40.2	*	33.6		24.4		36.0		26.9	
	(0.25)		(0.02)		(0.09)		(0.44)		(0.06)		(0.31)	
Q(12)	1.000		1.000		1.000		1.000		1.000		1.000	
Q(24)	1.000		1.000		1.000		1.000		1.000		1.000	

Panel B: Causality in Volatility

	Hong Kong		Japan		Malaysia		Singapore		Taiwan		Korea	
U.S. Granger-causes Asia												
	334.2	**	338.5	**	114.9	**	223.3	**	242.3	**	374.0	**
	(0.00)		(0.00)		(0.00)		(0.00)		(0.00)		(0.00)	
Q(12)	1.000		0.984		1.000		1.000		0.999		0.865	
Q(24)	1.000		0.000		0.856		0.998		1.000		0.999	
Asia Granger-causes U.S.												
	88.5	**	156.4	**	71.8	**	49.6	**	99.6	**	139.1	**
	(0.00)		(0.00)		(0.00)		(0.00)		(0.00)		(0.00)	
Q(12)	0.239		0.329		0.042		0.092		0.125		0.175	
Q(24)	0.000		0.000		0.000		0.000		0.000		0.000	

* and ** Statistical significance at 5% and 1% levels respectively

Table 6
Granger Causality Between U.S. and Asian Markets at 10-minute Intervals

The table shows Wald coefficient tests for Granger causality between the U.S. ETF and each Asian ETF, from January 2002 through December 2007. Panel A shows causality in returns and Panel B shows causality in volatilities. Chi-squared p-values are presented in parentheses below the coefficients. P-value coefficients for 12 and 24 lag Q-statistics on residual autocorrelation are presented at the foot of each panel. Results are generated using two-equation VAR systems with 24 lags for return models and 24 lags for volatility models, sampled at 10-minute intervals. Regression errors are corrected for heteroskedasticity and autocorrelation by the Newey-West Method.

Panel A: Causality in Returns

	Hong Kong		Japan		Malaysia		Singapore		Taiwan		Korea	
U.S. Granger-causes Asia												
	448.2	**	801.1	**	227.9	**	351.7	**	391.9	**	476.2	**
	(0.00)		(0.00)		(0.00)		(0.00)		(0.00)		(0.00)	
Q(12)	1.000		1.000		1.000		1.000		1.000		1.000	
Q(24)	1.000		1.000		1.000		1.000		1.000		1.000	
Asia Granger-causes U.S.												
	18.9		32.3		31.0		20.9		44.9	*	22.5	
	(0.76)		(0.12)		(0.15)		(0.64)		(0.01)		(0.55)	
Q(12)	1.000		1.000		1.000		1.000		1.000		1.000	
Q(24)	1.000		1.000		1.000		1.000		1.000		1.000	

Panel B: Causality in Volatility

	Hong Kong		Japan		Malaysia		Singapore		Taiwan		Korea	
U.S. Granger-causes Asia												
	260.4	**	275.0	**	128.1	**	189.4	**	228.7	**	299.4	**
	(0.00)		(0.00)		(0.00)		(0.00)		(0.00)		(0.00)	
Q(12)	0.990		0.786		0.996		0.995		0.980		0.562	
Q(24)	0.538		0.004		1.000		0.970		1.000		0.925	
Asia Granger-causes U.S.												
	103.3	**	126.6	**	109.4	**	60.2	**	87.6	**	111.9	**
	(0.00)		(0.00)		(0.00)		(0.00)		(0.00)		(0.00)	
Q(12)	0.000		0.000		0.000		0.000		0.000		0.000	
Q(24)	0.000		0.000		0.000		0.000		0.000		0.000	

* and ** Statistical significance at 5% and 1% levels respectively