Return and Volume Relation in the Tail: Evidence from Six Emerging Markets

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Abstract

This paper provides empirical evidence about the dependence of daily return and trading volume relations for indices of six emerging markets: Argentina, Chile, Malaysia, Mexico, Singapore and Thailand. I use bivariate threshold theory to explicitly model the joint distribution of absolute return and trading volume using the observations for all six markets. Five out of six countries have weaker but still significant correlations based on the observations exceeding the thresholds beyond optimal ones. I also find the return and volume relation overall is asymmetry, i.e. the correlation associated with positive return and volume is greater than that between negative return and volume. For four out of six countries in the sample, the results from the bivariate threshold model show that during the extreme price movement, this asymmetry correlation still holds.

Key words: Return, Volume, Extreme Value Theory, Asymmetric correlation.

1. Introduction

In this paper, I empirically study the dependence of stock market return and trading volume for six emerging economies, Argentina, Chile, Malaysia, Mexico, Singapore and Thailand. I use the bivariate threshold model (see Ledford and Tawn (1996) and Longin and Solnik (2000)) to study the relation of adjusted absolute return to trading volume when the observations are exceeding certain thresholds.

The driving sources of stock volatility and trading volume and their correlation have been of lasting interest in financial economics. There are several reasons why this issue is important. First, the price-volume relation provides us with insight into financial market structure. Various theoretical and empirical works have linked trading volume to the information inflow to the market and to difference of opinion among investors. The observed trading volume includes both liquidity-driven trading and information-driven trading. If we assume that liquidity trading comes to the market at a constant rate, the price change of stocks is mainly caused by new information arrived in the market. On the other hand, the more diverse the opinions of different investors are, the larger the new volume of trade will be. Correct identifying price-volume relation can lead us to understanding the mechanism of information flow transmission, the dissemination of information to the price and the extent to which market prices convey information. Second, if the dynamic structure of price-volume relation can be jointly determined, incorporating the price-volume relation will increase the power of forecasting return and volatility. Third, the return-volume relation can provide us with additional information about the empirical distribution of stock returns. It is a well-known fact that the empirical distribution of stock price deviates from the normal distribution. The well-known "Mixture of Distribution Hypothesis" proposes that the price data is governed by a conditional stochastic process with a changing variance parameter directed by a latent random variable proxy for the arrival of information flow. So the link between trading volume and conditional volatility can provide one explanation for why empirical distribution of stock returns appears to exhibit excess kurtosis.

The issue of price-volume relation in times of the extreme price movement and high trading volume is also very important. As one of the well-known characteristics of empirical distribution of asset return is fat-tail, which means there is extra probability mass in the tail area, the behavior of stock price and trading volume during extraordinary events such as financial crises needs to be carefully examined.

The importance of price-volume relation during extreme observations comes from several aspects. First, studying the price-volume relation during extreme price movement can provide a valuable vehicle for understanding the underlying information-driven or liquidity-driven trading story. Theoretically, during a financial crash, the same trading volume may lead to very different

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price changes, depending on how information is interpreted by market participants. For example, if the selling pressure is due to some investors having some private information, a reasonable amount of trading volume should be observed with the price movement. In this case, we should observe a consistent correlation between trading volume and price change under market normal conditions and market crashes. In another scenario, if the financial crisis is caused by the arrival of some public information, such as the deterioration of fundamentals of the economy, there is no reason to expect a high volume of trade, although price will drop sharply. Second, some people argue that the information contained in volume data can improve the modelling of expected return and conditional variance. The decreased price-volume relation in the tail can cast doubt on the ability of trading volume to serve as a proxy for information inflow during financial market stress. Third, price-volume relation in the tail is important because it can help us understand the fundamentals underlying financial crises. As argued by Gennotte and Leland (1990), in the absence of significant news, a small amount of hedge trading can cause crashes due to the illiquidity of the financial market. So the price-volume dependence is smaller during extreme price movement than observed during other periods. Chen, Hong and Stein (2000) find that trading volume can help to forecast the negative skewness (i.e., financial crisis) of the aggregate market.

Although there is a rich body of theoretic and empirical work on the price-volume relation, only a few works have focused on studying the price-volume relation during extreme price and volume movements. Moreover, almost all of these studies focus on the U.S. or other developed countries. Balduzzi, Kallal and Longin (1996) apply the data of stock-market prices and transaction volume on the day of minimal daily returns for each year from 1885 to 1990. They find that large minimal returns show little correlation with transaction volume. Marsh and Wagner (2000) study price-volume dependence empirically in seven international equity markets. They fit a GARCH-M model to examine the overall return-volume relation under "normal" market conditions and a bivariate extreme value model to examine the relation under conditions of market stress. Their main findings indicate that the dependence decreases for large extreme return and volume observations.

To my knowledge, no work has been done so far on the return-volume dependence during extreme price movements for emerging markets. I intend to fill in this gap in the present paper. Given the complications of the return-volume relation, further evidence and insights should be obtainable through an investigation of an alternative set of financial markets, especially, a set of emerging markets. In this paper, I use the data from six emerging markets: Singapore, Malaysia, Thailand, Mexico, Chile and Argentina. Broadly speaking, the information impact on stock price in emerging markets is not equivalent to that in the more developed markets; and also, there are significant institutional differences across the markets. From a statistical point of view, the empirical distribution of asset returns of emerging markets usually has a higher mean, higher volatility and much more significant excess kurtosis and skewness than those of developed countries. In practice, the risk of extreme downside movements for emerging markets has more killing power than in developed markets. All these facts suggest that a separate study on price-volume relation using emerging markets data is necessary and will be interesting.

Previous work provides us with empirical evidence that return and volume dependence during extreme price movements is smaller than in normal periods. There are at least three arguments in the literature that can explain why price-volume dependence may break down in the tail. First, Campbell, Grossman and Wang (1993) argue that large price movements are not necessarily associated with large trading volume. Suppose one observes a fall in stock prices. This could be due to public information that has caused all investors to reduce their valuations of the stock market. In this case, all the investors have the same belief or expectation, and there is no reason to expect a large amount of trade. In an Arrow-Debreu setting with complete markets, the prices of securities can change dramatically as new information comes to the market. These price changes instantaneously incorporate the news and do not require a large trading volume. Second, Marsh and Wagner (1999) argue that volume data may be a bad proxy for the underlying information process. The noisiness of the volume data is more severe during periods of high trading volume. As the correlation between price change and volume depends on an unobservable directing process, their relation could break down as one of them becomes noisier. The third explanation is based on Gennotte and Leland (1990). These authors show that information differences among market participants can cause financial markets to be relatively illiquid. As a consequence of diminished liquidity, a small amount of trading can trigger a large price movement. This situation is more likely to happen in small, non-mature financial markets such as emerging markets, where market illiquidity is one of the major concerns.

From a methodological point of view, I use bivariate extreme value theory to model the price-volume relation during extreme price and volume movements. Generally speaking, extreme value theory studies the limiting distribution of the underlying random variables without prior knowledge of the true distribution of the random variables. Balduzzi, Kallal and Longin (1996) use simple OLS to show that minimum returns have little correlation with transaction volume. But, as pointed out by Longin and Solnik (1999) and Ang and Chen (2000), it is not reliable to directly compare the estimated correlations conditional on different values of one or two underlying variables, so the results based on the simple linear regression may be misleading. As the correlation coefficients can be precisely pinned down only when the underlying distribution is specified, I apply the recent results from extreme value theory to the study of price-volume relation.

Consistent with previous work, I find for five out of six emerging markets that the dependence between absolute return and adjusted abnormal trading volume is significantly reduced during extreme price movements. I find these results still hold even when I decompose the total samples according to the directions of price change. The results from simple OLS regression indicate that return and volume are asymmetry correlated, i.e., the correlation is larger for positive returns than that for negative ones. For four out of six countries in the sample, the results from the bivariate threshold model show that during extreme price movements, this asymmetry correlation still holds.

The rest of the paper is organized as follows: Section 2 outlines the general framework for the bivariate threshold model. Section 3 gives information on data, summary statistics and the adjustment of daily trading volume series. In section 4, I provide estimation procedure and empirical results for the price-volume relation during extreme price and volume movements. In section 5, I summarize the whole paper.

2. Bivariate Threshold Model

2.1. Model Setup

The relation between return and trading volume under extreme price and volume trading conditions is important and interesting. Dalduzzi, Kallal and Longin (1995) are the first paper notices that the price-volume relation in the tail is different from the overall relation. Applying a linear regression to U.S. data from 1885 to 1990, they find large (in absolute term) minimal returns to show little correlation with trading volume. As Longin and Solnik (1999) and Ang and Chen (2000) point out, it is not reliable to compare directly the estimated correlations conditional on different values of one or two underlying variables, and methods based on a simple linear regression may be misleading. A statistical distribution function has to be specified in order to test the changing correlation coefficient based on different exceedance values. Several papers have used extreme value theory to study problems in financial markets. Longin and Solnik (1999) use bivariate extreme value theory to study international equity market correlation. Marsh and Wagner (2000) study the price-volume relation in seven international equity markets using a bivariate extreme model. In this paper, I apply a multivariate threshold model to study the price-volume relation for the extreme observations of six emerging markets.

Multivariate extreme value theory is concerned with the joint distribution of extremes of two or more dependent random variables. The first attempt to construct threshold-based methods of statistical inference in the multivariate cases is that of Coles and Tawn (1991) and Joe et al. (1992). Let F denote the joint distribution function of a d-dimensional random variable $(Y_1,Y_2,Y_3,...,Y_d)$, and let F_j denote the marginal distribution function of Y_j for $j=1,...,d$. The vector of thresholds is $\upsilon=(\upsilon_1,\upsilon_2,...\upsilon_d)$. The results from Ledford and Tawn (1997) and Tawn (1988) state that the limiting distribution for the multivariate exceedances function in terms of original variables is:

$$G(y_1,...y_d)=exp[-V\{-1/logF_1(y_1),...,-1/logF_d(y_d)\}],$$

where V is called the dependence function and is defined from R^d into R. One feature of multivariate extreme value distributions is that the dependence structure is preserved under transformations of the marginal distributions, so there is no loss of generality in restricting attention to a particular univariate extreme value family. As F_j can be arbitrary marginal distribution, we follow Daison and Smith (1990) in using the Generalized Pareto Distribution to model each marginal distribution above a high threshold. Connecting these marginal distributions to the marginal threshold distributions, we have for probability $0 \le p_j \le 1$,

$$F_j(y_j)=(1-p_j)+p_j\{1+\xi_j^*(y_j-\upsilon_j)/\sigma_j\}_+^{1/\xi_j}=1-p_j\{1+\xi_j(y_j-\upsilon_j)/\sigma_j\}_+^{1/\xi_j},$$

where p_j is the small probability that the observation is above the threshold υ_j, the threshold υ_j is taken to be the 1-p_j quantities of the marginal distribution. This means that, for a marginal distribution that fails to exceed the threshold, the only relevant information conveys for our model is that it occurs below the threshold, not its actual value.

Combining the above two equations, we have the joint distribution function for the multivariate threshold model:

$$G(y_1,\dots y_d)=exp[-V\{-1/log[1-p_1(1+\xi_1(y_1-\upsilon_1)/\sigma_1)_+^{1/\xi_1}],\dots,$$
$$-1/log[1-p_d(1+\xi_d(y_d-\upsilon_d)/\sigma_d)_+^{1/\xi_d}]\}].$$

The dependence function V maps the d-dimension marginal distribution function to a real number. The multivariate extreme theory does not give us any guidance on how to choose the dependence function V. In a specific case in which the marginal variables are independent, then $V(z_1,z_2,\dots,z_d)=\sum z_j^{-1}$. In this case the model factor is into the product of the marginal distribution, since,

$$G(y_1,\dots y_d)=exp[\sum_{j=1}^{d}\log\{1-p_j\{1+\xi_j(y_j-v_j)/\sigma_j)_+^{1/\xi_j}\}]=\prod\{1-p_j(1+\xi_j(y_j-v_j)/\sigma_j)_+^{1/\xi_j}\}=\prod F_j(y_j).$$

For the general case of the multivariate extreme dependent variable, the form of the dependence function is not known. In the field of engineering, the multivariate logistic dependence structure is commonly used. Following Tawn (1990), the symmetric logistic dependence function is :

$$V(z_1,z_2,\dots,z_d)=(z_1^{-1/\alpha}+\dots+z_d^{-1/\alpha})^{\alpha},$$

where α is the dependence parameter between 0 and 1. The limiting case of $\alpha\to 0$ corresponds to the case in which the random variables are perfectly dependent. As α increases, the dependence weakens. When $\alpha=1$, the variables are totally independent. The correlation coefficient ρ of extremes is related to the coefficient α by $\rho=1-\alpha^2$.

2.2. Estimation Procedure

I use maximum likelihood estimator (MLE) to estimate the model. The asymptotic properties of MLE are regular whenever the tail index $\xi>-1/2$, and alternative remedies are available for $\xi<-1/2$[1].

In the bivariate case, for a pair of high thresholds υ_1 and υ_2, the outcome space is divided into four regions:

$$\{R_{kl};k=I(Y_1>\upsilon_1),\ l=I(Y_2>\upsilon_2)\},$$

where I is the indicator function, which is equal to 1 if the condition is satisfied. Let the transformed marginal threshold be $r_j=-1/log(1-p_j)$ and let $z_j=-1/log\{1-p_j\{1+\xi_j(y_j-\upsilon_j)/\sigma_j\}^{1/\xi_j}$ I denote the likelihood contribution corresponding to a point (y_1,y_2), which falls in region R_{kl} *by* $L_{kl}(y_1,y_2)$, then we have the following:

$L_{00}(y_1,y_2)=exp\{-V(r_1,r_2)\}$
$L_{01}(y_1,y_2)=exp\{-V(r_1,z_2)\}V_2(r_1,z_2)K_2$
$L_{10}(y_1,y_2)=exp\{-V(z_1,r_2)\}V_1(z_1,r_2)K_1$
$L_{11}(y_1,y_2)=exp\{-V(z_1,z_2)\}\{V_1(z_1,z_2)V_2(z_1,z_2)-V_{12}(z_1,z_2)\}K_1K_2,$

where V_i denotes the partial derivative with respect to component i, and V_{ij} is cross derivative with respect to i component and j component. K_j is the derivative of z_j with respect to y_j.

[1] See, Smith, R.L. (1985,1994) for detail.

The likelihood contribution from a typical point (y_{1i},y_{2i}) from the logistic model with dependence parameter α and unknown parameters $\Theta=\{\upsilon_j,\sigma_j, \xi_j, p_j:j=1,2\}$ is given by

$$L_i(\alpha,\Theta)= \sum_{k,l\in\{0,1\}} L_{kl}(y_{1.i},y_{2i})I_{kl}(y_{1i},y_{2i}),$$

where $I_{k,l}(y_{1i},y_{2i})$ is the indicator function of (y_{1i},y_{2i}) for observations belong to region R_{kl}. The likelihood for a set of n independent points is given by

$$\mathrm{L_n}(\alpha,\Theta)=\Pi L_i(\alpha,\Theta).$$

Finally, the BFGS procedure is used to seek the parameters that maximize the above likelihood function.

2.3. Score Test for Independence

Under the bivariate threshold model, when the dependence parameter is $0<\alpha<1$, there is some dependence between the two variables. When the variables are independent, that is $\alpha=1$, α is on a boundary of the parameter space. Following Tawn (1988), I consider the score statistic for independence, which is defined for a typical pair of observations i by:

$$S_i=(\partial/(\partial\alpha))logL_i(\alpha,\Theta)|_{\alpha=1},$$

where Θ is the value of the parameters that jointly maximize above likelihood function when $\alpha=1$, i.e. $L_n(1,\Theta)$. The total score for a set of n observations is defined as $S_n=s_1+...+s_2$. Ledford and Tawn (1996)[1] show that if the variables are independent, then $-S_n/c_n\rightarrow N(0,1)$, where $c_n=(nlog\ n/2)^{0.5}$ as $n\rightarrow\infty$. My score tests are based on this result.

2.4. Threshold Selection

The distribution of observations over a certain threshold converges to the Generalized Pareto Distribution only when the threshold converges to the upper limit of the distribution, which is positive infinite in our case. But, in practice, a finite threshold value has to be used. Threshold selection is a critical issue in extreme value theory. Longin and Solnik (1999) use Monte Carlo simulation, which optimizes the trade-off between bias and inefficiency. But their method is computation intensive and only applies to positive tail estimators. So I use an alternative approach that is relatively easy and intuitive. This technique is called the mean residual life plot (Davison and Smith (1990), Smith (1990)). The motivation for this method is quite simple if the distribution of a random variable is Generalized Pareto Distribution, $Y\sim G(\sigma,\xi)$, with $\mu=0$, and $\upsilon>0$ (assuming $\upsilon<-\sigma/\xi$ in the case of $\xi<0$), the mean residual life is defined as:

$$E\{Y-\upsilon|Y>\upsilon\}=((\sigma+\xi\upsilon)/(1-\xi)).$$

Therefore, an empirical plot of $E\{Y-\upsilon|Y>\upsilon\}$ against υ should be approximately a straight line. I use the sample analogy of the mean residual function for the observations of random variable Y, $(y_1,y_2...y_n)$, which is the following:

$$\frac{\sum(y-u)I(y>u)}{\sum I(y>u)}$$ $I(y_i>u)$ is one, when $y_i>u$, and zero otherwise.

I plot this function against u and look for the smallest u over the region in which this is a straight line. As u increases, the number of observations that exceed u decreases. When u approaches its upper boundary, the plot becomes irregular. So I restrict the number of exceeding observations larger than 5 (i.e., $\sum I(y_i>u)>5$). The smallest u in the picture that makes the mean residual plot a straight line is the optimal threshold level in the model.

[1] See their proposition 1.

3. Data, Summary Statistics and Volume – Adjustment

3.1. Data

I study price-volume relation for six emerging markets: Singapore, Malaysia, Thailand, Mexico, Chile and Argentina. The reason for choosing these countries is that among all the emerging markets they have a relatively long history of trading volume data available.

The daily closing price and trading volume data for these six countries are obtained from DataStream International Inc. Except for Argentina, the data sample is from January 1, 1990 to December 31, 2000, totaling 2,870 observations. For Argentina, although the pricing data is available from January, 11, 1990, the volume data is only available only after June 13,1993. So I apply a shorter data sample for Argentina, totaling 1,939 observations. I exclude all non-trading days from the sample. The price index in local currency for each country is converted into U.S. dollars according to the official exchange rate between the currency of the corresponding country and the U.S. dollar. The continuously compounded percentage return or log return in U.S. dollars is calculated as 100 times the log difference between the current and previous day closing prices. I take natural logarithm of the daily volume to improve the stationary properties of the data.

3.2. Volume Adjustments

In order to apply the extreme value theory to study the relation of price change and trading volume in the tail, the time series of data should be stationary and serially uncorrected. But, as is a well-known fact, the trading volume data has a time trend and is serially correlated. So, for the first step, I detrend the log-volume series first by subtracting a 60-day backward of moving average from each current observation. The output for this method provides a series of a stationary abnormal trading volumes.

In the second step, an uncorrected stationary volume series is obtained through seasonal adjustment and ARMA estimation. It is a well-known fact that trading activities display a systematic calendar effect (e.g., see Gallant, Rossi and Tauchen (1992) and other). I choose two groups of dummy variables: day-of-the-week dummy and dummy variables for each of the months. Besides the seasonal dummies, I fit the detrended volume series into an ARMA(p,q) model. The order of autoregressive component p and the moving average component q are chosen according to Akaike's Information Criterion (AIC), which attempts to prevent over fitting the model. The residual from the final ARMA model is a stationary, serially uncorrected time series that will be used in the model as the volume series.

Finally, as the absolute value of daily return is another input for our bivariate extreme model, the serial correlation of absolute value of daily return has to be adjusted. Again, we apply the ARMA(p,q) model to generate a stationary, uncorrected return series.

4. Empirical Results

4.1. Summary Statistics

Table 1 displays the summary statistics of daily return and log-volume series. The means of daily returns are close to zero for all six countries. The standard deviation varies between 1.28% for Singapore and 2.27% for Thailand. The excess kurtosis for daily return of all six emerging markets is large and positive, indicating that returns have more mass in the tail areas than would be predicated by a normal distribution. Among these six countries, Argentina, Mexico and Singapore show negative skewness, while the others show positive skewness for market returns. For Argentina and Singapore, the hypothesis test of skewness equal to zero can not be rejected.

The mean value of the adjusted trading volume is close to zero for all six countries. This is because I detrend the raw volume series by subtracting each observation a past 60-day moving average. The standard deviation of volume data varies between 0.304 for Malaysia and 0.510 for Mexico. The excess kurtosis for the volume series is also positive and significant. Except for the case of Argentina, the skewness of volume series is positive. The values of excess kurtosis and skewness strongly reject the hypothesis that adjusted volume is normally distributed.

I report the cross correlation between return, absolute return, squared return and adjusted trading volume. Consistently with the results of the mixture of distribution model, the correlation coefficients are all positive. The correlation between absolute return and trading volume is the strongest among the three types of returns for all six countries.

4.2. Preliminary Analysis

4.2.1. Simple OLS

For a preliminary test of price-volume relation, I use the standard OLS to estimate the following equation:

$$V_t=\beta_0+\beta_1|r_t|+\beta_2|r_t|D_t+\beta_2 r_{t+1}+\varepsilon_t,$$

where V_t is the daily trading volume at time t, $|r_t|$ is the absolute value of daily return at time t. $D_t=1$ if $r_t<0$, and $D_t=0$ if $r_t\geq 0$. β_0 is a constant. β_1 measures the relation between absolute price change and trading volume, irrespective of the direction of price change. The estimated value of β measures the asymmetry in the price-volume relation. If the short positions are more costly than the long ones, investors should require a greater price change to transact in short positions. Hence, investors in short positions will be less responsive to price changes than those in long positions. This leads to an expectation that the dependence between volume and positive returns will be greater than that between volume and negative returns. So I predict that β_2 should be negative. β_3 measures the relation between current absolute return and last period trading volume. If the past information about trading activity can help predict future price movements, then β_3 should be significant.

The estimation results of OLS are shown in Table 3. For the overall regressions, the R^2 varies between 0.097 for Singapore and 0.025 for Chile. Consistent with our prediction, the estimated values of β_1 are significant and positive for all six countries. This confirms the early results from Table 2 that the absolute value of return and contemporary trading volume are positively correlated.

The asymmetric relations exist for all six countries because the estimated values of β_2 are negative and highly significant. The negative value of β_2 indicates that the slope of the negative returns is smaller than the slope for positive returns. In other words, the value of β_2 is the difference of slope coefficients of trading volume on absolute return between positive and negative price changes. The relatively higher cost for short position than for long position trading is one of the factors that explain the asymmetrical relation between absolute return and trading volume. Jennings, Starks and Fellingham (1981) provide another explanation. In their model, there are two kinds of traders: optimists and pessimists. They show that the "pessimist" traders trade less than the "optimist" ones. Since the price decreases as a result of pessimists' selling and increases as a result of optimists' buying, the trading volume is lower when price decreases than when price increases.

The estimated values of β_3 are significant only for Thailand and are insignificant for the rest of the five countries. The value of β_3 is positive for Argentina and negative for the other five countries. These results imply that information contained in past volume data does not have much power to predicate stock price movement for further periods[1].

All in all, the simple OLS estimation provides us with some preliminary results on the relation between return and adjusted trading volume. The contemporaneous absolute return and abnormal trading volume are linearly correlated. This relation is asymmetric, indicating that the correlation between positive return and volume is larger than the correlation between negative return and volume. Finally, the lagged period of trading volume does not contain much information to predict further price movement. In the next section, I follow the model of Lamoureux and Lastrapes (1990) to test the relation between second moment of stock return and trading volume.

4.2.2. GARCH Model

GARCH models the conditional variance of asset return as a function of past squared residual and lagged conditional variance. GARCH models have been shown to be a good fit for many financial time series. The mixture of distribution model provides an explanation for the GARCH properties of conditional volatility series. Based on the mixture of distribution hypothesis, asset re-

[1] Gervais, Kaniel and Mingelgrin (1999) document that stocks with high trading volume will tend to appreciate over the next period. They use firm level data and longer portfolio formation periods than those employed in the present study.

turn and trading volume are driven by the same latent information process. If the information process is serially correlated, then the conditional variance of asset return follows a GARCH process[1]. In general, despite the fact that the data on trading volume includes both informational and noisy trading, volume data is likely to contain information on price change. So, following Lamoureux and Lastrapes (1990), I estimate the GARCH (1,1) model using the data from six emerging markets:

$$R_t=\mu+\varepsilon_t \text{ where } \varepsilon_t \mid {}_{t-1}\sim N(0,\, h_t)$$
$$H_t=p_0+p_1\varepsilon_{t-1}+p_2h_{t-1}$$
$$H_t= p_0+p_1\varepsilon_{t-1}+p_2h_{t-1}+q*vol_t\,,$$

where r_t is the asset return. μ is the estimated mean value of asset return. ε_t is the innovation from the asset return and h_t is the conditional variance, which is a function of its lagged value (h_{t-1}) and past squared residual (ε_{t-1}). First, I estimate the GARCH model without volume data. Secondly, I plug the contemporaneous volume data into the GARCH model. If volume and volatility are governed by the same underlying information variable, we should expect q to be significant and positive. Moreover, the GARCH coefficient (p_2) should be reduced if trading volume is a proxy for the serially correlated information variable.

Table 4 shows the results of the estimated coefficients of the GARCH model with and without trading volume. In order to avoid the problem due to non-normality in the return residuals, I use a Quasi-MLE estimation proposed by Bollerslev and Wooldridge (1992). The estimated GARCH coefficients and their standard errors are estimated according to Broyden, Fletcher, Goldfarb and Shanno (BFGS) algorithm.

Without volume variable, the GARCH coefficients p_1 and p_2 are significant and p_1+p_2 close to but smaller than 1, indicating a high degree of persistence of the conditional volatility. When the contemporary abnormal trading volume is plugged into the conditional volatility equation, the estimated values of q are significant and positive for all six countries, which is consistent with the results of Lamoureux and Lastrapes (1990) and Marsh and Wagner (1999), who use data from the U.S. and six other developed countries. The likelihood ratio test for the restricted model (GARCH model without volume) vs. the unrestricted model (GARCH with trading volume) yields a test statistic that is $\chi^2(1)$. Except for the Argentina, the likelihood ratio test statistics are significant at the 5% level; all the others are significant at the 1% level. Therefore we favor the unrestricted model (GARCH with volume) and reject the restricted model (GARCH without volume).

As many previous studies have shown, GARCH effects may result from the time dependence in the rate of information flow. If the stock volatility and trading volume are driven by the same information process, as assumed by the "mixture of distribution hypothesis", the volume coefficient in the GARCH model should be significant and positive, and the persistence of conditional volatility measured by p_1+p_2 should be reduced. In Table 4, we compare the coefficient changes with and without volume variable and the coefficients of autoregressive conditional volatility p_2 are reduced for all six countries. The measure of conditional volatility persistency p_1+p_2 is only slightly reduced for five out of six countries when volume information is included in the equation. For Chile, the persistence even increases slightly when volume data is included in the GARCH model. This is different from the results of Lamoureux and Lastrapes (1990), who find that the GARCH effect almost disappear when using the data from U.S. individual stocks.

Estimation from the GARCH model provides us with empirical evidence that conditional volatility and abnormal trading volume are positively correlated. The theoretical explanation of this finding is that volume and volatility are both driven by a common, unobservable factor, which is determined by the arrival of new information. The degree of autoregression of conditional volatility is reduced when volume is introduced as an explanatory variable. But the GARCH coefficients are still significant in the presence of the volume variable and the persistence of conditional volatility is not significantly reduced for any of the six countries. One possible explanation is that because I use index level data. The information content of volume data from index level is not as precise as for data from individual firms.

[1] For detail, see Lamoureux and Lastrapes (1990, 1994).

4.3. Empirical Results

There are a total of seven unknown parameters: the tail probability (p_1 and p_2), the dispersion parameters (σ_1 and σ_2), the tail indies (ξ_1 and ξ_2) and the dependence parameter α.The results of all the unknown parameters for each of the six countries are listed in Table 5. Panels A, B, C, D, E and F correspond to the estimation results of Argentina, Malaysia, Chile, Mexico, Singapore and Thailand, respectively. For each country, Panel 1 shows the estimation of bivariate threshold model based on absolute price change and abnormal trading volume irrespective of the direction of price change. In order to test whether the asymmetric relation between price change and volume exists in the tail, I divide the total sample for each country into positive price changes and negative price changes. The results based on positive price changes, i.e., corr(max$|r_{i,t}|$, max(vol)) where $r_{i,t}>0$, are shown in Panel 2 for each country. The results of negative price changes, i.e., $corr(max|r_{i,t}|,max(vol))$ where $r_{i,t}<0$ are shown in Panel 3. The overall unconditional correlation coefficients of price change and volume dependence are listed in the last row of each table. The score tests for independence are listed in the last column of each table.

Most of the estimated tail indices are greater than -1/2 that guarantees the asymptotic efficiency of MLE[1]. The estimated probability that the observations exceed the threshold is equivalent to the empirical frequency. The tail indices for absolute return are all positive except for the case of Thailand. The dispersion parameter σ , probability p, and the correlation ρ are all estimated with great precision.

The estimated correlated coefficients change with the chosen thresholds. Let's take a look at the exceedence correlation between absolute return and abnormal trading volume irrespective of the direction of price change. For all six countries, there is strong evidence that a positive relation between price change and volume exists in the tail, as well as overall joint distribution. The score tests strongly reject the hypothesis that the variables are independent. Except for Malaysia, all countries show a decreasing absolute return and volume relation when the threshold goes higher. For example, in the results based on the data for Mexico, the correlation estimated based on the observations that exceed their relative means is 0.2686. For threshold at mean plus one standard deviation, the correlation coefficient drops to 0.2175, and mean plus 1.5 standard deviation, correlation goes to 0.1425. From the plot of mean residual life, the optimal threshold for return is at mean plus 1.85 times standard deviation, and for volume it is mean plus 1.3 times standard deviation. At the optimal threshold value, the correlation coefficient is 0.1406. Beyond this, when the threshold is cut at mean plus 2.05 times standard deviation, the correlation coefficient is 0.0898. Compared to the sample correlation between absolute return and trading volume 0.2239, the price-volume relation becomes weaker beyond the optimal threshold value. In finance theory, there are two potential explanations for the decreased correlation between absolute return and trading volume in the tail. First, trading volume is a noisy proxy for the underlying information process. The extent of noisiness of the volume data is more severe during periods of high volume of trading. If the correlation between return and volume is due to the same underlying information process, more noise in the trading volume data in the tail can lead to a decreased correlation between return and volume. Second, as argued by Gennotte and Leland (1990), in the absence of significant news, a small amount of hedge trading can cause crashes due to the reduced liquidity of the financial markets. Given the relative illiquidity of emerging markets compared to those of developed countries, the return-volume relation is prone to break down during extreme stock price movements.

Dividing the total observations according to directions of price change provides some interesting findings about the asymmetric relation between return and volume in the tail. Figure 1 graphically depicts the exceedence correlation and the thresholds used to define this for each of the country. In each figure, the solid line is for the correlation between absolute return and volume irrespective of direction of price change, the dotted line is for the extreme correlation between positive return and volume and the dashed lines for correlation between absolute return and trading volume when the return is negative. Except in the case of Malaysia, all the curves are downward sloping indicating that the estimated value of correlation coefficient ρ is decreasing as the level of the threshold increases. Except for Argentina and Mexico, the extreme correlation between abso-

[1] Except for Tables A1 and A3 (2.25,2.25) threshold and Table F3 (2.0,2.0) threshold.

lute return and abnormal trading volume is higher for positive return than for negative return. In other words, the asymmetric correlation between return and volume is preserved in the tail for all four of other countries. For Argentina and Mexico, there is no clear consistent pattern regarding which direction of price change has a larger return-volume relation. For example, in the case of the Mexican market index, when the threshold is the empirical mean plus half the standard deviation, correlation for absolute return and volume is higher for positive price changes (0.3093) than for negative price changes (0.2031). But when the threshold is mean plus 2.0 and 2.15 times standard deviation, the correlations for positive change (0.0220 and 0.0177, respectively) are lower than the corresponding negative price changes (0.0801 and 0.0443, respectively). For Chile, the correlation becomes 0 when the threshold is above its empirical mean plus 1.5 times its standard deviation.

The last column of each table is the score for testing the independence between absolute return and trading volume. In most cases, the score tests reject strongly the independence between return and volume. For example, for Chile, the correlation between absolute return and volume when return is negative, the score is 8.77 for observations above their empirical mean plus one half of the standard deviation, and this value is clearly significant at the 1% level, indicating the independence is strongly rejected. As the thresholds go higher, the score becomes 1.29 for the threshold at mean plus 1.5 times the standard deviation and 0.92 for the optimal threshold. These values are less significant, indicating that return and volume dependence is weaker. The values of the score tests verify our empirical results: as the threshold increases, the value of the score decreases and the dependence between absolute value of return and trading volume is smaller for the extreme observations exceeding the threshold.

5. Conclusion

This paper provides empirical evidence about the dependence of daily return and trading volume relations for six emerging markets: Argentina, Chile, Malaysia, Mexico, Singapore and Thailand.

First, simple OLS estimation provides us with empirical evidence that absolute return and trading volume are positively correlated, which supports the "mixture distribution hypothesis" that trading volume and price movement are governed by the same underlying information process. The return and volume relation overall is asymmetry, i.e., the correlation associated with positive return and volume is greater than the correlation between negative return and volume. The relative cost of short position trading and the different trading behavior of "optimist" and "pessimist" traders can provide explanations for this asymmetrical relation. The information contained in the past trading volume does not have much power to predict future price movements.

Second, I estimate the GARCH model and find out that for all six countries, the autoregressive coefficient of conditional volatility is reduced when contemporary volume data is plugged into the volatility equation. But the persistence of conditional volatility remains about the same.

Third, I use bivariate threshold theory to explicitly model the joint distribution of absolute return and trading volume. I find overall a positive correlation between absolute return and trading volume using all the observations for all six markets. Five out of the six countries have weaker but still significant correlations based on the observations that exceed thresholds beyond the optimal ones. For four out of the six countries, the return-volume asymmetry is preserved in the tail. Previous works have indicated that volume is a noisy measure of the rate of information flow. When trading volume is higher, the degree of nosiness may be even higher, so the return and volume dependence may lower during extreme price change and trading volume. If market liquidity is a concern for the emerging markets, it is important to note that a small amount of price change can trigger a large amount of trading volume, which causes the return-volume dependence to become weaker in the tail.

Overall, my empirical results support the "mixture of distribution hypothesis" for these six emerging markets. Although there exist significant institutional differences between mature and emerging financial markets, the old Wall Street adage "it takes volume to move price" generally holds across different markets. But it lacks a unified theory to explain the asymmetry relation between return and trading volume and, more importantly, explain the weaker dependence in the tail. Further work should thus pursue this thread to develop a microstructure model consistent with these empirical findings on the return-volume relation.

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Appendix

Table 1

Summary Statistics

This table gives the summary statistics for return and log trading volume for market Indies for six emerging markets. The second column is the mean (Stock return in percentage). The third column is the standard deviation. The fourth and fifth columns give the minimum and maximum of the observations. The sixth and seventh columns are the excess kurtosis and skewness. Figures in brackets are the significant level at which H_0 of no excess kurtosis (no skewness) can be rejected.

	Mean	Std	Min	Max	Kurtosis	Skewness
Argentina R	0.0084	1.9039	-13.3942	11.9649	6.0482 [0.000]	-0.0784 [0.1587]
Argentina V	-0.0001	0.4198	-5.1540	1.9556	27.7606 [0.000]	-1.5157 [0.000]
Chile R	0.0531	1.5588	-15.0358	17.5038	17.2238 [0.0000]	0.3498 [0.000]
Chile V	-0.0002	0.4112	-1.8165	2.5902	2.2116 [0.000]	0.3403 [0.000]
Malaysia R	0.0035	1.9399	-22.2153	24.3267	28.3542 [0.0000]	0.6703 [0.000]
Malaysia V	-0.0006	0.3041	-1.2494	1.8969	1.8016 [0.000]	0.4632 [0.000]
Mexico R	0.0443	1.9379	-21.7500	19.0118	17.7344 [0.000]	-0.7107 [0.000]
Mexico V	-0.0001	0.5106	-2.3898	5.8328	30.7506 [0.000]	1.5566 [0.000]
Singapore R	0.0129	1.2826	-8.4648	9.8042	7.4116 [0.000]	-0.0414 [0.3649]
Singapore V	0.0000	0.4962	-1.6864	2.0280	2.1056 [0.000]	0.4576 [0.000]
Thailand R	-0.0285	2.2708	-13.8388	15.8388	5.4737 [0.000]	0.4301 [0.000]
Thailand V	-0.0005	0.4122	-2.5594	3.4935	3.1625 [0.0000]	0.5555 [0.000]

Table 2

Correlations between Return and Trading Volume

	Corr (r, ln (V))	Corr (abs(r), ln (V))	Corr (r^2, ln (V))
Argentina	0.1287	0.2883	0.1914
Chile	0.0865	0.1398	0.0671
Malaysia	0.1780	0.2366	0.1711
Mexico	0.1033	0.2239	0.1026
Singapore	0.0855	0.2782	0.1908
Thailand	0.1002	0.2942	0.1859

Table 3

Results from OLS estimation

$V_t=\beta_0+\beta_1|r_t|+\beta_2 D_t |r_t|+\beta_3 r_{t+1} +\varepsilon_t$, where V_t is the trading volume at time *t*. $|r_t|$ is the absolute return at time *t*. r_{t+1} is the return at time *t+1*. *t*-statistics are in the brackets. One, two and three asterisks indicate significant at 10%, 5% and 1% levels respectively.

	β_0	β_1	β_2	β_3	R^2
Argentina	-0.0925*** [-8.08]	0.0926*** [12.88]	-0.054*** [-6.08]	0.0043 [0.99]	0.085
Chile	-0.0435*** [-8.09]	0.0636*** [8.45]	-0.0385*** [-3.94]	-0.0016 [-0.33]	0.025
Malaysia	-0.0523*** [-7.35]	0.0750*** [16.15]	-0.0564*** [-9.31]	-0.0025 [-0.82]	0.084
Mexico	-0.0947*** [-8.41]	0.1050*** [13.75]	-0.0599*** [-6.68]	-0.0036 [-0.81]	0.065
Singapore	-0.0702*** [-9.80]	0.1233*** [17.52]	-0.0843*** [-10.08]	-0.0056 [-1.35]	0.097
Thailand	-0.1947 [-10.74]	0.1579*** [16.37]	-0.0563*** [-4.66]	-0.0175** [-2.19]	0.095

Table 4

Estimation of GARCH model with and without volume variable the results are based on the following model: $r = \mu + \varepsilon_t$, where $\varepsilon_t \,|_{t-1} \sim N(0, h_t)$

Without volume: $h_t = p_0 + p_1\varepsilon^2{}_{t-1} + p_2 h_{t-1}$.

With volume: $h_t=p_0+p_1\ \varepsilon^2{}_{t-1} +p_2\ h_{t-1}+q{*}vol_t$. Standard errors are given below in parentheses. The likelihood ratio tests the hypothesis that H_0: $q=0, H_1: q\neq 0$. The P-values of likelihood ratio tests are given below in brackets.

	μ	P_0	P_1	P_2	$P_1 + P_2$	q	χ^1 (1)
Argentina No volume	0.0616 (0.0388)	0.1287 (0.0397)	0.1325 (0.0217)	0.8347 (0.0102)	0.9672		
Argentina w. volume	-0.0152 (0.0405)	0.3199 (0.1142)	0.2475 (0.0368)	0.5285 (0.0657)	0.7760	3.9133 (1.0452)	3.88 [0.05]
Chile No volume	0.0009 (0.0065)	0.0035 (0.0099)	0.0422 (0.0206)	0.9333 (0.0077)	0.9755		
Chile w. Volume	0.0184 (0.0208)	0.0255 (0.0233)	0.1353 (0.0177)	0.8603 (0.0059)	0.9953	0.0451 (0.0271)	45.40 [<0.001]
Malaysia	0.0585 (0.0199)	0.0329 (0.0178)	0.1198 (0.0182)	0.8731 (0.0065)	0.9929		
Malaysia	0.0597 (0.0201)	0.000 (0.1205)	0.1415 (0.0172)	0.8434 (0.0053)	0.9849	0.4718 (0.0153)	22.24 [<0.001]
Mexico	0.1069 (0.0260)	0.1621 (0.0336)	0.1947 (0.0214)	0.7693 (0.0119)	0.9640		
Mexico	0.0934 (0.0281)	0.1878 (0.0606)	0.3068 (0.0279)	0.5895 (0.0309)	0.8963	1.8841 (0.3526)	55.90 [<0.001]
Singapore	0.0349 (0.0171)	0.0301 (0.0202)	0.1226 (0.0238)	0.8643 (0.0096)	0.9869		
Singapore	0.0062 (0.0172)	0.0758 (0.0408)	0.3149 (0.0305)	0.5424 (0.0366)	0.8573	1.0865 (0.1893)	38.96 [<0.001]
Thailand	0.0284 [0.0303]	0.0487 (0.0296)	0.0978 (0.0189)	0.8966 (0.0064)	0.9944	0.9944	
Thailand	0.0288 (0.0309)	0.0220 (0.0667)	0.1328 (0.0328)	0.8476 (0.0171)	0.9804	0.4216 (0.1638)	27.95 [<0.001]

Table 5

Main Results: Estimation of Bivariate Threshold Model

The following model is estimated:

$$G(y_1, y2)=exp[-V\{-1/log[1-p_1(1+\xi_1(y_1-\upsilon_1)/\sigma_1)_+^{1/\xi 1}]-1/log[1-p_2(1+\xi_2(y_2-\upsilon_2)/\sigma_2)_+^{1/\xi 2}]\}]$$

$$V(z_1, z2)=(z_1^{-1/\alpha}+z_2^{-1/\alpha})^{\alpha}$$

where υ_1=mean+θ_1*STD;

υ_2=mean+θ_2*STD;

p_1 and p_2 are the probabilities that certain observations exceeding their thresholds. σ_1 and σ_2 are dispersion parameters. ξ_1 and ξ_2 are tail indices. α is related to the correlation coefficient by $\rho=1-a^2$. The corresponding standard deviations are in parentheses. * indicates optimal threshold based on the residual life plot. P-values of score tests are given below in brackets.

Panel A1. Argentina: correlation between absolute value of return and trading volume

Threshold	P_r	ξ_r	σ_r	P_v	ξ_v	σ_v	α	ρ	score
(0.5,0.5)	0.3726 (0.0146)	0.1917 (0.0562)	0.9582 (0.0719)	0.4385 (0.0147)	-0.0167 (0.0412)	0.1820 (0.0111)	0.8292 (0.0174)	0.3124	39.51 [0.00]
(1.0,1.0)	0.2339 (0.0135)	0.2150 (0.0815)	1.0358 (0.1081)	0.1835 (0.0125)	0.0539 (0.0815)	0.1628 (0.0181)	0.8391 (0.0240)	0.2959	26.08 [0.000]
(1.5,1.5)	0.1403 (0.0114)	0.1795 (0.1106)	1.2249 (0.1717)	0.0581 (0.0078)	-0.1120 (0.2660)	0.2184 (0.0639)	0.8547 (0.0355)	0.2694	17.45 [0.000]
(1.75,1.75)	0.1117 (0.0105)	0.1942 (0.1357)	1.2070 (0.2036)	0.0328 (0.0060)	-0.2966 (0.1907)	0.3841 (0.0877)	0.9137 (0.0363)	0.1651	11.45 [0.000]
(2.4,1.46)	0.0657 (0.0083)	0.2081 (0.1872)	1.3048 (0.2950)	0.0624 (0.0081)	-0.1460 (0.2310)	0.2293 (0.0600)	0.8572 (0.0407)	0.2652	15.56 [0.000]
(2.4,2.1)	0.0658 (0.0084)	0.1834 (0.1797)	1.2927 (0.2888)	0.0214 (0.0049)	-0.2793 (0.2717)	0 3182 (0.0949)	0.9223 (0.0447)	0.1493	10.03 [0.000]
(2.25,2.25)	0.0708 (0.0087)	0.0945 (0.1515)	1.4550 (0.2899)	0.0186 (0.0046)	-0.7117 (0.2968)	0.2513 (0.0854)	0.9528 (0.0350)	0.0922	7.43 [0.000]
Corr (|r|, v)								0.2883	

Panel A2. Argentina: correlation between absolute return and trading volume when return is positive

Threshold	P_r	ξ_r	σ_r	P_v	ξ_v	σ_v	α	ρ	score
(0.5,0.5)	0.3604 (0.020)	0.2440 (0.08)	0.9461 (0.102)	0.4333 (0.021)	-0.0119 (0.059)	0.1886 (0.016)	0.7825 (0.026)	0.3877	29.53 [0.000]
(1.0,1.0)	0.2258 (0.019)	0.2868 (0.118)	1.0222 (0.152)	0.2002 (0.018)	0.3022 (0.142)	0.1155 (0.019)	0.7850 (0.035)	0.3327	20.78 [0.000]
(1.5,1.5)	0.1342 (0.016)	0.2668 (0.179)	1.1768 (0.257)	0.0499 (0.010)	-0.4195 (0.217)	0.4216 (0.108)	0.9152 (0.043)	0.1624	7.27 [0.00]
(1.75,1.75)	0.1030 (0.014)	0.2240 (0.206)	1.3812 (0.345)	0.0385 (0.009)	-0.4368 (0.271)	0.3591 (0.109)	0.8846 (0.054)	0.2175	6.96 [0.00]
(2.8,1.5)	0.0474 (0.01)	0.4077 (0.456)	1.3347 (0.639)	0.0511 (0.010)	-0.4388 (0.226)	0.4352 (0.112)	0.8532 (0.065)	0.2720	6.97 [0.00]
(2.25,2,25)	0.0648 (0.012)	0.0760 (0.272)	1.7859 (0.539)	0.0251 (0.008)	-0.3470 (0.321)	0.1268 (0.054)	0.9661 (0.041)	0.0667	2.55 [0.011]
Corr (|r|, v)								0.3213	

Panel A3. Argentina: correlation between absolute return and trading volume when return is negative

Threshold	P_r	ξ_r	σ_r	P_v	ξ_v	σ_v	α	ρ	score
(0.5,0.5)	0.3650 (0.021)	0.0902 (0.07)	1.1715 (0.118)	0.4410 (0.021)	-0.0284 (0.053)	0.1685 (0.014)	0.8725 (0.023)	0.2387	29.97 [0.000]
(1.0,1.0)	0.2375 (0.019)	0.1554 (0.109)	1.1528 (0.163)	0.1739 (0.017)	0.0741 (0.118)	0.1458 (0.023)	0.8490 (0.034)	0.2791	20.04 [0.000]
(1.5,1.5)	0.1464 (0.016)	0.0943 (0.125)	1.3383 (0.232)	0.0551 (0.011)	0.2089 (0.335)	0.1322 (0.052)	0.8808 (0.049)	0.2114	12.74 [0.00]
(1.75,1.75)	0.1224 (0.015)	0.1644 (0.158)	1.1576 (0.240)	0.0267 (0.008)	-0.440 (0.359)	0.3076 (0.140)	0.9190 (0.055)	0.1554	11.53 [0.00]
(2.0,1.4)	0.0997 (0.014)	0.3260 (0.228)	0.9780 (0.262)	0.0766 (0.013)	0.2993 (0.26)	0.1071 (0.033)	0.8810 (0.047)	0.2238	12.72 [0.00]
(1.85,1.85)	0.1141 (0.015)	0.2261 (0.182)	1.0626 (0.243)	0.0221 (0.007)	-0.404 (0.471)	0.3595 (0.193)	0.9007 (0.064)	0.1887	11.47 [0.00]
(2.25,2.25)	0.1004 (0.04)	0.4075 (0.199)	0.8524 (0.205)	0.0159 (0.004)	-0.8422 (0.906)	0.1172 (0.068)	0.9389 (0.004)	0.1184	5.61 [0.00]
corr(|r|,v)								0.1936	

Panel B1. Malaysia: correlation between absolute return and volume

Threshold	P_r	ξ_r	σ_r	P_v	ξ_v	σ_v	α	ρ	score
(0.5,0.5)	0.2917 (0.012)	0.3552 (0.055)	0.8648 (0.06)	0.4415 (0.012)	0.0599 (0.019)	0.1838 (0.001)	0.8419 (0.015)	0.2912	60.61 [0.000]
(1.0,1.0)	0.1653 (0.009)	0.3988 (0.085)	1.0649 (0.116)	0.2301 (0.011)	0.1620 (0.050)	0.1551 (0.012)	0.8315 (0.021)	0.3086	43.62 [0.000]
(1.5,1.5)	0.0977 (0.008)	0.3953 (0.122)	1.3825 (0.210)	0.0990 (0.008)	0.2770 (0.095)	0.1473 (0.019)	0.8212 (0.029)	0.3056	34.89 [0.000]
(2.0,2.0)	0.0619 (0.007)	0.3262 (0.164)	1.8825 (0.376)	0.0414 (0.006)	0.3615 (0.152)	0.1614 (0.032)	0.8065 (0.042)	0.3495	30.59 [0.00]
(2.45,1.4)*	0.0467 (0.006)	0.3390 (0.211)	1.9147 (0.489)	0.1199 (0.009)	0.2463 (0.083)	0.1461 (0.017)	0.8461 (0.033)	0.2841	30.77 [0.000]
(2.45,1.75)	0.0473 (0.006)	0.3507 (0.162)	1.9186 (0.492)	0.0598 (0.007)	0.2561 (0.106)	0.1757 (0.027)	0.8343 (0.039)	0.3039	28.62 [0.000]
(2.25,2.25)	0.0503 (0.006)	0.1977 (0.162)	2.3532 (0.492)	0.0286 (0.005)	0.4412 (0.194)	0.1477 (0.037)	0.8504 (0.046)	0.2768	28.69 [0.00]
corr(|r|,v)								0.2366	

Panel B2. Malaysia: correlation between absolute return and volume when return is positive

Threshold	P_r	ξ_r	σ_r	P_v	ξ_v	σ_v	α	ρ	score
(0.5,0.5)	0.2786 (0.016)	0.4591 (0.087)	0.8232 (0.092)	0.4208 (0.017)	0.1014 (0.038)	0.1785 (0.012)	0.8090 (0.022)	0.3455	44.28 [0.00]
(1.0,1.0)	0.1526 (0.013)	0.4587 (0.125)	1.1701 (0.185)	0.2066 (0.015)	0.2531 (0.080)	0.1395 (0.016)	0.7836 (0.032)	0.3860	34.90 [0.00]
(1.5,1.5)	0.0938 (0.011)	0.4809 (0.176)	1.4622 (0.317)	0.0773 (0.010)	0.3908 (0.153)	0.1423 (0.028)	0.7877 (0.046)	0.3795	27.08 [0.00]
(1.75,1.75)	0.0746 (0.010)	0.4647 (0.206)	1.6648 (0.418)	0.0457 (0.008)	0.4470 (0.195)	0.1553 (0.040)	0.7979 (0.055)	0.3633	24.01 [0.00]
(2.25,1.45)*	0.0514 (0.008)	0.5325 (0.246)	1.8854 (0.63)	0.0843 (0.011)	0.3695 (0.144)	0.1487 (0.028)	0.7761 (0.055)	0.3977	24.41 [0.00]
(2.0,2.0)	0.0619 (0.009)	0.5055 (0.246)	1.7520 (0.508)	0.0333 (0.007)	1.0098 (0.453)	0.0749 (0.035)	0.7600 (0.065)	0.4224	24.78 [0.00]
(2.25,2.25)	0.0519 (0.009)	0.4753 (0.276)	1.7987 (0.598)	0.0192 (0.005)	1.0306 (0.513)	0.0880 (0.048)	0.8480 (0.069)	0.2808	19.28 [0.00]
corr(|r|,v)								0.2789	

Panel B3. Malaysia: correlation between absolute return and volume when return is negative

Threshold	P_r	ξ_r	σ_r	P_v	ξ_v	σ_v	α	ρ	score
(0.5,0.5)	0.2917 (0.017)	0.4200 (0.101)	0.8458 (0.102)	0.4741 (0.017)	-0.0253 (0.040)	0.1837 (0.012)	0.8716 (0.021)	0.2403	26.06 [0.000]
(1.0,1.0)	0.1592 (0.014)	0.2269 (0.113)	1.4435 (0.215)	0.2860 (0.017)	0.0772 (0.067)	0.1447 (0.014)	0.8990 (0.025)	0.1918	18.50 [0.00]
(1.5,1.5)	0.1076 (0.012)	0.2333 (0.146)	1.6322 (0.306)	0.1233 (0.013)	0.1632 (0.132)	0.1463 (0.025)	0.8791 (0.035)	0.2272	14.83 [0.00]
(1.75,1.75)	0.0903 (0.011)	0.2397 (0.163)	1.6376 (0.345)	0.0799 (0.011)	0.1368 (0.175)	0.1618 (0.037)	0.9095 (0.035)	0.1728	12.20 [0.00]
(2.0,2.0)	0.0720 (0.010)	0.2000 (0.175)	1.9082 (0.437)	0.0554 (0.009)	0.2249 (0.275)	0.1559 (0.051)	0.8870 (0.045)	0.2132	11.51 [0.000]
(1.65,1.41)*	0.0952 (0.012)	0.2316 (0.156)	1.6742 (0.335)	0.1522 (0.014)	0.2032 (0.121)	0.1290 (0.020)	0.8854 (0.034)	0.2161	14.8 [0.00]
(2.25,2.25)	0.0592 (0.009)	0.1715 (0.185)	2.0573 (0.509)	0.0374 (0.008)	-0.042 (0.293)	0.2280 (0.081)	0.9054 (0.048)	0.1802	9.21 [0.00]
corr(|r|,v)								0.1968	

Panel C1. Chile: correlation between absolute return and trading volume

Threshold	P_r	ξ_r	σ_r	P_v	ξ_v	σ_v	α	ρ	score
(0.5,0.5)	0.3158 (0.012)	0.3564 (0.064)	0.7704 (0.059)	0.4425 (0.012)	0.0683 (0.035)	0.2530 (0.013)	0.9284 (0.014)	0.1380	17.41 [0.00]
(1.0,1.0)	0.1838 (0.010)	0.3149 (0.087)	1.0004 (0.105)	0.2404 (0.011)	0.1327 (0.057)	0.2336 (0.018)	0.9525 (0.015)	0.0927	9.34 [0.00]
(1.5,1.5)	0.1176 (0.009)	0.2755 (0.103)	1.1957 (0.153)	0.1198 (0.009)	0.2137 (0.091)	0.2196 (0.026)	0.9630 (0.017)	0.0726	5.75 [0.00]
(2.0,2.0)	0.0796 (0.007)	0.3325 (0.130)	1.2179 (0.204)	0.0558 (0.006)	0.3293 (0.153)	0.2134 (0.040)	0.9691 (0.021)	0.0608	3.68 [0.00]
(1.85,1.95)*	0.0925 (0.008)	0.3576 (0.132)	1.1153 (0.174)	0.0574 (0.006)	0.2577 (0.137)	0.2435 (0.043)	0.9631 (0.021)	0.0724	4.29 [0.00]
(2.25,2.25)	0.0633 (0.007)	0.2941 (0.155)	1.3781 (0.259)	0.0378 (0.005)	0.5063 (0.237)	0.1837 (0.049)	0.9884 (0.016)	0.0231	1.93 [0.054]
corr(|r|,v)								0.1398	

Panel C2. Chile: correlation between absolute return and trading volume when return is positive

Threshold	P_r	ξ_r	σ_r	P_v	ξ_v	σ_v	α	ρ	score
(0.5,0.5)	0.3204 (0.016)	0.4600 (0.094)	0.7166 (0.078)	0.4320 (0.017)	0.1205 (0.051)	0.2357 (0.017)	0.8848 (0.020)	0.2171	17.99 [0.00]
(1.0,1.0)	0.1749 (0.014)	0.3231 (0.126)	1.1479 (0.174)	0.2222 (0.015)	0.2062 (0.085)	0.2191 (0.025)	0.9233 (0.024)	0.1475	9.78 [0.00]
(1.5,1.5)	0.1077 (0.012)	0.2534 (0.170)	1.5095 (0.305)	0.1018 (0.012)	0.3639 (0.160)	0.2058 (0.039)	0.9265 (0.030)	0.1416	6.77 [0.00]
(2.0,2.0)	0.0723 (0.010)	0.1020 (0.159)	2.0687 (0.435)	0.0443 (0.008)	0.5321 (0.321)	0.2309 (0.081)	0.9264 (0.030)	0.1416	4.56 [0.00]
(2.15,1.4)*	0.0704 (0.009)	0.2039 (0.205)	1.7231 (0.425)	0.1261 (0.013)	0.3825 (0.148)	0.1812 (0.032)	0.9422 (0.029)	0.1122	5.41 [0.00]
(2.25,2.25)	0.0655 (0.009)	0.1592 (0.195)	1.8504 (0.452)	0.0262 (0.006)	0.2066 (0.324)	0.4498 (0.179)	0.9579 (0.037)	0.0824	2.73 [0.006]
corr(|r|,v)								0.1861	

Panel C3. Chile: correlation between absolute return and trading volume when return is negative

Threshold	P_r	ξ_r	σ_r	P_v	ξ_v	σ_v	α	ρ	score
(0.5,0.5)	0.3284 (0.017)	0.3759 (0.094)	0.7221 (0.080)	0.4642 (0.017)	0.0322 (0.055)	0.2572 (0.019)	0.9654 (0.017)	0.0680	8.77 [0.00]
(1.0,1.0)	0.1794 (0.015)	0.2300 (0.107)	1.1456 (0.158)	0.2577 (0.016)	0.0162 (0.077)	0.2647 (0.028)	0.9779 (0.021)	0.0437	3.96 [0.00]
(1.25,1,25)	0.1447 (0.014)	0.2373 (0.121)	1.1877 (0.185)	0.1815 (0.015)	-0.0182 (0.084)	0.2825 (0.035)	0.9929 (0.021)	0.0141	2.26 [0.024]
(1.5,1.5)	0.1191 (0.013)	0.2521 (0.134)	1.2007 (0.209)	0.1292 (0.013)	-0.0271 (0.093)	0.2864 (0.041)	1.000 (0.020)	0.0000	1.29 [0.197]
(2.15,1.51)*	0.0701 (0.010)	0.3704 (0.210)	1.1716 (0.296)	0.1292 (0.013)	-0.0164 (0.095)	0.2794 (0.040)	1.000 (0.023)	0.0000	0.92 [0.358]
corr(|r|,v)								0.0811	

Panel D1. Mexico: correlation between absolute return and volume

Threshold	P_r	ξ_r	σ_r	P_v	ξ_v	σ_v	α	ρ	score
(0.5,0.5)	0.3492 (0.012)	0.2937 (0.052)	0.8883 (0.057)	0.4516 (0.012)	0.0595 (0.034)	0.2385 (0.012)	0.8552 (0.014)	0.2686	19.84 [0.00]
(1.0,1.0)	0.2031 (0.011)	0.3308 (0.075)	1.0035 (0.092)	0.2190 (0.011)	0.2194 (0.069)	0.1901 (0.016)	0.8846 (0.019)	0.2174	14.68 [0.00]
(1.5,1.5)	0.1218 (0.009)	0.4379 (0.111)	0.9788 (0.127)	0.0713 (0.007)	0.1678 (0.147)	0.2715 (0.047)	0.9260 (0.023)	0.1425	6.88 [0.00]
(2.0,2.0)	0.0656 (0.007)	0.4456 (0.165)	1.3010 (0.246)	0.0314 (0.005)	-0.081 (0.179)	0.4101 (0.096)	0.9481 (0.029)	0.1011	3.13 [0.00]
(1.85,1.35)*	0.0864 (0.008)	0.6554 (0.176)	0.8273 (0.155)	0.1241 (0.009)	0.4108 (0.126)	0.1590 (0.023)	0.9270 (0.022)	0.1406	6.83 [0.00]
(2.05,2.05)	0.0627 (0.007)	0.4463 (0.169)	1.3164 (0.256)	0.0291 (0.005)	-0.110 (0.180)	0.4257 (0.102)	0.9540 (0.029)	0.0898	2.81 [0.005]
(2.25,2.25)	0.0521 (0.006)	0.4323 (0.186)	1.4340 (0.309)	0.0245 (0.004)	-0.022 (0.233)	0.3558 (0.103)	0.9718 (0.027)	0.0556	1.68 [0.093]
corr(|r|,v)								0.2239	

Panel D2. Mexico: correlation between absolute return and volume when return is positive

Threshold	P_r	ξ_r	σ_r	P_v	ξ_v	σ_v	α	ρ	score
(0.5,0.5)	0.3618 (0.016)	0.3068 (0.073)	0.8828 (0.078)	0.4417 (0.017)	0.0499 (0.047)	0.2253 (0.015)	0.8311 (0.020)	0.3093	21.65 [0.00]
(1.0,1.0)	0.2187 (0.015)	0.3546 (0.109)	0.9178 (0.120)	0.1928 (0.014)	0.2600 (0.106)	0.1578 (0.021)	0.9219 (0.023)	0.1501	9.56 [0.00]
(1.5,1.5)	0.1207 (0.012)	0.2715 (0.137)	1.2991 (0.221)	0.0536 (0.009)	0.1094 (0.232)	0.2769 (0.076)	0.9277 (0.035)	0.1394	4.51 [0.00]
(1.75,1.75)	0.1034 (0.011)	0.3965 (0.178)	1.0817 (0.223)	0.0337 (0.007)	-0.0143 (0.303)	0.3334 (0.119)	0.9485 (0.031)	0.1003	2.89 [0.004]
(2.0,2.0)	0.0751 (0.010)	0.4686 (0.256)	1.2458 (0.288)	0.0252 (0.006)	0.4504 (0.912)	0.2387 (0.137)	0.9889 (0.031)	0.0220	0.66 [0.509]
(2.70,1.15)*	0.0472 (0.008)	0.7295 (0.356)	0.8961 (0.333)	0.1347 (0.013)	0.3535 (0.154)	0.1506 (0.027)	0.9449 (0.032)	0.1072	4.18 [0.00]
(2.15,2.15)	0.0702 (0.009)	0.2179 (0.176)	1.6092 (0.362)	0.0210 (0.006)	-0.2401 (0.375)	0.4187 (0.190)	0.9911 (0.030)	0.0177	0.23 [0.818]
corr(|r|,v)								0.2722	

Panel D3. Mexico: correlation between absolute return and volume when return is negative

Threshold	P_r	ξ_r	σ_r	P_v	ξ_v	σ_v	α	ρ	score
(0.5,0.5)	0.3437 (0.017)	0.3538 (0.081)	0.8262 (0.083)	0.4514 (0.018)	0.0835 (0.052)	0.2478 (0.018)	0.8927 (0.019)	0.2031	16.94 [0.00]
(1.0,1.0)	0.1890 (0.012)	0.3814 (0.121)	1.0129 (0.147)	0.2268 (0.016)	0.1433 (0.091)	0.2451 (0.029)	0.9111 (0.025)	0.1699	9.04 [0.00]
(1.5,1.5)	0.1084 (0.012)	0.4553 (0.185)	1.1455 (0.242)	0.1086 (0.012)	0.3179 (0.188)	0.2164 (0.047)	0.9240 (0.032)	0.1462	5.43 [0.00]
(2.0,2.0)	0.0636 (0.009)	0.3399 (0.208)	1.6737 (0.424)	0.0430 (0.008)	-0.0962 (0.205)	0.4640 (0.129)	0.9591 (0.037)	0.0801	1.96 [0.05]
(2.60,1.45)*	0.0454 (0.008)	0.7454 (0.403)	1.1382 (0.459)	0.1215 (0.013)	0.3743 (0.186)	0.1962 (0.041)	0.9146 (0.042)	0.1635	3.37 [0.00]
(2.15,2.15)	0.0572 (0.005)	0.3641 (0.227)	1.6431 (0.449)	0.0384 (0.008)	-0.0745 (0.223)	0.4339 (0.131)	0.9776 (0.035)	0.0443	1.15 [0.250]
corr(|r|,v)								0.1794	

Panel E1. Singapore: correlation between absolute return and volume

Threshold	P_r	ξ_r	σ_r	P_v	ξ_v	σ_v	α	ρ	score
(0.5,0.5)	0.3621 (0.012)	0.2505 (0.050)	0.6177 (0.040)	0.3897 (0.012)	0.0208 (0.038)	0.2560 (0.014)	0.8408 (0.015)	0.2930	45.69 [0.00]
(1.0,1.0)	0.2198 (0.011)	0.2421 (0.071)	0.7222 (0.066)	0.1512 (0.009)	0.0297 (0.068)	0.2528 (0.025)	0.8638 (0.020)	0.2538	32.22 [0.00]
(1.5,1.5)	0.1327 (0.009)	0.1861 (0.091)	0.8769 (0.104)	0.0548 (0.006)	0.1493 (0.134)	0.2023 (0.036)	0.8922 (0.027)	0.2039	24.11 [0.00]
(2.0,2.0)	0.0844 (0.008)	0.1738 (0.122)	0.9510 (0.151)	0.0279 (0.005)	0.1810 (0.232)	0.2095 (0.061)	0.9388 (0.029)	0.1186	19.33 [0.00]
(2.4,1.55)*	0.0641 (0.007)	0.3199 (0.187)	0.8384 (0.183)	0.0502 (0.006)	0.2234 (0.157)	0.1840 (0.037)	0.9270 (0.032)	0.1406	19.17 [0.00]
(2.45,1.75)	0.0585 (0.006)	0.2347 (0.186)	0.9358 (0.210)	0.0280 (0.005)	0.1875 (0.233)	0.2094 (0.061)	0.9367 (0.031)	0.1226	17.71 [0.00]
(2.25,2.25)	0.0674 (0.007)	0.1698 (0.145)	1.0311 (0.189)	0.0516 (0.006)	0.0024 (0.086)	0.2107 (0.031)	0.9402 (0.028)	0.1160	16.03 [0.00]
corr(|r|,v)								0.2782	

Panel E2. Singapore: correlation between absolute return and volume when return is positive

Threshold	P_r	ξ_r	σ_r	P_v	ξ_v	σ_v	α	ρ	score
(0.5,0.5)	0.3643 (0.010)	0.3277 (0.074)	0.5368 (0.05)	0.4545 (0.017)	-0.09 (0.044)	0.2431 (0.016)	0.8056 (0.02)	0.3510	45.24 [0.00]
(1.0,1.0)	0.1996 (0.014)	0.2268 (0.099)	0.8086 (0.103)	0.2796 (0.016)	-0.0768 (0.07)	0.2238 (0.02)	0.8019 (0.027)	0.3569	36.95 [0.00]
(1.5,1.5)	0.1302 (0.013)	0.1904 (0.123)	0.8972 (0.146)	0.1374 (0.013)	-0.2056 (0.09)	0.2550 (0.034)	0.8500 (0.033)	0.2775	30.48 [0.00]
(2.0,2.0)	0.0863 (0.011)	0.2252 (0.167)	0.9115 (0.194)	0.0715 (0.010)	-0.1735 (0.161)	0.2156 (0.047)	0.8616 (0.04)	0.2576	24.32 [0.00]
(2.30,1.5)*	0.0661 (0.10)	0.2201 (0.198)	0.9604 (0.243)	0.1389 (0.013)	-0.2107 (0.09)	0.2556 (0.034)	0.8657 (0..04)	0.2505	24.01 [0.00]
(2.25,2.25)	0.0761 (0.01)	0.2573 (0.19)	0.8970 (0.21)	0.0622 (0.010)	0.0084 (0.239)	0.1603 (0.05)	0.8661 (0.044)	0.2498	22.81 [0.00]
corr(|r|,v)									0.3321

Panel E3. Singapore: correlation between absolute return and volume when return is negative

Threshold	P_r	ξ_r	σ_r	P_v	ξ_v	σ_v	α	ρ	score
(0.5,0.5)	0.3506 (0.017)	0.2200 (0.075)	0.6873 (0.067)	0.4463 (0.017)	0.1255 (0.056)	0.1684 (0.013)	0.8889	0.2098	21.48 [0.00]
(1.0,1.0)	0.2262 (0.016)	0.2589 (0.106)	0.7200 (0.095)	0.2466 (0.016)	0.1987 (0.094)	0.1639 (0.020)	0.8910	0.2061	14.75 [0.00]
(1.5,1.5)	0.1422 (0.014)	0.2531 (0.140)	0.8189 (0.140)	0.1254 (0.013)	0.1727 (0.137)	0.1961 (0.034)	0.8865 (0.032)	0.2141	24.11 [0.00]
(2.0,2.0)	0.0848 (0.011)	0.2348 (0.213)	0.9390 (0.234)	0.0635 (0.010)	0.0407 (0.164)	0.2637 (0.06)	0.9384 (0.035)	0.1194	5.21 [0.00]
(2.20,1.85)*	0.0741 (0.010)	0.3848 (0.285)	0.8209 (0.253)	0.0829 (0.01)	0.2047 (0.198)	0.2004 (0.047)	0.9066 (0.039)	0.1780	6.73 [0.00]
(2.25,2.25)	0.0753 (0.010)	0.2713 (0.247)	0.9016 (0.255)	0.0564 (0.009)	0.0711 (0.184)	0.2462 (0.061)	0.9583 (0.033)	0.0817	3.88 [0.00]
corr(|r|,v)								0.1810	

Panel F1. Thailand: correlation between absolute return and volume

Threshold	P_r	ξ_r	σ_r	P_v	ξ_v	σ_v	α	ρ	score
(0.5,0.5)	0.3504 (0.012)	0.1373 (0.05)	1.5981 (0.104)	0.4302 (0.012)	0.0358 (0.035)	0.3149 (0.016)	0.8462 (0.02)	0.2839	41.94 [0.00]
(1.0,1.0)	0.2294 (0.011)	0.0714 (0.065)	1.8984 (0.159)	0.1543 (0.010)	0.0775 (0.073)	0.3224 (0.032)	0.8610 (0.020)	0.2586	25.95 [0.00]
(1.5,1.5)	0.1618 (0.010)	0.0902 (0.086)	1.7907 (0.194)	0.0483 (0.006)	0.0560 (0.135)	0.3618 (0.07)	0.9205 (0.025)	0.1527	14.86 [0.00]
(2.0,2.0)	0.1031 (0.008)	-0.0026 (0.103)	2.1042 (0.282)	0.0178 (0.004)	0.0881 (0.235)	0.3561 (0.111)	0.9392 (0.033)	0.1179	10.29 [0.00]
(2.75,1.75)*	0.0556 (0.006)	-0.1528 (0.101)	2.6051 (0.401)	0.0302 (0.005)	0.1013 (0.189)	0.3370 (0.083)	0.9422 (0.030)	0.1122	9.80 [0.00]
(2.85,1.85)	0.0510 (0.006)	-0.1738 (0.102)	2.6864 (0.424)	0.0241 (0.004)	0.0613 (0.192)	0.3652 (0.096)	0.9443 (0.032)	0.1083	9.47 [0.00]
(2.25,2.25)	0.0824 (0.008)	-0.1344 (0.08)	2.5308 (0.334)	0.0119 (0.003)	0.1043 (0.296)	0.3459 (0.137)	0.9494 (0.04)	0.0986	5.58 [0.00]
corr(|r|,v)								0.2942	

Panel F2. Thailand: correlation between absolute return and volume when return is positive

Threshold	P_r	ξ_r	σ_r	P_v	ξ_v	σ_v	α	ρ	score
(0.5,0.5)	0.3508 (0.017)	0.2726 (0.078)	1.2324 (0.118)	0.4490 (0.017)	0.0521 (0.054)	0.3235 (0.024)	0.7589 (0.022)	0.4240	35.50 [0.00]
(1.0,1.0)	0.2220 (0.015)	0.2186 (0.115)	1.5037 (0.205)	0.1572 (0.014)	0.1070 (0.129)	0.3006 (0.048)	0.8101 (0.031)	0.3437	20.94 [0.00]
(1.5,1.5)	0.1383 (0.013)	-0.0058 (0.169)	2.0701 (0.41)	0.0430 (0.008)	-0.4061 (0.269)	0.5140 (0.163)	0.9031 (0.041)	0.1844	11.84 [0.00]
(2.0,2.0)	0.1142 (0.023)	-0.0769 (0.203)	2.2541 (0.215)	0.0211 (0.007)	-0.5044 (0.345)	0.4608 (0.216)	0.9431 (0.044)	0.1105	9.26 [0.00]
(2.55,1.05)*	0.0547 (0.009)	-0.4598 (0.204)	3.6078 (0.888)	0.1612 (0.014)	0.0540 (0.122)	0.3104 (0.048)	0.8837 (0.039)	0.2190	10.88 [0.00]
(2.25,2.25)									
corr(|r|,v)								0.3424	

Panel F3. Thailand: correlation between absolute return and volume when return is negative

Threshold	P_r	ξ_r	σ_r	P_v	ξ_v	σ_v	α	ρ	score
(0.5,0.5)	0.3780 (0.017)	0.2420 (0.081)	1.0327 (0.099)	0.4089 (0.017)	0.0493 (0.046)	0.2840 (0.020)	0.8745 (0.20)	0.2352	17.95 [0.00]
(1.0,1.0)	0.2258 (0.015)	0.0969 (0.099)	1.3904 (0.172)	0.1755 (0.014)	0.1683 (0.096)	0.2384 (0.031)	0.9183 (0.025)	0.1567	8.70 [0.00]
(1.5,1.5)	0.1421 (0.013)	-0.0215 (0.111)	1.6785 (0.252)	0.0602 (0.009)	0.3151 (0.210)	0.2230 (0.058)	0.9747 (0.026)	0.0499	2.50 [0.012]
(2.0,2.0)	0.0929 (0.011)	-0.0722 (0.129)	1.8020 (0.326)	0.0175 (0.005)	0.2156 (0.366)	0.3979 (0.186)	0.9821 (0.031)	0.0354	1.28 [0.201]
(2.50,1.35)*	0.0567 (0.009)	-0.1813 (0.149)	2.1786 (0.475)	0.0842 (0.011)	0.3122 (0.183)	0.2118 (0.047)	0.9546 (0.033)	0.0887	2.91 [0.004]
(2.25,2.25)	0.0886 (0.011)	0.0361 (0.169)	1.4920 (0.319)	0.0159 (0.005)	0.5526 (0.586)	0.2424 (0.155)	0.9785 (0.034)	0.0425	1.31 [0.190]
corr(|r|,v)								0.2222	

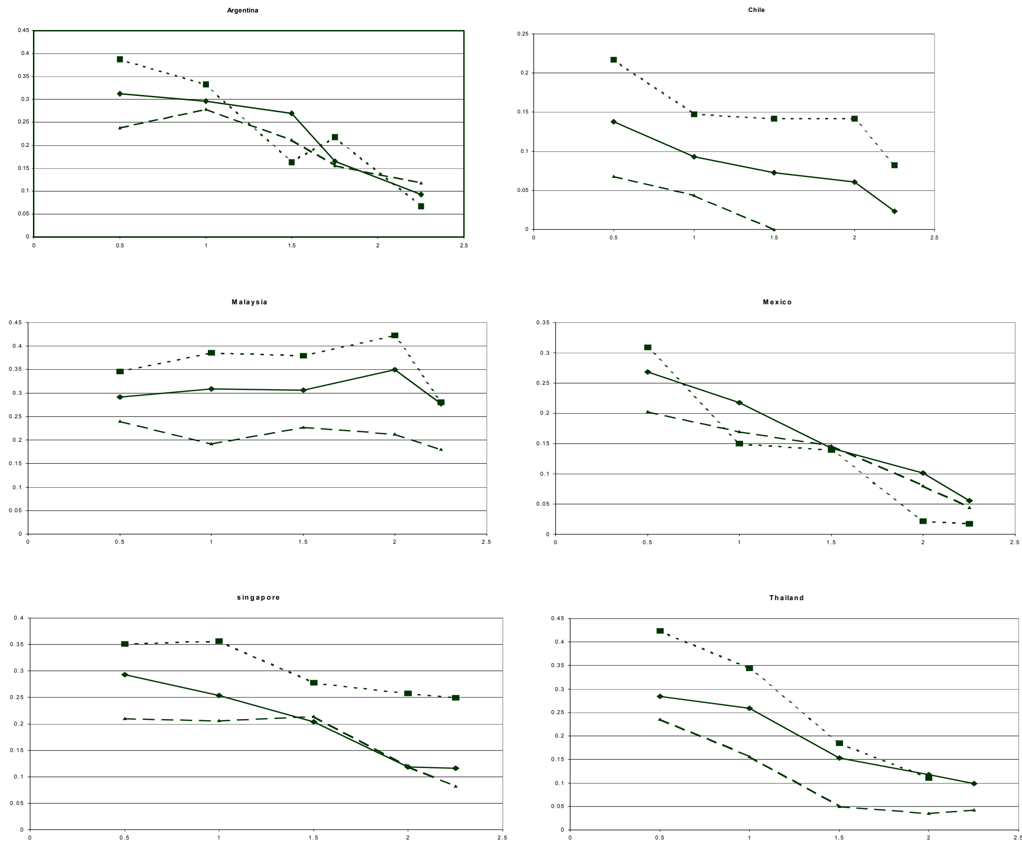

Fig. 1. Estimated Correlations Between Absolute Return and Trading Volume

The solid line is for the correlation between absolute return and volume irrespective of direction of price change, the dotted line is for the extreme correlation between positive return and volume and the dashed lines for correlation between absolute return and trading volume when the return is negative. The vertical axis is the correlation and the horizontal axis is the threshold.