On the relationship between trading volume and stock price volatility in CASE

Article *in* International Journal of Managerial Finance · February 2009

DOI: 10.1108/17439130910932369 · Source: RePEc

2 authors:

Eric Girard
Siena College

Mohammed Omran
Graduate School of Business Arab Academy for Science, Techno…

بورصتي القاهرة والأسكندرية
Cairo & Alexandria Stock Exchanges

CASE

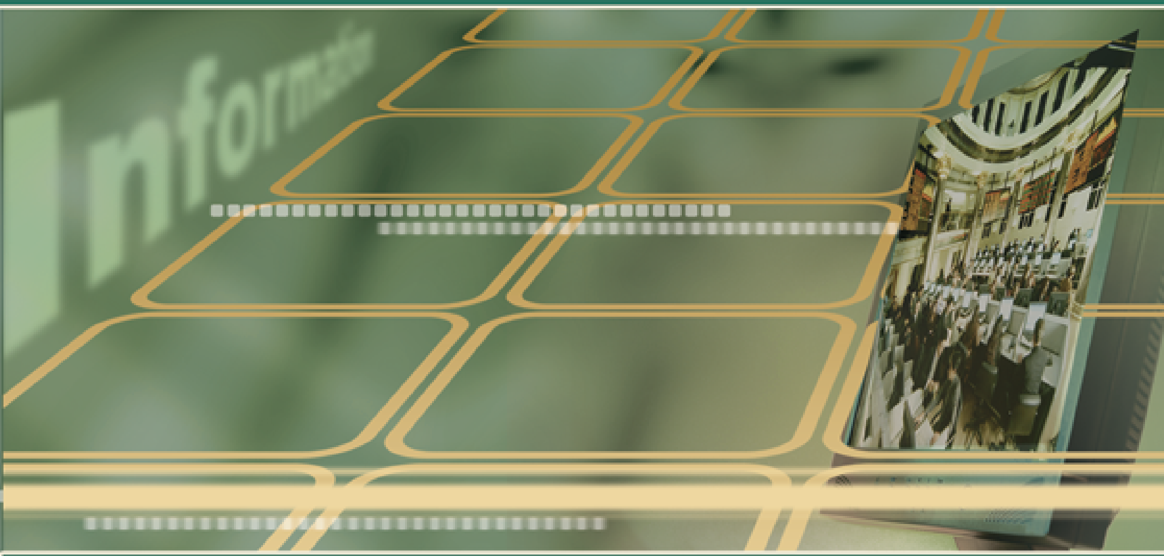
Cairo & Alexandria Stock Exchanges

Occasional Papers

No. 1

On the Relationship Between Trading Volume and Stock Price Volatility in CASE

Mohammed Omran - Eric Girard



2007

CASE Occasional Papers, sponsored by the Cairo and Alexandria Stock Exchanges (CASE), is a series of brief scholarly monographs that represent a sample of the interesting and diverse research taking place in global, as well as regional, economic and finance circles. These monographs are written by members of CASE as well as by other economists, financial economists, practitioners and academicians, and are published by CASE. They are in turn addressed to practitioners, academicians, as well as policy makers, and constitute an important prepublication outlet for disseminating research-in-progress and promoting constructive debate.

The mission of CASE Occasional Papers is to provide a platform for researchers and practitioners, from multiple disciplines, to disseminate information on financial and economic issues. The Occasional Papers is directed at mapping out contemporary changes and developments in the financial markets, and is devoted to publication of original scholarly research in investment and portfolio management, capital markets and institutions, corporate finance and corporate governance.

Papers accepted for publication will be subject to referring by well established figures, regionally and internationally, in the economic and finance fields.

About Authors

Mohammed Omran is the Vice Chairman of Cairo and Alexandria Stock Exchanges and Professor of Finance at the Arab Academy for Science and Technology. Professor Omran was a visiting professor in several research and academic institutions such as University of Plymouth, University of Oklahoma, the World Bank, University of Laval, and Vaasa University. He severed several years as an Economist at both the Arab Monetary Fund in Abu Dhabi and the International Monetary Fund in Washington DC. He was an advisor to the Minister of Investment and an Acting Executive Director to the Egyptian Institute of Directors. Professor Omran had been awarded several research grants and prizes, and he was a Fullbright Scholar and he is a Research Fellow at the Economic Research Forum. He specializes in financial markets, corporate governance, corporate finance and privatization concentrating on the MENA region and he has more than 30 published papers in several international Economics and Finance Journals such as *Journal of Financial Research, Journal of International Financial Markets, Institutions and Money, World Development, International Review of Law and Economics, Multinational Finance Journal, International Review of Financial Analysis, Journal of Investing, and Emerging Market Review.*

Eric Girard is a Hickey Professor of Finance at Siena College, Albany (New York). He has taught a variety of graduate and undergraduate courses in investments, portfolio management, and derivatives. Professor Girard is the president of a Hedge Fund (Arcsin Tactical Trading, LLC) specialized in the trading of commodity futures and the director of Siena College's "Center for Global Financial Studies." Professor Girard serves on the board of the Academy of Financial Services and is the editor of the Review of Business Research. He serves as reviewer for many academic journals and is a frequent presenter in academic conferences in the US. Professor Girard has published over 40 articles and his work have appeared in several leading Finance Journals such as *the Financial Review, the Journal of International Financial Markets, the Review of Futures Markets, the Journal of Multinational Finance, Journal of International Financial Markets, Institutions and Money, and the International Review of Financial Analysis*.

On the Relationship between Trading Volume and Stock Price Volatility in CASE*

Mohammed Omran[a,1] **and Eric Girard**[b,2]

[a] *Cairo and Alexandria Stock Exchange, 4(A) El Sherifein St., Down Town, Postal Code 11513, P.O. Box 358 Mohammed Farid, Cairo Egypt*
Email: mmomran@egyptse.com

[b] *Siena College,School of Business, Finance Department, 515 Loudon Road, Loudonville, NY 12211, USA*
Email: egirard@siena.edu

Abstract

We examine the change in speed of dissemination of order flow information on stock volatility of return in 79 traded companies at the Cairo and Alexandria Stock Exchange (CASE). We find that information size and direction have a negligible effect on conditional volatility and, as a result, we suspect the presence of noise trading and speculative bubbles. We find that the persistence in volatility is not eliminated when lagged or contemporaneous trading volume is incorporated into a GARCH model. We show that, when volume is further broken down into its expected and unexpected components, volatility persistence decreases. This is especially true after May 2001, which marks the beginning of a succession of major stock market reforms. We also find that anticipated information shocks can have a negative impact on the volatility of return, particularly prior to May 2001. The decrease in the negative relationship between expected volume and volatility after May 2001 suggests that trading efficiency and information dissemination have improved. This is an important finding for CASE as it encourages the reform momentum and reinsures foreign investors.

Keywords: TGARCH/GARCH models; volume and volatility; emerging capital markets

JEL Classification no: G1

---

[1]Omran is the Vice Chairman of Cairo and Alexandria Stock Exchange and a Professor of Finance at the Arab Academy for Science and Technology.

[2] Girard is Hickey Chair of Business and Associate Professor of Finance, Siena College, School of Business, Finance Department.

*An earlier version of this paper has been presented in the 2006 Financial Management Association (FMA) Annual Meeting, Utah, USA.

1. Introduction

Our paper examines the relationship between daily information flow, proxied by trading volume, and the volatility of seventy-nine traded companies in the Cairo and Alexandria Stock Exchange (CASE), the only official stock exchange in Egypt.

CASE is an interesting evolving financial market to investigate. Firstly, Egyptian equities are emerging as promising investment vehicles for global investors seeking high returns and value investing. Stock returns averaged 3.34 percent per month from 2001 to 2005[1], price-earnings ratio (PE) practically remained unchanged from 1998 to 2005 (around 10x), and price-to-book value (PBV) decreased from 3.4x from 1998 to 2001 to 2.1x from 2001 to 2005. Secondly, as evidenced by the increase in composite, economic, financial and political risk ratings from 1998 to 2005, financial liberalization and stock market reforms have led to greater transparency and an increase in portfolio investments and foreign direct investments in CASE. CASE grew from a total capitalization of approximately 70 billion Egyptian pounds (20 billion US dollars) in January 1998 to more than 200 billion Egyptian pounds (35 billion US dollars) in December 2004. The average monthly value traded and the average number of shares traded also increased substantially during the same period.

Major stock market developments started in May 2001 when (i) a new automated trading system was implemented, (ii) the Egypt Information Dissemination Company (EGID) was established to disseminate information to the market to increase the level of transparency, and (iii) Egypt gained some international recognition when it

[1] During the same period, MSCI AC WORLD, MSCI EM, MSCI North America, MSCI Europe, and MSCI Japan and Pacific had monthly returns of 0.11%, 1.35%, 0.05%, -0.20%, and 0.36%, respectively.

was included in the Morgan Stanley Capital International Emerging Markets Free Index, East Europe Middle East and Africa Index, and the All Country World Index. Further significant market reforms continued after May 2001.

It is important to understand the effects of a changing trading system on stock price discovery as they may show local policy makers how to design better systems in the future. As Pagano and Roell (1993 and 1996) point out, trading systems differ in the speed of dissemination of order flow information. The change in trading procedures in CASE offers an opportunity to examine how the evolution of a trading system affects the informational content of trading activity and its relationship with conditional volatility of stock returns.

The finance literature on stock market volatility has shown that the time series of market returns is not drawn from a single probability distribution but rather from a mixture of conditional distributions with varying degrees of efficiency in generating the expected returns.[2] The autoregressive 'mixing variable' is considered to be the rate at which information arrives at the market, and explains the presence of GARCH effects in daily stock price movements. Assuming trading volume as a proxy for this 'mixing variable', several studies have provided empirical evidence on this positive linkage. For example, Tauchen and Pitts (1983) suggest that, in liquid or mature markets, where the number of traders is large, the relationship between trading volume and volatility of price change should be positive. Anderson (1996), Gallo and Pacini (2000), Kim and Kon (1994), and Lamoureux and Lastrapes (1990) provide support

[2] The Mixture of Distributions Hypothesis (MDH) was put forward by Clark (1973), Epps and Epps (1976), Tauchen and Pitts (1983) and Lamoureux and Lastrapes (1990).

for this notion in U.S. stock markets while Omran and McKenzie (2000) find evidence of this hypothesis in U.K. stock markets and Zarraga (2003) for the Spanish stock market. With respect to less developed markets, Pyun, Lee and Nam (2000) provide supporting evidence from the Korean stock market, Bohl and Henke (2003) from the Polish stock market, while Lucey (2005) finds mixed evidence for the Mixture of Distributions Hypothesis (MDH) in the Irish stock market.

There are explanations other than MDH for the positive relationship between volume and conditional volatility. For instance, MDH assumes that dissemination of information is symmetrical and all traders view changes in supply and demand simultaneously, restoring equilibrium immediately. Copeland (1976) and Jennings, Starks and Fellingham (1981) argue in favor of asymmetric dissemination of information where informed traders take positions and adjust their portfolios accordingly, resulting in a series of sequential equilibria before a final equilibrium is attained. This sequential dissemination of information from trader to trader is correlated with the number of transactions, and trading volume rises as the rate of arrival of information to the market increases.

Tauchen and Pitts (1983) have also described the possibility of a negative relationship between volume and volatility of stock returns. The authors suggest that both volatility and trading volume are determined by new information flow rates to the market, traders' response to new information arrival, and the number of active traders. As a result, in thinly traded and highly volatile markets, infrequent trading can cause prices to deviate substantially from fundamentals. An increase in the number of traders and speculative trading activity will realign prices with fundamentals, leading to more efficient prices and lower volatility. As a result we may expect to observe that, in thinner markets, variance would decrease with an increase in trades and prices adjusted through speculative trading. Indeed, in many younger markets, transactions are made through a broker, based on negotiations between parties. If the official price reporting mechanism is weak, brokers gather and process information from market sources regarding transactions that have taken place in that market; this information is then passed on to a trader (buyer or seller). As trading volume in the market increases, one would expect more information to be available in the market which, in turn, would improve market transparency and reduce uncertainty and market volatility. In other words, when market breadth and depth are smaller, informed traders can drive bid-ask spreads high. As is the case in emerging markets with their embryonic insider trading laws, informed traders can lead to considerable losses on the part of market makers. So, in markets where a cluster of traders might have superior information relative to the specialists or market makers, the incentive to market making is reduced and will lead to high spreads to avoid losing money to informed traders. Because there is a well established literature on the inverse relationship between volume and spreads, it makes sense that without the arrival of new information (expected volume) to all market traders, trading is going to decrease and large shifts in prices might occur at the same time (through speculation on the part of informed traders and the resulting increase of spreads on the part of market makers). Thus, in less efficient trading systems, trading volume is expected to drop (but prices can still shift dramatically), implying a negative relationship between volume and volatility of returns.

In sum, if information flow, proxied by the volume traded, is separated into an expected and an unexpected component[3], there should be, theoretically, a positive relationship between unexpected volume and volatility regardless of the efficiency of the trading system. However, in less efficient trading systems, the relationship between expected volume and volatility could be negative.

Our paper investigates the sign of the relationship between volatility and volume before and after May 2001. A change in relationship between volume and volatility will indicate the extent of the development of CASE and the efficiency of price discovery in its trading system. Interestingly, most empirical studies on the relationship between trading volume and volatility of returns have been conducted on developed financial markets and, more recently, on a few established emerging markets in Asia, Eastern Europe, and Latin America. Furthermore, the majority of these emerging market studies uses only aggregate (index) data and very few of them have concentrated on individual common stocks. Thus, focusing on the firm level, our study contributes to a nascent literature on price discovery in emerging capital markets.

Using daily return and volume data for a sample of seventy-nine companies, we show that, from January 1998 to November 2005, the size of a volatility shock is generally much more important than the leverage effect. We attribute the observation to the presence of noise trading and speculative bubbles. We also find that the inclusion of total volume traded does alter the persistence of GARCH effects. However, when the

[3] Arago and Nieto (2005) re-examine the results of Lamoureux and Lastrapes (1990) and argue that it is more appropriate to split trading volume into two components: a component considered "normal" by the market and hence called *expected* volume and a component motivated by the unpredictable flow of information to the market, called *unexpected* volume. Applying this logic, Arago and Nieto find that the effects of the unexpected trading volume on volatility are much greater than those of total volume.

volume is split up into expected and unexpected volume, GARCH effects are reduced as put forward by the MDH. Furthermore, we find a negative relationship between expected volume and volatility, which can only be explained by the Sequential Information Hypothesis (SIH). This negative relationship between volume and volatility also suggests that the official price reporting mechanism is weak and inefficient. Interestingly, the observed noise trading and/or speculative bubbles, and the negative relationship between volume and volatility are considerably reduced after 2001. We conclude that if the change in local policies to design better systems is starting to crystallize, more reforms are warranted if CASE wants to attract more foreign investors.

The rest of the paper is structured as follows: section 2 describes the data. Section 3 develops the models, while section 4 presents the results. Section 5 summarizes and concludes the paper.

2. Data

CASE is the only registered securities exchange in Egypt where member firms or brokers buy and sell common stocks, preferred stocks, government bonds, corporate bonds, and close-ended mutual funds electronically. The exchange is a governmental entity regulated by the Capital Market Authority (CMA). There are no restrictions placed on foreign ownership, capital gain can be repatriated freely, and dividends and capital gains are not taxable. The exchange operates from 9:45 a.m. to 3:30 p.m.—i.e., an “Over the Counter Market” trading session starts at 9:45 a.m. and ends at 11:15 a.m., a “Primary Dealers” trading session starts at 10:30 a.m. and ends at 2:30 p.m., and the “Listed Securities” trading session starts at 11:30 a.m. and ends at 3:30 p.m.

In 2001, Egypt was included in several MSCI indices (MSCI EM Free, EMEA, and AC WORLD). Some of this international recognition came with CASE's major reforms which started in May 2001—i.e., the exchange implemented a new automated trading system, and the EGID was created to disseminate information and increase the level of transparency. Further significant efforts to improve the exchange's transparency and efficiency continued from May 2001 to 2005. For instance, in 2002, CASE removed the 5 percent ceiling on daily prices applicable to the most active stocks and divided the OTC market into orders and dealers markets. In 2004 and 2005, CASE started cooperation agreements with Abu Dhabi Securities Market, Muscat Stock Exchange, Bahrain Stock Exchange, Casablanca Stock exchange, and Khartoum Stock Exchange. In April 2005, CASE implemented a new automated linking system. Same day trading became allowed by October 2005, and open end certificates on the CASE 30 Index were listed and traded on international markets.

To investigate the return volatility and volume relationship, we consider daily returns and the trading volume for seventy-nine stocks listed at CASE for the period January 1st, 1998 to May 23rd, 2005. Return and volume data are provided directly by CASE. To further investigate the effect of stock market reforms on trading efficiency, the sample is broken down into two sub-periods around May 2001—i.e., January 1, 1998 to May, 31, 2001 and June 1, 2001 to May 23, 2005. The time series contain some missing values, so our empirical scrutiny relies on about 1,687 observations for each of the 79 shares—i.e., approximately 775 observations for the first period and 912 for the second.

Table 1

Descriptive statistics: Country, market and sample (January 1998 to May 2001)

Risk ratings and economic measures are obtained from the ICRG database (composite risk=[economic risk + financial risk + political risk]/2). Market statistics are obtained from the Emerging Market Data Base. Q(12) and $Q^2(12)$ are the Ljung-Box (1978) Q statistics on the first 12 lags of the sample autocorrelation function of returns and the squared demeaned returns, distributed as $\chi^2(12)$. The 5% critical value for this test is 21.03.ADF is the Augmented Dickey Fuller test with lag length chosen using AIC (under the null hypothesis, the series is non-stationary and the critical value for the 5% level is around -2.9, depending on the lag chosen). KPSS is the Kwiatkowski, Phillips, Schmidt, and Shin test with lag length chosen using Newey-West bandwidth tests for the null hypothesis of stationary (under the null hypothesis, the series is stationary and the critical value for the 5% level is 0.463).

Panel A: January 1998 to May 2001					
Country statistics	Average	Median	Standard deviation	Maximum	Minimum
Composite risk rating	69.69				
Economic risk rating	36.42				
Financial risk rating	38.22				
Political risk rating	64.72				
Debt service ratio	9.02%				
GDP per head of population	1370.32				
Inflation	3.78%				
Real GDP growth	5.32%				
Total foreign debt as % GDP	35.57%				
Exchange rate	3.52				
Market statistics					
No. of companies	929	1,004	151	1,084	650
Market cap (Egyptian pound)	99,186.29	95,798.77	21,044.79	138,893.80	68,810.00
Market cap (US$)	28,156.81	27,501.82	5,740.67	40,555.30	20,164.10
Value traded (Egyptian pound)	2,251.87	2,035.44	1,255.45	6,435.89	686.97
Value traded (US$)	646.53	576.71	370.18	1,879.20	178.20
Shares traded	65.42	62.30	35.65	192.44	13.83
Days traded	21	21	2	23	16
Dividend yield	6.02	6.13	0.75	7.43	4.12
P/E	9.65	9.36	2.61	15.86	6.16
P/BV	3.40	3.29	0.94	5.42	1.55
Sample statistics					
Number of companies	79				
Percentage of total market capitalization	79%				
Percentage of volume traded to total volume traded	93%				
Return (Egyptian pound—monthly)	-1.56%	-1.76%	8.33%	19.72%	-14.01%
Return—Q12	28.33	28.32	4.84	51.67	22.91
Return—$Q^2(12)$	30.99	31.72	5.99	60.81	30.2
Return—ADF	-12.22	-12.53	-3.46	-5.38	-22.33
Return—KPSS	0.060	0.061	0.021	0.230	0.011
Volume—Q12	41.91	40.184	8.36	62.858	32.57
Volume—$Q^2(12)$	50.94	48.03	12.76	75.77	35.85
Volume—ADF	-15.66	-14.00	-2.82	-5.11	-21.08
Volume—KPSS	0.102	0.061	0.021	0.230	0.041

Table 1: continued

Panel B: June 2001 to May 2005					
Country statistics	Average	Median	Standard deviation	Maximum	Minimum
Composite risk rating	71.28				
Economic risk rating	37.65				
Financial risk rating	39.05				
Political risk rating	65.85				
Debt service ratio	11.06%				
GDP per head of population	1299.30				
Inflation	3.90%				
Real GDP growth	4.51%				
Total foreign debt as % GDP	33.09%				
Exchange rate	5.35				
Market statistics					
No. of companies	1048	1105	129	1153	787
Market cap (Egyptian pound)	140,062.68	129,631.40	30,115.56	204,477.03	101,072.72
Market cap (US$)	26,040.30	25,807.19	2,481.72	32,795.03	21,818.18
Value traded (Egyptian pound)	3,616.08	3,450.61	926.32	7,035.54	1,466.64
Value traded (US$)	675.72	677.44	148.30	866.40	200.73
Shares traded	99.97	96.51	44.78	211.39	39.12
Days traded	21	21	2	23	16
Dividend yield	6.16	6.67	2.34	9.98	1.70
P/E	11.43	10.02	4.84	23.93	5.85
P/BV	2.16	1.98	0.70	4.08	1.22
Sample statistics					
Number of companies	79				
Percentage of total market capitalization	78%				
Percentage of volume traded to total volume traded	95%				
Return (Egyptian pound—monthly)	3.34%	2.22%	8.08%	18.35%	-13.07%
Return--Q12	30.01	31.22	5.29	53.97	24.88
Return--Q^2(12)	31.22	31.92	5.39	59.02	30.88
Return—ADF	-13.86	-13.27	-3.99	-7.09	-28.28
Return—KPSS	0.051	0.062	0.024	0.200	0.026
Volume—Q12	40.17	38.91	7.32	60.003	31.09
Volume—Q^2(12)	51.23	51.22	10.06	71.52	38.44
Volume—ADF	-14.66	-14.83	-3.12	-6.81	-24.39
Volume—KPSS	0.090	0.085	0.020	0.190	0.032

We contrast country, market and sample statistics for the two periods of study in Table 1 (January 1998 to May 2001 in Panel A and June 2001 to May 2005 in Panel B). As seen from Table 1, the GDP growth rate marginally decreased from the 1998-2001 period to the 2001-2005 period (5.32 percent to 4.51 percent). In fact, Egypt's economy was certainly hurt by the September 11, 2001 terrorist attacks on the United States, the lower oil export revenues and reduced tourist revenues hurting the country's real GDP growth. Since 2001, Egypt's economy has only been growing slowly, in part due to regional tensions and a world economic slowdown, but steadily with real GDP growth of

3.2 percent in 2002, 3.1 percent in 2003, 4.2 percent in 2004, and an estimated 5.3 percent in 2005. The later figures tend to be similar to those for the period 1998-2001. While inflation has slightly increased and the Egyptian pound has depreciated vis-à-vis the US dollar from one period to another, international liquidity measured by the debt service ratio and foreign debt as a percentage of GDP have remained, to a large extent, constant. As a result, the average composite, political, financial and economic country risk ratings have improved from one period to another. In fact, financial liberalization and stock market reforms have led to greater transparency and an increase in portfolio investments and foreign direct investments in CASE.

This is shown in the "market statistics" sections of Table 1. CASE has grown from a total capitalization of approximately 100 billion Egyptian pounds to 140 billion Egyptian pounds, the median number of companies traded has increased from 1,004 to 1,105, the average monthly value traded has risen from 2.2 to 3.6 million Egyptian pounds, and the average number of shares traded has increased from 65 to 100 thousand per month from 1998-2001 to 2001-2005. In addition, stock returns have averaged an excess of 4.9 percent per month from one period to the other. Finally, PE (around 10x) and dividend yield (around 6 percent) have practically remained unchanged from 1998 to 2005, and PBV has decreased from 3.4x to 2.1x.

To assess the distributional properties of the daily index returns and volume, various descriptive statistics are reported in the "sample statistics" sections in Table 1. The daily stock returns are calculated as the logarithmic first difference of the stock price for each of the 79 stocks used in our sample, which constitute an average of 79 percent of market capitalization and 93 percent of the total volume traded in period one, and 78 percent of the total market capitalization and 95 percent of the total volume traded in period two. We also take the natural log of total volume traded for each stock. Unit root is absent for all 79 stock returns and volume series as evidenced by strongly significant ADF and non-significant KPSS test results.[4] Therefore, stock returns and volume series follow a stationary process.

The null hypothesis for normality of the return series is strongly rejected (Jarque-Bera tests are available upon request). Thus, stock return series are skewed and highly leptokurtic as compared to the normal distribution. The Ljung-Box Q(12) statistic for 12th order autocorrelations are statistically significant, while the Ljung-Box test statistic $Q^2(12)$ (for the demeaned squared data) indicates the presence of conditional heteroskedasticity. These findings suggest the use of GARCH modeling (Bollerslev, 1986), which allows for conditional variance in the returns. Also, the General Error Density (GED) distribution may be appropriate because of significant excess kurtosis and skewness (Arago and Nieto, 2005).

The volume series display significant autocorrelations, which remain large for 12 lag periods. Significant autocorrelations in the volume series have also been found in many earlier studies (see, for example, Gallant, Rossi and Tauchen, 1992; and Campbell, Grossman and Wang, 1993). This suggests that trading activity is autocorrelated and this will manifest itself in GARCH effects.

[4]The Augmented Dickey Fuller (ADF) tests for the null hypothesis of the presence of unit roots while the Kwiatkowski, Phillips, Schmidt, and Shin (KPSS) tests for the null hypothesis of the absence of unit roots. The lag length is chosen using the Akaike Information Criterion (AIC) and a trend component was found to be statistically insignificant.

3. Methodology

The use of a GARCH specification for investigating the volume-volatility relationship is suggested by Lamoureux and Lastrapes (1990). GARCH effects in daily stock returns are expected to reflect the serial correlation of the rate of daily information arrival, i.e., the trading volume.[5] Under the MDH, the variance of daily price increments is heteroskedastic and positively related to the rate of daily information arrival. Accordingly, the conditional variance of the daily price change is considered to be an increasing function of the rate at which new information enters the market. Foster and Viswanathan (1995) show a positive conditional correlation between volume and variance of price changes that depends on the trading history. Using a multi-period rational expectations model of stock trading, in which investors have differential information concerning the underlying value of the stock, He and Wang (1995) show that when all information is public, clustering in trading implies that arrival of new information is serially correlated. Thus, a positive relationship is expected between trading volume and the conditional variance of the daily price change.

Following Glosten, Jagannathan and Runkle (1993) and Zakoian (1994), we use an asymmetric GARCH method known as Threshold GARCH (TGARCH) to model stock return volatility. The model captures asymmetric characteristics such as the leverage effect, in which negative shocks have a greater impact on conditional volatility than positive shocks of the same magnitude. The TGARCH specification also captures

---

[5] Because new information is unobservable, trading volume or trading activity is often used as a proxy for the rate of daily information arrival. In fact, Berry and Howe (1994) find a positive relationship between public information, as measured by the number of news releases by Reuters News Service, and trading volume.

volatility clustering, i.e., when large (small) price changes tend to follow large (small) price changes. Further, the TGARCH model allows accounting for leptokurtosis and skewness, both of which indicate departure from normality of the data, and both of which are regarded as well known characteristics of daily stock returns.

The Threshold GARCH (1,1) is described as follows:

$$\begin{aligned} R_t &= \alpha + \varepsilon_t \\ \sigma_t^2 &= \gamma + \omega\varepsilon_{t-1}^2 + \eta\varepsilon_{t-1}^2 d_{t-1} + \psi\sigma_{t-1}^2 \end{aligned} \tag{1}$$

where R_t is the realized return of the stock, expressed as a random walk process with an error term of mean zero and conditional variance σ^2_t. The conditional variance σ^2_t is specified as a function of the mean volatility ?, ε_{t-1}^2, which is the lag of the squared residual from the mean equation (the ARCH term) and which provides news about volatility clustering; σ^2_{t-1}, which is last period's forecast variance (the GARCH term) and finally, the term for capturing the asymmetry, $\varepsilon_{t-1}^2 d_{t-1}$. The parameter $d_t = 1$ if $\varepsilon_t < 0$, and 0 otherwise, so that good news ($\varepsilon_t > 0$) and bad news ($\varepsilon_t < 0$) are allowed to have different impacts on the conditional variance; good news has an impact of ? , while bad news has an impact of ? + ?. Accordingly, if ? >0, a leverage effect exists: bad news has a greater impact than good news.

Unlike the linear GARCH model, there are no restrictions on the parameters ? , ? and ? to ensure non-negativity of the conditional variance. Persistence of volatility is measured by ? — if ? equals 1, current shocks persist indefinitely in conditioning the future variance. It also represents the change in the response function of shocks to volatility per period. A value greater than one implies that the response function of volatility is explosive and a value less than unity implies that the response to volatility shocks declines over time.

Due to the well-known non-normality of the disturbance term (ε_t), the distribution is better approximated by the General Error Density (GED) distribution. Under the GED assumption, the log of the likelihood function for t observations is represented by $L(\Theta) = \sum_{t=1}^{T} I(\Theta)$, where Θ represents the set of parameters of the average and conditional variance to be estimated with

$$I(\Theta)_t = \ln(\frac{\nu}{\lambda}) - 0.5\left|\frac{\varepsilon_t}{\sigma_t \lambda}\right|^{\nu} - (1+\frac{1}{\nu})\ln(2) - \ln(\Gamma(\frac{1}{\nu})) - 0.5\ln(\sigma_t^2) \qquad (2)$$

where $\lambda = \exp((-1/\nu)\ln(2) + 0.5\ln(\Gamma(1/\nu) - 0.5\ln(\Gamma(3/\nu))))$, and ν is a tail-thickness parameter. When ν is equal to 2, ε_t is normally distributed, while ν less than 2 implies a fat-tailed distribution for ε_t.

In the next model, we extend the TGARCH specification to investigate the volume-volatility relationship as suggested by Lamoureux and Lastrapes (1990). Under MDH, the variance of daily price increments is heteroskedastic and positively related to the rate of daily information arrival. Accordingly, the unexpected price change in a day, ε_t, will be the sum of a number of intra-day price changes. GARCH effects may be explained as a manifestation of time dependence in the rate of evolution of intra-day price changes driven by new information arrival. Following earlier studies, we use daily trading volume as a proxy for the unobservable new information arrival.

Assuming that the daily number of information arrivals is serially correlated, equation (1) can be modified as follows:

$$R_t = \alpha + \varepsilon_t$$
$$\sigma_t^2 = \gamma + \omega\varepsilon_{t-1}^2 + \eta\varepsilon_{t-1}^2 d_{t-1} + \psi\sigma_{t-1}^2 + \zeta_0 \ln V_{t-1} \tag{3}$$

where V_{t-1} is the trading volume. We use lagged volume for representing contemporaneous volume to avoid the problem of simultaneity since lagged values of endogenous variables are classified as predetermined (Harvey, 1989).[6] As in the case of equation 1, equation 3 is also estimated under the GED distribution assumption.

According to MDH, ζ_0 should be >0 and significant, and GARCH effects (ψ) should disappear if volume is serially correlated and is a good proxy for the flow of information to the market. In the case where trading activity does not fully capture the rate of information arrival and other exogenous directing variables affect the variance equation, GARCH effects, although reduced, will remain. We hypothesize that the more efficient the trading system, the higher will be the informational content of trading volume, reflecting a higher level of transparency of transactions.

In the last model, we examine whether surprises in trading activity convey more information and thus have a larger effect on return volatility than expected activity. As mentioned earlier, trading volume, being serially correlated, is highly forecastable. Accordingly, we apply ARMA(p,q) processes to partition activity into expected and unexpected components as follows:

$$EV_t = \sum_{i=1}^{p} \beta_i V_{t-i} + \sum_{j=1}^{q} \delta_j \varepsilon_{t-j} + Dum_t + \varepsilon_t \tag{4}$$

and

$$UV_t = V_t - EV_t \tag{5}$$

[6] In the same vein, Hiemstra and Jones (1994) have found bidirectional non-linear Granger causality between stock returns and trading activity and provide further evidence of the importance of the informational content of lagged trading activity.

where V_t is the observed volume at time t; EV_t is the expected volume at time t; UV_t is the unexpected volume at time t, and 'Dum' is a dummy variable that controls for the day of the week. As in Arago and Nieto (2005), for the first forecast, we use data for total daily volume corresponding to the first six months. From then on, the ARMA models are estimated using a moving window which drops the first day of the series and introduces the following day. Consequently, the ARMA model always uses information from the immediately preceding six months. For each stock, we have a series of daily volume, expected volume and unexpected volume. In order to examine the impact of unexpected volume of information, we investigate an expanded version of equation 3:

$$\begin{gathered} R_t = \alpha + \varepsilon_t \\ \sigma_t^2 = \gamma + \omega\varepsilon_{t-1}^2 + \eta\varepsilon_{t-1}^2 d_{t-1} + \psi\sigma_{t-1}^2 + \zeta_1 \ln EV_{t-1} + \zeta_2 \ln UV_{t-1} \end{gathered} \tag{6}$$

where EV_{t-1} and UV_{t-1} represent the expected and unexpected components of volume at t-1, respectively. As for equations 1 and 3, we use lagged variables as proxies for contemporaneous volume to avoid the problem of simultaneity and equation 6 is also estimated under the GED distribution assumption.

4. Results

Tables 2-4 report results of selected parameters of the estimated TGARCH(1,1) model[7] for stock returns—i.e., the model without the inclusion of volume in the

[7] As we optimize a GED log likelihood, we do not use the Quasi-Maximum Likelihood procedure of Bollerslev and Wooldridge (1992) to estimate the standard errors. The iterative procedure used is based upon the method of Berndt-Hall-Hall-Hausman (BHHH) to maximize the log-likelihood function.

conditional variance in Table 2, with the total volume traded in Table 3, and with expected and unexpected trading volume in Table 4. For each table, results are broken down into period one and period two (before and after May 2001). Since it is pointless to present all estimated 474 TGARCH equations (79 stocks x 2 periods x 3 models), we report our findings in terms of descriptive statistics on the coefficients in the variance equation of each model—i.e., average, median, standard deviation, maximum and minimum coefficient values as well as the percentage of significant coefficients, positive coefficients and significant coefficients that are positive.

Before analyzing the results, it should be mentioned that we find strong evidence that the daily index returns can be characterized by a TGARCH(1,1) model with GED distributed residuals. Since v is lower than 2 during each period and in each model, the criterion for using the GED distribution is satisfied. Diagnostic tests on the estimated standardized residuals indicate that the TGARCH model is well specified.[8] Indeed, for each period and each model, Q(12), Q^2 (12), and Engle and Ng (1993b), joint test of sign and size are insignificant.

---

[8] Estimated standardized residuals are defined as $z_t = \hat{\varepsilon}_t / \hat{\sigma}_t$, where $\hat{\varepsilon}_t$ is the residual from the TGARCH model and $\hat{\sigma}_t$ is the estimated conditional standard deviation.

Table 2
Volatility persistence with volume traded

$$\begin{aligned} R_t &= \alpha + \varepsilon_t \\ \sigma_t^2 &= \gamma + \omega\varepsilon_{t-1}^2 + \eta\varepsilon_{t-1}^2 d_{t-1} + \psi\sigma_{t-1}^2 \end{aligned} \qquad (1)$$

$$\begin{aligned} R_t &= \alpha + \varepsilon_t \\ \sigma_t^2 &= \gamma + \omega\varepsilon_{t-1}^2 + \eta\varepsilon_{t-1}^2 d_{t-1} + \psi\sigma_{t-1}^2 + \zeta_0 \ln V_{t-1} \end{aligned} \qquad (3)$$

$$\begin{aligned} R_t &= \alpha + \varepsilon_t \\ \sigma_t^2 &= \gamma + \omega\varepsilon_{t-1}^2 + \eta\varepsilon_{t-1}^2 d_{t-1} + \psi\sigma_{t-1}^2 + \zeta_1 \ln EV_{t-1} + \zeta_2 \ln UV_{t-1} \end{aligned} \qquad (6)$$

where ε_t follows General Error Density (GED) distribution—i.e., the log of the likelihood function for t observations is represented by $L(\Theta) = \sum_{t=1}^{T} I(\Theta)$, where Θ represents the set of parameters of the average and conditional variance to be estimated with

$$I(\Theta)_t = \ln(\frac{\nu}{\lambda}) - 0.5\left|\frac{\varepsilon_t}{\sigma_t\lambda}\right|^{\nu} - (1+\frac{1}{\nu})\ln(2) - \ln(\Gamma(\frac{1}{\nu})) - 0.5\ln(\sigma_t^2)$$

with $\lambda = \exp((-1/\nu)\ln(2) + 0.5\ln(\Gamma(1/\nu) - 0.5\ln(\Gamma(3/\nu))))$, and ν is a tail-thickness parameter. Also, $UV_t = V_t - EV_t$ where $EV_t = \sum_{i=1}^{p}\beta_i V_{t-i} + \sum_{j=1}^{q}\delta_j\varepsilon_{t-j} + Dum_t + \varepsilon_t$. Q(12) and $Q^2(12)$ are the Ljung-Box (1978) Q statistics on the first 12 lags of the sample autocorrelation function of standardized residuals and the squared standardized residuals, distributed as $\chi^2(12)$ with 5% critical value of 21.03. EN test is the joint test of sign and size of Engle and Ng (1993b. It consists in testing the null hypothesis of H_0: $b_1 = b_2 = b_3 = 0$ in $u_t^2 = a + b_1 S_{t-1}^{-} + b_2 S_{t-1}^{-}\varepsilon_{t-1} + b_3 S_{t-1}^{+}\varepsilon_{t-1} + e_t$, where u_t^2 are the squared standardized residuals, ε^2_t/h_t, S_{t-1}^{-} is a dummy variable taking the value of one when ε_{t-1} is negative and zero otherwise, and $S_{t-1}^{+} = 1 - S_{t-1}^{-}$. This is an F test with 95% critical value of 2.60. 'LL' is the log likelihood value. ***, **, * indicate significance at the 1%, 5%, and 10% level, respectively.

Period: 01/01/98 to 05/31/01	ω	η	ψ	ζ_0 x 10^{-5}	ζ_1 x 10^{-5}	ζ_2 x 10^{-5}	ν	LL	Q (12)	Q^2 (12)	EN
Average	0.2451	0.0828	0.6255				1.0926	1467.6230	16.966	4.807	1.2340
Median	0.2490	0.0519	0.6324				1.0803	1478.9811	18.901	5.665	1.2210
Standard dev	0.1323	0.2255	0.1088				0.3683	627.0578	3.723	2.194	0.2222
Max	0.4855	0.3865	0.9637				1.4623	2170.9192	20.048	9.633	2.2399
Min	0.0722	-0.2438	0.4005				0.5034	992.3226	4.379	1.268	0.3218
% of coefficients that are significant	69%	21%	100%				100%		0%	0%	0%
% of coefficients that are positive	100%	62%	100%				100%	100%	100%	100%	100%
% of significant coefficients that are positive	100%	100%	100%				100%		0%	0%	0%

Period: 06/01/01 to 05/23/05	ω	η	ψ	ζ_0 x 10^{-5}	ζ_1 x 10^{-5}	ζ_2 x 10^{-5}	ν	LL	Q (12)	Q^2 (12)	EN
Average	0.2090	0.1284	0.7839				1.1824	1656.7892	13.590	6.299	1.1985
Median	0.2079	0.1098	0.8345				1.1299	1747.7575	16.774	4.612	1.0446
Standard dev	0.1054	0.1822	0.0985				0.4350	872.7131	3.006	1.223	0.3988
Max	0.3507	0.4436	0.9793				1.9431	3037.5047	20.549	9.853	2.0070
Min	0.0755	-0.0971	0.6473				0.1477	1044.6900	4.880	1.239	0.1127
% of coefficients that are significant	72%	27%	100%				100%		0%	0%	0%
% of coefficients that are positive	100%	86%	100%				100%	100%	100%	100%	100%
% of significant coefficients that are positive	100%	100%	100%				100%		0%	0%	0%

As shown in Table 2, the volatility persistence, measured by ψ, is generally quite low during the first period — it ranges from 0.4005 to 0.9637 and averages 0.6255 — but it is less than one, indicating stationary persistence. It is higher during the second period — it ranges from 0.6473 to 0.9793 and averages 0.7839 — indicating that volatility persists more in the second period as compared to the first period. However, stocks are prone to larger size shocks or volatility clustering during the first period—?

ranges between 0.0722 and 0.4855 and averages 0.2451; 69 percent of these values are significant and all significant values are positive, as compared to the second period—? ranges between 0.0755 and 0.3507 and averages 0.2090; 72 percent of these values are significant and all significant values are positive. Asymmetry, measured by η is usually positive and slightly more significant during the second period as compared to the first period (all 27 percent significant η's are positive during period two and all 21 percent significant η's are positive during period one). During both periods, η is much lower than ?, indicating that the size of the news is more important than its direction. As suggested by Shiller (1989), speculative bubbles resulting from non-economic factors might be at the origin of this observation.

Table 3
Volatility persistence with total trading volume

Period: 01/01/98 to 05/31/01	ω	η	ψ	ζ_0 x 10^{-5}	ζ_1 x 10^{-5}	ζ_2 x 10^{-5}	ν	LL	Q (12)	Q^2 (12)	EN
Average	0.2489	0.0563	0.6176	0.1599			1.2029	1612.1906	14.895	4.472	1.0332
Median	0.2564	0.0512	0.6277	0.1218			1.0146	1564.8366	13.845	4.480	0.9981
Standard dev	0.1381	0.2093	0.1407	0.7524			0.3844	610.0673	3.535	1.608	0.2234
Max	0.4503	0.3947	0.9538	2.7558			1.8160	2317.3567	19.148	8.995	2.2398
Min	0.0736	-0.3638	0.3954	-1.0240			0.6976	1006.7118	4.640	1.954	0.1887
% of coefficients that are significant	62%	17%	100%	57%			100%		0%	0%	0%
% of coefficients that are positive	100%	77%	100%	69%			100%	100%	100%	100%	100%
% of significant coefficients that are positive	100%	100%	100%	87%			100%		0%	0%	0%

Period: 06/01/01 to 05/23/05	ω	η	ψ	ζ_0 x 10^{-5}	ζ_1 x 10^{-5}	ζ_2 x 10^{-5}	ν	LL	Q (12)	Q^2 (12)	EN
Average	0.2088	0.1370	0.7580	0.5408			1.2439	1770.1329	15.885	6.051	1.3211
Median	0.2016	0.1159	0.7641	0.4133			1.1939	1810.2136	15.380	5.760	1.3591
Standard dev	0.1185	0.1960	0.0993	0.5577			0.3935	870.8808	2.163	2.127	0.3002
Max	0.3467	0.4425	0.9520	1.1986			1.9136	3241.2277	18.416	12.576	2.4100
Min	0.0796	-0.0728	0.5899	-0.2829			0.7268	1220.7236	2.603	2.448	0.3888
% of coefficients that are significant	80%	30%	100%	98%			100%		0%	0%	0%
% of coefficients that are positive	100%	86%	100%	93%			100%	100%	100%	100%	100%
% of significant coefficients that are positive	100%	100%	100%	99%			100%		0%	0%	0%

The results for when trading volume is included in the conditional variance specification are reported in Table 3. Results pertaining to ? and η are the same as for Tabe 2. Furthermore, volatility persistence (ψ) is marginally reduced as compared to when volume is excluded from the variance equation for both periods (it averages 0.6176 with total volume as compared to 0.6255 without in period one and 0.7580 with total volume as compared to 0.7839 without in period two). Thus, the inclusion of total trading volume in conditional volatility does not reduce volatility persistence. This finding of muted support for the MDH in capital markets is consistent with previous studies. Indeed, Chen, Firth and Rui (2001) analyze nine of the world's largest developed stock markets and find that volatility persists even after they incorporate contemporaneous and lagged volume effects.[9] In the case of emerging markets, Bohl and Henke (2003) find that while volatility persistence disappears in a majority of 20 Polish stocks when trading volume is included, it is not the case for one-fifth of their sample.

From 1998 to 2001, the coefficient of volume (ζ_0) averages 0.1599 10^{-5} and ranges from -1.0240 10^{-5} to 2.7558 10^{-5}, it is positive for 69 percent of the stocks and significant for 57 percent of the observations (87 percent of the significant coefficients are positive). In period two, ζ_0 averages 0.5408 10^{-5} and ranges from -0.2829 10^{-5} to 1.1986 10^{-5}, it is positive for 93 percent of the stocks and significant for 98 percent of the observations (99 percent of the significant coefficients are positive). Thus, there are

[9] Sharma, Mougoue and Kamath (1996) contend that while the volatility of individual assets is influenced by both firm-specific and market-wide factors, indices are affected primarily by market factors and hence, inclusion of volume may not reduce the GARCH effects in this case.

many more negative ζ_0 's during the first period as compared to the second period. The negative relationship between volume and volatility in the market has been described by Tauchen and Pitts (1983). The authors suggest that both volatility and trading volume are determined by new information flow rates to the market, traders' response to new information arrivals and the number of active traders. As a result, in thinly traded and highly volatile emerging markets, infrequent trading can cause prices to deviate substantially from fundamentals. An increase in the number of traders and speculative trading activity will realign prices with fundamentals, leading to more efficient prices and lower volatility.

It is more likely that in CASE, dissemination of information is asymmetric and initially only well informed traders take positions. As information is sequentially transmitted from trader to trader, less informed traders also take positions. After a series of intermediate transient equilibria, a final equilibrium is reached resulting in lower volatility. These results can be explained by the SIH of Copeland (1976) and Jennings, Starks and Fellingham (1981).

Finally, we investigate whether the impact of unexpected trading activity on stock return volatility is greater than expected activity. We examine whether the expected and unexpected components of volume have different effects on the conditional variance by partitioning trading activity using an ARMA(p,q) process specific to each index series and selected with the AIC criteria (results are available upon request). The fitted values of these models are used as the expected component while the forecast errors are used as the unexpected component, as explained earlier in the methodology section.

Table 4
Volatility persistence with expected and unexpected trading volume

Period: 01/01/98 to 05/31/01	ω	η	ψ	ζ_0 x 10^{-5}	ζ_1 x 10^{-5}	ζ_2 x 10^{-5}	ν	LL	Q (12)	Q^2 (12)	EN
Average	0.2471	0.0321	0.5183		-0.3916	0.7290	1.3900	1718.3721	14.415	4.927	1.64122
Median	0.2478	0.0592	0.4993		-0.2876	0.4236	1.4005	1890.8535	13.789	4.480	1.34536
Standard dev	0.1369	0.1263	0.0746		1.0038	0.3466	0.3547	800.1425	3.848	1.705	0.2988
Max	0.4201	0.3273	0.8218		1.9767	3.5701	1.9445	2528.1681	19.481	13.677	2.543
Min	0.0731	-0.3927	0.2667		-1.2001	0.2698	0.7689	1190.8082	5.252	0.749	0.7771
% of coefficients that are significant	63%	15%	100%		55%	63%	100%		0%	0%	0%
% of coefficients that are positive	100%	81%	100%		27%	100%	100%	100%	100%	100%	100%
% of significant coefficients that are positive	100%	100%	100%		17%	100%	100%		0%	0%	0%
Period: 06/01/01 to 05/23/05	ω	η	ψ	ζ_0 x 10^{-5}	ζ_1 x 10^{-5}	ζ_2 x 10^{-5}	ν	LL	Q12	Q^2 (12)	EN
Average	0.2045	0.1207	0.5128		0.1808	1.4099	1.3029	1813.7489	18.530	3.950	1.4986
Median	0.2062	0.0970	0.5120		0.2132	1.6381	1.3892	1930.6192	13.675	8.995	1.3435
Standard dev	0.0627	0.1629	0.1028		0.7942	0.6313	0.4008	952.0558	14.653	11.158	0.2888
Max	0.3477	0.4277	0.8766		2.4807	4.2609	1.9175	3457.4006	19.239	13.278	2.1877
Min	0.0191	-0.0766	0.1938		-0.6112	0.6087	0.8066	1247.1870	9.132	12.057	0.3391
% of coefficients that are significant	83%	35%	100%		76%	87%	100%		0%	0%	0%
% of coefficients that are positive	100%	87%	100%		74%	100%	100%	100%	100%	100%	100%
% of significant coefficients that are positive	100%	100%	100%		81%	100%	100%		0%	0%	0%

In Table 4, we present the results of estimating equation (6). Results pertaining to ? and η are the same as for Table 3 and. All 79 stocks have positive coefficients associated with unexpected volume (ζ_2) during each period (63 percent being significant in period one and 87 percent being significant in period two). However, the situation is quite different for the impact of expected volume (ζ_1) on volatility. During both periods, the coefficients associated with expected volume are smaller than the ones associated with unexpected volume. These observations suggest that surprises in trading volume always convey most of the information associated with trading volume. Thus, unexpected news affects volatility in CASE significantly during both periods.

Also, in period one, the coefficients associated with expected volume are negative for 73 percent of the stocks. In period two, only 26 percent of the coefficients associated with expected volume are negative. The prevailing negative relationship between expected volume and volatility during period one reinforces our prior findings—i.e., variance decreases with an increase in trades and prices are adjusted through speculative trading. Indeed, in many younger markets, transactions are made through a broker, based on negotiations between parties. If the official price reporting mechanism is weak, brokers gather and process information from market sources regarding transactions that have taken place in that market; this information is then passed on to a trader (buyer or seller). As trading volume in the market increases, one would expect more information to be available in the market which, in turn, would improve market transparency and reduce uncertainty and market volatility.

Further, if trading volume is expected to drop (but prices can still shift dramatically), a negative relationship is implied between expected volume and volatility of returns. This is a characteristic of an inefficient trading system and, to some extent, of inefficiency in the market. Indeed, when market breadth and depth are smaller, informed traders can drive bid-ask spreads high. As is the case in emerging markets with their embryonic insider trading laws, informed traders can lead to considerable losses on the part of market makers. So, in markets where a cluster of traders might have superior information relative to the specialists or market makers, the incentive to market making is reduced and will lead to high spreads to avoid losing money to informed traders.

Because there is a well established literature on the inverse relationship between volume and spreads, it makes sense that without the arrival of new information (expected volume) to all market traders, trading is going to decrease and large shifts in prices might occur at the same time (through speculation on the part of informed traders and the resulting increase of spreads on the part of market makers).

In the final model, we also note that the volatility persistence coefficient (ψ) is somewhat lower as compared to our earlier results. During the first period, the coefficient averages 0.5183 (as compared to 0.6255 without volume). During the second period, the coefficient averages 0.5128 (as compared to 0.7839 without volume). In this case, volume coveys some information and affects volatility in a manner somewhat consistent with MDH.

5. Summary and Conclusions

We have examined the interaction of volatility and volume in seventy-nine traded companies in CASE over a period from January 1998 to May 2005. The study provides empirical support for the TGARCH specification for explaining the daily time dependence in the rate of information arrival to the market for stocks traded on CASE.

First, based on a TGARCH (1,1) model, we find that (i) the size of volatility shocks is indeed lower for the 2001-2005 period as compared to the 1998-2001 period, and (ii) the leverage effect also differs across the two periods and is higher after May 2001. Furthermore, we observe that the sign and size of volatility shocks are closer (in value) during 2001-2005 as compared to 1998-2005. However, during both periods, the size of a volatility shock is much more important than the leverage effect, probably due to the presence of noise trading and speculative bubbles. Though, this is less true during the 2001-2005 period.

Second, when total volume is included in the conditional variance specification, volume tends (on average) to be positively related to volatility. This observation is even stronger during the second period, although the inclusion of total volume traded does alter the persistence of GARCH effects during both periods. Most interestingly, when the volume is split up into its expected and unexpected components and these terms are included in the conditional variance estimation, GARCH effects are reduced. In this case, volume conveys information and affects volatility in a manner somewhat consistent with MDH. However, the existence of a negative relationship between expected volume and volatility is better explained by the SIH of Copeland (1976) and Jennings, Starks and Fellingham (1981). Indeed, it is more likely that in CASE, dissemination of information is asymmetric and initially only well informed traders take positions. As information is sequentially transmitted from trader to trader, less informed traders also take positions. After a series of intermediate transient equilibria, a final equilibrium is reached resulting in lower volatility.

Finally, regarding expected volume, our findings have some interesting policy implications. Undeniably, emerging markets are notoriously less liquid and efficient than mature markets. Thus, the official price reporting mechanism is typically weaker and insider trading law differentials with developed markets are significant. In this case, informed traders tend to lead the speculative trading activity and drive bid-ask spreads higher, further diminishing the liquidity of the market. Because this situation still exists after May 2001 and it seems to be less important as compared to prior May 2001, our findings suggest that the changes in local policies to design better systems are starting to crystallize. However, more reforms are warranted if CASE wants to attract foreign investors.

References

Andersen, T.G. (1996). Return volatility and trading volume: An information flow interpretation of stochastic volatility. *Journal of Finance, 51*, 169-204.

Arago, V., & Nieto, L. (2005). Heteroskedasticity in the returns of the main world stock exchange indices: Volume versus GARCH effects. *Journal of International Financial Markets, Institutions and Money, 15*, 271-284.

Berry, T.,&Howe, K.M. (1994). Public informational arrival. *Journal of Finance, 49*, 1331-1346.

Blume, L., Easley, D., & and O'Hara, M. (1994). Market statistics and technical analysis: The role of volume. *Journal of Finance, 49*, 153-181.

Bohl, M.T. & Henke, H. (2003). Trading volume and stock market activity: The Polish case. *International Review of Financial Analysis, 12*, 513-525.

Bollerslev, T., (1986). Generalized autoregressive conditional heteroskedasticity. *Journal of Econometrics, 31*, 307-327.

Bollerslev, T., & Wooldridge, J.M. (1992). Quasi-maximum likelihood estimation and inference in dynamic models with time-varying covariances. *Econometric Reviews, 11*, 143-172.

Campbell, J.Y., Grossman, S.J. & Wang, J. (1993). Trading volume and serial correlation in stock returns. *Quarterly Journal of Economics, 58,* 906-939.

Chatrath, A., Ramchander, S. & Song, F. (1996). The role of futures trading activity in exchange rate volatility. *Journal of Futures Markets, 16*, 561-584.

Chen, G., Firth, M. & Rui, O.M. (2001). The dynamic relation between stock returns, trading volume, and volatility. *The Financial Review, 38*, 153-174.

Clark, P.K. (1973). A subordinated stochastic process model with finite variance for speculative prices. *Econometrica, 41*, 135-156.

Copeland, T. E. (1976). A model for asset trading under the assumption of sequential information arrival. *Journal of Finance, 31*, 1149-1168.

Cornell, B. (1981). The relationship between volume and price variability in futures markets. *Journal of Futures Markets, 1*, 304-316.

Crouch, R.L. (1970). The volume of transaction and price change on the New York Stock Exchange. *Financial Analyst Journal, 26*, 104-109.

Epps, T. W., & Epps, M.L. (1976). The stochastic dependence of security price changes and transaction volumes: Implications for the mixture-of-distributions hypothesis. *Econometrica, 44*, 305-321.

Foster, F.D., & Viswanathan, S. (1995). Can speculative trading explain the volume-volatility relation? *Journal of Business and Economics Statistics, 13*, 379-396.

Gallant, A.R., Rossi, P.E., & Tauchen, G. (1992). Stock prices and volume. *The Review of Financial Studies, 5*, 199-242.

Gallo, G., & Pacini, B. (2000). The effects of trading activity on market volatility. *European Journal of Finance, 6*, 163-175.

Gervais, K. R., & Mingelgrin, D.H. (2001). The high-volume return premium. *Journal of Finance, 56*, 877-919.

Glosten, L.R, Jagannathan, R.,&Runkle, D.E. (1993).On the relation between expected value and the volatility of the nominal excess returns on stocks. *Journal of Finance, 48*, 1779-1801.

Grammatikos, T., & Saunders, A. (1986). Futures price variability: A test of maturity and volume effects. *Journal of Business, 59,* 319-330.

Harris, L. (1986). Cross-security tests of the mixture-of-distributions hypothesis. *Journal of Financial and Quantitative Analysis, 21*, 39-46.

Harvey, A.C. (1989). *Forecasting, structural time series models and the Kalman Filter*, Cambridge, U.K: Cambridge University Press.

He, H., & Wang, J. (1995). Differential information and dynamic behavior of stock trading volume. *Review of Financial Studies, 8*, 919-972.

Hiemstra, C., & Jones, J. (1994). Testing for linear and non-linear Granger causality in the stock price-volume relationship. *Journal of Finance, 49*, 1639-1664.

Jennings, R. H., Starks, L.T. & Fellingham, J.C. (1981). An equilibrium model of asset trading with sequential information arrival. *Journal of Finance, 36*, 143-161.

Karpoff, J. (1987). The relation between prices changes and trading volume: A survey. *Journal of Financial and Quantitative Analysis, 22,* 109-126.

Kim, D., & Kon, S. (1994). Alternative models for the conditional heteroskedasticity of stock returns. *Journal of Business, 67*, 563-588.

Lamoureux, C.G., & Lastrapes, W.D. (1990). Heteroskedasticity in stock return data: Volume versus GARCH effects. *Journal of Finance, 45,* 221-229.

Lee, B. S., & Rui, O.M.(2002). The dynamic relationship between stock returns and trading volume: Domestic and cross-country evidence.*Journal of Banking and Finance, 26*, 51-78.

Lucey, B.M. (2005). Does volume provide information? Evidence from the Irish stock market. *Applied Financial Economics Letters, 1(2),* 105-109.

Malliaris, A.G., & Urrutia, J. L. (1998). Volume and price relationships: Hypotheses and testing for agricultural futures. *Journal of Futures Markets, 18*, 53-72.

Najand, M., & Yung, K. (1991). A GARCH examination of the relationship between volume and price variability in futures markets. *Journal of Futures Markets, 11*, 613-621.

Omran, M., & McKenzie, E. (2000). Heteroskedasticity in stock returns data revisited: Volume versus GARCH effects. *Applied Financial Economics, 10*, 553-560.

Pagano, M., & Roell, R. (1993). Auction and dealership markets. What is the difference? *European Economic Review, 36*, 613-623.

Pyun, C., Lee, S., & Nam, K. (2000). Volatility and information flows in emerging equity markets: A case of the Korean stock exchange. *International Review of Financial Analysis, 9*, 405-420.

Ranter, M., & Leal, R.P.C. (2001). Stock returns and trading volume: Evidence from the emerging markets of Latin America and Asia. *Journal of Emerging Markets, 6*, 5-22.

Saatcioglu, K., & Starks, L.T. (1998). The stock price-volume relationship in emerging stock markets: The case of Latin America. *International Journal of Forecasting, 14,* 215-226.

Sharma, J.L., Mougoue, M., & Kamath, R. (1996). Heteroskedasticity in stock market indicator return data: volume versus GARCH effects. *Applied Financial Economics, 6*, 337-342.

Shiller, J.R. (1989). *Market Volatility*, MIT Press.

Silvapulle, P., & Choi, J.S. (1999). Testing for linear and nonlinear Granger causality in the stock price-volume relation: Korean evidence. *Quarterly Review of Economics and Finance, 39*, 59-76.

Tauchen, G., & Pitts, M. (1983). The price variability-volume relationship on speculative markets. *Econometrica, 51*,485-505.

Zakoian, J. (1994). Threshold heteroskedastic models. *Journal of Economic Dynamics and Control, 18*, 931-995.

Zarraga, A. (2003). GMM-based testing procedures of the mixture of distributions model. *Applied Financial Economics, 13*, 841-848.

Guide for Authors

1. Papers to be submitted to: editor@egyptse.com

2. Papers are accepted in Arabic as well as English.

Submission of a paper will be held to imply that it contains original unpublished work and is not being submitted for publication elsewhere.

3. Subject matter of the submitted papers should be totally relevant to finance and economic topics related to financial markets.

4. Submission of accepted papers as electronic manuscripts, i.e., by e-mail or on disk with accompanying manuscript, is encouraged. Electronic manuscripts have the advantage that there is no need for re-keying of text, thereby avoiding the possibility of introducing errors and resulting in reliable and fast delivery of proofs. The preferred storage medium is a disk in MS-DOS format.

5. Manuscripts should be double spaced, with wide margins, and printed on one side of the paper only. All pages should be numbered consecutively. Titles and subtitles should be short. References, tables, and legends for the figures should be printed on separate pages.

6. The first page of the manuscript should contain the following information: (i) the title; (ii) the name(s) and institutional affiliation(s) of the author(s); (iii) an abstract of not more than 250 words. A footnote on the same sheet should give the name, present address, and telephone and fax numbers of the corresponding author [as well as an e-mail address].

7. The first page of the manuscript should also contain at least one classification code according to the Classification System for Journal Articles as used by the Journal of Economic Literature; in addition, up to five key words should be supplied.

8. Acknowledgements and information on grants received can be given in a first footnote, which should not be included in the consecutive numbering of footnotes.

9. Footnotes should be kept to a minimum and numbered consecutively throughout the text with superscript Arabic numerals. They should be double spaced and not include displayed formulae or tables.

10. Displayed formulae should be numbered consecutively throughout the manuscript as (1), (2), etc. against the right-hand margin of the page. In cases where the derivation of formulae has been abbreviated, it is of great help to referees if the full derivation can be presented on a separate sheet (not to be published).

11. References to publications should be as follows: "Smith (1992) reported that..." or "This problem has been studied previously (e.g., Smith et al., 1969)". The author should make sure that there is a strict one-to-one correspondence between the names

and years in the text and those on the list. The list of references should appear at the end of the main text (after any appendices, but before tables and legends for figures). It should be double spaced and listed in alphabetical order by authors name. References should appear as follows:

- For monographs:
  Hawawini, G. and I. Swary, 1990, Mergers and Acquisitions in the U.S. Banking Industry: Evidence from the Capital Markets (North-Holland, Amsterdam).

- For contributions to collective works:
  Brunner, K. and A.H. Meltzer, 1990, Money supply. In: Friedman, B.M., Hahn, F. (Eds.), Handbook of Monetary Economics, Vol. 1. North-Holland, Amsterdam, pp. 357-396.

- For periodicals:
  Griffiths, W., Judge, G., 1992, Testing and estimating location vectors when the error covariance matrix is unknown. Journal of Econometrics 54, 121-138.

- For unpublished material:
  Hermalin, B., Weisbach, M., 1995. Endogenously chosen boards and their monitoring of the CEO. Unpublished working paper. University of California, Berkeley.

Note *that journal titles should not be abbreviated.*

12. Illustrations will be reproduced photographically from originals supplied by the author; they will not be redrawn by the publisher. Please provide all illustrations in quadruplicate (one high-contrast original and three photocopies). Care should be taken that lettering and symbols are of a comparable size. The illustrations should not be inserted in the text, and should be marked on the back with figure number, title of paper, and authors name. All graphs and diagrams should be referred to as figures, and should be numbered consecutively in the text in Arabic numerals. Illustrations for papers submitted as electronic manuscripts should be in traditional form.

13. Tables should be numbered consecutively in the text in Arabic numerals and printed on separate sheets.

Any manuscript which does not conform to the above instructions, may be returned for the necessary revision before publication.

Page proofs will be sent to the corresponding author. Proofs should be corrected carefully; the responsibility for detecting errors lies with the author. Corrections should be restricted to instances in which the proof is at variance with the manuscript. Extensive alterations will be charged. Ten off-prints of each paper are supplied free of charge to the corresponding author.