The Relation Between Option Trading Activity and Equity Volatility

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ABSTRACT

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We examine the relationship between option trading activity and the underlying equity volatility in the context of the mixture of distribution hypothesis. Trading activity is divided into expected and unexpected components. As previously documented with stock volume, we find that a surge in option volume is also positively related to equity volatility. This indicates that the series contains information pertaining to the underlying stock. Further, unexpected trading activity has a substantially larger effect on stock volatility than does expected activity. There is little evidence of a relation between anticipated option volume and equity volatility. This finding suggests the existence of an option market does not destabilize equity markets. Interestingly, we find negligible evidence that contradicts the market depth hypothesis whereby market growth is believed to reduce volatility in prices. The results demonstrate an insignificant relation between expected option open interest, a proxy for market depth, and stock volatility.

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1. INTRODUCTION

The price-volume relation is the focus of countless studies in finance. Why is the relationship so important? No doubt it is because the relation has repercussions on not one but several elements influencing financial markets. First, the relationship is contingent upon market structure. How information is disseminated, how information is conveyed in prices, the size of the market and short sale constraints have direct bearing on the relationship. Second, the research is fundamental to event studies. If price change and volume distributions are jointly determined (MDH), then new insights may be used to improve the power of inference in event studies. Beaver (1968) proposed that price changes can explain the market's evaluation of new information, while the accompanying volume represents the magnitude to which the traders disagree about this information. Third, it has bearing on contract success in the futures market. Much of a contract's success depends on price speculation, which, in turn, is linked to price variability. Success is defined by trading activity, therefore, the strength of the price-volume relation has implications on contract success. New findings concerning the price-volume relationship may help in improving the success rate of new contract introductions. Fourth, the research may provide insight on the empirical distribution of speculative prices. There are several theories that explain the positive price-volume correlation, however, the mixture of distributions hypothesis (MDH) is one which is the focus of much attention. It attempts to explain the relationship through the distribution of speculative prices. The price-volume relation may have implications on the efficient market hypothesis. There is substantial evidence of option trading preference over corresponding stocks. Research has shown that options precede their underlying stocks in absorbing new information, subsequently, they play a predominant role in the determination of equity equilibria. The existence of a strong equity price-option volume relation may open the door for further research on this topic. Finally, it is a widely held belief that derivative markets destabilize the equity market. This is the rationale behind exchange-imposed trading restrictions on futures. However, the belief may be under false pretence. Bessimbinder and Seguin (1992) conclude futures trading may actually reduce volatility in the equity market. Further research into the interrelation between futures trading and equity prices may force exchanges to modify their regulations.

If this area of research has been so intensely scrutinized, why conduct yet another study on the price-volume relation? A rudimentary response to this question would be because it has never been done before. Previous research has focused on either the equity or futures market or even a cross-examination of the two. No one has yet examined the interrelation between option trading activity and equity volatility. However, the option preference theory (Copeland (1976)) provides further justification to investigate this supplement of the price-volume research.

Since option markets commenced trading, the investment community has been concerned with the impact it may have on the behaviour of the securities market. The options market has seen tremendous success since its inception with volume exceeding that of underlying securities. Accompanying this success is the concern that such large volume of derivative instruments may have implications on efficiency in the equities market.

The fact that many stocks, especially stocks with large trading volume, have their options trading at the same time may provide an alternative channel for information flowing into the market. Investors possessing information on a stock will choose to act on it through its option rather than the underlying stock. According to the option trading preference theory, transacting in options impose fewer constraints and provides greater price elasticity. As such, option volume may contain information not inherent in corresponding stock volume (contemporaneously). Therefore, by concentrating only on stocks, previous work on the price-volume relation may have "missed out" on a large portion of information flow that could have been captured by options volume.

The ultimate purpose of this study is to determine whether options provide an alternative channel for information pertaining to the underlying equities. The GARCH(1,1) approach will facilitate the link between conditional volatility and trading activity. Using stock volume as a proxy for information flow, prior studies have used the approach to demonstrate the link between heteroscedasticity in daily stock returns and the random rate of information flow in the market . If the option preference theory holds, then option volume should also have the capacity to serve as a proxy for information flow. This study will attempt to confirm this hypothesis. In doing so, we will test the strength of the stock volatility-option volume relation against the volatility-volume relation in the underlying equity. At the same time, we will investigate whether or not the existence of options promotes instability in underlying equities. The price change-volume relation is asymmetric with a positive correlation between price change per se and volume. This study will attempt to find new insights on this phenomenon by employing an AGARCH process (Engle, 1990). The approach is very similar to GARCH(1,1), however, it contains an additional parameter that captures sign changes. Thus, the return sign is permitted to influence the relation between conditional variance and trading activity. We examine the differentiating effects between expected and unexpected components of trading activity on conditional volatility in both the GARCH and AGARCH models. We investigate the market depth hypothesis in which greater market depth is believed to lessen volatility in equity prices. Finally, daily dummies are incorporated into the GARCH model to capture the relation between days of the week and volatility. The plan of this paper is as follows. Section 2 will assess the early as well as the recent literature on the price-volume relation and the option trading preference theory. Section 3 will justify our selection of trading activity variables. In Section 4, we will illustrate the method used to decompose trading activity into expected and unexpected components. Sections 5 and 6 briefly describe the data and methodology respectively, while section 7 discusses the empirical results. Finally, the last section provides a summary and conclusion.

2. LITERATURE REVIEW

I. Early Research: Absolute Price Changes-Volume Correlation

There have been numerous studies on the absolute price change (APC)-volume relation. The majority of them support a positive correlation. Ying (1966) is the first researcher to document a positive relation. Motivated by the Godfrey, Granger, and Morgenstern (1964) study reporting no correlation, Ying applies chi squared tests, analysis of variance, and cross spectral methods to S&P 500 index and outstanding shares traded on the NYSE. He concludes that:

- Small volume is accompanied by a fall in price.
- Large volume is accompanied by a rise in price
- A large volume is usually accompanied by either a large increase or a decrease in price.

Ying's empirical methods were quickly criticized. For one, the price series (S&P 500) is not directly comparable to the volume series (NYSE). Secondly, the daily price series is adjusted with quarterly dividends and the daily volume series is adjusted with monthly figures of shares outstanding. Nonetheless, his research provided the groundwork for future empirical studies.

Crouch (1970) found a positive correlation between APC and volume using both indices and individual stocks. His contribution to this area of research is his use of hourly intervals as opposed to daily intervals. The strongest correlation is evident when the shortest interval was combined with the largest indices. In addition, he believes certain market practices enhance volume and promote the positive relation. For one, stop losses will spur volume with greater fluctuations in prices. Secondly, margin calls triggered by price fluctuations , will force many investors to sell and this creates volume. However, a factor working against the positive relation is a longer interval length. In the event where a daily interval is used, large price fluctuations may occur within the day, but by day's end, they may net themselves out with only a small daily price change. The result is a minimal price change coinciding with large volume.

Inspired by the presence of leptokurtosis in the distribution of speculative prices, Clark (1973) accounted for this phenomenon by way of the APC-volume relation. Using cotton futures, he found a positive correlation between daily APC and corresponding contracts traded. Also motivated by the leptokurtotic distribution in prices, Morgan (1976) investigated the relationship using daily data on common stocks. His findings support a positive relation between the variance of returns and volume. Building on Clark's theory in which leptokurtosis is linked to the APC-volume relationship, Westerfield's (1977) results show a significantly positive relation between the daily price changes and corresponding volume for 315 common stocks. Cornell (1981) was encouraged by the implications the relation may have on the success of new futures contracts and conducted a study using 17 contracts for commodities. His results support a positive relation between the variance of daily log price and the average daily volume. Furthermore, the relationship would be more impressive if it were not for distorting factors such as price limits. scalping, and price trading that are only apparent in the futures market. Cornell found that introducing contracts with greater price variability will improve the possibility of success.

Tauchen and Pitts (1983) make an important contribution to the study of the relationship. In addition to volume, they examine the relation between market depth and speculative prices. They hypothesize that the variance of price changes decreases with a growing market. Equity prices are derived from the average of all traders' reservation prices. In a growing market, there is an increasing number of traders and subsequently, more terms in this average. The result is dilution in trader differences in reservation prices and decreasing price variability. Not surprising, they also find a positive APC-volume correlation. Using transaction as well as daily data for 50 common stocks, Harris (1987) found support for a positive price-volume correlation. Wood, McInish and Ord (1985) also found a positive correlation using a large sample of stocks and two interval periods.

There are numerous other early empirical studies on the relation between absolute price changes and volume, all confirming a positive relation save Godfrey et al (1964). Table A summarizes the early empirical work on the relation.

II. Recent Literature on the Price-Volume Relation

Early research on the relation discovered that the distribution of speculative price changes is leptokurtotic and slightly skewed to the right, an indication of non-normality and instability in financial returns. The reason for non-normality is the observed heteroscedasticity in stock returns. Accordingly, French, Schwert, and Stambaugh (1987) found that the standard deviation in returns of the S&P 500 composite index is significantly different in the two sample periods tested. Motivated by these results, Schwert and Seguin (1990) conduct a separate study showing that

Table A

Summary of Emperical Studies on Absolute Price Changes-Volume Correlation[*]

Authors	Year of study	Sample Data	Sample Period	Interval Period	Positive Correlation
Godfrey et al	1964	stock market 3 common stocks	1959-62	weekly, daily	NO
Ying	1966	stock market aggregates	1957-62	daily	YES
Crouch	1970	stock market aggregates, 3 stocks	1966-68	hourly, daily	YES
Clark	1973	Cotton futures	1945-58	daily	YES
Epps and Epps	1976	20 common stocks	jan. 1971	transactions	YES
Morgan	1976	17 common stocks 44 common stocks	1962-65 1926-68	4 days, monthly	YES
Westerfield	1977	315 common stocks	1968-1969	daily	YES
Cornell	1981	Futures contracts	1968-79	daily	YES
Tauchen and Pitts	1983	T-bill futures	1976-79	daily	YES
Comiskey, Walking & Weeks	1984	211 common stocks	1976-79	yearly	YES
Harris	1984	50 common stocks	1981-83	transactions, daily	YES
Rutledge	1984	Futures contracts	1973-76	daily	YES
Wood, Mcinish & Ord	1985	946 common stocks 1138 common stocks	1971-72 1982	minutes	YES
Grammatikos & Saunders	1986	Future contracts	1978-83	daily	YES
Harris	1986	479 common stocks	1976-77	daily	YES
Jain & Joh	1986	stock market	1979-83	hourly	YES
Richardson, Sefcik & Thompson	1987	106 common stocks	1973-82	weekly	YES

[*] Source: J.M. Karpoff "The Relation between Price Changes and Trading Volume: A Survey". Journal of Financial and Quantitative Analysis, 1987, pg 113.

the heteroscedasticity model (ARCH) increased the evidence that firm size is correlated to risk-adjusted returns. Furthermore, the Generalized Autoregressive Conditional Heteroscedasticity model (GARCH) developed by Bollerslev (1986) allows for heteroscedasticity in returns. The model specifies that conditional variance is a linear function of past squared residuals as well as lagged conditional variances. Research has shown (G)ARCH(1,1) process provides an optimal fit for the majority of financial return series (Engle (1982), Engle and Bollerslev (1986), Bollerslev (1987)).

Early researchers document the heteroscedastic properties of financial time series distribution but never account for the persistence in volatility shocks when examining APC-volume relation. The reason being they did not apply appropriate empirical methods to accommodate for the non-normal characteristics inherent in the data.

Lamoureux and Lastrapes (1990) are the first researchers to utilize the GARCH(1,1) process in examining the price-volume relation. Their objective was to determine whether volume relates to conditional variance of financial series returns through the observance of heteroscedasticity. The data consisted of daily volume and return series for 20 actively traded common shares.

Their results reveal the majority of stocks have statistically significant coefficients for lagged errors and lagged conditional variances. This observation confirms the existence of heteroscedasticity in returns and that the GARCH(1,1) is best suited to capture and account for this heteroscedasticity. However, when volume is included in the model, the coefficients for lagged errors and lagged variances become small and statistically insignificant, whereas the coefficients for volume are positive and statistically significant. That is, once volume is included in the model, lagged residuals and variances cease to contribute information about conditional variances of returns. The authors suggest that volume explains much of the non-normality and heteroscedasticity in returns and that returns are linked to corresponding volume (through the observance of conditional variance).

Motivated by the notion that greater futures-trading activity leads to greater equity volatility, Bessimbinder and Seguin(1992) take the research on the price-volume relation one step further. The study examines the differentiating affects of spot volume and futures volume on equity volatility. In addition, trading activity is partitioned into expected and unexpected components to determine whether the effects of volume on volatility are homogenous. This was easily accomplished using an ARIMA(0,1,10) specification.

Their results reveal a significant relation between equity volatility and futures-trading activity. With respect to spot markets, Unexpected volume and expected volume have statistically significant positive coefficients, however, the coefficients for unexpected volume components are consistently larger than those for expected spot volume components. Theoretically, unanticipated volume shocks should have a greater positive affect on volatility. Conversely, the coefficients for expected futures volume are negative and statistically significant, while the coefficients for unexpected futures volume are positive and significant. The observed negative coefficients implies that greater expected futures volume may reduce volatility in the equity markets and is contrary to exchange regulations that restrict futures trading based on the belief futures trading destabilizes equity markets. According to their findings, increased futures activity may actually promote stability in equity markets.

In a more recent study (1993) by the same authors, they examine the relation between volatility, volume and market depth across eight futures contracts. As before, using an ARIMA specification, trading activity is partitioned into expected and unexpected components. In addition, their model includes daily dummies to examine day of the week effects. The study also investigates asymmetries in the volatility-volume relation with respect to volume shocks. A positive shock is defined as volume above expected level and a negative shock is defined as volume below its expected level.

As observed in their earlier study, there is a strong positive correlation between volatility and volume be it unexpected or expected. Unexpected volume components have larger, more statistically significant coefficients than expected volume components. The authors conclude unexpected volume has a greater impact on volatility than expected volume.

The coefficients relating expected open interest to volatility are all negative and significant. According to Bessimbinder and Seguin (1992, 1993) , open interest is believed to be associated with the number of traders or the amount of capital flowing into the market. These factors enhance market depth and invariably promote lower volatility shocks. An unforeseen result is the appearance of statistically significant negative coefficients relating unexpected open interest to volatility. However, these coefficients are not as statistically significant as their expected counterparts. Nonetheless, this result indicates an unanticipated increase in open interest during a trading day will decrease volatility.

With respect to the volatility-volume asymmetry, positive unexpected volume produced larger, more significant coefficients than negative unexpected volume. In fact, the authors conclude positive shocks result in 76 percent greater volatility than negative shocks. This result implies that greater levels of volume are associated with higher levels of volatility. Interestingly, the majority of coefficients relating volume to returns are not significant , which suggests the absence of price-volume asymmetry in the futures market. This finding is consistent with the costly short sale hypothesis (Karpoff, 1987).

Most day of the week coefficients are not statistically significant. In their earlier study, the coefficients for Wednesday and Thursday are significant, although they are negative.

III. Theoretical Explanation

Research has clearly shown a strong association between absolute price change and volume. However, what is the basis for its existence? There are several theories that attempt to explain the positive correlation between return volatility and trading volume. The majority of these focus on information flow across market participants. They can be classified into three categories.

a. *Sequential Arrival of Information*

The Sequential Arrival of Information theory (SAI) was devised by Copeland (1976) and subsequently extended by Jennings, Starks and Fellingham (1981). The theory assumes price changes are known with certainty between intermediate and final equilibrium prices. However the price adjustment process as well as the total volume that results in reaching equilibrium are random. The price-volume relationship is contingent upon the new information entering the market and the percentage of traders who shift their demand curves.

New information is disseminated sequentially one trader at a time. As each trader absorbs the information, he shifts his demand curve and a new intermediate equilibrium price is reached. Once all traders have assimilated the new information and consequently shifted their demand curves, the final equilibrium price is reached. In lieu of shifting demand curves, the sequential assimilation of new information generates both trading volume and price movements. In periods experiencing numerous information shocks, both price changes and volume are characterized by increases.

The strength of the price change-volume relationship is a function of the disagreement among the traders concerning the new information. If all traders are in agreement that the information is favourable. Traders actions will force higher prices and greater volume. On the other hand, if traders tend to disagree about the information, price change as well as volume will be less profound.

b. The Mixture of Distribution Hypothesis

A second theory proposes a positive contemporaneous relation between price volatility and volume. The Mixture of Distribution Hypothesis (MDH) was first introduced by Clark (1973) and later extended by Tauchen and Pitts (1983), and Harris (1987). The theory is based on information flow in the market. Price changes and volume are jointly independently and identically distributed and the number of informational events occurring each day is random.

The arrival of information into the market will generate both price changes and volume. Each occurrence of the many daily informational events will result in normal distributions of price changes and volume. Each event yields an intermediate equilibrium price change and volume. The final price change and volume for the day is the cumulation of all the daily equilibria. The price-volume relation arises because the distribution of daily price changes and volume are jointly determined by the number of continuous random informational events during the day. Tauchen and Pitts (1983) build on the theory by providing an explicit expression for the manifestation of the relationship. The number of traders for any given day is fixed; the number of daily informational events is random and consequently, so is the number of daily equilibria (I). The final daily price change and volume is the cumulation of all inter-day price changes and volume. The daily price change and volume are given in equations (1) and (2).

$$(1) \qquad V=\sum_{i=1}^{I} V_i, \quad V_i \sim N(\mu_2, \sigma_2^2)$$

$$(2) \qquad \Delta P=\sum_{i=1}^{I} \Delta P_i, \quad \Delta P_I \sim N(0, \sigma_1^2)$$

The daily price changes and volume are mixtures of many normal distributions with the same directing variable I. As previously stated, the moments of the daily price change distribution and volume distribution are contingent upon the number of daily equilibria. This relation is expressed in equation (3).

$$(3) \qquad \Delta P \sim N(0, \sigma_1^2 I) \qquad V \sim N(\mu_2 I, \sigma_2^2 I)$$

Subsequently, the derivation of the price-volume relation is expressed by the following

$$(4) \qquad Cov(\Delta P_2, V) = E[\Delta P^2] - E[\Delta P^2]E[V]$$

$$(5) \qquad = \sigma_1^2 \mu_2 E[I^2] - \sigma_1^2 \mu_2 (E[I])^2$$

$$(6) \qquad = \sigma_1^2 \mu_2 Var[I] > 0$$

Equation (6) illustrates the positive covariance between price change and volume evolves because both are associated with an unobserved mixing variable (I), namely the number of informational events.

The MDH explains the occurrence of leptokurtosis and the ensuing non-normality in price change distributions. Since the daily price change and volume distributions are conditional on the random number of informational events, we would expect the moments of the distribution (mean and standard deviation) to be random. Essentially, daily price changes and volume are sampled from a set of distributions with different variances. Thus, the variance of daily price changes and volume is not constant. The end result is heteroscedasticity and leptokurtosis giving rise to non-normality in return distributions.

It is apparent that the observance of heteroscedasticity and hence GARCH effects in returns support the MDH. Appropriately, Lamoureux and Lastrapes (1990) use the GARCH(1,1) process to model the return series and make the link between conditional variances and volume. In reference to the GARCH(1,1) process, if the MDH applies then the following holds true

$$(7) \qquad r_t = \mu_{t-1} + \epsilon_t, \qquad \epsilon_t | (\epsilon_{t-1}, \epsilon_{t-2} \ldots\ldots)$$

$$(8) \qquad \epsilon_t | n_t \sim N(0, \sigma^2 n_t)$$

where r_t is the rate of return, μ_{t-1} is the mean return conditional on past information, and ε_t has a mean of zero and a variance that is conditional upon the number of daily informational events(n_t). The authors assume that n_t is serially correlated. This can be written as

$$(9) \quad n_t = k + bn_{t-1} + u_t$$

where k is a constant and μ_t is white noise. Designate

$$(10) \quad \Omega_t = E(\epsilon_t^2 | n_t)$$

and given the acceptance of the MDH, then variance is conditional on the random number of daily informational events (equation (11)).

$$(11) \quad \Omega_t = \sigma^2 n_t$$

Substituting this expression into the autoregressive model for n_t , the result is the following

$$(12) \quad \Omega_t = \sigma^2 k + b\Omega_{t-1} + \sigma^2 u_t$$

Equation (12) illustrates that their are volatility shocks or as these authors describe it " ...persistence in conditional variance..."[1] that only the GARCH process can account for. The previous expressions also demonstrates the association between the random number of informational events and heteroscedasticity in returns. The daily distributions for price changes and volume are sampled from a set of inter-day distributions with different variances. Each of these distributions (intermediate equilibria) is

[1] See Lamoureux, C.G. and W.D. Lastrapes (1990), pg 223.

determined by the number of informational events entering the market. Given that the rate of information flow is stochastic and thus random, the variance of these distributions is also random and thus inconsistent. The end result is heteroscedasticity in daily returns and the prerequisite for utilizing a GARCH process. To summarize, the variance of returns are proportional to the random number of informational events entering the market; this relation is given by Ω_t in equation (11). If by including volume (a proxy for information flow n_t) in the GARCH model results in the disappearance of volatility shocks, then this will confirm both returns and volume distributions are determined by n_t. Furthermore, it will establish the link between price changes and volume.

c. Life Cycle Theory

Developed by Admati and Pfleiderer(1988), a more recent explanation for the positive price-volume correlation focuses on life cycle trading. Life cycle trading influences the supply available to speculators in the market. Since speculators are associated with higher levels of price volatility, we get greater volume occurring with higher levels of volatility. Simply stated, speculators tend to transact in bull markets, consequently, high levels of volatility and greater volume are bunched in time.

IV. Asymmetry in The Price-Volume Relation

Market participants have always adhered to the notion that volume is heavier in bull markets than is bear markets. This would imply a positive relationship between volume and price change per se.

Epps (1975) found support for asymmetry in the relation. Using daily and transaction data for 20 common stocks, his results conclude that greater volume is associated with positive price changes, while lower levels of volume is associated with negative price changes. Volume seems to be heavier for transactions in which prices tick up than for transactions in which prices tick down.

Motivated by limitations in the Epps study, Hanna (1978) replicated the study with modifications. Epps is criticized for using a sample period which may have been unique and therefore biased. The sample period in question experienced the fifth greatest decline in interest rates in history. Using an unbiased sample period, Hanna's finding are identical to that of Epps.

A study by Smirlock and Starks (1984) provides partial support for asymmetry in the price-volume relationship. Their research consists of transaction data for 131 common stocks. In periods that experienced new informational arrival, asymmetries are observed. Where the volume associated with positive price changes is greater than the volume for negative price changes. However, in all other periods, the asymmetry is reversed. The volume associated with negative price changes is greater than the volume for positive price changes. Studies by Rogalski (1978), Jain and Joh (1988), Richardson, Sefcik and Thompson (1986), Harris (1987) obtain findings supporting the positive relation between volume and price change per se. Conversely, studies by James and Edmister(1983), Wood, McInish and Ord (1985) did not find support for positive correlation between price per se and volume. In fact, the Wood et al study reveals a negative correlation between price change per se and volume. The volume for transactions in which prices tick down is greater than the volume for transactions characterized by upticks.

The empirical evidence on asymmetry supporting a positive relation between price change and volume is weak and inconclusive compared to research on APC-volume relation. Table B summarizes the research on the relation.

V. Theoretical Explanation

What explains the observance of the positive price change-volume correlation? Epps and Epps (1976) rationalize its occurrence through the law of supply and demand and investors utility functions. The authors assume the market contains only two types of investors: bears and bulls. Bulls tend to perceive the value of assets with optimism and as such, they react only to positive information. Bears, on the other hand, are of a

Table B

Summary of Emperical Studies on Price Changes per se-Volume Correlation[b]

Authors	Year of study	Sample Data	Sample Period	Interval Period	Positive Correlation
Granger & Morgenstern	1963	Stock market aggregates 2 common stocks	1939-61	weekly	NO
Godfrey et al	1964	stock market aggregates 3 common stocks	1959-62 1951-53,63	weekly, daily,trans.	NO
Ying	1966	stock market aggregates	1957-62	daily	YES
Epps	1975	20 NYSE bonds	jan. 1971	trans.	YES
Morgan	1976	17 common stocks	1962-65	4 days,	YES
		44 common stocks	1926-68	monthly	
Epps	1977	20 common stocks	jan. 1971	trans. daily	YES
Hanna	1978	20 NYSE bonds	may 1971	trans.	YES
Rogalski	1978	10 common stocks 10 warrants	1968-73	monthly	YES
James & Edmister	1983	500 common stocks	1975,77-79	daily	NO
Comiskey, Walking & Weeks	1984	211 common stocks	1976-79	yearly	YES
Harris	1984	50 common stocks	1981-83	trans., daily	YES
Smirlock & Starks	1985	131 common stocks	1981	trans.	YES
Wood , McInish and Ord	1985	946 common stocks 1138 common stocks	1971-72 1982	minutes	NO
Harris	1986	479 common stocks	1976-77	daily	YES
Jain & Joh	1986	stock market aggregates	1979-83	hourly	YES
Richardson, Sefcik & Thompson	1987	106 common stocks	1973-82	weekly	YES

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[b] Source: J.M. Karpoff, "The Relation between Price Changes and Trading Volume: A Survey", Journal of Financial and Quantitative Analysis, 1987, pg118.

pessimistic nature and tend to respond only to negative information. The authors reason that bulls create the demand, while bears produce the supply in the market. Furthermore, the demand curves of bulls are much steeper than the supply curves of bears. In lieu of this greater steepness, any reaction by bulls resulting in positive price changes will produce volume greater than a reaction by bulls resulting in negative price changes. The consequence is a positive price change-volume relation.

Karpoff (1987) questions this model believing it is not likely bulls will ignore negative information and bears will ignore positive information. He proposes the relationship is observed because of the different costs involved between taking long and short positions. Restrictions on short sales (ie. margins and unavailability of short sale funds) are costly for the investor. An investor with negative information may thus be reluctant to act on it. With fewer traders acting on negative information, falling prices will produce less volume than rising prices. However, in markets with no short sale constraints, the positive correlation will not be observed. Futures are just such markets. In support of his costly short sale hypothesis, Karpoff (1988) illustrates the absence of the positive price change-volume correlation in this market.

VI. Research on Option Trading Preference

There have been numerous studies conducted to test the efficiency of the securities market. Such studies have included the testing of security price reaction to announcements, including stock splits, stock dividends, mergers and acquisitions, secondary block offerings, and quarterly earnings and dividends. However, the effects of option listing on the market efficiency of underlying securities has not received its deserved attention.

Proponents of the Option Trading Preference Theory (Black (1975), Manaster and Rendleman (1982)) suggest that traders often prefer taking positions in the option rather than the underlying asset itself. Manaster and Rendleman(13) provide three reasons for this preference:

- Since one option is the equivalent to taking a position in 100 shares, there is a reduction in transaction costs.

- There is the absence of an uptick rule in shorting options.

- Finally, traders can obtain a greater degree of leverage through option positions.

As a consequence, options are an investment vehicle that provides for greater liquidity, lower trading costs, and fewer restrictions than stocks. Furthermore, its dramatic potential for greater returns through enhancing cash flows and reducing risk make options even more attractive to investors. Therefore, one would expect options to play a predominant role in determining equilibrium prices for the underlying asset. This is evident in the one day lead time option trading has over stock trading in absorbing new information (Manaster and Rendleman, 1982). No doubt, this is an important issue in itself since inefficiencies of extreme proportions may tarnish the credibility of the securities markets and has direct bearing on the EMH.

Does the existence of the options market have any impact on the securities market? Initially, the research has found inconclusive evidence of option listing impact on securities. The Nathan Report (Robert P. Nathan Associates, 1974) funded by the CBOE, tested whether the securities market's liquidity, volume, volatility, price movements and operational efficiency were influenced by the advent of the options market. The study found that there is some influence but it is small and negligible. However, the study was conducted in 1973, a very short time after options commenced trading on the CBOE and thus trading volume was still relatively light. In spite of this result, the CBOE continued to fund studies on option listing impact. In general, the subsequent research found little evidence of option listing influence on the price and volume of securities, but did find some indication of influence on volatility. Trennepohl and Dukes (1979) attempt to determine whether or not option listing affected the systematic risk of the underlying security. The study involves a 30 month period surrounding the initial option listing. They concluded that option listing had no significance on systematic risk. Klemkosky (1978) investigates the effects of an option expiration on the price of the underlying security, and he did find some evidence of price influence. Furthermore, Hayes and Tennenbaum (1979) looked at 64 companies that were listed with options upon the market's opening. Their study involves a cross sectional study between an experimental group and a control group (without option listings) over a 65 month period. Their results are interesting in that the CBOE option listed security had a market share increase from 25 to 34 percent compared to the control group. This is a 33% increase in market share over the control group. Klemkosky and Maness (1980) examined the impact of option trading on the risk of individual securities and a portfolio of option listed securities. Beta is used as the risk measure and the market model is the method employed to measure the option market's impact on risk. The authors look at three periods-one surrounding the opening of the options market on the CBOE and two post periods. Their results reveal that option listing had negligible consequences on the betas of individual securities, as well as on the betas of entire portfolios.

The previous studies cited indicate mixed results on the option market's influence. Although not conclusive, several of the studies researched by this student indicated evidence of influence on the underlying security's volatility.

Since, it is generally accepted that options are more attractive than underlying securities and that the options market seems to influence (in some way) the securities market, is it safe to assume that option prices are predictors of stocks prices- absolutely not. The research cited made no mention of the direction of this influence. According to Anthony (1988), there is good reason to believe that option prices predict stock prices. The study attempted to find a causal relation between option volume and the trading volume of underlying securities The study hinges on the fact that trading volume can be used as proxy for the rate of information arrival. Copeland (1976) suggests that the relationship between absolute price changes and volume is positive and linear given the sequential arrival of information hypothesis. Anthony strives to determine if the sequential flow of information is applicable to the volumes of option and securities market. The methodology involves the use of the econometric tests for causality devised by Granger (1977).

A sample of 25 firms was used. Applying the test for causality to each of the observations reveal that option volume predicted stock volume in 12 of the 25 observations, while stock volume caused option volume in 3 of the 25 observations. In addition, the results show a one day lead that option volume had over stock volume in absorbing information. These findings are consistent with the sequential theory of information arrival and the option preference hypothesis. It must be cautioned that this research did not deal with the market efficiency question, only the direction of the relationship between option and securities volume.

Patell and Wolfson (1978) explore the notion of whether anticipated information releases are reflected in call option prices. They examine the behaviour of call option prices surrounding the dates of a financial reporting event. In this case, it is the annual earnings announcement. The authors believe that call options were an ideal instrument for this type of analysis since anticipated future changes in the underlying security should be reflected in implied volatilities. Essentially, they looked at implied volatilities through a time series surrounding the date of the announcement. What they found is an anticipation to the announcement evidenced by the profound increase in implied volatility prior to the event. However, leading up the announcement date, the implied volatilities dropped dramatically. What is important about this study is it supports the hypothesis that option premia provide information regarding future underlying stock price movements.

In a similar study, Manaster and Rendleman (1982) examine whether implied stock prices calculated via the Black-Scholes Option Pricing Model contain information concerning future movement of observed stock prices. The problem with using implied BSOPM stock prices is that they are difficult to compute since the standard deviations of securities are difficult to observe. The authors solve this problem by calculating the implied volatility and implied price simultaneously and minimizing the sum of the squared deviations between observed and calculated option prices.

The research involved creating two portfolios. One portfolio was created using the implied stock prices and the other was constructed using the observed stock prices. Then the proportional errors (Δ) were calculated for each stock in the portfolio. The proportion is expressed in equation (13).

$$(13) \qquad \Delta_{jt} = \frac{(S^{*}_{jt} - S_{jt})}{S_{jt}}$$

where S^{*}_{jt} is the implied stock price and S_{jt} is the observed stock price. (Δ_{jt}) is defined as the percentage deviation of observed stock price from implied price for each observation. The average (Δ) between the portfolios for all 172 companies in the sample was determined. A large (Δ) meant that information may be contained in the implied stock prices that is not inherent in the observed stock prices. If inefficiencies do exist, then one would expect abnormal returns from the portfolio ie. arbitrage opportunity. Therefore, the study proceeded to verify whether or not there is a positive relationship between a large estimated (Δ) and future stock returns. A positive relationship may indicate the existence of abnormal returns. They found a strong positive relationship between a large average (Δ) and future stock returns.

Manaster and Rendleman conclude that there may be non-normalities in the market caused by options listing, where options contain information not yet absorbed by the underlying stock. Interestingly, they do not automatically infer inefficiencies in the market from their findings. In fact, they propose that option markets may actually promote efficiency in the securities markets because they accelerate the rate at which stocks absorb new information.

Jennings and Starks (1986) conducted a study comparing the price adjustment process to quarterly earnings announcements between two samples. One sample contains option listed securities, the other contains non-option listed securities. The data were chosen cautiously so that characteristics of all observations in both samples are similar in every aspect except for option listing differences. They are matched as closely as possible with respect to the following three characteristics- (1) Firm capitalization, (2) Number of institutional investors holding the stock and (3) number of transactions in the sample period. This is to ensure that differences other than option listing do not contaminate the results. The methodology involves measuring the price change sequences surrounding the quarterly earnings announcement. That is, the speed at which the announcement is absorbed through the observation of price changes.

Their results reveal differences in the price adjustment process between option listed and non-option listed securities for the time periods in question. Option listed securities have a price adjustment sequence that occurred zero to three days after the earnings announcement (that is higher or lower than expected), while non-option firms exhibited a much longer period of price adjustment. The fact that non-option firms took much longer to adjust suggests that option trading preference may hold true. Investors with valuable information will act on it through option trading. As a result, prices of option listed securities will absorb new information faster than prices of non-option listed stocks. The findings also support the notion of option listing promotes efficiency. Furthermore, the authors suggest that option markets provide other advantages including an outlet for information transfer, a source for risk reduction, contributing to market completeness.

At the very least, the above synopsis of research on option preference provides enough evidence of option market impact on the equity market. Therefore, it is not out of the question to postulate that option volume will influence equity price changes to provide the basis for our study.

3. THE SELECTION OF THE TRADING ACTIVITY VARIABLES

In addition to the obvious trading activity variables-option and stock volume, our research will include option open interest. Early theoretical research by Epps and Epps (1976), Tauchen and Pitts (1983), Harris (1987) and others continuously make mention of variables representing market depth. In fact, Tauchen and Pitts theorize that greater market depth may reduce volatility. Most commonly, market depth is represented by the number of traders in the market and more often than not, it is assumed to be fixed. As such, it implies that market depth plays a substantial role in the price-volume relation. Bessimbinder and Seguin (1993) investigate the relation between market depth and volatility in the futures market. They equate market depth to the number of traders in the market or the amount of capital flowing into the market. These factors are suspected to enhance market depth and reduce volatility. Their results support this hypothesis in that the relation between market depth and volatility was found to be negative. In the opinion of this researcher, greater market depth translates into more market participants and thus, a larger proportion of accurate information in the market. This will dilute the effects of traders with inaccurate information and reduces the volatility in prices. In any event, the crucial point is that market depth is relevant to this study. The most readily available proxy for market depth is option open interest[2] and we will include it in our analysis.

4. EXPECTED VERSUS UNEXPECTED COMPONENTS

It is widely accepted in the literature of economics and finance that expected and unexpected components of variables have differentiating effects. As such, our study distinguishes between unexpected and expected components of trading activity. With respect to the price-volume relation, we want to determine whether surprises in trading activity have a greater impact on volatility than anticipated activity. Bes' .mbinder and Seguin (1992, 1993) decompose volume into unexpected and expected components using an ARIMA(0,1,10) specification. Their results support the premise that unexpected volume explains more about the volatility in prices than expected volume.

Our study will decompose trading activity into expected and unexpected components. Volume for most financial time series follows an autoregressive structure. This is not surprising because according to the MDH, both volume and prices are determined jointly by the unobserved mixing variable (number of daily information events), which is also hypothesized to be serially correlated. Fortunately, serial correlation makes

[2] This assumes option open interest is a viable measure for equity market depth, which is a reasonable assumption According to the Option Preference Theory, many investors with information concerning the underlying equity will transact in the options market.

volume highly forecastable.

Each trading activity variable will be partitioned into expected and unexpected components using the forecasting methods of Box and Jenkins (1976). The expected component is predictable in that we can use past volume observation to estimate expected volume. Any portion of volume that cannot be predicted from historical values is deemed unexpected and unpredictable. Expected and unexpected components can be written as

$$(14) \qquad V_t = E(V_t | V_{t-1}, V_{t-2} \ldots\ldots) + \epsilon_t = E(V_t) + \epsilon_t$$

where $E(V_t)$ is the mean value for the volume series and any deviation from the mean is unexpected and contained in the error term. Yet, how do we model our volume series. Schwert (1977) uses a moving average process of order (4) to model expected components for his volume series. However, he found the third MA parameter to be insignificant.

Following Schwert (1977), this study will also employ an MA(4) to model the expected volume component. However, since many stationary random processes cannot be modeled as solely an autoregressive or moving average process and because this study does not attempt to find an ideal model for forecasting, it will also incorporate an AR(1). The final model is now an ARIMA process of order (0,1,4) given by equation (15).

$$(15) \quad \hat{V}_t = \Phi_1 V_{t-1} + \alpha + \delta d_t + \epsilon_t - \Theta_1 \epsilon_{t-1} - \Theta_2 \epsilon_{t-2} - \Theta_3 \epsilon_{t-3} - \Theta_4 \epsilon_{t-4}$$

After obtaining the estimates for expected volume using the forecasting model specified in equation (15) , we merely subtract them from actual volume counterparts to compute the unexpected volume components.

To account for the influence of option expiry, we incorporate an intervention dummy (d_t) in our forecasting model. The reason for the intervention analysis is that there is still the possibility of unexpected shocks to volume due to expiration-day effects. Studies by Klemkosky (1978), Manaster and Rendleman (1982), Anthony (1988) and others document evidence of option markets influencing equity markets. Klemkosky concludes that an option's expiry has an impact on underlying stock's price. Since, numerous studies referenced document the positive stock price-stock volume correlation, it is safe to presume an option's expiry will also influence the underlying stock's volume. This is the rationale behind the use of intervention analysis.

5. EMPIRICAL METHODS

I. *GARCH process*

This study strives to provide additional evidence on the interrelation between volatility and volume. Prior research has postulated the MDH to be the cause of heteroscedasticity in speculative prices (Clark (1973), Tauchen and Pitts (1983), Harris (1987)). Furthermore, we know that the GARCH(1,1) process provides an optimal fit for many economic time series because it captures the persistence in volatility shocks (see Bollerslev (1987), French, Schwert and Stambaugh(1987), Lamoureux and Lastrapes (1990)). The model accommodates for this persistence by imposing an autoregressive structure on conditional variances, whereby they are linearly related to lagged errors squared and lagged conditional variances.

Why should we use the GARCH modelling process? Bessimbinder and Seguin (1992, 1993) successfully study the relationship without employing the GARCH model as described in this paper. Their methodology involved simultaneously solving linear equations for return and standard deviation. Although they include parameter estimates for lagged raw residuals and lagged standard deviations to capture volatility shocks, it is not a GARCH process. Using their methodology, it is not possible to justify the price-volume relation through the MDH. Since this researcher accepts the validity of the MDH, this study will employ methods which link it to the relationship. Lamoureux and Lastrapes (1990) establish the link between GARCH (heteroscedasticity in returns), MDH, and Volume as described previously in this paper. They show that in the absence of volume, the GARCH model captures the persistence in volatility shocks. However, once volume is included, the lagged squared errors and lagged conditional variances stop contributing information concerning conditional variances. This study will also use the GARCH(1,1) model to investigate the volatility-volume relation. The GARCH(1,1) is expressed by the following

(16) $r_t=\mu_{t-1}+\epsilon_t$

(17) $\epsilon_t|(\epsilon_{t-1},\epsilon_{t-2}........)\sim N(0,h_t)$

(18) $h_t=\beta_o+\beta_1\epsilon_{t-1}^2+\beta_2 h_{t-1}$

where r_t is the rate of return and μ_{t-1} is the mean return conditional on past returns. After estimating coefficients for the GARCH(1,1) model without volume, the expected and unexpected components for each of the three trading activity variables will be included in the model (not simultaneously). The trading activity variables being stock volume, option volume, and option open interest. The model will take the following form

(19) $h_t=\beta_0+\beta_1\epsilon_{t-1}^2+\beta_2 h_{t-1}+\beta_3 E_t+\beta_4 U_t$

where E_t and U_t in equation (19) are the contemporaneous expected and unexpected volume components respectively.

Next, we add parameters for day of the week effects. This is done to capture any differences in daily volatility in returns (French (1980), Bessimbinder and Seguin(1992,1993)). Equation (20) illustrates the model in its entirety.

$$h_t=\alpha_o+\beta_1\epsilon_{t-1}^2+\beta_2 h_{t-1}+\beta_3 E_t+\beta_4 U_t+\beta_5 M_t+\beta_6 T_t+\beta_7 TH_t+\beta_8 F_t \tag{20}$$

where M (Monday), T (Tuesday), TH (Thursday) and F (Friday) represent the days of the week indicators.

II. *Asymmetric GARCH*

Past research on the asymmetry of the price change-volume relation is weak and inconclusive. However, more studies than not have shown the relationship to be positive. This study will explore further into the asymmetric phenomena and in doing so, attempt to provide more conclusive evidence of its existence.

The question is can we use a GARCH-type process to incorporate asymmetry into our research? The answer is yes. The exponential GARCH (Nelson, 1991) and asymmetric GARCH (Engle, 1990) are two methods that allow us to do so. Unfortunately, the parameter estimates for the EGARCH are not as easily obtained as the parameter estimates for the AGARCH. We opt to using an AGARCH(1,1) process.

The AGARCH model makes it possible to link the conditional variances to not only the absolute magnitude of the lagged residual but also to their actual sign. Unlike the AGARCH, the GARCH model does not accommodate for sign changes in the residuals because it is linear function of lagged squared residuals-an absolute magnitude. Engle (1990) proposes the model take the following form

$$h_t=\beta_0+\beta_1|\epsilon_{t-1}|^{1.70}-\beta_2\epsilon_{t-1}+\beta_3 h_{t-1} \quad (21)$$

It is the third term (β_2) in equation (21) that captures the relation between sign changes in lagged residuals and conditional variance.

The model contains a geometric decay for the absolute residuals-the absolute residual maintain a power of 1.7; according to Engle it is an approximation. A geometric distributed lag of absolute residual is necessary for the model to provide an optimal fit.

Previous research (Nelson, 1991) linking conditional variance to the sign of the lagged residuals reveals the relation to be negative. This implies that falling prices (negative returns) produce greater volatility that rising prices (positive returns). The observed inverse relation is attributed to leverage effects (Christie (1982), Nelson(1991)). As prices fall, one can achieve greater returns with a change in price. Essentially returns are magnified with falling prices. Consequently, returns become more elastic and more volatile.

As with the GARCH model, we will determine the parameter estimates for the AGARCH without volume. Next, the model will include contemporaneous unexpected and expected components for each of the trading activity variables (equation(22)).

$$(22) \quad h_t = \beta_0 + \beta_1 |\epsilon_{t-1}|^{1.70} - \beta_2 \epsilon_{t-1} + \beta_3 h_{t-1} + \beta_4 E_t + \beta_5 U_t$$

This study uses the maximum likelihood method to ascertain the coefficient estimates for the GARCH and AGARCH models. It involves the numerical maximization of loglikelihood function by way of the Berndt, Hall, Hall and Hausman Algorithm. The method requires initial estimates for the coefficients. However, the BHHH method is very confining with respect to their values, whereas the simplex method maintains more lenient prerequisites. As such, the maximum likelihood estimates of the coefficients using the simplex method serve as the initial values for the calculation of the estimates using the BHHH method.

6. DATA

Our study uses data on 45 companies (table 2A) that trade on the NYSE and have options listed on the CBOE. In order to avoid nonsynchronous data in either market, we selected the highest ranking stocks in terms of option volume for our sample period. Since stocks with listed options are required to maintain a minimum level of trading activity for this privilege, the nonsynchronous trading problem is avoided in both stock and option markets. The sample period consists of a seven month period between January 1, 1991 and July 31, 1991; the interval period is daily. The Compustat tapes supplied the data on equities. However, the data on option volume is not as easily accessible without incurring greater costs.

Instead, Francis Emory Fitch Publications (1991) provides data for daily option sales on the CBOE.

The option volume data from these publications requires some screening before it can be put through analysis. Options contain volume not only based on information concerning underlying stocks but also based on hedging and arbitrage strategies[3]. Since this study examines the interrelation between equity prices and option volume, we require only that volume pertaining to information flowing between these two markets. Fortunately, Francis Emory Fitch publications distinguishes between option volume based on spreads and those that are not. We merely tabulated the total daily option volume and subtracted the volume based on spread strategies. Covered position strategies are not included in the spread volume. However, volume pertaining to this particular spread strategy is assumed to be constant and consequently, its inclusion in option volume will not attenuate the price-volume relation.

Yet another obstacle is the difference in the trading day between the NYSE and CBOE. The CBOE trading closes ten minutes after trading on the NYSE. This technical factor alone may exaggerate a lead-lag time between the option and equity market in assimilating information (Anthony, 1988), thus affecting our results. Furthermore, it is not conceivable that option volume will impact equity prices contemporaneously when one

[3]It is assumed that these strategies disregard information specific to the underlying stock.

market has stopped trading-the channel for information flow is severed. In lieu of this, the volume for the last ten minutes of each trading day on the CBOE is also subtracted from the total daily option volume.

The data comprises of the following series for each stock: close to close price changes, open to close price changes, close to close returns[4], open to close returns, option expiry indicator, day of the week indicator, raw option volume, standardized option volume, standardized stock volume, open interest. Standardized option volume is defined as raw option volume for the day divided by its corresponding open interest, whereas the standardized stock volume is defined as stock volume divided by number of shares outstanding. Options have differing premiums and maturities and thus they are not directly comparable to their underlying stocks. Relative volume values will alleviate this problem.

Due to circumstances relating to the option expiry cycle, all the stocks in our sample had a portion of their options expiring in every month. As such, the option expiry dummy indicates the third Thursday and Friday of <u>each</u> month in the sample. The number "2" indicates the third Thursday of every month, while the number "1" designates the third Friday of each month. Zero designates all other days in the sample.

[4]Returns are cum-dividend and adjusted for stock splits.

7. EMPIRICAL RESULTS

Preliminary examination of the stock price change-option volume relation provides groundwork for further investigation. Table 1 (appendix A) illustrates mean correlation results between various price change series and volume series. All stocks are examined individually[5], after which the average is tabulated. In the first case, the absolute value of close to close price changes (A) are matched with each volume series. The results reveal that close to close price changes possess a stronger positive correlation with option volume than with stock volume. In the second case, the absolute value of open to close price changes (B) are matched with each volume series. Again, we find price changes have a stronger positive correlation with option volume than with stock volume. These findings are common to almost all the various price change series. The following summarizes the results in table 1:

- Except for price change series F and L, all price changes maintain stronger positive correlations with option volume than with stock volume.
- In all cases, close to close price changes possess stronger positive correlations with volume than does open to close price changes.
- In all cases, positive price changes have stronger positive correlations with volume than does absolute negative price changes.

The last point supports previous research on the price change-volume

[5]The correlation results for individual stocks are reported in appendix B.

relation in which a positive correlation is documented; larger volume is associated with positive changes. Furthermore, the results point out that option volume may in fact have a stronger positive association with price changes (returns) than the underlying stock volume. As a consequence of close to close price changes having a stronger correlation with volume (in general) than open to close price changes coupled with the realization that the majority of investors are not day traders, hereafter, this study will not include open to close data in the analysis.

I. Empirical Properties

Prior to examining the results of the maximum likelihood estimates for the GARCH and AGARCH models, we illustrate some important empirical properties of the data that corroborate with the MDH. Table 2A reports the test statistics for skewness, kurtosis, and autocorrelation. The skewness and kurtosis statistics are tests for normality. The table documents the non-normality of the daily return series. With respect to skewness, the non-normality is not so apparent; only 8 stocks are found to be non-symmetric at the 5% level and a mere 6 stocks at the 1% level. On the other hand, the kurtosis statistic reveals strong evidence of leptokurtosis; 20 (17) stocks exhibit leptokurtosis at the 5% (1%) level. These results support the findings of early research (Clark (1973), Harris (1987)) in which the distribution of returns are leptokurtotic.

This same table also reports the Box-Ljung Q-statistic for autocorrelation for up to 20 lags. According to Tauchen and Pitts (1983) and other proponents of the MDH, the price change distribution is determined by the random number of daily informational events. Since daily informational events are suspected to be serially correlated and given its direct relation to price changes, we would expect price changes (returns) to also follow an autoregressive structure. Our results are in accord with the above hypothesis. All 45 stocks have statistically significant Q-statistics at the 5% level. Even at the 1% level, 44 of the 45 stock's Q-statistics are significant.

Table 2B illustrates the results of Engle-ARCH heteroscedasticity test on the daily returns. The return series should exhibit heteroscedasticity according to the MDH. The daily price changes are sampled from a set of distributions with different variances. This set of distributions change from day to day because they are determined by a stochastic process-the number of daily informational events (Clark (1973), Tauchen and Pitts (1983), Harris (1987)). This previously mentioned relation was stated on numerous occasions in this paper and will continue to be reiterated because it is the central point that will links theoretical research with our empirical results. Our findings support early research. At the 5% significance level, returns exhibit heteroscedasticity for at least 36 of the 45 stocks at each of the first, second and fourth lags. Although, only 27 of the 45 stocks exhibit statistically significant χ^2-statistics at the tenth lag, it is still more than half of our sample. The results are similar at the 1% significance level. There are indications of heteroscedasticity in returns for 34 stocks at the first lag, 35 stocks at the second lag, 29 stocks at the fourth lag, and 23 stocks at the tenth lag. These results reveal strong evidence of heteroscedasticity in our return series.

II. Difference Between The Two Volume means

This study employs an ARIMA(0,1,4) forecasting model accompanied by an intervention analysis to decompose the volume series into expected and unexpected components. The intervention is the effect of option expiry on each trading activity. As this paper has shown, the option market has an impact on the stock market. Whether option expiry has an impact on any of our volume series is yet to be determined and the basis for the statistics in table 3. STF is test statistic for the significant difference between the average stock volume for Fridays characterized by option expiry and the average stock volume for all other Fridays. Nineteen of the 45 stocks exhibit a significant (at the 5% level) difference between the two means. STT is the same analysis except it is comparing the average stock volume for Thursdays prior to Friday option expiry and the average stock volume for all other Thursdays in the sample. In this case, only 5 stocks exhibit a significant difference between the two means. OPF and OPT are similar investigations but they are pertaining to option volume. we find 19 stocks show significant difference between the two Friday option volume means. Concerning option volume on Thursdays, only 12 stocks exhibit a significant difference between the two means. OIF and OIT are the T-test results pertaining to open interest. With respect to open interest on Fridays, 16 stocks demonstrate statistically significant differences between the two means. For Thursdays open interest, it is 17 stocks. These results reveal moderate evidence of expiration-day effects and provides enough evidence to warrant the use of an intervention analysis in our forecasting model.

III. Results For the GARCH Model Variations

a. GARCH(1,1)

Table 4A reports the maximum likelihood estimates[6] for the GARCH(1,1) model without volume. It also reports the average estimated coefficients and average T-statistic for all the stocks in the sample. The results show that the average coefficient (β_1) for lagged squared residuals is not significant at the 5% level with an average T-statistic of 1.45. As such, only 10 of the 45 stocks exhibited statistically significant coefficients relating lagged squared residuals to conditional variance. However, the average coefficient (β_2) for lagged conditional variance is positive and significant at both the 5% and 1% levels with an average T-statistic of

[6] R.A.T.S version 4.0 statistical package is used to determine all estimates, see appendix C for a sample program

3.558. This result is agreement with findings by Lamoureux and Lastrapes (1990). It suggests conditional variance is explained by lagged variances in the no-volume model and an indication of persistence in conditional variance. It also complies with the MDH. Heteroscedasticity is a consequence of the MDH and it is the reason why the GARCH process performs so well under these condition. The fourth column ($\beta_1+\beta_2$) is the total persistence in volatility measured by the GARCH model (see Lamoureux and Lastrapes, 1990).

b. GARCH with stock volume

Table 4B reports the results when stock volume is included in the GARCH model. Forty-four stocks exhibit statistically significant positive coefficients (at the 5% level) relating unexpected stock volume to conditional variances. Even at the 1% level, 39 stocks exhibit significant coefficients. In general, unexpected volume coefficients are larger and more significant than any other in the model with an average coefficient (β_4) and T-statistic of 0.196 and 4.395 respectively. For the expected stock volume variable, only 20 of the 45 stocks have statistically significant positive parameters. This number falls to 13 at the 1% significance level. The average coefficient (β_3) and average T-statistic for expected volume are smaller than their unexpected volume counterparts. In agreement with findings by Bessimbinder and Seguin (1992, 1993), unexpected volume components contribute more information about volatility than expected volume components.

In the presence of stock volume, the coefficients for lagged variances become insignificant. This is consistent with results found by Lamoureux and Lastrapes, and suggests that stock volume, a proxy for information flow, explains for much of the heteroscedasticity in returns (MDH). Further evidence is the difference in the measure of persistence in volatility shocks ($\beta_1+\beta_2$). The average for this measure in the GARCH model alone is 0.335. Once volume is added, its value falls to -0.04, signifying diminishing volatility shocks. This finding demonstrates that the price-volume relation arises because both series are jointly determined by the same mixing variable

c. GARCH with raw option volume

The maximum likelihood estimates for the GARCH(1,1) with raw option volume are reported in table 4C. At the 5% significance level, only 19 expected option volume coefficients are significant with an average coefficient (β_3) of 0.028 and an insignificant T-statistic of 1.371. Unlike the finding by Bessimbinder and Seguin (1992), where the futures (derivative) market is suspected to stabilize the equity market, this result implies that the existence of an option (derivative) market has little effect on equity volatility.

Not surprisingly, unexpected option volume explains volatility better than the expected component. At the 5% level, 41 stocks have unexpected coefficients that are positive and significant with an average coefficient (β_4) and significant T-statistic of 0.036 and 4.16 respectively. Only 19 stocks obtain statistically significant expected option volume coefficients (at the 5% level). The results are similar at the 1% level, where 36 of the 44 stocks obtain statistically significant coefficients for the unexpected component and only 11 stocks possess significant coefficients for the expected component. Again, this result is agreement with findings by Bessimbinder and Seguin(1992, 1993); unexpected volume plays a larger role in explaining volatility. But more importantly, the results show that option volume may also serve as a proxy for information flow.

Once option volume is included in the model, the estimated coefficient for lagged variances become insignificant with the average T-statistic decreasing to 0.899 from 3.558 in the GARCH model without volume. This implies that option volume, like stock volume explains much of the heteroscedasticity in returns. In accordance with the MDH, option volume and price changes are also jointly determined by the same mixing variable giving rise to a positive correlation. The GARCH measure of persistence in volatility shocks ($\beta_1+\beta_2$) has fallen from 0.335 (without volume) to -0.121 in the model with option volume.

d. GARCH with standardized option volume

Table 4D illustrates the results of the GARCH model with a measure for standardized option volume. This activity series provides for an interesting relative measure for option volume in that it is influenced by the size of the market. In any event, we find no profound difference in the results between standardized option volume and raw option volume. The coefficient for unexpected volume component is positive and statistically more significant that its expected counterpart. As did raw option volume, this measure for volume may also serve as a surrogate for information flow. The coefficients for lagged variances become insignificant once standardized option volume is included in the model with volume explaining much of the conditional variance.

e. GARCH with open interest

A measure for market depth is also incorporated into the GARCH model. Table 4E reveals the results of GARCH(1,1) with option open interest. The findings are not as strong as for other trading activity variables. Only 13 stocks have positive and statistically significant coefficients for unexpected open interest with an average coefficient (β_4) that is significant at 5% but not a 1%. Furthermore, the average coefficient (β_3) of for the expected component is significant neither at the 1% level nor at the 5% level. Interestingly, the average coefficient (-0.203) for the unexpected component is negative implying an inverse relation between market depth and volatility. That is, an increase in market size will result in a reduction in volatility. This is in agreement with previous works and theoretical research for which greater market depth is hypothesized to reduce volatility (Tauchen and Pitts (1983), Bessimbinder and Seguin (1993)). Unlike its unexpected counterpart, the average coefficient for the expected component is positive; this result is inconsistent with the market depth hypothesis. Nonetheless, open interest is a poor substitute for information flow and fails to explain the heteroscedasticity in returns. After open interest is included in the model, the average coefficient for lagged variances (β_2) does become statistically insignificant but barely; the average T-statistic is 1.854. This suggests that even after open interest is added to the model, persistence in variance still exists.

f. Day of the week effects

Table 5A reports the GARCH model with stock volume as well as day of the week indicators. Adding day of the week indicators did not lead to any significant changes to the results pertaining to other parameters in the model. Unexpected volume components still explain most of the variance in returns with 41 of the 45 stocks exhibiting statistically significant positive coefficients. As anticipated, the average coefficient for the expected component is smaller and less significant than for its unexpected counterpart with only 23 stocks having statistically significant coefficients (at 5%) . The average coefficients for lagged squared residuals as well as the lagged variances are small and insignificant. Concerning the day of week indicators, previous work has documented a weekend effect in returns. In general, Fridays exhibit greater positive returns, while Mondays have lower or negative returns. In any event, the main point is that both days demonstrate excessive volatility compared to other days of the week. Our results do not corroborate with the weekend effect. The coefficient for neither Monday nor Friday is statistically significant at the 5% level. Only 10 stocks obtained statistically significant coefficients (β_8) for Friday. With respect to a Monday effect, the number is even smaller with a mere 6 stocks having statistically significant coefficients (β_5). The Thursday indicator is the closest to showing a day of the week effect with 18 of the 45 stocks having statistically significant coefficients (β_7). However, with an average T-statistic of 1.505, the average coefficient is still insignificant at the 5% level. The results are similar for the GARCH model with option volume and day of the week indicators. Table 5B reveals none of the average coefficients for day of the week indicators are significant. Nevertheless, the Monday indicator did obtain statistically significant coefficients (β_5) for 21 stocks at the 5% level. Moreover, the average coefficient (β_7) for the Thursday effect is significant at the 10% level with 22 stocks obtaining statistical significance (5% level). Oddly enough, the Tuesday indicator (β_6) shows the strongest evidence of a day of the week effect in the open interest model (table 5C). It has an average T-statistic of 1.664, enough for statistical significance at 10% but not at 5%. Even though the evidence pertaining to day of the week effects is weak and inconclusive, this is not unusual. Bessimbinder and Seguin obtain similar results; they find weak and inconclusive evidence pertaining to day of the week effects and volatility.

VI. Results for Asymmetric Garch Variations

The crucial facet making the AGARCH model different from the GARCH model is the extra term capturing sign changes in residuals. Table 6A demonstrates the results of the AGARCH model excluding volume. The average coefficient (β_3) relating lagged variance to conditional variance is statistically significant at both the 5% and 1% levels; the average coefficient (β_1) for absolute magnitude of residuals is insignificant having an average T-statistic of 1.432. These findings are precisely the same as findings in the GARCH model alone. This is not surprising, except for extra term in the AGARCH model, they are essentially the same model . As for this extra term that captures sign changes in the residuals (β_2), we find it to be positive and insignificant with average coefficient and T-statistic of 0.169 and 1.372 respectively. Thus, sign changes in returns do not contribute information about conditional variance. In spite of this, the result does support findings by previous authors. It is important to note that the sign in front of term representing sign changes (β_2) in the model is negative. Given that the average coefficient for sign change is positive, it possesses an inverse relation to volatility. Therefore, negative price changes produce greater volatility than positive price changes. This result is in agreement with those found by Nelson(1991).

a. AGARCH with stock volume

What happens when we add stock volume to the AGARCH model? Table 6B reports these results. As observed in the GARCH model with stock volume, the unexpected volume component contributes most of the information pertaining to variance with the largest and most statistically significant coefficient (β_5). In addition, the average coefficient (β_3) for lagged variances becomes insignificant once volume in included. With respect to the common terms between the GARCH and AGARCH models, the results are very similar. What about the coefficient for sign changes? Concerning the AGARCH model without volume, eleven of the 45 stocks have statistically significant coefficients (β_2) for sign changes at 5%. Once stock volume is added , there are only 3 stocks having the same characteristic. Furthermore, the average T-statistic for this parameter decreases from 1.372 in the no-volume model to 0.794 in the model incorporating stock volume. Although the evidence is weak, this observation supports the hypothesis that sign changes in residuals may in fact contribute information about conditional variance and possibly explain the existence of asymmetry in the relation.

b. AGARCH with option volume, open interest

Table 6C reports the results of the AGARCH with option volume. The results are quite similar to that of stock volume, as such, we will not reiterate them. Nevertheless, it is important to note the similarities in the results illustrate that option volume is just as effective as stock volume in revealing information pertaining to volatility. As for open interest in the AGARCH model (table 6D), neither unexpected nor expected coefficients are significant. In fact, none of the coefficients in model show a statistically significant relation to conditional variance.

V. Goodness of Fit Test

We now take up a formal test for comparing the performance each model variation in terms of how well it adequately fits the data . In other words, we will ascertain which of the different variations of the GARCH model provides the optimal fit for the data. The test uses the likelihood ratio to make the goodness of fit comparisons. The ratio is expressed in equation (23).

$$(23) \quad \lambda = \frac{Max\, L(\theta)\ for\ the\ constant\ variance\ model}{Max\, L(\theta)\ for\ each\ model\ variation}$$

where $L(\theta)$ is the likelihood function. The test statistic is given by -2λ and has a χ^2-distribution with degrees of freedom r, where r is the number of unlike parameters between the models being compared.

Tables 7A and 7B illustrate the goodness of fit test for the GARCH model variations. Each variation is compared to the constant variance model. The test reveals that the GARCH excluding volume (test A) provides a poor fit with only 10 stocks have statistically significant χ^2-statistics. However, once stock volume is added to the model (test B), the fit improves dramatically ; 37 stocks obtain a superior fit over the constant variance model. The fit is equally improved when we add raw option volume to the GARCH(1,1) model (test C); 35 stocks obtain significant χ^2-statistics. Interestingly, The GARCH with standardized option volume (test D) did not perform as well as its counterpart with only 27 stock's χ^2-statistics obtaining significance. Throughout this study, open interest has been contributing weak findings. So it is not surprising that it provides the poorest fit (test E) of all activity variables with only 5 of the 45 stocks obtaining significant χ^2-statistics. When day of the week indicators are included in the model with volume, the goodness of fit diminishes. The model with stock volume and day effects (test F) possess only 14 stocks with a superior fit over the constant variance model. The findings are even weaker for the other volume variables with day effects: 6 stocks with significant χ^2-statistics for the option volume model (test G) with day effects and a mere 2 of the 45 stocks with significant χ^2-statistics in the case for open interest (test H) with day effects.

Two important points are derived from this goodness of fit analysis: (1) The GARCH model with volume (in general) provides a better fit for the data than the GARCH model excluding volume. (2) GARCH with stock volume and GARCH with option volume both provide an equally good fit for the data. Thus, we find that volume is the key variable omitted in the GARCH no-volume model that explains for its lack of fit. Consequently, volume is superior to lagged variances in explaining heteroscedasticity in returns. Furthermore, option and stock volume are both equally effective at explaining the observed heteroscedasticity.

The AGARCH process is not directly comparable to the GARCH process. No doubt, it is due to the extra term contained in the AGARCH model. As an alternative, each AGARCH with volume model is compared to the AGARCH without volume model. Table 7C reports the results. We find that the model with option volume (test I) fits the data just as well the model with stock volume (test J). In both cases, all 45 stocks obtain statistically significant χ^2-statistics.

8. SUMMARY AND CONCLUSION

In this study, we examine the relation between option volume and the volatility in underlying equity prices. We first illustrate that price changes in equities have a stronger positive correlation with corresponding option volume than stock volume. The study then proceeds to explain observed volatility-volume positive correlation in the context of the MDH. By utilizing a GARCH(1,1) process, we examine just how effective contemporaneous stock and option volume perform as proxies for information flow. We find that option volume is as effective as stock volume at representing information flow, both variables are equally proficient at predicting conditional volatility. This is an indication that the distributions of not only stock volume and price changes but also option volume are determined simultaneously by the same mixing variable, namely the number of daily informational events. At the very least, we conclude options will convey incoming informational events contemporaneously with the underlying equity. Given that a lead-lag time between the option market and stock market of up to one day has been documented, it is possible that option volume precedes stock volume in assimilating informational events infiltrating the market. Anthony (1988) claims the observed lead-lag phenomenon may be due to technical factors. The fact that the CBOE closes ten minutes after the NYSE may contribute to longer lead-lag time. However, this study made adjustments to account for this technical factor. The true lead-lag time is theorized to be less than one trading day and since this study uses a daily interval, a within-day lead-lag time between options and stocks will not be captured.

Market regulations and practices have lead us to believe derivative markets destabilize equity markets. The negative relation documented between expected futures volume and equity volatility implies futures trading actually promotes stability. This study finds no evidence of a relation between expected option volume and volatility. As with the futures market, our results suggest the existence of an options market does not promote instability in the equities market.

Concerning the asymmetry in the price-volume relation, the study shows larger volume is more associated with positive price changes than with negative price changes; this is consistent with previous works. We employ an asymmetric GARCH model to capture the sign changes in returns. Although the coefficient relating sign changes to volatility is insignificant, its value is negative implying an inverse relation. Previous works attribute this observation to leverage effects (Christie (1982), Nelson (1991)). Interestingly, the average T-stat for the sign change parameter decreases when volume is included in the model. Although weak, it may be an indication sign changes in returns influence the price-volume relation providing support for asymmetry.

The results also support the premise that expected and unexpected volume components have differentiating effects. In the context of the GARCH and AGARCH models, the unexpected components show substantially larger effect on the volatility of returns than does the expected components.

The findings provide evidence in support of the market depth hypothesis. In general, the average coefficient for unexpected open interest in both the GARCH and AGARCH models is negative. This suggests an unexpected increase in open interest (market depth) will lessen the reaction of volatility to unexpected volume. This finding is consistent with prior studies in which greater market size is believed to reduce volatility in returns (Tauchen and Pitts (1983), Bessimbinder and Seguin (1993)). Although, the average coefficient for expected open interest is positive, it is still insignificant and thus does not contradict the market depth hypothesis. Finally, this study finds no indication of a relation between days of the week and volatility.

The conclusions confirmed in this study will affect financial markets in three ways. First, the fact that the option market provides an alternate channel for information flow will have consequences on the Efficient Market Hypothesis. It has been suggested that the existence of the option market may enhance efficiency (see Jennings and Starks, 1986). Although, it is not documented in this study, If in fact options do assimilate information prior to their underlying stocks, then arbitrage opportunities will persist. The specific consequence on efficiency is not tested in this study. Our findings merely demonstrate the existence of an option market impact on the EMH, whether the option market enhances or diminishes efficiency is an interesting topic of future research. Second, since option volume, stock volume, and stock prices are jointly determined, we can improve the power of inference in event studies by studying the reactions to informational events in the option as well as the underlying stock. Finally, the study provides new insight into the empirical distribution of speculative prices. Option volume is an adequate proxy for information flow and it is just as effective as stock volume in explaining conditional variance.

There are a several potential extensions of this analysis. A shorter interval period might be employed to capture within-day differences in reaction time between options and stocks; a transaction interval would be the obvious choice. This study shed some light on the role of open interest as a measurement for market depth. The fact that open interest provides information not inherent in typical volume data is an interesting topic worthy of further analysis. The GARCH process has been extensively studied in financial literature and has long been accepted by academia. The same can not be said for the asymmetric GARCH process. This point alone is ample justification for future research on this unfamiliar model.

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Appendix A: Tables

TABLE 1: Mean Correlation Results For All the Stocks in the Sample

	OVOL	NOVOL	SOVOL	SSVOL
A	0.439	0.431	0.431	0.399
B	0.365	0.356	0.357	0.334
C	0.486	0.474	0.474	0.430
D	0.347	0.342	0.350	0.336
E	0.419	0.406	0.401	0.373
F	0.311	0.292	0.291	0.297
G	0.445	0.437	0.438	0.411
H	0.380	0.370	0.371	0.353
I	0.491	0.480	0.481	0.439
J	0.371	0.342	0.355	0.352
K	0.421	0 408	0.407	0.379
L	0.297	0.291	0.292	0.315

Note: A=Absolute close to close price changes,B=Absolute open to close price changes
C=Positive close to close price changes,D=AB' value of negative close to close changes
E=Positive open to close price changes,F=ABS value of negative open to close changes
G=ABS value of Standardized* close to close price changes, H=ABS value of Standardized*
open to close changes, I=Standardized* positive close to close price changes
J=ABS value of Standardized* negative close to close, K=Standardized* positive open to close
L=ABS value of Standardized* negative open to close price changes.

OVOL=raw option volume, NOVOL=OVOL-volume for last ten min. of trading.
SOVOL=NOVOL/open interest, SSVOL=stock volume/number of shares o/s.

* **Corresponding price change divided by the daily average stock price**

TABLE 2A

Emperical Properties of Daily Returns: S(Skewness)[a], K(Kurtosis)[b],

Q(20)[c] is the Box-Ljung Q-statistic for autocorrelations of up to 20 lags.

Co.	S	K	Q(20)	Co.	S	K	Q(20)
ARC	-0.481	3.631	34.329	LTD	-0.109	2.982	53.027
AVP	0.231	4.469	68.048	MCD	0.259	3.441	42.898
BA	-0.387	3.202	43.467	MMM	-0.151	3.745	66.341
BAC	0.270	4.188	59.723	MOB	0.041	2.89	60.559
BMY	-0.058	3.001	70.797	MRK	0.196	3.447	76.087
BV	0.545	3.802	55.751	NCR	0.393	7.268	82.332
C	0.084	3.914	73.979	OXY	0.095	3.788	60.913
CCI	0.454	4.415	57.793	PCI	-1.183	11.621	40.641
DOW	0.311	3.817	75.266	PEP	-0.305	5.027	59.827
EK	-0.024	2.734	58.035	S	-0.274	3.381	77.214
F	-0.386	3.004	53.260	SLB	0.308	5.092	51.212
FLR	0.125	4.922	51.148	STK	-0.241	4.521	42.705
GE	-0.087	3.521	91.074	SYN	0.234	3.169	51.706
GM	0.138	4.142	51.717	T	-0.112	3.363	52.161
GPS	0.207	4.058	45.059	TOY	-0.277	3.339	62.221
HM	0.315	3.476	76.097	TXN	-0.172	3.409	38.339
HNZ	0.156	3.421	96.605	UAL	0.047	3.306	48.194
HWP	0.059	5.191	60.397	UPJ	0.034	4.516	114.56
I	0.330	5.975	37.616	WMT	-0.221	3.473	75.909
IBM	-0.191	7.594	53.602	XON	-0.168	3.185	75.893
JNJ	0.132	2.719	85.758	XRX	0.484	9.057	59.082
KM	0.110	3.054	79.630				
KO	0.180	3.389	67.055	The proportion of stocks significant at			
LA	-0.748	5.725	53.731				
				5%	8/45	20/45	45/45
				1%	6/45	17/45	44/45

[a] The critical values are 0.38(5%) and 0.48(1%).

[b] The critical values are 3.80(5%) and 4.06(1%).

[c] The critical values are 31.41(5%) and 37.57(1%).

TABLE 2B

Engle-ARCH Test on daily returns for the first, second, forth and tenth lags.

The test uses a Chi-squared Distribution[a]

Co.	FIRST	SECOND	FORTH	TENTH	Co.	FIRST	SECOND	FORTH	TENTH
ARC	2.386	2.858	2.897	6.874	LTD	10.863	11.610	11.418	18.895
AVP	11.357	13.809	16.361	20.029	MCD	3.219	3.548	3.787	13.462
BA	18.084	18.861	29.911	40.527	MMM	8.652	8.814	10.057	13 047
BAC	12.879	18.829	18.508	20.105	MOB	11.521	13.325	13.928	16.893
BMY	17.290	18.042	19.289	25.094	MRK	5.894	6.672	11.423	22.661
BV	5.630	9.283	10.323	12.284	NCR	29.958	35.236	38.685	42.033
C	5.344	6.822	8.244	9.927	OXY	32.645	34.442	35.593	41.806
CCI	13.054	13.086	19.496	23.483	PCI	10.465	10.731	11.548	12.377
DOW	19.774	20.723	20.549	24.838	PEP	11.713	11.954	12.458	19.156
EK	10.477	10.957	11.534	17.549	S	12.884	13.051	23.378	30.208
F	1.545	2.162	5 171	10.917	SLB	21.368	24.192	24.378	25.337
FLR	29.821	30.510	30.068	36.132	STK	1.825	1.891	2.017	13.178
GE	13.925	20.566	21.762	21.451	SYN	1.420	4.537	7.379	16.714
GM	1.743	2.135	4.451	8.219	T	14.762	19.728	19.381	25.449
GPS	6.652	12.227	15.778	22.476	TOY	10.393	12.616	13.228	17.317
HM	7.4334	13.734	20.232	33.528	TXN	3.332	4.190	11.724	16.695
HNZ	8.318	18.007	19.127	26.420	UAL	5.284	5.235	6.747	10.864
HWP	10.731	11.084	12.978	14.727	UPJ	25.108	29.383	32.162	50.143
I	8.108	9.201	9.275	12.254	WMT	36.871	39.249	40.281	45.723
IBM	26.761	34.548	38.535	38.113	XON	21.553	21.959	21.904	25.300
JNJ	6.347	9.418	11.892	26.245	XRX	25.804	29.687	32.511	33.542
KM	10.889	14.389	9.703	11.625					
KO	8.876	13.495	19.997	29.006	The proportion of stocks significant at				
LA	24.553	24.318	28.272	27.636					
					5%	37/45	37/45	36/45	27/45
					1%	34/45	35/45	29/45	23/45

[a] The critical chi-stats at 5% are 3.84(1), 5.99(2), 9.49(4), and 18.31(10).
The critical chi-stats at 1% are 6.63(1), 9.21(2), 13.28(4) and 21.67(10).

TABLE 3

T-test* For the Significant Difference Between two Means.

Co.	STF	STT	OPF	OPT	OIF	OIT
ARC	2.782	1.641	0.971	1.504	1.920	2.345
AVP	0.014	1.413	0.601	0.780	1.222	1.219
BA	2.958	1.574	3.057	1.904	1.749	1.647
BAC	0.011	0.974	0.429	1.131	1.835	1.531
BMY	3.607	1.651	2.389	1.494	1.662	1.779
BV	-0.396	1.481	0.661	1.447	1.611	1.452
C	0.512	0.029	1.779	0.205	2.297	2.309
CCI	1.503	2.152	0.002	1.166	1.990	2.535
DOW	6.282	1.281	4.123	2.595	2.307	2.135
EK	5.093	0.379	2.671	0.614	1.773	1.751
F	0.984	0.004	0.359	0.457	1.487	1.528
FLR	0.683	-0.023	2.590	1.170	1.429	1.052
GE	4.570	1.648	0.139	2.075	2.388	2.361
GM	2.311	0.488	0.406	0.418	1.210	1.085
GPS	1.588	0.506	1.509	0.251	1.037	1.139
HM	0.091	0.083	1.005	0 973	1.866	2.182
HNZ	2.589	1.018	-0.059	-0.502	1.384	0.373
HWP	1.324	1.495	2.817	1.752	1.868	1.964
I	-0.545	-0.434	1.060	-0.747	1.891	1.858
IBM	3.417	2.286	2.611	3.814	3.233	2.558
JNJ	5.409	0.927	2.331	1.099	1.437	1.312
KM	-0.327	-0.222	0.482	-0.760	1.158	1.110
KO	5.620	1.711	3.300	2.279	1.813	1.713
LA	-0.286	0.874	3.148	0.994	2.338	2.207
LTD	0.226	-0.800	1.905	-0.165	1.432	1 331
MCD	1.222	1.292	2.625	1.295	1.386	1.145
MMM	6.735	1.111	3.440	1.916	2.799	3.056
MOB	5.933	0.086	0.286	0.386	0.985	0.768
MRK	6.195	2.451	0.564	3.427	3.067	2.691
NCR	1.045	-0.859	1.780	0.148	1.487	1.446
OXY	1.204	-0.710	0.637	0.006	2.286	2.366
PCI	-0.491	-0.554	-0.366	-0.939	2.056	2.493
PEP	1.289	1.891	2.492	2.548	2.622	2.705
S	7.307	2.400	1.013	1.207	2.008	2.436
SLB	2.084	0.895	1.062	2.052	1.692	1.597
STK	0.381	3.108	5.042	3.895	1.801	1.439
SYN	-0.083	1.523	1.388	2.195	0.914	0.804
T	6.669	1.339	2.854	0.501	1.029	1.244
TOY	1.794	0.665	1.453	2.487	1.419	1.172
TXN	0.908	1.522	1.900	0.802	2.286	2.196
UAL	1.053	1.169	3.941	1 956	1.281	1.379
UPJ	0.884	-0.848	0.911	-0.243	1.333	1.460
WMT	4.793	0.733	2.408	0.796	2.137	1.202
XON	8.017	0.832	2.758	1.849	2.519	2.335
XRX	1.618	1.725	0.821	0.577	1.322	1.281
Proportion of stocks significant at 5%						
	19/45	5/45	19/45	12/45	16/45	17/45

STF = Avg. Friday stock volume with expiration vs. Avg. Friday stock volume without.
STT = Avg. Thursday stock volume with expiration vs. Avg. Thursday stock volume without.
OPF = Avg. Friday option volume with expiration vs. Avg. Friday option volume without
OPT = Avg. Thursday option volume with expiration vs. Avg. Thursday option volume without.
OIF = Avg Friday open interest with expiration vs. Avg. Friday open interest without.
OIT = Avg Thursday open interest with expiration vs. Avg. Thursday open interest without

* The critical t-stat at 5% is 2.052.

TABLE 4A

Maximum Likelihood estimates of GARCH(1,1) without Volume. (T-stats*)

Co.	β_1	β_2	$\beta_1+\beta_2$	Co.	β_1	β_2	$\beta_1+\beta_2$
ARC	0.097	0.739	0.836	LTD	-0.021	-0.924	-0.945
	(1.322)	(4.254)			(-0.725)	(-48.629)	
AVP	0.138	0.661	0.799	MCD	0.041	0.264	0.305
	(1.094)	(2.811)			(0.498)	(0.293)	
BA	0.208	0.311	0.519	MMM	-0.002	0.349	0.347
	(1.802)	(2.058)			(-0.045)	(0.325)	
BAC	0.099	-0.284	-0.185	MOB	-0.033	0.772	0.739
	(0.872)	(-0.362)			(-0.666)	(2.768)	
BMY	0.067	-0.200	-0.133	MRK	0.041	-0.121	-0.08
	(0.447)	(-0.134)			(0.403)	(-0.063)	
BV	0.221	-0.665	-0.444	NCR	1.016	0.291	1.307
	(2.999)	(-5.503)			(5.808)	(5.194)	
C	0.501	0.285	0.786	OXY	0.078	0.084	0.162
	(3.115)	(1.433)			(0.525)	(0.099)	
CCI	0.249	0.0241	0.2731	PCI	0.477	0.152	0.629
	(2.128)	(0.188)			(4.657)	(0.666)	
DOW	0.063	0.698	0.761	PEP	0.297	-0.066	0.231
	(0.669)	(2.825)			(2.527)	(-0.119)	
EK	0.074	0.578	0.652	S	0.135	0.651	0.786
	(0.939)	(2.106)			(1.309)	(2.759)	
F	0.177	-0.357	-0.18	SLB	0.032	-0.543	-0.511
	(1.741)	(-0.922)			(0.531)	(-0.585)	
FLR	0.140	0.626	0.766	STK	0.293	0.369	0.662
	(1.968)	(3.508)			(1.911)	(1.529)	
GE	-0.066	0.509	0.443	SYN	-0.144	1.043	0.899
	(-0.644)	(0.814)			(-4.305)	(55.156)	
GM	0.070	-0.162	-0.092	T	-0.068	0.497	0.429
	(0.793)	(-0.137)			(-2.742)	(0.881)	
GPS	0.198	0.513	0.711	TOY	-0.071	0.554	0.483
	(1.419)	(2.109)			(-1.032)	(1.013)	
HM	0.001	-0.191	-0.19	TXN	-0.054	0.464	0.41
	(0.008)	(-0.274)			(-0.761)	(1.028)	
HNZ	0.178	0.387	0.565	UAL	-0.064	0.338	0.274
	(1.848)	(1.289)			(-0.867)	(0.438)	
HWP	0.039	0.609	0.648	UPJ	0.002	0.088	0.09
	(0.621)	(1.288)			(0.024)	(0.021)	
I	0.283	-0.316	-0.033	WMT	0.141	0.059	0.2
	(3.094)	(-1.949)			(0.944)	(0.064)	
IBM	-0.026	0.402	0.376	XON	0.057	0.508	0.565
	(-0.464)	(0.438)			(0.556)	(0.634)	
JNJ	0.262	-0.280	-0.018	XRX	0.389	0.067	0.456
	(1.520)	(-0.823)			(2.126)	(0.217)	
KM	-0.045	0.026	-0.019				
	(-0.369)	(0.017)		Mean	β_1	β_2	$\beta_1+\beta_2$
KO	0.063	0.041	0.104	Coefficien	0.128	0.207	0.335
	(0.494)	(0.036)		T-stat	1.453	3.558	
LA	0.216	0.475	0.691				
	(1.769)	(2.358)		The proportion of stocks significant at			
				5%	10/45	14/45	
				1%	7/45	8/45	

*The critical T-statistic is 1.96 at 5% and 2.576 at 1% significance.

TABLE 4B

Maximum Likelihood Estimates of GARCH(1,1) with stock Volume. (T-stats[a]).

Co.	β_1	β_2	$\beta_1+\beta_2$	β_3	β_4
ARC	0.004	-0.347	-0.343	0.128	0.120
	(0.114)	(-1.628)		(3.911)	(5.310)
AVP	0.002	-0.109	-0.107	0.042	0.070
	(0.063)	(-2.268)		(3.285)	(4.956)
BA	0.099	-0.710	-0.611	0.121	0.119
	(0.657)	(-1.289)		(1.608)	(3.081)
BAC	0.054	-0.266	-0.212	0.275	0.148
	(0.348)	(-0.364)		(0.953)	(1.988)
BMY	0.085	0.087	0.172	0.104	0.240
	(0.969)	(1.203)		(1.466)	(5.532)
BV	-0.085	0.016	-0.069	0.055	0.079
	(-1.132)	(0.074)		(1.897)	(3.726)
C	0.136	0.089	0.225	0.207	0.328
	(1.181)	(0.765)		(2.012)	(4.985)
CCI	0.111	-0.016	0.095	0.270	0.290
	(0.586)	(-0.054)		(1.683)	(5.550)
DOW	0.037	0.278	0.315	0.191	0.187
	(0.367)	(1.321)		(2.891)	(5.129)
EK	-0.077	-0.236	-0.313	0.108	0.172
	(-1.555)	(-1.480)		(2.164)	(4.918)
F	0.052	0.293	0.345	0.051	0.200
	(0.509)	(0.995)		(1.064)	(14.624)
FLR	-0.095	0.231	0.136	0.085	0.169
	(-1.387)	(0.555)		(1.437)	(4.347)
GE	-0.097	0.127	0.03	0.141	0.279
	(-6.615)	(0.960)		(2.224)	(5.176)
GM	-0.038	0.293	0.255	0.094	0.412
	(-0.491)	(1.300)		(0.595)	(3.701)
GPS	0.013	0.061	0.074	0.123	0.218
	(0.139)	(0.227)		(1.699)	(6.561)
HM	-0.029	-0.013	-0.042	0.185	0.259
	(-0.629)	(-0.084)		(7.198)	(5.348)
HNZ	0.096	-0.050	0.046	0.249	0.247
	(1.323)	(-0.303)		(2.973)	(2.661)
HWP	0.140	0.138	0.278	0.100	0.325
	(2.092)	(0.982)		(1.539)	(5.604)
I	0.043	-0.0001	0.0429	0.089	0.197
	(0.324)	(-0.0001)		(1.116)	(3.177)
IBM	0.065	-0.049	0.016	0.086	0.159
	(0.981)	(-0.951)		(3.330)	(5.376)
JNJ	0.031	-0.392	-0.361	0.198	0.117
	(0.203)	(-1.525)		(2.523)	(3.429)
KM	0.009	0.168	0.177	-0.0003	0.118
	(0.067)	(0.343)		(-0.002)	(2.159)
KO	-0.084	-0.019	-0.103	0.397	0.291
	(-2.650)	(-0.094)		(4.361)	(2.849)
LA	-0.048	0.260	0.212	0.077	0.197
	(-0.625)	(1.249)		(2.776)	(6.139)

[a] The critical T-statistic is 1.96 at 5% and 2.576 at 1% significance.

TABLE 4B

Maximum Likelihood Estimates of GARCH(1,1) with stock Volume. (T-stats[a]).

Co.	β_1	β_2	$\beta_1+\beta_2$	β_3	β_4
LTD	-0 042	-0.834	-0 876	0.172	0.039
	(-0 645)	(-1 323)		(1.221)	(0 545)
MCD	-0.041	-0.017	-0 058	0 157	0.142
	(-0.566)	(-0.068)		(2.547)	(3 080)
MMM	-0 119	-0.201	-0 32	0.115	0 137
	(-2.529)	(-1.163)		(2 321)	(3.831)
MOB	-0 063	0.209	0 146	0.039	0.089
	(-0.467)	(0 790)		(0.842)	(2.288)
MRK	-0.093	-0.123	-0.216	0.106	0.167
	(-3.709)	(-1.054)		(2.465)	(4.278)
NCR	-0.084	0.016	-0.068	0.013	0.015
	(-2.378)	(0.063)		(3.511)	(7.685)
OXY	-0 058	-0.193	-0.251	0.239	0 306
	(-0.468)	(-0.334)		(0.941)	([illegible].159)
PCI	0.013	0.437	0.45	0.022	0 128
	(0.100)	(1 361)		(0.426)	(5.063)
PEP	0 091	0.029	0 12	0.104	0.378
	-0 833	(0 155)		(1.003)	(6.288)
S	0.065	0.256	0.321	0.148	0.306
	(0.595)	(1.055)		(1.826)	(3.577)
SLB	-0.120	0.111	-0.009	0.169	0.194
	(-2 791)	(0.222)		(0.969)	(2.512)
STK	0.009	0.075	0 084	0.138	0.197
	(0 063)	(0.278)		(1.701)	(4.321)
SYN	-0 114	0 305	0.191	0.033	0.111
	(-2.250)	(0.636)		(0.677)	(3.413)
T	-0.082	0.086	0 004	0.002	0 170
	(-3.184)	(0.404)		(0.037)	(4.249)
TOY	-0.045	-0.658	-0 703	0.564	0.217
	(-1.534)	(-1.487)		(2.973)	(3.841)
TXN	-0.005	-0.154	-0 159	0.092	0.159
	(-0 074)	(-0.516)		(0.812)	(3.159)
UAL	0 008	-0 163	-0.155	0.023	0.039
	(0.055)	(-0 842)		(1.847)	(3.564)
UPJ	0 029	-0.301	-0.272	0.178	0.114
	(0 483)	(-0 997)		(3.037)	(5.924)
WMT	-0.038	-0 024	-0.062	0.375	0.607
	(-0.335)	(-0.097)		(1.381)	(3.875)
XON	-0.035	-0.181	-0.216	0.461	0.237
	(-0 507)	(-1.726)		(3.285)	(2.875)
XRX	0.026	-0.092	-0.066	0.075	0.131
	(0.349)	(-0.465)		(2.808)	(4.955)
Mean	β_1	β_2	$\beta_1+\beta_2$	β_3	β_4
Coefficien	-0.006	-0.035	-0.041	0.147	0.196
T-stat	1.087	0.778		2.029	4.395
The proportion of stocks significant at					
5%	8/45	1/45		20/45	44/45
1%	5/45	0/45		13/45	39/45

[a] The critical T-statistic is 1.96 at 5% and 2.576 at 1% significance.

TABLE 4C

Maximum Likelihood Estimates of GARCH(1,1) with Raw Option Volume. (T-stats*)

Co.	β_1	β_2	$\beta_1+\beta_2$	β_3	β_4
ARC	0.028	-0.106	-0.078	0.015	0.014
	(0.399)	(0.204)		(1.404)	(3.189)
AVP	0.095	0.240	0.335	0.037	0.050
	(0.717)	(1.351)		(3.202)	(4.211)
BA	-0.034	-0.415	-0.449	0.011	0.008
	(-0.898)	(-0.792)		(2.199)	(4 667)
BAC	-0.027	-0.162	-0.189	0.029	0.036
	(-0.343)	(-0.548)		(1.305)	(4 083)
BMY	-0.067	-0.013	-0.080	0.005	0.014
	(-0.783)	(-0.102)		(0.527)	(4.338)
BV	-0.048	0.082	0.034	0.026	0.046
	(-0.897)	(0.452)		(1.339)	(3.670)
C	-0.072	0.043	-0.029	0.057	0.064
	(-1.111)	(0.399)		(3.191)	(3.668)
CCI	-0.076	0.087	0.011	0.020	0.031
	(-0.515)	(0.305)		(0.981)	(4.376)
DOW	0.051	0.033	0.084	0.021	0.036
	(0.791)	(0.204)		(2.392)	(5.097)
EK	-0.085	-0.396	-0.481	0.015	0.016
	(-1.783)	(-1.429)		(4.369)	(3.560)
F	-0.092	0.514	0.422	0.006	0.020
	(-1.086)	(1.435)		(0.700)	(4.179)
FLR	-0.082	-0.106	-0.188	0.069	0 084
	(-0.963)	(-0.369)		(1.632)	(3.163)
GE	-0.031	-0.274	-0.305	0.005	0.006
	(-0.411)	(-0.515)		(1.106)	(2.534)
GM	-0.031	-0.201	-0.232	0 010	0 015
	(-0.491)	(-0.439)		(1.110)	(3.302)
GPS	0.064	0.454	0.518	-0.050	0 071
	(0.556)	(2.491)		(-1.043)	(2.863)
HM	0.068	-0.381	-0.313	0.063	0 064
	(0.473)	(-1.135)		(2.291)	(2.794)
HNZ	0.12	0.124	0.244	0 021	0.027
	(1.572)	(0.408)		(1.176)	(2.203)
HWP	0.043	0.030	0.073	0.011	0.028
	(0.458)	(0.147)		(1.839)	(3.850)
I	-0.008	-0.016	-0.024	0.128	0.158
	(0.080)	(-0.061)		(1.674)	(2.848)
IBM	0.053	0.092	0.145	0.0005	0.0017
	(0.880)	(0.629)		(2.310)	(6.594)
JNJ	-0.909	-0.710	-1.619	0.082	0.039
	(-3.117)	(-3.169)		(3.559)	(1.913)
KM	-0.023	0.103	0.08	0.011	0.034
	(-0.188)	(0.154)		(0.368)	(1 933)
KO	0.026	-0.497	-0.471	0 023	0.008
	(0.246)	(-1.589)		(3.599)	(3.071)
LA	0.023	0.255	0.278	0.0189	0 074
	(0.292)	(1 123)		(1.601)	(5 537)

* The critical T-statistic is 1.96 at 5% and 2.576 at 1% significance.

TABLE 4C

Maximum Likelihood Estimates of GARCH(1,1) with Raw Option Volume. (T-stats[a])

Co.	β_1	β_2	$\beta_1+\beta_2$	β_3	β_4
LTD	-0.010	-0.266	-0.276	0.056	0.043
	(-0.168)	(-0 789)		(2.091)	(2.257)
MCD	-0.001	-0.437	-0 438	0.036	0.023
	(-0.023)	(-0.919)		(2.468)	(3.838)
MOB	-0.061	-0.097	-0.158	0.007	0.009
	(-0.842)	(-0.299)		(0.904)	(1.841)
MRK	-0.029	-0.118	-0.147	0.006	0.009
	(-0.431)	(-0.352)		(1.343)	(4.881)
NCR	0.782	0.047	0.829	8.00E-04	-4.00E-05
	(3.223)	(0.604)		(5.677)	(-0.487)
OXY	0.025	-0.670	-0.645	0.027	0.016
	(0.192)	(-0.968)		(1.429)	(2.298)
PCI	0.047	-0.482	-0.435	0.022	0.016
	(0.482)	(-2.111)		(3.242)	(3.004)
PEP	0.110	0.066	0.176	0.005	0.019
	(0 775)	(0.339)		(0.626)	(4.334)
S	0 126	0.408	0.534	0.0127	0.036
	(2.025)	(4.473)		(1.406)	(7.306)
SLB	0.027	-0.701	-0.674	0.068	0.026
	(0.247)	(-0.832)		(1.205)	(1.792)
STK	0 061	-0.080	-0.019	0.131	0.176
	(0.469)	(-0.352)		(2.059)	(3.496)
SYN	-0.109	-0.499	-0.608	0.031	0.024
	(-5.085)	(-1.579)		(3.635)	(26.047)
T	0.226	0.169	0.395	0.0023	0.0042
	(1.425)	(0.566)		(1.149)	(3.749)
TOY	-0.078	-0.425	-0.503	0.099	0.072
	(-1.823)	(-0.851)		(1.588)	(3.215)
TXN	-0.016	-0.256	-0.272	0.043	0.057
	(-0.406)	(-0.744)		(1.926)	(3.416)
UAL	-0.128	0.054	-0.074	0.017	0.031
	(-2.147)	(0.295)		(3.288)	(4.308)
UPJ	0 056	0.136	0 192	0.0017	0.005
	(0.569)	(0.588)		(1.793)	(5.443)
WMT	-0 016	-0.017	-0.033	0.007	0.012
	(-0.188)	(-0.069)		(1.519)	(5.112)
XON	0.032	-0.786	-0.754	0.010	0.005
	(0.235)	(-1.905)		(2.665)	(3.775)
XRX	-0.005	-0.195	-0.200	0.025	0.058
	(-0.094)	(-1.497)		(1.720)	(4.841)
Mean	β_1	β_2	$\beta_1+\beta_2$	β_3	β_4
Coefficien	0.001	-0.122	-0.121	0.028	0.036
T-stat	0.906	0.899		1.371	4.160
The proportion of stocks significant at					
5%	5/44	5/44		19/44	41/44
1%	3/44	2/44		11/44	36/44

[a] The critical T-statistic is 1.96 at 5% and 2.576 at 1% significance.

TABLE 4D

Maximum Likelihood Estimates of GARCH(1,1) with Standardized[a] Option Volume. (T-stats[b])

Co.	β_1	β_2	$\beta_1+\beta_2$	β_3	β_4
ARC	0.031	-0.108	-0.077	0.0022	0.002
	(0.421)	(-0.215)		(1.325)	(3 179)
AVP	0.014	0.108	0.122	0.0068	0.0065
	(0.117)	(0.917)		(2.805)	(2.462)
BA	-0.031	-0.557	-0.588	0.0079	0.0063
	(-0.244)	(-0.677)		(1.207)	(2.084)
BAC	0.037	-0.298	-0.261	0.011	0.010
	(0.253)	(-0.585)		(1.417)	(2.945)
BMY	-0.024	-0.066	-0.090	-9 9E-05	0.0049
	(-0.595)	(-1.368)		(-0.105)	(5.627)
BV	-0.049	0.110	0.061	0.032	0.025
	(-0.934)	(0.502)		(1.857)	(5.289)
C	0.0805	0 087	0.1675	0.015	0.019
	(0.809)	(0.435)		(2.026)	(2.795)
CCI	-0.191	-0.329	-0.520	0.029	0.019
	(-4.444)	(-0.702)		(1.792)	(3.687)
DOW	0.012	-0.462	-0.450	0.011	0.0079
	(0.407)	(-1.101)		(2.673)	(4.555)
EK	-0.076	-0.279	-0.355	0.007	0 0067
	(-0.882)	(-0.916)		(3.269)	(4.653)
F	-0.095	0.802	0.707	0.0011	0.0021
	(-7.651)	(2 444)		(0.579)	(2.267)
FLR	-0.055	0 142	0.087	0.0059	0.0093
	(-1.495)	(0.562)		(2.217)	(6 145)
GE	-0.017	-0.753	-0.770	0.0058	0.0032
	(-0.336)	(-0.831)		(0.964)	(2.047)
GM	-0.038	-0.574	-0.612	0.015	0.0093
	(-1.208)	(-1.216)		(2.406)	(3.806)
GPS	0.047	0.194	0.241	3 40E-04	0.0088
	(0.579)	(0.682)		(0.037)	(4.483)
HM	0.066	-0.266	-0.200	0.0077	0.013
	(0.612)	(-1.401)		(2.368)	(5.515)
HNZ	0.087	0 166	0.253	0.0031	0.0034
	(1.247)	(0 535)		(1.448)	(2.249)
HWP	-0.025	0 352	0.327	5.10E-04	0 0072
	(-0.243)	(0.751)		(0 158)	(2.676)
I	0.024	-0.0039	0.0201	0.0076	0.011
	(0.213)	(-0.011)		(1.388)	(2 742)
IBM	0.0047	0.092	0.0967	0.0011	0.0029
	(0.044)	(0 436)		(1.354)	(5.702)
JNJ	0.0025	-0.364	-0 362	0 0048	0.0045
	(0.023)	(0.748)		(1 764)	(2.731)
KM	0.041	-0.096	-0 055	0.0018	0 0051
	(0.303)	(-0.162)		(0.398)	(2.082)
KO	0.033	-0 051	-0 018	0.0012	0.0046
	(0.281)	(-0.273)		(0.361)	(2.802)
LA	-0 095	-0.383	-0.478	0.045	0 022
	(-3 784)	(-1.775)		(6.247)	(6.215)

[a] Raw option volume divided by its open interest.

[b] The critical T-statistic is 1.96 at 5% and 2.576 at 1 % significance.

TABLE 4D

Maximum Likelihood Estimates of GARCH(1,1) with Standardized[a] Option Volume. (T-stats[b])

Co.	β_1	β_2	$\beta_1+\beta_2$	β_3	β_4
LTD	-0.015	-0.155	-0.170	0.011	0.013
	(-0.329)	(-0.673)		(1.420)	(2.505)
MCD	-0.0082	-0.436	-0.444	0.011	0.0067
	(-0.130)	(-0.864)		(2.075)	(3.894)
MOB	-0.061	-0.093	-0.154	0.0014	0.0017
	(-0.752)	(-0.243)		(0.946)	(1.749)
MRK	-0.019	-0.039	-0.058	0.0017	0.0039
	(0.253)	(-0.132)		(0.887)	(4.276)
NCR	0.539	0.028	0.567	0.0011	-3.10E-04
	(2.778)	(0.134)		(2.295)	(-2.047)
OXY	0.048	0.117	0.165	4.40E-04	0.0068
	(0.384)	(0.323)		(0.095)	(2.304)
PCI	0.844	-0.029	0.815	0.0086	0.0035
	(2.008)	(-0.160)		(4.901)	(1.878)
PEP	-0.011	-0.672	-0.683	0.021	0.0079
	(-0.141)	(-1.992)		(3.457)	(3.918)
S	0 121	0.193	0.314	0.0033	0.011
	(1.600)	(1.462)		(1.578)	(6.268)
SLB	0 032	-0.254	-0.222	0.0059	0.0044
	(0.532)	(-1.026)		(1.907)	(3.559)
STK	0.105	-0.203	-0.098	0.018	0.019
	(0.852)	(-1.063)		(3.168)	(4.282)
SYN	0.053	0.080	0.133	-8.50E-04	0.0071
	(0.748)	(0.232)		(-0.218)	(2.958)
T	0.157	0.085	0.242	0.0029	0.0035
	(0.844)	(0.365)		(1.154)	(3.862)
TOY	-0.061	-0.444	-0.505	0.029	0.018
	(-0.548)	(-0.832)		(1.334)	(2.262)
TXN	-0.013	-0.142	-0.155	0.010	0.0095
	(-0.198)	(-0.754)		(3.062)	(4.397)
UAL	-0.023	0.492	0.469	0.0016	0.0059
	(-0.318)	(2.339)		(0.523)	(5.060)
UPJ	0.086	-0.089	-0.003	0.006	0.0073
	(0.851)	(-0.780)		(4.478)	(36.433)
WMT	-0.035	0.209	0.174	0.0052	0.0075
	(-0.298)	(0.887)		(1.786)	(3.203)
XON	-0.052	-0.028	-0.080	0.0039	0.0029
	(-0.635)	(-1.083)		(2.421)	(2.931)
XRX	0.022	-0.037	-0.015	0.0029	0.009
	(0.275)	(-0.250)		(1.225)	(4.136)
Mean	β_1	β_2	$\beta_1+\beta_2$	β_3	β_4
Coefficien	0.034	-0.090	-0.056	0.0083	0.0082
T-stat	0.945	0.792		1.797	3.060
The proportion of stocks significant at					
5%	5/44	3/44		16/44	42/44
1%	4/44	0/44		7/44	31/44

[a] Raw option volume divided by its open interest.

[b] The critical T-statistic is 1.96 at 5% and 2.576 at 1 % significance.

TABLE 4E

Maximum Likelihood Estimates of GARCH(1,1) with Option Open Interest. (T-stats[a])

Co.	β_1	β_2	$\beta_1+\beta_2$	β_3	β_4
ARC	0.058	-0.488	-0.430	-0.0053	-0.156
	(0.582)	(-0.598)		(-0.046)	(-1.115)
AVP	0.231	-0.245	-0.014	-0.095	-0.562
	(6.426)	(-3.034)		(-11.645)	(-6.659)
BA	0.026	0.403	0.429	-0.033	0.050
	(0 280)	(0.717)		(-1.236)	(1.044)
BAC	0.012	-0.929	-0.917	0.287	-0.206
	(0.117)	(-4.810)		(1.605)	(-0.711)
BMY	0.056	-0.209	-0.153	-0.013	-0.008
	(0.399)	(-0.118)		(-0.246)	(-0.039)
BV	0.299	-0.476	-0.177	-0.081	0.073
	(6.509)	(-13.270)		(-7.102)	(1.384)
C	0.509	0.259	0 768	0.016	0.385
	(2.582)	(0.866)		(0.125)	(4.568)
CCI	0.169	-0.032	0.137	0.071	0.250
	(1.696)	(-0.210)		(1.786)	(2.256)
EK	-0.065	-0.640	-0.705	0.121	0.088
	(-0.885)	(-0.860)		(1.666)	(0.635)
F	0.137	-0.725	-0.588	0.047	0.017
	(1.489)	(-1.359)		(0.576)	(0.083)
FLR	0.041	0.631	0.672	-0.019	0.925
	(0.282)	(1.342)		(-0.077)	(4.923)
GE	-0.054	-0.039	-0.093	0.029	-0.0099
	(-0.401)	(-0.041)		(0.634)	(-0.209)
GPS	0.079	0.639	0.718	-0.482	0.509
	(0.435)	(1.803)		(-1.422)	(1.115)
HM	-0.069	-0.167	-0.236	0.078	-0.943
	(-0.914)	(-0.382)		(0.455)	(-1.770)
HNZ	0.167	0.191	0.358	0.067	-0.133
	(1.777)	(0.377)		(0.261)	(-0.356)
HWP	0.070	0.453	0.523	-0.040	-0.411
	(0.548)	(0.731)		(-0.337)	(-2.360)
I	0.284	-0.332	-0.048	0.286	0.947
	(2.047)	(-3.602)		(0 268)	(0.414)
IBM	-0.0015	0.368	0.3665	0.0023	-0.065
	(-0.036)	(0.534)		(0.309)	(-3.093)
JNJ	0.276	-0.271	0.005	0.064	0.100
	(1.698)	(-1.467)		(3.066)	(8.969)
KM	0.014	-0.608	-0.594	0.011	-0.409
	(0.124)	(-0.423)		(0.063)	(-0.666)
KO	-0.012	-0.521	-0.533	0.201	0.042
	(-0.120)	(-0.486)		(1.554)	(1.664)
LA	0.105	0.686	0.791	-0.328	-1.039
	(1.253)	(4.187)		(-1.438)	(-4.148)

[a] The critical T-statistic is 1.96 at 5% and 2.576 at 1%

TABLE 4E

Maximum Likelihood Estimates of GARCH(1,1) with Option Open Interest. (T-stats[a])

Co	β_1	β_2	$\beta_1+\beta_2$	β_3	β_4
LTD	-0 087	0.582	0.495	0.108	0.384
	(-0.846)	(1.049)		(0.795)	(3.503)
MCD	0.042	-0.344	-0.302	0.036	-0.679
	(0.515)	(-2.719)		(0.506)	(-2.520)
MOB	-0.0069	-0.819	-0.826	0.083	-0.216
	(-0.267)	(-9.441)		(1.607)	(-1.881)
MRK	-0.006	0.628	0.622	0.026	0.082
	(-0.065)	(1.070)		(0.653)	(1.676)
NCR	1.157	0.239	1 396	-0.0037	-0.0012
	(4.912)	(3.966)		(-4.197)	(-1.121)
PCI	0.453	0.222	0.675	-0.081	-0.0044
	(4.502)	(1.136)		(-1.863)	(-0.040)
S	0.141	0.510	0.651	0.057	-0.366
	(1.182)	(1.728)		(0.526)	(-3.365)
SLB	0.0052	0.683	0.688	-0.121	-0.772
	(0.096)	(1.494)		(-0.855)	(-1.799)
STK	0.195	0.431	0.626	-0.597	-5.557
	(1.328)	(1.021)		(-0.701)	(-1.741)
SYN	-0.067	0 646	0.579	0.031	-0.252
	(-0.829)	(1.537)		(0.330)	(-1.187)
T	0.232	0.260	0.492	-0.014	-0.125
	(2.985)	(3.565)		(-19.599)	(-7.213)
TOY	-0 086	-0.215	-0.301	0.186	-0.708
	(-4.516)	(-0.354)		(1.344)	(-3.834)
TXN	-0.059	0.301	0.242	0.171	0.473
	(-1.156)	(0 212)		(0.409)	(0.867)
UAL	0.017	-0.599	-0.582	0.083	-0.113
	(0.116)	(-0.957)		(1.251)	(-0.475)
UPJ	0.0053	0.132	0.137	-0.031	-0.035
	(0.055)	(0.168)		(-1.089)	(-1.359)
WMT	0.131	0.457	0.588	-0.021	-0.011
	(0.955)	(0.666)		(-0.491)	(-0.175)
XON	0.010	0.613	0.623	-0.008	0.055
	(0.100)	(1.071)		(-0.291)	(0.876)
XRX	-0.040	-0.737	-0.777	0.590	0.283
	(-1.881)	(-0 794)		(1.657)	(0.618)
Mean	β_1	β_2	$\beta_1+\beta_2$	β_3	β_4
Coefficient	0.109	0.023	0.133	0.017	-0.203
T-stat	1 420	1.854		1.852	2.060
The proportion of stocks significant at					
5%	9/40	9/40		6/40	13/40
1%	7/40	8/40		5/40	10/40

[a] The critical T-statistic is 1.96 at 5% and 2.576 at 1%

TABLE 5A

Maximum Likelihood Estimates of GARCH(1,1) with stock volume and day[a] Indicators.(T-stats[b])

Co.	β_1	β_2	β_3	β_4	β_5	β_6	β_7	β_8
ARC	0.777	-0.002	0.268	0.588	0 062	-0.0001	0.202	0.282
	(1.036)	(-0 268)	(0.582)	(1 756)	(2.591)	(-0 373)	(2.636)	(2 648)
AVP	0.692	-0 009	0.072	0 144	-0 0001	2 00E-04	-2 00E-04	1.00E-04
	(1.436)	(-0.051)	(1.238)	(2.703)	(-0.226)	(0 662)	(-1 180)	(0 401)
BA	0.185	-0 279	0.064	0.113	0.0001	2 00E-05	8.00E-05	5 00E-05
	(1.546)	(-1.280)	(2 736)	(4.949)	(1.419)	(1 000)	(1 540)	(2.820)
BAC	0.155	-0.206	0.234	0 147	2.00E-04	1.30E-04	1.80E-04	2.20E-04
	(0.948)	(-0.877)	(1.430)	(2.501)	(0.731)	(0 981)	(0.826)	(1 083)
BMY	-0.119	-0 001	0 101	0.295	2 40E-04	7 90E-05	0.011	0.118
	(-1.289)	(-0.533)	(1.491)	(3 041)	(2.263)	(1.339)	(2 573)	(2.639)
BV	-0.083	0.042	0.054	0.077	1.40E-04	-1.4E-05	-5.1E-05	-6 9E-06
	(-0 948)	(0.168)	(1 785)	(3.317)	(0.757)	(-0 053)	(-0.249)	(-0.036)
C	-0.0041	0 045	0.285	0 397	-3 20E-04	3 60E-04	-1 80E-04	-4 2E-05
	(-0.034)	(-0 310)	(1 480)	(3.557)	(-0 707)	(0 558)	(-0 397)	(-0 082)
CCI	0.348	-0.034	0.287	0.258	5 70E-05	8 00E-06	4 50E-05	-1 10E-04
	(1 515)	(-0 195)	(2 379)	(4.877)	(0.419)	(0 067)	(0 265)	(-0 807)
DOW	-0.0502	4.00E-04	0 289	0.154	1.60E-04	-7.7E-05	0 032	-7 9E-05
	(-0 877)	(0 158)	(2.517)	(1 633)	(0.785)	(-0.590)	(2 569)	(-0 579)
EK	0.166	-9 30E-04	0 072	0 212	1 90E-04	4 50E-05	0 051	0 115
	(0.858)	(-0.076)	(1 056)	(2.618)	(0 198)	(1 391)	(2 620)	(2 637)
F	-0 053	-0 212	0 204	0.218	1 90E-04	8 10E-05	-8 2E-05	9 8E-06
	(-0 794)	(-0.946)	(2.325)	(3 365)	(0.941)	(0.719)	(-1 063)	(0 065)
FLR	0.371	0.0015	0 118	0.196	0 019	-3.2E-05	0.0017	-4 6E-05
	(1.799)	(0.023)	(3 495)	(4 339)	(2 461)	(-0 027)	(1 661)	(-0 317)
GE	-0.088	0.304	0.093	0 247	-3 6E-05	2 6E-06	-2 9E-06	-2 8E-05
	(-2 161)	(1.588)	(1 911)	(4 258)	(-1.272)	(0 039)	(-0 037)	(-0 395)
GM	0 502	0 014	0.464	0.605	7E-07	-6 4E-06	0 126	-0 00201
	(1 186)	(0.337)	(2.013)	(3 367)	(0 003)	(-0 022)	(2 616)	(-0 388)
GPS	0 117	-0 0011	0 116	0.225	2.20E-04	1.10E-04	0.0035	1.80E-04
	(0.856)	(-0.023)	(1.971)	(3 184)	(1.790)	(0 995)	(2 114)	(1 787)
HM	-0.048	-0 108	0.245	0 247	1 60E-04	-3 5E-05	5 30E-05	-3 9E-05
	(-1 417)	(-0.643)	(2 505)	(4 616)	(0 653)	(-0.246)	(0 294)	(-0 409)
HNZ	-0 032	-7 90E-04	0 225	0 169	1.50E-04	3 80E-05	7.40E-05	1 60E-04
	(-0 757)	(-0.088)	(2.311)	(2 429)	(0 666)	(0 701)	(1 056)	(1 517)
HWP	0.608	0.0018	0 244	0.487	-1 70E-04	-5 70E-04	0 158	-8 10E-04
	(1.483)	(0 298)	(2.787)	(2.623)	(-0.226)	(-0 816)	(2 612)	(-0 703)
I	0 289	-0 144	0 205	0.151	2.70E-04	2 50E-04	-3 10E-04	-5 80E-04
	(4.099)	(-1 152)	(4.215)	(3.745)	(0 716)	(1 076)	(-1 037)	(-2 732)
IBM	0.101	-0.031	0.066	0 132	2 70E-05	1.10E-05	1 30E-06	-6 40E-06
	(1.085)	(-0 143)	(4 567)	(5.134)	(0.557)	(0 154)	(0 033)	(-0 291)
JNJ	0.692	0 010	0 162	0 225	-9.7E-06	-1 00E-05	0.069	0 055
	(1.441)	(0 364)	(0.859)	(2.086)	(-0 0065)	(-0 302)	(2 631)	(2 567)
KM	-0.0789	0.212	0.069	0 138	1 90E-04	2 70E-04	6 40E-05	-6 70E-05
	(-1.189)	(0.741)	(0 627)	(3.544)	(1 069)	(1 355)	(0 906)	(-1 155)
KO	-0 083	-0 021	0 467	0 368	1 50E-05	-1 40E-06	-6 30E-05	5 20E-05
	(-1.853)	(-0 146)	(3.941)	(3.068)	(0 192)	(-0 0175)	(-1 061)	(0 559)
LA	-0 044	0.173	0 091	0 169	1 00E-04	2.90E-04	1.20E-04	2 50E-04
	(-0 741)	(0 847)	(2 484)	(5.307)	(0 662)	(2 716)	(1 166)	(1 814)

[a] Monday(M), Tuesday(T), Thursday(TH), and Friday(F).

[b] The critical T-statistic is 1.96 at 5% and 2.576 at 1% significance.

TABLE 5A

Maximum Likelihood Estimates of GARCH(1,1) with stock volume and day[a] indicators.(T-stats[b])

Co.	β_1	β_2	β_3	β_4	β_5	β_6	β_7	β_8
LTD	0.022	0 415	0 0047	0 118	1 70E-04	2 70E-04	4.30E-05	-2.60E-04
	(0 204)	(0 895)	(0.045)	(1 281)	(0.841)	(1.511)	(0.171)	(-1.395)
MCD	-0 0142	0 171	0.091	0 144	1 10E-04	1.50E-04	1.80E-04	-3.80E-06
	(-0.288)	(1.234)	(1.791)	(3.391)	(1.380)	(2.001)	(1.985)	(-0.103)
MMM	-0 118	0.237	0 046	0.143	-8.2E-06	-2.80E-05	8.50E-05	3.10E-05
	(-2.524)	(0 974)	(1.345)	(4.980)	(-0.281)	(-0.862)	(1.208)	(0.750)
MOB	0.025	0.096	0.042	0.138	1.10E-04	3.20E-05	0.0033	-3.50E-04
	(0.102)	(0.406)	(0 432)	(2 247)	(1.077)	(0.358)	(2.476)	(-0.466)
MRK	0.852	-0 0035	0.233	0 167	-4 00E-04	-1.20E-04	-5.00E-04	-4.50E-04
	(8.610)	(-0 089)	(6.102)	(5.510)	(-1.223)	(-0.319)	(-1.708)	(-1.552)
NCR	1 015	0 063	0.281	0 423	0 109	-0 0014	0.194	-5.60E-04
	(0 163)	(2.412)	(1.066)	(1.428)	(2.518)	(-1.088)	(2.620)	(-0.077)
OXY	-0.015	-0 375	0.417	0.271	-1 1E-05	-4 90E-05	-1 70E-05	-9.20E-05
	(-0.152)	(-1 341)	(2.682)	(3.132)	(-0.036)	(-0.539)	(0 125)	(-0.68[illegible])
PCI	0.073	0.072	0.081	0 148	9.00E-05	-3.20E-05	-9.60E-06	8.10E-[illegible]
	(0.448)	(0 184)	(1 00)	(4.777)	(0.791)	(-0.311)	(-0.111)	(0.092)
PEP	0.137	-0 024	0 152	0.382	5.00E-05	1 60E-04	8.40E-05	9.60E-05
	(1.633)	(-0.158)	(1 441)	(4.956)	(0 478)	(0.805)	(0.750)	(0.996)
S	0.314	0.0022	0.165	0.438	1.40E-04	-7.9E-05	0.057	-4 5E-05
	(1.322)	(0 048)	(0 947)	(3.917)	(0.975)	(-0 918)	(2 604)	(-0.017)
SLB	0 828	0 0015	0.138	0 369	2.10E-04	-2.20E-04	0.121	-2.80E-04
	(1.587)	(0 161)	(0.836)	(1.746)	(0.525)	(-0.804)	(2.615)	(-0.248)
STK	0 00053	0 0036	0.131	0 158	-7.30E-05	3.10E-04	0.0031	-8.8E-06
	(0 011)	(0 238)	(3 687)	(4.430)	(-0 304)	(0 745)	(1 916)	(-0 034)
SYN	0 624	-0.0023	0 143	0.309	7.70E-05	-1 60E-04	0 214	0.062
	(1.178)	(-0 455)	(0 765)	(1.851)	(0 128)	(-0.323)	(2 654)	(2.637)
T	0.504	-0 0013	0 260	0.239	-1.9E-05	-5.4E-05	0.136	0.056
	(2.558)	(-0 588)	(1 725)	(2 088)	(-0 108)	(-0.506)	(2 653)	(2 641)
TOY	-0 089	0 127	0.243	0 271	-3 6E-05	-1 70E-04	-3.10E-04	-1.80E-04
	(-2 366)	(0 541)	(2 443)	(3.716)	(-0 332)	(-1.008)	(-1.974)	(-1.107)
TXN	0.354	-0 007	0 089	0.235	-1.20E-04	1.30E-04	1.90E-04	-1 60E-05
	(1 534)	(-0.042)	(0.578)	(3.221)	(-0.638)	(0 388)	(0.643)	(-0 081)
UAL	-0 037	-0 09	0.025	0 045	1.10E-04	5.30E-05	1.00E-04	4.30E-05
	(-0 425)	(-0 775)	(2.818)	(6 297)	(1 244)	(0.668)	(1.813)	(0.915)
UPJ	-0 025	-0.0093	0 118	0 141	-3.3E-05	-7.70E-05	0.017	2.70E-04
	(-0 341)	(-0.307)	(3 865)	(4.572)	(-0.181)	(-0.462)	(2.511)	(0.471)
WMT	0.267	0 017	0.419	0.657	1.70E-04	3.80E-05	2.20E-04	1.60E-05
	(1 111)	(0 101)	(0 971)	(2.345)	(0 865)	(0.249)	(0.842)	(0 098)
XON	0.221	0.0002	0 098	0.265	1.60E-05	-4.00E-05	0.127	-9 3E-05
	(0.925)	(0 072)	(0.417)	(2.551)	(0.174)	(-0.517)	(2.637)	(-0.229)
XRX	0 354	-0.0039	0.107	0.237	0.044	3 40E-04	-5.3E-05	0.181
	(0 986)	(-0 390)	(2.079)	(2.985)	(2.614)	(0.582)	(-0 554)	(2.632)
Mean	β_1	β_2	β_3	β_4	β_5	β_6	β_7	β_8
Coefficient	0 214	0.008	0 173	0.250	0 005	2.28E-06	0.034	0.019
T-stat	1 329	0.503	1.926	3 409	0.844	0.692	1.505	1.014
The proportion of stocks significant at								
5%	7/45	1/45	23/45	41/45	6/45	1/45	18/45	10/45
1%	3/45	0/45	13/45	34/45	3/45	1/45	13/45	8/45

[a] Monday(M), Tuesday(T), Thursday(TH), and Friday(F).

[b] The critical T-statistic is 1.96 at 5% and 2.576 at 1% significance.

TABLE 5B

Maximum Likelihood Estimates of GARCH(1,1) with Option Volume and Day[a] Indicators (T-stats[b]).

Co.	β_1	β_2	β_3	β_4	β_5	β_6	β_7	β_8
ARC	1.327	0.0089	0.186	0.314	0.0003	0.030	0.023	3.30E-05
	(0.744)	(0.1613)	(1.534)	(2.614)	(0.1504)	(2.539)	(2.373)	(0.041)
AVP	1.430	0.027	0.0852	0.266	0.045	1.60E-02	8.30E-04	8.70E-04
	(2.368)	(0.191)	(1.482)	(2.774)	(2.538)	(2.201)	(0.364)	(0.378)
BA	0.941	-0.033	0.244	0.316	-0.0016	-1.90E-03	0.152	0.0031
	(0.329)	(-1.543)	(2.919)	(4.036)	(-0.604)	(-0.868)	(2.496)	(0.745)
BAC	1.165	0.043	0.098	0.244	0.0018	0.0410	7.80E-04	7.80E-04
	(1.777)	(0.965)	(1.347)	(2.941)	(1.083)	(2.576)	(0.478)	(0.497)
BMY	1.516	-0.010	0.021	0.015	0.0036	3.10E-04	0.016	0.0021
	(2.327)	(-0.088)	(1.593)	(2.852)	(2.321)	(0.819)	(2.561)	(1.088)
BV	0.030	0.041	0.023	0.057	-7.70E-05	-1.50E-04	-4.9E-05	2.70E-04
	(0.637)	(0.431)	(1.543)	(4.154)	(-0.396)	(-1.024)	(-0.261)	(0.993)
C	0.862	0.028	0.170	0.164	-0.0040	-0.0019	0.083	0.059
	(1.501)	(0.376)	(1.881)	(2.671)	(-0.844)	(-1.925)	(2.506)	(2.335)
CCI	0.055	-0.056	0.022	0.021	-7.30E-05	6.70E-05	-4.90E-05	-8.90E-05
	(0.984)	(-0.945)	(7.035)	(8.421)	(-1.572)	(0.468)	(-1.129)	(-2.242)
DOW	0.362	0.0440	0.077	0.138	-3.50E-04	-1.70E-04	0.034	0.030
	(0.405)	(0.418)	(1.130)	(2.521)	(-0.111)	(-0.415)	(2.545)	(2.280)
EK	1.608	0.023	0.083	-0.078	0.095	-0.0017	0.096	-0.0027
	(0.923)	(1.429)	(2.093)	(-2.816)	(2.530)	(-1.299)	(2.541)	(-1.628)
F	0.440	0.022	0.024	0.064	1.00E-04	1.30E-04	2.80E-04	1.70E-04
	(1.012)	(0.105)	(0.863)	(2.472)	(0.351)	(0.405)	(0.665)	(0.466)
FLR	0.433	0.0515	0.194	0.328	0.105	-0.0066	-7.40E-04	0.106
	(0.653)	(0.294)	(1.638)	(2.281)	(2.274)	(-0.339)	(-1.284)	(2.571)
GE	1.181	0.033	0.196	0.189	-0.0107	-0.0033	0.061	0.225
	(0.414)	(0.700)	(2.147)	(2.699)	(-2.928)	(-1.329)	(2.316)	(2.505)
GM	0.384	0.134	0.142	0.305	0.035	-0.0036	0.0017	0.0013
	(0.373)	(2.008)	(2.158)	(3.745)	(2.344)	(-1.710)	(2.744)	(0.957)
GPS	0.385	0.152	0.062	0.100	-3.20E-04	1.70E-04	-1.10E-04	-1.90E-05
	(1.485)	(0.785)	(1.214)	(2.916)	(-1.946)	(0.592)	(-0.383)	(-0.059)
HM	0.121	-0.265	0.043	0.062	1.40E-04	-6.1E-05	5.10E-05	2.20E-04
	(1.085)	(-1.426)	(2.166)	(4.363)	(0.679)	(-0.702)	(0.371)	(1.102)
HNZ	0.670	0.0043	0.125	0.179	2.40E-04	3.60E-05	0.148	-8.30E-04
	(0.976)	(2.379)	(1.951)	(2.328)	(0.582)	(0.159)	(2.622)	(-2.824)
HWP	0.541	0.0081	0.316	0.468	-0.0015	-0.0019	0.153	-0.0019
	(0.401)	(0.776)	(3.373)	(3.426)	(-0.908)	(-1.361)	(2.491)	(-0.986)
I	0.968	0.043	0.191	0.447	0.0017	4.50E-04	-2.10E-04	0.0011
	(1.711)	(0.335)	(1.721)	(2.386)	(1.095)	(0.574)	(-2.475)	(1.206)
IBM	1.094	-0.102	0.039	0.086	0.149	0.015	0.192	0.0204
	(0.512)	(-0.834)	(2.123)	(4.025)	(2.041)	(0.905)	(2.531)	(0.882)
JNJ	1.041	-0.0021	0.077	0.181	8.20E-04	5.70E-04	0.058	4.20E-04
	(0.707)	(-0.031)	(2.055)	(3.597)	(1.310)	(1.337)	(2.540)	(0.112)
KM	1.162	-0.068	0.068	0.108	-2.40E-04	-5.70E-05	1.30E-04	-1.20E-04
	(3.452)	(-1.501)	(4.222)	(5.610)	(-1.726)	(-0.476)	(0.466)	(-1.049)
KO	0.523	0.0044	0.149	0.122	0.018	-0.0012	0.103	-0.0015
	(0.416)	(0.069)	(1.817)	(2.030)	(2.269)	(-0.771)	(2.557)	(-0.226)
LA	0.754	-0.031	0.2[illegible]	0.264	-0.0034	-0.0021	0.012	0.0014
	(1.131)	(-0.118)	(1.579)	(2.215)	(-1.194)	(-0.833)	(1.451)	(0.263)

[a] Monday(M), Tuesday(T), Thursday(TH) and Friday(F).

[b] The critical T-statistic is 1.96 at 5% and 2.576 at 1% significance.

TABLE 5B

Maximum Likelihood Estimates of GARCH(1,1) with Option Volume and Day[a] Indicators (T-stats[b]).

Co	β_1	β_2	β_3	β_4	β_5	β_6	β_7	β_8
LTD	0.848	0 054	0.245	0.473	0.098	-0.0062	7.10E-05	0.111
	(0.868)	(0.908)	(2.543)	(3 702)	(2.482)	(-0.999)	(0.052)	(2.737)
MCD	-0.0186	-0.237	0.029	0.019	-4 70E-05	1.00E-04	5 40E-05	2.30E-05
	(-0.266)	(-0 865)	(2 922)	(3.361)	(-0.622)	(0 932)	(0 504)	(0.409)
MMM	-0 081	0 049	0.017	0 025	-6 5E-05	1.90E-05	-1.80E-05	3.40E-05
	(-1 887)	(0.311)	(2.845)	(4.667)	(-2.227)	(0.390)	(-0 441)	(0.822)
MOB	1 322	-0 011	0 343	0.470	0 098	8.80E-04	-5.00E-04	3.80E-04
	(0.717)	(-0 261)	(3 210)	(3.937)	(2.532)	(0.210)	(-0 909)	(0.491)
MRK	0.751	0.0048	0 116	0.118	0 078	-0 0015	0 125	-4.20E-04
	(0 463)	(0.354)	(2.355)	(2.339)	(2.508)	(-1.155)	(2 587)	(-0.193)
NCR	1.204	0.045	0.081	-0.053	0.117	-0.0042	0.117	-0.0055
	(0.092)	(1.614)	(2.384)	(-3.163)	(2.449)	(-1.407)	(2.474)	(-1.333)
OXY	0.334	-0.035	0 014	0.015	4.60E-04	7.90E-05	0.0063	0.0036
	(1 502)	(-0 312)	(2.815)	(3.193)	(2.630)	(1 516)	(2.343)	(2.307)
PCI	0.302	0.00035	0.114	0.148	0.024	-5 00E-05	0.059	-1.30E-04
	(0 280)	(0.015)	(1.682)	(2.894)	(2 425)	(-0 076)	(2.532)	(-0.104)
PEP	0.573	-0.0081	0 087	0.116	-4.50E-04	-6.40E-04	-6.50E-05	-2.40E-04
	(0 682)	(-0.032)	(1.388)	(2.621)	(-0.425)	(-0 667)	(-0 0604)	(-0.221)
S	0.205	0.035	0 055	0.058	-3.70E-04	-3.40E-04	-5.10E-04	0.045
	(1 093)	(0 337)	(2.176)	(2 681)	(-0.091)	(-0.922)	(-1.767)	(2 563)
SLB	-0.061	-0 127	0 0281	0 039	-1.20E-04	-1.10E-04	-1 30E-04	-1.10E-04
	(-1.062)	(-0.661)	(1 594)	(3 692)	(-0 804)	(-0 853)	(-1.255)	(-0.895)
STK	0 137	-0 061	0.129	0 172	1 70E-04	4.10E-04	1.10E-04	8.30E-05
	(1.234)	(-0 510)	(2 916)	(4 191)	(0.872)	(1.239)	(0.633)	(0.703)
SYN	-0 041	-0 295	0.017	0.023	2 10E-04	1 10E-04	3.40E-05	-8.3E-05
	(-0 508)	(-0.734)	(0 985)	(2.859)	(0 821)	(0.687)	(0.187)	(-0 704
T	1 125	0 015	0 146	0.059	-0.0027	-0 0019	0 140	-0.0048
	(0 543)	(0.254)	(3.181)	(2.244)	(-1.739)	(-1.086)	(2.533)	(-0.545)
TOY	0.865	0 0096	0.195	0.384	2.30E-04	-2 70E-04	4 70E-04	5.80E-04
	(1.278)	(0 089)	(1.274)	(3.781)	(0.580)	(-0.623)	(0.549)	(0.895)
TXN	0.495	-6.3E-05	0 194	0.306	1 50E-05	-2.50E-04	0.201	1.80E-04
	(0.696)	(-0.029)	(2 503)	(3 328)	(0 015)	(-0 259)	(2 601)	(0.184)
UAL	0.714	0 041	0.107	0.145	-3.80E-04	-6.20E-04	-5 00E-04	0.0065
	(0 902)	(0 458)	(2 387)	(2 583)	(-0.499)	(-1 465)	(-1.260)	(1.915)
UPJ	-0 155	0.039	0 132	0.277	0.148	-0.0064	0 015	0.0034
	(-0 085)	(1 412)	(2.147)	(4.125)	(2.425)	(-1.709)	(1.713)	(0 894)
WMT	0.869	-0 0068	0.026	0 030	0.0099	-1.10E-04	0.0251	0 0015
	(1 582)	(-0.170)	(2 192)	(2.715)	(2.344)	(-0.263)	(2.492)	(1.088)
XON	0.209	0.0083	0.0085	0.0045	0.0022	-4.50E-05	0.0046	-5.3E-05
	(1 849)	(0 478)	(4 511)	(4.357)	(2.302)	(-1.358)	(2.463)	(-0.651)
XRX	0.674	0.034	0 085	0.196	-3.20E-04	-1.20E-04	1.70E-04	0.097
	(0 859)	(1 054)	(1.378)	(2.510)	(-0.787)	(-0.418)	(0.789)	(2.604)
Mean	β_1	β_2	β_3	β_4	β_5	β_6	β_7	β_8
Coefficien	0 650	-0.008	0 112	0.164	0.022	0.0013	0.041	0.016
T-stat	0 994	0 617	2.240	3 307	1.452	0 974	1.610	1.104
The proportion of stock significant at								
5%	4/45	2/45	29/45	45/45	21/45	4/45	22/45	11/45
1%	1/45	0/45	13/45	37/45	6/45	2/45	13/45	6/45

[a] Monday(M), Tuesday(T), Thursday(TH) and Friday(F).

[b] The critical T-statistic is 1.96 at 5% and 2.676 at 1% significance.

TABLE 5C

Maximum Likelihood Estimates of GARCH(1,1) with Open Interest and day[a] Indicators,(T-stats[b]).

Co.	β_1	β_2	β_3	β_4	β_5	β_6	β_7	β_8
ARC	0.422	-0.0075	0 302	0.539	-1.4E-05	-1.80E-04	4.20E-04	-1.90E-04
	(3.380)	(-0 118)	(4.202)	(6 687)	(-0.143)	(-2.084)	(1.343)	(-2.072)
AVP	0.791	0.0043	0.317	0 761	-6 30E-04	-0.0011	0.139	-0 0014
	(5.421)	(0.297)	(4.206)	(2 366)	(-1.831)	(-4 012)	(2 616)	(-0.651)
BA	0.784	-0.0086	-0.042	0.382	0.0016	8 70E-04	0.126	0.0880
	(1.123)	(-0.678)	(-0 547)	(3 051)	(2.461)	(1.582)	(2.689)	(2.716)
BAC	0.0426	0 588	0.102	0.189	1.10E-05	-2 90E-04	-2 40E-04	-1 70E-04
	(0.606)	(1.444)	(0.782)	(0.707)	(0 073)	(-3 318)	(-1.528)	(-0.883)
BMY	0.369	-0.006	0.062	0.406	0.0028	0 0020	-3 7E-05	0 416
	(0.576)	(-0.973)	(0.338)	(1.721)	(2 415)	(1 821)	(-0 111)	(2 641)
BV	0.242	-0.317	-0 141	-0.036	-1.00E-03	-2.00E-04	-6 70E-04	-5.40E-04
	(3.224)	(-2 007)	(-3.357)	(-0.441)	(-1.677)	(-0.517)	(-3.252)	(-1.51)
C	0 594	0.239	0.084	0.111	2.80E-05	4.20E-04	1 60E-04	5.40E-04
	(3.052)	(0.909)	(1.078)	(0.961)	(0.216)	(1.672)	(1.333)	(2 638)
CCI	0.892	0.0201	0 143	0.539	-5.50E-04	-6.70E-04	-8.60E-04	-1.20E-03
	(2.993)	(0.148)	(1.549)	(3.229)	(-0.768)	(-0.972)	(-1 167)	(-1.611)
DOW	0.138	0.0089	0.294	0.084	2 20E-04	-7.30E-05	2.40E-03	-2 30E-04
	(1.349)	(1.065)	(4.226)	(1.624)	(1.202)	(-0 701)	(2 122)	(-2 559)
EK	1.111	-0.0083	0.051	0.417	0 0033	0.0030	0.00023	0 363
	(1.138)	(-0.746)	(0.212)	(1.851)	(1.727)	(1.909)	(0 473)	(2 638)
F	0.211	-0 493	0 051	-0.072	7.90E-05	1.20E-05	-1 50E-04	-2 30E-05
	(1.835)	(-1.479)	(0.754)	(-0.305)	(0.341)	(0 156)	(-1 709)	(-0 139)
FLR	-0.026	0.176	-0.0031	0 763	-1.80E-04	-4 30E-04	-1 70E-06	-1.60E-04
	(-0.419)	(0 307)	(-0 018)	(0.738)	(-0.674)	(-1.689)	(-0.0044)	(-0 398)
GE	0 131	0 118	0 018	-0 047	8.90E-04	5.20E-04	4 80E-04	2 20E-04
	(0 520)	(0.211)	(0.314)	(-0.834)	(1 988)	(1 724)	(1 315)	(1 375)
GM	0 615	-0.048	0 279	0.781	0.0032	0.002	0 054	0 058
	(0.650)	(-0.992)	(3 130)	(1 962)	(1 707)	(1 529)	(2 649)	(2 897)
GPS	0 019	0 798	-0.257	0 263	9.00E-05	-1.60E-04	3 60E-04	-3 60E-04
	(0 175)	(2.618)	(-0 830)	(0.242)	(0.477)	(-1.035)	(1.558)	(-1 651)
HM	-0.0054	-0 082	-0.0158	-1.448	-1.50E-04	-3.10E-04	-1.20E-04	-2 40E-05
	(-0.104)	(-0.384)	(-0 3005)	(-5 819)	(-1.395)	(-2.975)	(-0.632)	(-0 146)
HNZ	0 195	0.4880	0.099	-0 059	-7 00E-05	-1.40E-04	-1 50E-05	-1.40E-04
	(1.855)	(1 158)	(0.321)	(-0 125)	(-1.117)	(-2.212)	(-0 126)	(-1 210)
HWP	0.025	0 313	-0 031	0.303	-8.20E-05	3.20E-04	-1 20E-04	3.90E-04
	(0.239)	(0.393)	(-0.171)	(1 675)	(-0.292)	(1 287)	(-0 332)	(0.662)
I	0.996	0.012	0.219	0.264	-1 40E-04	-5 60E-04	-8 90E-04	-5.60E-04
	(7.121)	(1.530)	(3 454)	(0.555)	(-0 215)	(-0.884)	(-1 407)	(-0 877)
IBM	0.071	0 146	-0.005	-0.073	3 50E-05	4 50E-04	-6.80E-05	4 10E-05
	(0.594)	(1 622)	(-0.625)	(-3.609)	(0.419)	(4.521)	(-1 376)	(0 521)
JNJ	1.235	-0.0048	-0.063	0.187	7.50E-04	6.60E-05	1.10E-04	0.077
	(6.686)	(-0 422)	(-3 959)	(3 484)	(0 701)	(7 361)	(3 401)	(2 636)
KM	0.053	0 217	-0.055	0.249	-4 70E-05	2 10E-04	-7.50E-05	-8 60E-05
	(0 391)	(0.317)	(-0.383)	(1.533)	(-0 456)	(0.813)	(-0 491)	(-0.383)
KO	-0 079	-0.427	0.173	0.016	-5 10E-05	1.40E-05	2.00E-05	-9.00E-06
	(-3 175)	(-0.633)	(2.349)	(1 715)	(-0 476)	(0 208)	(0 257)	(-0 177)
LA	0.175	0.0081	0.196	-0 163	0 0027	3 10E-04	0 052	-0 0014
	(1 172)	(0.252)	(1.705)	(-0 712)	(2 949)	(0.534)	(2.461)	(-0 [illegible])

[a] Monday(M), Tuesday(T), Thursday(TH) and Friday(F).

[b] The critical T-statistic is 1.96 at 5% and 2.576 at 1% significance.

TABLE 5C

Maximum Likelihood Estimates of GARCH(1,1) with Open Interest and day[a] Indicators,(T-stats[b]).

Co	β_1	β_2	β_3	β_4	β_5	β_6	β_7	β_8
LTD	0.833	0.031	0.249	0 551	-8 40E-04	-0.0013	-0.0012	-0.0016
	(6 971)	(1 194)	(10.845)	(8.379)	(-1.086)	(-1.80)	(-1.611)	(-2.094)
MCD	0.069	0.498	0.026	0.132	1.40E-04	8 10E-06	4.20E-04	-1.40E-04
	'(0 920)	(1.820)	(0 371)	(0.474)	(1.470)	(0.138)	(3.238)	(-1.487)
MMM	0 062	-0.173	0.013	-0.183	-2 20E-04	-1.00E-04	-9.40E-05	-1.70E-04
	(0 875)	(-0.348)	(0.257)	(-1.564)	(-2.232)	(-1.206)	(-1.102)	(-3.068)
MOB	0 216	0 055	0 126	-0.134	9.10E-06	-1.30E-04	1.90E-04	-1.50E-04
	(1 189)	(0.217)	(1 966)	(-1.112)	(0.157)	(-1.928)	(0.916)	(-1.562)
MRK	0.513	-0 0058	0.170	0.531	0.0023	0.0014	-2.50E-04	0 405
	(0.712)	(-0 915)	(0.645)	(1 643)	(1.938)	(1.283)	(-0.442)	(2 637)
NCR	0.553	-0.0076	0.141	0.014	8.40E-05	9.60E-05	9.20E-03	2 90E-04
	(1.875)	(-0.242)	(3.773)	(3.446)	(1.268)	(2 148)	(2.585)	(0.922)
OXY	0 0958	0.049	0.035	0.055	9 50E-06	-2.90E-04	6.30E-05	-2.40E-04
	(0 651)	(0 096)	(0.374)	(0.244)	(0.051)	(-1.385)	(0.253)	(-0.933)
PCI	0.501	0.023	-0.056	0.122	7.40E-06	-6.30E-05	-6.30E-05	-1.60E-04
	(3.547)	(0 200)	(1.494)	(0.778)	(0.071)	(-0.727)	(-0 705)	(-2.394)
PEP	0 733	-0 049	0 382	0 459	0.013	0.012	-0.001	0.278
	(0.687)	(-0 917)	(0.964)	(0.663)	(2.314)	(2 181)	(-0.746)	(2.626)
S	0 149	-0 0065	0 337	0 593	2.50E-04	-1.30E-04	0.056	9 20E-04
	(1.242)	(-0.277)	(3 253)	(3 012)	(1.171)	(-1.120)	(2.612)	(0.669)
SLB	0.391	-0.052	0 195	0.672	2.10E-05	-2.60E-05	4 10E-04	1.80E-05
	(0.862)	(-0 0978)	(0 403)	(2.249)	(0.049)	(-0.070)	(0.934)	(0.0387)
STK	0 154	0.383	-0 771	-6.633	-1.60E-04	6 30E-04	-1.30E-04	1.60E-04
	(1 131)	(1.327)	(-1.051)	(-2 635)	(-0.669)	(1.283)	(-0.319)	(0.411)
SYN	-0 077	0.421	0.072	0.029	4.30E-04	1 30E-04	1.30E-04	8.50E-05
	(-1.129)	(0 853)	(0.700)	(0.103)	(2 936)	(0 775)	(0.609)	(0.498)
T	0.0079	-0 511	-0 036	-0.075	2.50E-05	7.50E-05	8.60E-05	6 30E-05
	(0.133)	(-0.869)	(-2 832)	(-1.035)	(0.225)	(1.207)	(0.787)	(1.041)
TOY	-0.065	-0 123	0.184	-0 415	-1.20E-04	-1.10E-04	-4.50E-05	-3.50E-05
	(-1.412)	(-0.198)	(1 367)	(-0.840)	(-0.394)	(-0.577)	(-0.205)	(-0.219)
TXN	-0 013	0 523	0 144	0 313	-4.60E-04	-4.30E-04	-4.60E-04	4.90E-04
	(-0.264)	(1 109)	(1 004)	(0 701)	(-1 75)	(-2.323)	(-1 365)	(1 332)
UAL	0.302	-0.043	0.089	0.303	9.30E-05	7.40E-05	1.10E-04	6.80E-05
	(1.552)	(-0 196)	(2 459)	(2 680)	(0.562)	(0.634)	(0 991)	(0.646)
UPJ	0 281	-0.0055	0 02	0.052	-9.20E-04	-0 0010	0.015	-6.90E-04
	(1 152)	(-0.078)	(2.019)	(5.255)	(-3.084)	(-3 510)	(2.346)	(-0 600)
WMT	0.168	0 433	-0.016	-0.0082	6.50E-05	3.10E-05	1.70E-04	-1 30L-04
	(1 141)	(0 681)	(-0 345)	(-0 101)	(0.587)	(0.291)	(0.963)	(-0.698)
XON	0.015	0.605	0.012	-0.0067	-1 60E-04	-2.30E-04	-2.70E-04	-2.00E-04
	(0.268)	(1.237)	(0 359)	(-0.054)	(-3.038)	(-3 506)	(-1.673)	(-1.873)
XRX	0.0027	0.215	0.036	0.144	6.90E-05	1.20E-04	7.90E-04	-2.50E-04
	(0 038)	(3.364)	(0.430)	(0.408)	(0.553)	(0.876)	(4.462)	(-2.946)
Mean	β_1	β_2	β_3	β_4	β_5	β_6	β_7	β_8
Coefficient	0 309	0 089	0 070	0.019	5.87E-04	3.74E-04	0.01	0.037
T-stat	1 678	0.821	1 682	1.852	1.141	1.655	1.405	1.389
The proportion of stocks significant at								
5%	13/45	4/45	15/45	15/45	11/45	15/45	12/45	14/45
1%	10/45	2/45	11/45	12/45	4/45	7/45	8/45	11/45

[a] Monday(M), Tuesday(T), Thursday(TH) and Friday(F).

[b] The critical T-statistic is 1.96 at 5% and 2.576 at 1% significance.

TABLE 6A

Asymmetric GARCH(1,1)[a] without Volume, (T-stats[b])

Co.	ß1	ß2	ß3	Co	ß1	ß2	ß3
ARC	0.241	-2 126	0.715	LTD	-0.034	-1.411	-0 937
	(1.243)	(-1 433)	(4.338)		(-0.395)	(-1 235)	(-20 748)
AVP	1.345	3.132	-0 0261	MCD	0.097	0.054	0.281
	(2.233)	(0.976)	(-0.079)		(0 414)	(0.0203)	(0.317)
BA	0.425	-8.193	0.704	MMM	0.091	-1 711	0 596
	(1.815)	(-5.083)	(6.747)		(0 508)	(-0.929)	(3 081)
BAC	-0.207	2.563	0.497	MOB	-0.182	-1.654	0.781
	(-1.548)	(1.331)	(1.297)		(-1.622)	(-1.621)	(3 785)
BMY	0.166	1 190	-0.018	MRK	0.037	2.377	-0.454
	(0.424)	(0.517)	(-0.013)		(0.173)	(1.771)	(-1.067)
BV	0.416	14.964	-0.442	NCR	2 135	-0.324	0 378
	(1.422)	(2.994)	(-2.374)		(6.965)	(-0.242)	(5 856)
C	1.773	4.432	0.308	OXY	0.353	2.957	-0 451
	(3 367)	(0.955)	(1.790)		(0.831)	(1.181)	(-1 099)
CCI	1.199	10.509	-0.116	PCI	1.074	-6.445	0 094
	(3.01)	(2.017)	(-0.777)		(3.598)	(-2 665)	(0 562)
DOW	0.230	2 451	0.679	PEP	0.714	-7 456	-0.053
	(0.793)	(0.987)	(2.843)		(2 476)	(-2.209)	(-0 284)
EK	-0.168	-3.0337	-0.065	S	0.311	-2.671	0 679
	(-0.634)	(-1.589)	(-0 132)		(1 232)	(-0.904)	(3 484)
F	0.326	-5.936	-0 121	SLB	0.068	1 188	-0 694
	(0.916)	(-2.089)	(-0.424)		(0.374)	(0.636)	(-1 291)
FLR	0.321	-4.692	0.662	STK	0.707	-8 461	0 1101
	(1.584)	(-1 691)	(4.036)		(1.636)	(-1.497)	(0 302)
GE	-0.302	-0.949	0.645	SYN	-0.325	1.017	1 01
	(-2.147)	(-0.939)	(2.465)		(-3.174)	(1.256)	(21 453)
GM	0.267	-2 407	-0 0967	T	0.428	-5.312	-0 291
	(0.910)	(-0.659)	(-0 110)		(1.525)	(-2 616)	(-0 743)
GPS	0 951	7.831	0.341	TOY	0.11	-2 877	-0.918
	(2.501)	(1.641)	(1.574)		(0.961)	(-1.897)	(-23 601)
HM	-0.044	2.65	-0.211	TXN	-0.288	-2.837	0 251
	(-0.202)	(0.888)	(-0.355)		(-1.145)	(-1.005)	(0.405)
HNZ	0.469	-0.883	0.376	UAL	0.004	1.268	0 576
	(1.715)	(-0.377)	(1.155)		(0.017)	(0.581)	(0.826)
HWP	0.114	-0.726	0.637	UPJ	-0.033	-0 794	-0 092
	(0.414)	(-0.201)	(1 596)		(-0.128)	(-0 244)	(-0.0602)
I	0 853	-1.084	-0.449	WMT	0 243	-2 721	-0 166
	(2.336)	(-0.252)	(-1.77)		(0.557)	(-1.51)	(-0 213)
IBM	0.118	-4.677	-0.093	XON	0 113	-1 142	0 446
	(0.250)	(-2.306)	(-0.221)		(0.412)	(-0.611)	(0 496)
JNJ	0.833	-0.341	-0 277	XRX	0 687	10 492	-0 075
	(1.693)	(-0 139)	(-0.912)		(2.20)	(3.524)	(-0 310)
KM	-0.098	0.834	-0.026				
	(-0.261)	(0 282)	(-0.019)	Mean	ß1	ß2	ß3
KO	0.223	-4.163	-0.261	Coefficien	1 192	0.169	0 964
	(0.529)	(-1.606)	(-0 638)	T-stat	1 432	1.372	2 858
LA	0 739	-16.364	0.517				
	(2 178)	(-2.652)	(3.202)	The proportion of stocks significant at			
				5%	13/45	11/45	14/45
				1%	6/45	6/45	12/45

[a] The daily return were adjusted: 1000X

[b] The critical T-statistics are 1.96 at 5% and 2.576 at 1%.

TABLE 6B

Asymmetric GARCH(1,1)[a] with Stock Volume, (T-stats[b]).

Co.	β_1	β_2	β_3	β_4	β_5
ARC	0.261	-1.536	-0.377	1.087	1.127
	(0.882)	(-1.197)	(-2.149)	(3.299)	(4.483)
AVP	0.181	1.267	-0.154	0.359	0.615
	(0.844)	(0.808)	(-1 318)	(2 402)	(4.506)
BA	0.273	1.4670	-0.682	1.171	1.274
	(1.041)	(1.037)	(-1.497)	(1.727)	(3.152)
BAC	-0.0181	6.181	-0.302	2.644	1.249
	(-0.122)	(3.578)	(-1 61)	(3.964)	(5.054)
BMY	0.138	0.061	0.071	1.213	2 372
	(0.596)	(0.051)	(0 454)	(2.375)	(4.971)
BV	-0.261	-0.468	0.011	0.557	0.814
	(-1.056)	(-0.205)	(0 054)	(2.063)	(3.694)
C	0.735	-1.74	0.202	0.908	3.205
	(1.571)	(-0 574)	(1.348)	(1 212)	(3.972)
CCI	0.426	1.048	-0.061	2.120	2 173
	(1.194)	(0.384)	(-0.255)	(2 253)	(6.887)
DOW	0.031	1.356	0 187	2.475	1 865
	(0.125)	(0.637)	(0.872)	(2.673)	(3.492)
EK	-0.089	1 504	-0.168	1.033	1.796
	(-0.335)	(0.933)	(-0.805)	(1.956)	(4.963)
F	0.250	-3 152	-0.055	1.775	2.470
	(0.741)	(-1.316)	(-0.217)	(1.736)	(3 376)
FLR	-0.235	-1.863	-0.021	0.936	1.331
	(-1.562)	(-1.539)	(-0.061)	(2.263)	(6.468)
GE	-0.376	-1.088	0.382	1.209	2.298
	(-6.260)	(-3.238)	(1.516)	(2.552)	(5.211)
GM	-0.037	-1 859	0.173	0.492	3.508
	(-0.146)	(-0.621)	(1.355)	(0 386)	(4.689)
GPS	0.141	1.775	0.045	1.345	2.272
	(0.366)	(0.431)	(0.213)	(1.735)	(3.675)
HM	-0.228	-1.742	0.014	1.823	2.753
	(-2.002)	(-1.436)	(0 093)	(2.179)	(5.058)
HNZ	0.277	-2.247	0.045	2.371	2.113
	(1.356)	(1.240)	(0.208)	(2.859)	(2.585)
HWP	0.399	1.428	0.142	1.228	3.323
	(1.632)	(0.540)	(0.706)	(1.542)	(5.123)
I	0.117	0.558	0.0083	0 905	2.005
	(0.277)	(0.129)	(0.052)	(1.099)	(3.103)
IBM	0.013	1.246	-0.098	0.938	1.574
	(0.079)	(1.426)	(1.371)	(3.701)	(5.971)
JNJ	0.281	3.5931	-0.118	1.161	1.431
	(0.758)	(1.469)	(-0.429)	(1.437)	(2 845)
KM	0.353	6.023	0.128	0.693	1.471
	(0.912)	(1.847)	(0.443)	(0.544)	(2.741)
KO	-0.208	0 741	0.018	3.902	3.309
	(-1.118)	(0.415)	(0 082)	(4.075)	(3.064)
LA	-0.342	1.819	C.295	0 594	1.715
	(-2.782)	(0.944)	(5.281)	(2.099)	(5 637)

[a] The Returns were adjusted: 1000X

[b] The critical T-statistic is 1.96 at 5% and 2.576 at 1% significance.

TABLE 6B

Asymmetric GARCH(1,1)[a] with Stock Volume, (T-stats[b]).

Co.	β_1	β_2	β_3	β_4	β_5
LTD	-0.07	-1.541	-0.919	2.0[illegible]	-0.029
	(-0 338)	(-0.916)	(-2.688)	(1.664)	(-0.071)
MCD	-0.165	-0.197	-0.046	1.635	1.406
	(-0.878)	(-0.089)	(-0.164)	(2.734)	(2.900)
MMM	-0.115	-0.329	-0.11	1.065	1.421
	(-0.571)	(-0.281)	(-0.954)	(2.576)	(4.486)
MOB	-0.159	-0.58	0.162	0.328	0.854
	(-0.472)	(-0.286)	(0 686)	(0.597)	(2.259)
MRK	-0.283	0 758	-0.057	1.654	1.8780
	(-1.894)	(0.640)	(-0.450)	(2.726)	(3.569)
NCR	0.059	1.128	0.045	0.144	0.206
	(0.151)	(0.526)	(0.140)	(1.649)	(3.975)
OXY	0 055	0.645	-0.304	3.909	2.826
	(0.144)	(0.292)	(-1.142)	(2.756)	(3.403)
PCI	-0.039	0.44	0.471	0.159	1.312
	(-0 113)	(0.284)	(1.192)	(0.242)	(5.097)
PEF	0.245	-2.294	-0.206	1.825	4.441
	(0 493)	(-0 551)	(-0.505)	(0.883)	(3.452)
S	0.278	-1.0481	0.221	1.581	3.110
	(0.765)	(-0.395)	(0.985)	(1.534)	(3.202)
SLB	-0.078	0 775	-0.224	1.834	1.807
	(-0.211)	(0.338)	(-0.535)	(1.681)	(3.564)
STK	0.047	-0 388	0.075	1.376	1.970
	(0.089)	(-0.094)	(0.272)	(1.691)	(3.962)
SYN	-0.469	0 13	0.533	0.368	1.111
	(-1.443)	(0.044)	(1.152)	(0.599)	(2.812)
T	0.037	1.824	0.246	1.008	2.241
	(0.091)	(0 888)	(1.149)	(1.125)	(4.266)
TOY	-0.242	-1.578	-0.531	5.103	2.186
	(-2.246)	(-0.835)	(-1.621)	(4.199)	(3.011)
TXN	0.327	0.099	-0 73	0.657	0.824
	(0.840)	(0.046)	(-1.590)	(1.151)	(3.235)
UAL	0.0657	0.377	-0.095	0.214	0.391
	(0.172)	(0.159)	(-0.321)	(1.783)	(3.376)
UPJ	-0.234	-1 009	0 117	0.985	1.447
	(-1.895)	(-0 946)	(0.712)	(2.768)	(5.326)
WMT	-0.147	-0.688	-0.0083	3.543	5.932
	(-0.350)	(-0.248)	(-0.032)	(1.245)	(3.157)
XON	0.0032	0.025	-0.224	3.666	2.558
	(0.0128)	(0.019)	(-1.183)	(2.692)	(2.663)
XRX	0.112	4.7096	-0.152	0.801	1.360
	(0.467)	(1.883)	(-0.682)	(3.69)	(4.404)
Mean	β_1	β_2	β_3	β_4	β_5
Coefficien	0.0291	0.3473	-0.0456	1.4849	1.9403
T-stat	0.905	0.794	0.901	2.04[illegible]	3.931
The proportion of stocks significant at					
5%	4/45	2/45	3/45	23/45	44/45
1%	2/45	2/45	2/45	14/45	43/45

[a] The Returns were adjusted: 1000X

[b] The critical T-statistic is 1.96 at 5% and 2.576 at 1% significance.

TABLE 6C

Asymmetric GARCH(1,1)[a] with Option Volume, (T-stats[b]).

Co.	β_1	β_2	β_3	β_4	β_5
ARC	0.134	-1.108	-0.512	0.233	0.128
	(0.574)	(-0.611)	(-1.07)	(2.117)	(3.222)
AVP	0.034	1.237	-0 254	0.533	0.426
	(0 101)	(0.576)	(-1.151)	(3.589)	(2.430)
BA	0.257	1.2250	0 338	0.029	0.100
	(0.833)	(0.754)	(2.154)	(1 751)	(6 148)
BAC	0.225	2 175	-0.132	0.361	0.358
	(0.565)	(0.694)	(-0.495)	(1.600)	(3.741)
BMY	-0.174	-0.832	-0 017	0.092	0.1510
	(-0.678)	(-0.525)	(0.132)	(1.155)	(4 131)
BV	-0.243	0.982	0.064	0.283	0 478
	(-1.953)	(0.537)	(0.436)	(1.548)	(4.042)
C	-0.114	2.989	0.053	0.514	0.548
	(-0 465)	(1 209)	(0 401)	(3.129)	(3.605)
CCI	-0.077	3.579	0.123	0.121	0.268
	(-0.248)	(1.146)	(0.487)	(1.113)	(5.854)
DOW	0.377	3.942	-0.01	0.251	0.342
	(0.937)	(1.456)	(-0.05)	(2.551)	(5.961)
EK	-0.082	0.998	-0.316	0.125	0.145
	(-0.264)	(0.570)	(-1.492)	(3.819)	(4.291)
F	-0.227	1.245	0.356	0.077	0.200
	(-1.073)	(0.779)	(1.114)	(0.839)	(3.837)
FLR	-0.384	0.483	0.247	0.424	0.814
	(-4.034)	(1.929)	(1 014)	(2.441)	(6.186)
GE	0.131	0.064	-0.083	0 023	0.053
	(-0.521)	(0.025)	(-0.161)	(0.671)	(2.514)
GM	-0.222	-1.181	-0 386	0.104	0 141
	(2.081)	(-0.816)	(-0.924)	(1 462)	(3.539)
GPS	0.332	0.717	0.476	-0.673	0.655
	(0.594)	(0.148)	(2.108)	(-1 158)	(2.114)
HM	0.31	0.881	-0.398	0.594	0.658
	(0.415)	(0.131)	(-0.832)	(1.576)	(2 120)
HNZ	0.276	-2.227	0.134	0.252	0.276
	(1.353)	(-1.121)	(0.495)	(1.332)	(2.209)
HWP	0.106	1.064	0.029	0.12	0.297
	(0.394)	(0.440)	(0 149)	(1.763)	(3.648)
I	-0.133	-2.404	-0.087	1.452	1.551
	(-0.426)	(-0.734)	(-0.332)	(1.985)	(3.076)
IBM	-0.052	0.139	-0.472	0.009	0 017
	(-1.016)	(0.097)	(-5.635)	(2.651)	(7.142)
JNJ	0.172	0.7970	-0.621	0.103	0.086
	(0.522)	(0 461)	(-1.705)	(1.795)	(2.973)
KM	0.402	7.968	-0.139	0.502	0.477
	(1.469)	(2.703)	(-0.471)	(1.811)	(2.747)
KO	-0.153	2.16	-0.155	0.211	0.144
	(-0.938)	(1.898)	(-0.558)	(2.726)	(3.648)
LA	0.086	1.174	0.306	0.069	0.694
	(0.641)	(0.377)	(2.560)	(0.433)	(5.880)

[a] The Returns were adjusted: 1000X

[b] The critical T-statistic is 1.96 at 5% and 2.576 at 1% significance.

TABLE 6C

Asymmetric GARCH(1,1)[a] with Option Volume, (T-stats[b]).

Co.	β_1	β_2	β_3	β_4	β_5
LTD	0.156	2.609	-0.089	0.369	0 446
	(0.593)	(0.879)	(-0.408)	(2.368)	(2.796)
MCD	0.082	1.298	-0.556	0 406	0.249
	(0.718)	(1.021)	(-1.873)	(3.861)	(4.478)
MMM	0.016	-2.178	-0.064	0 188	0.218
	(0.092)	(-1.618)	(-0 311)	(2.299)	(4.22)
MOB	-0.144	-1.019	-0.114	0 049	0.084
	(-0.604)	(-0.565)	(-0.313)	(0.599)	(1.743)
MRK	0.081	1.907	-0.128	0.046	0.0880
	(0.327)	(1 180)	(-0.364)	(1.209)	(4.575)
NCR	-0.157	0 467	0.248	0.007	0.012
	(-0 693)	(0.369)	(1.213)	(2.808)	(6.731)
OXY	0.353	3 484	-0.555	0.223	0.161
	(0 798)	(1.334)	(-1.569)	(2.295)	(2.258)
PCI	0.234	3.189	-0.272	0.237	0.176
	(0.900)	(1.417)	(-0.904)	(3.395)	(2.722)
PEP	0.257	-1.914	0 058	0.054	0.194
	(0.644)	(-0.746)	(0.309)	(0.643)	(4.119)
S	0.099	1.036	0.265	0.192	0.383
	(0.367)	(0.850)	(0.743)	(1.241)	(4.872)
SLB	0.017	1.173	-0.09	0.227	0.366
	(0.057)	(0.378)	(-0.501)	(1.192)	(3.001)
STK	0 121	2.525	-0 076	1.382	1.868
	(0 263)	(0 578)	(-0 389)	(2.279)	(3.767)
SYN	-0.074	4.254	-0.119	0.181	0.269
	(-0 193)	(1.087)	(-0.259)	(0.898)	(3.123)
T	0.622	-0.161	0.151	0.023	0.041
	(1.559)	(-0 066)	(0.493)	(1.141)	(3.285)
TOY	-0 357	0.443	0.051	0.385	0 562
	(-2.657)	(0.181)	(0.181)	(1.244)	(4.100)
TXN	-0.065	-0.238	-0 135	0.499	0.519
	(-0.312)	(-0.122)	(-1.003)	(4.841)	(6.024)
UAL	-0.094	1.328	0.174	0.103	0.246
	(-0.334)	(0.857)	(0.625)	(1.925)	(3.800)
UPJ	-0.051	-3.663	0 092	0.026	0.049
	(-0.422)	(-2.399)	(0.471)	(2.334)	(5.311)
WMT	0.062	1.156	0.241	0.065	0.121
	(0.098)	(0.428)	(0.517)	(0.965)	(3.272)
XON	-0.286	-1.749	-0.053	-0.044	0.077
	(-2.096)	(-1.525)	(-0.345)	(2.446)	(3.599)
XRX	0.0035	3.155	-0.124	0.266	0.525
	(0.016)	(1.419)	(-0.771)	(1.759)	(3.243)
Mean	β_1	β_2	β_3	β_4	β_5
Coefficien	0.0413	0.9593	-0.0567	0.2376	0.3480
T-stat	0.796	0.861	0.877	1.927	3.913
The proportion of stocks significant at					
5%	4/45	2/45	4/45	19/45	44/45
1%	1/45	1/45	?/45	8/45	39/45

[a] The Returns vere adjusted: 1000X

[b] The critical T-statistic is 1.96 at 5% and 2.576 at 1% significance.

TABLE 6D

Asymmetric GARCH(1,1)[a] with Option Open interest. (T-stats[b]).

Co.	β_1	β_2	β_3	β_4	β_5
ARC	0.345	-3.886	-0.334	-0.0048	-0.02
	(1.268)	(-1.611)	(-1.958)	(-0.511)	(-2.332)
AVP	0.544	1.63	-0.255	-0.007	-0.062
	(1.207)	(0.602)	(-0.487)	(-2.001)	(-1.553)
BA	0.281	0.543	0.732	-6.20E-04	0 0055
	(0.951)	(0.298)	(2.368)	(-0 337)	(3 691)
BAC	-0 195	2.908	-0 617	0.033	0 0078
	(-2.265)	(2.194)	(-1 454)	(2.893)	(0 513)
BMY	0.208	1.248	0.142	4.10E-04	-0 0013
	(0.518)	(0.516)	(0.136)	(0 083)	(-0.068)
BV	0.562	6 646	-0.649	-0 0036	-0 0025
	(2.802)	(1.763)	(-7.038)	(-1.214)	(-0 152)
C	1.847	3 09	-0.038	0.012	0.035
	(2.786)	(0 504)	(-1.277)	(1.036)	(3.957)
CCI	0.95	7.615	-0.103	0 0085	0 019
	(2 507)	(1 732)	(-0 695)	(1 763)	(1 811)
EK	-0 051	0.042	0 788	3 60E-04	0 0048
	(-0 246)	(0.022)	(1 816)	(0 09)	(0.699)
F	0 508	-7.261	0 034	0 0068	0.021
	(1 261)	(-2.174)	(0 133)	(0 976)	(1.892)
FLR	0.123	-1 992	0 764	0 0011	0 072
	(0.347)	(-0.631)	(2 325)	(0 078)	(4 681)
GE	-0.269	-0 663	0 707	9 40E-04	3.20E-04
	(-1.247)	(-0 371)	(1 455)	(0 196)	(0 067)
GPS	0 173	-0 402	0 627	-0 056	0.037
	(0.236)	(-0 072)	(1.268)	(-0 814)	(0.233)
HM	-0.268	0.681	-0.261	0 005	-0.085
	(-2.016)	(0.317)	(-0.494)	(0 304)	(-1.568)
HNZ	0.315	-3 773	0.211	0 0068	-0 036
	(1.281)	(-1 664)	(0 454)	(0 303)	(-0 899)
HWP	0.216	0 236	0 600	-0.0025	-0.044
	(0.500)	(0.058)	(1.091)	(-0 201)	(-2.121)
I	0 823	0 572	-0 359	0 015	0 111
	(1.897)	(0.258)	(-3.939)	(0.153)	(0 567)
IBM	-0.065	0 677	0 284	3 80E-04	-0.013
	(-0.368)	(0 570)	(1 399)	(0 569)	(-5.173)
JNJ	0.837	-0 4430	-0 257	0.0061	0 0096
	(1.730)	(-0.160)	(-1 441)	(1 744)	(9.351)
KM	0.346	2 357	-0 204	-0 0079	-0.061
	(0.693)	(0.663)	(-0.237)	(-0.333)	(-0.878)
KO	-0.052	-0.04	-0.538	0 019	0 0038
	(-0.191)	(-0.015)	(-0.498)	(1.557)	(1.342)

[a] **The Returns were adjusted: 1000X**

[b] **The critical T-statistic is 1.96 at 5% and 2.576 at 1% significance.**

TABLE 6D

Asymmetric GARCH(1,1)[a] with Option Open interest, (T-stats[b])

Co.	β_1	β_2	β_3	β_4	β_5
LTD	-0.16	-3.261	-0.816	0.027	0.022
	(-0.608)	(-0 908)	(-1.438)	(2.492)	(0.595)
MCD	0.174	0.528	-0 326	0.0027	-0.078
	(0.596)	(0.240)	(-1.511)	(0.347)	(-2.515)
MOB	-0.205	-0.996	0.34	-0.015	-0 033
	(-0.802)	(-0 589)	(1 966)	(-2.281)	(-1.857)
MRK	-0.034	1.923	-0.553	0 0088	0.0068
	(-0.139)	(1.490)	(-0.795)	(1.950)	(1.222)
NCR	0 872	3.904	0.544	-2.90E-04	-6.10E-04
	(2.774)	(3.341)	(5.248)	(-3.984)	(-2.222)
OXY	0.188	-0 819	0.333	-0.0032	0.011
	(0.452)	(-0.325)	(0.503)	(-0.402)	(0.564)
PCI	0.971	-5.043	0.213	-0.0074	-2.30E-04
	(3.500)	(-2.042)	(1.239)	(-1.904)	(-0.018)
S	0.366	-5.325	0.292	0 004	-0.035
	(0.839)	(-1.390)	(1.194)	(0.395)	(-3.138)
STK	0.674	-3 649	0.707	-0.031	-0.542
	(1.546)	(-1.287)	(4 677)	(-0 455)	(-1.863)
SYN	-0.228	0 654	0 675	0.0035	-0.027
	(-1 168)	(0.223)	(1.576)	(0.306)	(-1.334)
TOY	-0.421	-1 95	-0 151	0.019	-0.046
	(-2 486)	(-0.998)	(-0.277)	(1.519)	(-1.044)
TXN	-0.229	0.445	0.636	0.0053	0.039
	(-1.367)	(0 137)	(1.042)	(0.250)	(1.204)
UAL	0.144	0.687	-0 699	0 01	-0 011
	(0.298)	(0.307)	(-0.686)	(1.218)	(-0.416)
WMT	0.528	-0.38	0.344	-0.0022	-0.0011
	(1.209)	(-0.120)	(0.504)	(-0.406)	(-0.148)
XON	-0.043	-0.868	0.694	-8.20E-04	0.0043
	(-0.150)	(-0.502)	(1.501)	(-0.238)	(0.630)
XRX	0.486	10.645	-0.134	0.025	0.013
	(1.311)	(3.804)	(-0.656)	(2.216)	(0.448)
Mean	β_1	β_2	β_3	β_4	β_5
Coefficient	0.2773	0.1697	0.0912	0.0021	-0.0183
T-stat	1 23	0.916	1.532	1.014	1.696
The proportion of stocks significant at					
5%	9/37	5/37	9/37	6/37	10/37
1%	5/37	2/37	4/37	1/37	7/37

[a] The Returns were adjusted: 1000X

[b] The critical T-statistic is 1.96 at 5% and 2.576 at 1% significance.

TABLE 7A

Maximum Likelihood Ratio Test For the Goodness of Fit

(refer to footnote).The Test Uses A Chi-squared Distribution.

Co.	Test A	Test B	Test C	Test D	Co.	Test A	Test B	Test C	Test D
ARC	5.92	0.42	8.22	8.34	LTD	-10.3	-9.3	8.34	7.28
AVP	4 58	27.04	36 36	-31.52	MCD	0.58	12 8	25 38	25 34
BA	0.38	24.1	43.14	18.92	MMM	0 28	23.14	-144.24	-371.56
BAC	0.4	-0.28	31.7	8.82	MOB	1.58	-7.64	-7.7	-5.88
BMY	0.3	22.5	13.3	-24 92	MRK	0.22	2.54	14 18	10 4
BV	-3.5	45.92	35.44	37.18	NCR	40.98	98 6	3.52	27.9
C	25.5	27.52	29.76	24.98	OXY	1.14	1.26	10	9 64
CCI	6 44	39.66	48.02	26.92	PCI	19	46 64	51.2	13.12
DOW	2.18	12.86	23.78	14.8	PEP	5.72	36.94	31.58	34
EK	1.64	23.2	22.46	26.3	S	7	12	27.7	32.52
F	-5.26	26.02	19 76	4.52	SLB	1.32	11.78	-7.48	6.92
FLR	5.94	60 24	34 26	70.68	STK	6 52	34.2	25.4	32.06
GE	5.2	13.12	15.62	3.42	SYN	13.24	11.24	12.08	5.24
GM	1.14	14.08	11.86	20 68	T	2.5	12.8	11.42	-15.6
GPS	7.38	27 6	12 7	10.4	TOY	1.5	16.32	9.02	-4.5
HM	-7.02	52 1	33.44	42.4	TXN	-6.34	17.48	25.58	5.3
HNZ	7.92	10.4	4.66	5.82	UAL	1 5	25.38	-17.34	27.2
HWP	1.14	38.6	28.94	25.72	UPJ	0	42.64	24.64	45 14
I	14.06	26.28	24 02	24	WMT	1.3	17 96	25.88	22.08
IBM	3.68	45 46	53 28	55.16	XON	1 1	0.92	-8.6	--
JNJ	3.26	10.12	-105.76	15.02	XRX	0.76	27 84	41.2	36.48
KM	0.24	0 46	0 66	1 92					
KO	0.7	16.8	19 7	9.2	The critical chi-squared statistic at 5%				
LA	12.94	111.48	94 16	110.82		5.99	9.49	9.49	9.49
					The proportion of stocks significant at 5%				
						10/45	37/45	35/45	27/44

Test A = GARCH(1,1) vs Constant variance model
Test B = GARCH(1,1) with stock volume vs Constant variance model
Test C = GARCH(1,1) with raw option volume vs Constant variance model
Test D = GARCH(1,1) with standardized option volume vs Constant variance model

TABLE 7B

Maximum Likelihood Ratio Test For the Goodness of Fit

(refer to footnote) The Test Uses a Chi-squared Distribution.

Co.	Test E	Test F	Test G	Test H
ARC	-14.48	-552.94	-411.34	-142.98
AVP	-100.88	-56.42	-294 04	-361.92
BA	3.74	30 46	-398 16	-314.48
BAC	-7 46	-0 16	-215 88	-4.94
BMY	-10 9	-247.46	-273 44	-274.3
BV	-155.66	46 68	32 78	-7.42
C	18 4	18 32	-363.7	36
CCI	2.26	52 92	79.44	-26.08
DOW	--	-101.54	-256.88	-59.92
EK	-11.88	-258.14	-391.6	-273.6
F	-5.48	25.84	-49.22	-4.82
FLR	-9.7	-60.54	-317.3	-72.16
GE	-8.64	11	-517.08	-80.16
GM	--	-151.9	-279.1	-295
GPS	-1	-31.6	-11.54	11.88
HM	6.84	25.2	14.98	-11.04
HNZ	-5.92	2.5	-220.84	0.56
HWP	-8.56	-146.42	-256.66	-25.9
I	0.16	-120	-46.28	-93.98
IBM	-3.78	42.58	-554.12	4.8
JNJ	3 02	-310.4	-313.08	-281.22
KM	-5.5	-39.72	-73.08	-19.88
KO	9 17	20.52	-355.58	3.96
LA	19 36	135 92	-81.4	-49.5

Co	Test E	Test F	Test G	Test H
LTD	-5.64	-13.48	-354.26	-245.06
MCD	-4.62	28.3	-3.08	6.42
MMM	--	1.84	7.5	-32.34
MOB	-5.92	-112.86	-407 52	-70
MRK	-6.92	-270	-465.28	-312.6
NCR	17.48	-653.68	-655.58	-226
OXY	--	16.82	-125.22	-3.52
PCI	17.6	35.76	-317.56	26.58
PEP	--	33.7	-105.6	-276.88
S	-0.14	-112.64	-195.7	-137.74
SLB	-15.28	-165.98	11.46	-39.8
STK	8.22	1.64	12.34	14.14
SYN	-7.82	-286.98	15.36	-2.66
T	-35.58	-232 88	-399.98	-42.12
TOY	-4.98	19.1	-87.26	-14
TXN	-11.9	-38.42	-194.44	-13.14
UAL	-9.32	36.36	-155.86	-10.42
UPJ	-4 8	-61.62	-474.06	-124.26
WMT	-10.38	-6.98	-273.76	-7.6
XON	-13.84	-172.4	-190 74	-11.74
XRX	-7.34	-246 76	-185.82	10.86
The critical chi-squared statistic at				
5%	9.49	15.51	15.51	15.51
The proportion of stocks significant at				
5%	5/40	14/45	6/45	2/45

Test E = GARCH(1,1) with open interest vs Constant variance model
Test F = GARCH(1,1) with stock volume and day indicators vs Constant variance model
Test G = GARCH(1,1) with option volume volume and day indicators vs Constant variance model
Test H = GARCH(1,1) with open interest and day indicators vs Constant variance model

TABLE 7C

Maximum Likelihood Ratio Test For Goodness of Fit

(refer to footnote).The Test Uses the Chi-squared Distribution.

Co.	Test i	Test J	Test K	Co.	Test I	Test J	Test K
ARC	22.74	26.58	11.94	LTD	12.04	26.82	14.38
AVP	50.4	33.68	16.96	MCD	40.44	54.08	18.9
BA	39.72	52.2	18.98	MMM	38.56	53.4	--
BAC	42.16	58.76	18.5	MOB	16.74	17.1	-59.5
BMY	47.26	43	16.54	MRK	39.16	45.1	23.44
BV	20.96	13.44	-16 1	NCR	24 76	51.26	8.98
C	21.22	30.7	12.86	OXY	51.64	36.08	16.28
CCI	67.66	72.28	23.52	PCI	52.56	53.7	24.6
DOW	35.82	55.24	--	PEP	41	49.74	--
EK	49.34	52.06	13.36	S	31.36	44.42	21.24
F	41.46	41.32	18.34	SLB	45.54	35.6	--
FLR	93.52	79.58	19.66	STK	53.64	45.44	96.64
GE	37.14	37.36	13.58	SYN	30.52	30.66	12.24
GM	45.4	39.38	--	T	31.1	26.68	--
GPS	45.48	29	10.78	TOY	39.12	44.48	17.16
HM	74.2	41.4	27.46	TXN	41.56	57.96	15.26
HNZ	31.08	25.22	14.26	UAL	52.32	60.38	16.8
HWP	64.88	55.76	17.52	UPJ	58.18	62.28	--
I	39.64	37.88	14.84	WMT	43.6	41.44	15.16
IBM	63.84	29.44	27.1	XON	26	29.4	11.34
JNJ	33.22	38.08	27.36	XRX	52.7	59.12	21.86
KM	31.72	40.12	22.76				
KO	42.1	40.72	31.8	The critical chi-squared at			
LA	110.92	96.9	--	5%	5.99	5.99	5 99
				The proportion of stocks significant			
					45/45	45/45	35/37

Test I = AGARCH(1,1) with stock volume vs AGARCH(1,1) without volume
Test j = AGARCH(1,1) with raw option volume vs AGARCH(1,1) without volume
Test K = AGARCH(1,1) with open interest vs AGARCH(1,1) without volume

Appendix B: Correlation Tables for Individual Stocks

Note: OVOL=raw option volume, NOVOL=OVOL-volume for last ten minutes of trading, SOVOL=NOVOL/open interest, SSVOL=stock volume/number of shares outstanding.

Correlation Results for Absolute value of Open to Close Price Changes with Volume

Co.	OVOL	NOVOL	SOVOL	SSVOL
ARC	0.412	0.400	0.369	0.226
AVP	0.473	0 475	0.333	0 467
BA	0.278	0.271	0.307	0.309
BAC	0.363	0.357	0.322	0.254
BMY	0.321	0.308	0.303	0.356
BV	0.352	0 351	0.507	0.335
C	0.495	0.492	0 463	0.459
CCI	0.465	0.455	0.433	0.242
DOW	0.267	0.272	0.226	0.327
EK	0.391	0.378	0.379	0.331
F	0.368	0.363	0.367	0.371
FLR	0.604	0.599	0.550	0.608
GE	0.384	0.369	0.327	0.323
GM	0.255	0.231	0.274	0.241
GPS	0.256	0.251	0.331	0.214
HM	0.268	0.266	0.265	0.262
HNZ	0.176	0.161	0.174	0.190
HWP	0.366	0.369	0.385	0.230
I	0.431	0.417	0.431	0.386
IBM	0.453	0.431	0.388	0.261
JNJ	0.285	0.284	0.266	0.221
KM	0.737	0.737	0.725	0.667
KO	0.372	0.345	0.120	0.360
LA	0.273	0.267	0 273	0.109
LTD	0.318	0.314	0.297	0.214
MCD	0.412	0.421	0.453	0.516
MMM	0.206	0.197	0.237	0.178
MOB	0.440	0.433	0.437	0.439
MRK	0.255	0.244	0.206	0.264
NCR	0.377	0.363	0.422	0.296
OXY	0.453	0.442	0 473	0.480
PCI	0.553	0.540	0.565	0.460
PEP	0.342	0.339	0.367	0.244
S	0.500	0.481	0.395	0.359
SLB	0.184	0.188	0.193	0.467
STK	0.498	0.482	0.512	0.582
SYN	0.164	0.143	0.232	-0.013
T	0.189	0.186	0.168	0.177
TOY	0.559	0.540	0.560	0.474
TXN	0.311	0.311	0.522	0.296
UAL	0.480	0.468	0.458	0 677
UPJ	0.321	0.304	0.238	0.346
WMT	0.163	0.148	0.139	0.301
XON	0.155	0.148	0.159	0.160
XRX	0.481	0.481	0.496	0 385
Mean	0.365	0.356	0.357	0.334

Correlation Results for Absolute value of Close to Close Price Changes with Volume

Co.	OVOL	NOVOL	SOVOL	SSVOL
ARC	0.472	0.461	0.422	0.338
AVP	0.523	0.497	0.518	0.531
BA	0.512	0.515	0.572	0.474
BAC	0.428	0.422	0.355	0.286
BMY	0.384	0.372	0.358	0.364
BV	0.343	0.341	0.481	0.351
C	0.545	0.542	0.537	0.452
CCI	0.542	0.532	0.488	0.285
DOW	0.360	0.368	0.407	0.392
EK	0.533	0.520	0.496	0.512
F	0.429	0.424	0.441	0.450
FLR	0.623	0.613	0.588	0.613
GE	0.473	0.469	0.477	0.394
GM	0.447	0.427	0.470	0.441
GPS	0.202	0.193	0.160	0.109
HM	0.402	0.404	0.386	0.444
HNZ	0.476	0.464	0.550	0.421
HWP	0.247	0.247	0.272	0.276
I	0.551	0.532	0.541	0.482
IBM	0.559	0.546	0.527	0.381
JNJ	0.360	0.358	0.345	0.312
KM	0.765	0.764	0.811	0.800
KO	0.501	0.482	0.200	0.501
LA	0.365	0.354	0.354	0.060
LTD	0.451	0.445	0.471	0.385
MCD	0.482	0.485	0.503	0.478
MMM	-0.247	0.230	0.260	0.227
MOB	0.649	0.638	0.632	0.674
MRK	0.393	0.381	0.314	0.361
NCR	0.569	0.572	0.638	0.598
OXY	0.419	0.408	0.435	0.505
PCI	0.616	0.610	0.625	0.513
PEP	0.490	0.485	0.507	0.271
S	0.500	0.488	0.402	0.471
SLB	0.276	0.276	0.296	0.467
STK	0.538	0.525	0.559	0.535
SYN	0.313	0.293	0.381	0.164
T	0.343	0.341	0.271	0.350
TOY	0.580	0.571	0.552	0.482
TXN	0.508	0.509	0.586	0.514
UAL	0.450	0.441	0.439	0.625
UPJ	0.444	0.428	0.401	0.432
WMT	0.290	0.273	0.280	0.370
XON	0.441	0.437	0.482	0.351
XRX	0.540	0.537	0.543	0.518
Mean	0.446	0.449	0.452	0.421

Correlation Results For Positive Open to Close Price Changes with Volume

Co.	OVOL	NOVOL	SOVOL	SSVOL
ARC	0.430	0.409	0.366	0.274
AVP	0.489	0.476	0.401	0.545
BA	0.278	0.261	0.293	0.257
BAC	0.425	0.395	0.314	0.330
BMY	0.333	0.313	0.310	0.507
BV	0.131	0.125	0.226	0.185
C	0.572	0.563	0.526	0.460
CCI	0.491	0.479	0.499	0.314
DOW	0.402	0.390	0.304	0.325
EK	0.689	0.670	0.676	0.593
F	0.482	0.470	0.451	0.424
FLR	0.714	0.717	0.684	0.695
GE	0.527	0.522	0.514	0.469
GM	0.380	0.372	0.405	0.415
GPS	0.263	0.261	0.355	0.353
HM	0.295	0.293	0.273	0.329
HNZ	0.483	0.498	0.522	0.297
HWP	0.310	0.286	0.260	0.232
I	0.223	0.192	0.159	0.189
IBM	0.444	0.444	0.414	0.453
JNJ	0.647	0.629	0.574	0.472
KM	0.339	0.335	0.313	0.186
KO	0.382	0.356	0.283	0.301
LA	0.789	0.789	0.805	0.740
LTD	0.380	0.367	0.348	0.192
MCD	0.497	0.492	0.501	0.360
MMM	0.248	0.241	0.176	0.182
MOB	0.309	0.287	0.315	0.314
MRK	0.382	0.367	0.333	0.383
NCR	0.451	0.431	0.457	0.269
OXY	0.515	0.503	0.540	0.550
PCI	0.734	0.722	0.700	0.621
PEP	0.278	0.274	0.325	0.274
S	0.448	0.424	0.392	0.333
SLB	0.182	0.189	0.162	0.469
STK	0.541	0.520	0.536	0.654
SYN	0.151	0.119	0.230	-0.112
T	0.602	0.598	0.648	0.518
TOY	0.359	0.345	0.257	0.244
TXN	0.469	0.441	0.408	0.299
UAL	0.338	0.339	0.517	0.303
UPJ	0.554	0.541	0.521	0.628
WMT	0.337	0.313	0.292	0.373
XON	0.276	0.253	0.244	0.332
XRX	0.275	0.267	0.240	0.252
Mean	0.419	0.406	0.401	0.373

Correlation Results for Positive Close to Close Price Changes with Volume

Co.	OVOL	NOVOL	SOVOL	SSVOL
ARC	0.562	0.544	0.562	0.386
AVP	0.492	0.474	0.434	0.461
BA	0.594	0.585	0.619	0.505
BAC	0.404	0 375	0.229	0.279
BMY	0.411	0.391	0.358	0.456
BV	0.196	0.184	0.324	0.345
C	0.709	0.702	0.682	0.565
CCI	0.625	0.616	0.565	0.287
DOW	0.514	0.503	0.505	0.365
EK	0.575	0.[illegible]8	0.569	0.565
F	0.500	0.493	0.477	0.542
FLR	0.678	0.672	0.658	0.586
GE	0.431	0.419	0.414	0.423
GM	0.484	0.476	0.465	0.481
GPS	0.255	0.249	0.333	0.408
HM	0.436	0.438	0.476	0.565
HNZ	0.536	0.519	0.582	0.414
HWP	0.398	0.410	0.409	0.314
I	0.296	0.249	0.239	0.200
IBM	0.710	0.696	0.637	0.472
JNJ	0.466	0.461	0.442	0.319
KM	0.844	0.845	0.839	0.837
KO	0.416	0.401	0.367	0.423
LA	0.468	0.459	0.437	0.065
LTD	0.492	0.486	0.457	0.480
MCD	0 356	0.348	0.332	0.158
MMM	0.363	0.342	0.366	0.417
MOB	0.426	0.421	0.393	0.431
MRK	0.408	0.391	0.324	0.228
NCR	0.610	0.617	0.662	0.609
OXY	0.528	0.516	0.542	0.639
PCI	0.767	0.762	0.757	0.662
PEP	0.408	0.398	0.439	0.230
S	0.520	0.504	0.448	0.504
SLB	0.277	0.269	0.281	0.511
STK	0.581	0.562	0.554	0.584
SYN	0.250	0.229	0.360	0.051
T	0.357	0.354	0.293	0.343
TOY	0.642	0.628	0.572	0.520
TXN	0.408	0.408	0.546	0.405
UAL	0.526	0.516	0.505	0 605
UPJ	0.314	0 301	0.248	0.301
WMT	0.439	0.408	0.407	0.421
XON	0.573	0.569	0.590	0.469
XRX	0.604	0.598	0.635	0.535
Mean	0.486	0.474	0.474	0.430

Correlation Results for Absolute Negative Open to Close Price Changes with Volume.

Co.	OVOL	NOVOL	SOVOL	SSVOL
ARC	0.324	0.317	0.280	0.188
AVP	0.460	0.484	0.207	0.392
BA	0.321	0.327	0.375	0.455
BAC	0.403	0.396	0 412	0.208
BMY	0.351	0.346	0.328	0.276
BV	0.652	0.655	0.789	0.553
C	0.555	0.553	0.518	0.494
CCI	0.367	0.350	0.227	0.136
DOW	0.205	0.228	0.218	0.392
EK	0.052	0.054	0.050	0.137
F	0.738	0.070	0.147	0.092
FLR	0.415	0.394	0.322	0.543
GE	0.263	0.244	0.155	0.246
GM	0.082	0.036	0.107	0 064
GPS	0.258	0.236	0 316	0.222
HM	0.344	0.350	0.411	0.118
HNZ	0.286	0.283	0.256	0.326
HWP	0 111	0.110	0.077	0.216
I	0.576	0.567	0.582	0.505
IBM	0.608	0.594	0.591	0.543
JNJ	0.152	0.140	0.077	0.000
KM	0.140	0.146	0.144	0.331
KO	0.415	0.394	0.002	0.449
LA	0.757	0.762	0.700	0.687
LTD	0.089	0.092	0.138	0.055
MCD	0.110	0.113	0.113	0.026
MMM	0.529	0.547	0 639	0.689
MOB	0.022	0.007	0.024	-0.108
MRK	0.149	0.143	0.027	0.253
NCR	0.266	0.267	0.379	0.362
OXY	0.453	0.444	0.494	0.369
PCI	0.182	0.182	0.265	0.281
PEP	0.520	0.511	0.471	0.263
S	0.399	0.382	0.301	0.256
SLB	0.167	0.167	0.207	0.390
STK	0.261	0.261	0.284	0.289
SYN	0.203	0.191	0.245	0.120
T	0.239	0.249	0.285	0.183
TOY	-0.005	0.001	-0.012	0.051
TXN	0.643	0.638	0.659	0.610
UAL	0.276	0.265	0.546	0.209
UPJ	0.420	0.408	0.540	0.758
WMT	0.425	0.418	0.297	0.456
XON	-0.032	-0.047	-0.095	0.250
XRX	-0.134	-0.140	0.010	0.048
Mean	0.311	0.292	0.291	0.297

Correlation Results For Absolute value of Negative Close to Close Price Changes and Volume

Co.	OVOL	NOVOL	SOVOL	SSVOL
ARC	0.223	0.221	0.134	0.273
AVP	0.596	0.552	0.647	0.597
BA	0.428	0.433	0.497	0.488
BAC	0.511	0.508	0.526	0.303
BMY	0.414	0.407	0.404	0.372
BV	0.616	0.619	0.770	0.548
C	0.489	0.481	0.490	0.321
CCI	0.298	0.284	0.243	0.187
DOW	0.100	0.113	0.132	0.307
EK	0.486	0.482	0.416	0.443
F	0.307	0.307	0.410	0.181
FLR	0.406	0.385	0.286	0.565
GE	0.312	0.305	0.245	0.171
GM	0.369	0.331	0.435	0.360
GPS	0.327	0.308	0.186	0.048
HM	0 238	0 245	0.185	0.150
HNZ	0.104	0.101	0.134	0.179
HWP	0.415	0.409	0.417	0.433
I	0.723	0.715	0.706	0.639
IBM	0.699	0.689	0.707	0.707
JNJ	0.251	0.253	0.288	0.237
KM	0.050	0.050	0.019	0.167
KO	0.448	0.432	0.020	0.428
LA	0.764	0.762	0.835	0.839
LTD	0.192	0.203	0.247	0.060
MCD	0.285	0.292	0.307	0.163
MMM	0.501	0.504	0.573	0.678
MOB	-0.031	-0.057	-0.065	-0.090
MRK	0.300	0.301	0.215	0.432
NCR	0.502	0.498	0.613	0.568
OXY	0.275	0.267	0.309	0.185
PCI	0.375	0.374	0.401	0.333
PEP	0.563	0.573	0.571	0.297
S	0.312	0.298	0.203	0.302
SLB	0.180	0.187	0.217	0.357
STK	0.305	0.306	0.348	0.311
SYN	0.393	0.377	0.387	0.355
T	0.293	0.296	0.365	0.238
TOY	0.013	0.029	-0.055	0.009
TXN	0.546	0.542	0.575	0.521
UAL	0.327	0.323	0.532	0.252
UPJ	0.409	0.398	0.484	0.666
WMT	0.398	0.385	0.340	0.407
XON	0.113	0.099	0.085	0.319
XRX	-0.189	-0.187	-0.044	-0.203
Mean	0.347	0.342	0.350	0.336

Correlation Results for Standardized[a] Open to Close Price Changes with Volume

Co.	OVOL	NOVOL	SOVOL	SSVOL
ARC	0.392	0.376	0.336	0.226
AVP	0.406	0.407	0.303	0.342
BA	0.280	0.274	0.313	0.331
BAC	0.427	0.406	0.349	0.279
BMY	0.327	0.311	0.300	0.420
BV	0.514	0.502	0.539	0.500
C	0.538	0.536	0.503	0.478
CCI	0.456	0.446	0.493	0.244
DOW	0.278	0.286	0.254	0.338
EK	0.368	0.353	0.370	0.322
F	0.381	0.372	0.384	0.341
FLR	0.589	0.583	0.571	0.618
GE	0.459	0.450	0.419	0.418
GM	0.232	0.207	0.274	0.229
GPS	0.246	0.229	0.323	0.316
HM	0.263	0.263	0.269	0.261
HNZ	0.375	0.380	0.388	0.272
HWP	0.184	0.170	0.183	0.188
I	0.499	0.483	0.482	0.374
IBM	0.499	0.490	0.482	0.475
JNJ	0 433	0.414	0.383	0.247
KM	0.223	0.223	0.233	0.169
KO	0.398	0.376	0.111	0.389
LA	0.741	0.744	0.756	0.695
LTD	0.315	0.307	0.303	0.137
MCD	0.354	0.353	0.357	0.233
MMM	0.419	0.428	0.450	0.546
MOB	0.199	0.180	0.223	0.137
MRK	0.288	0.275	0.211	0.350
NCR	0.378	0.363	0.427	0.293
OXY	0.496	0.485	0.508	0.493
PCI	0.528	0.515	0.547	0.457
PEP	0.390	0.386	0.400	0.265
S	0.418	0.395	0.364	0.274
SLB	0.155	0.158	0.166	0.435
STK	0.499	0.478	0.558	0.552
SYN	0.277	0.262	0.234	0.221
T	0.410	0.411	0.454	0.347
TOY	0.287	0.280	0.211	0.216
TXN	0.535	0.524	0.560	0.480
UAL	0.365	0.361	0.542	0.302
UPJ	0.446	0.434	0.450	0.671
WMT	0.415	0.396	0.334	0.445
XON	0.194	0.174	0.165	0.328
XRX	0.224	0.219	0.220	0.237
Mean	0.380	0.370	0.371	0.353

[a] **Absolute value of price changes divided by average daily stock price.**

Correlation Results For Standardized[a] Close to Close Price Changes with Volume

Co.	OVOL	NOVOL	SOVOL	SSVOL
ARC	0.431	0.419	0.378	0.328
AVP	0.502	0.473	0.520	0.437
BA	0.482	0.480	0.530	0.465
BAC	0.466	0.450	0.365	0.286
BMY	0.395	0.379	0.359	0.433
BV	0.631	0.620	0.595	0.650
C	0.594	0.593	0.583	0.468
CCI	0.534	0.522	0.488	0.231
DOW	0.278	0.284	0.305	0.325
EK	0.490	0.479	0.465	0.463
F	0.460	0.454	0.472	0.456
FLR	0.597	0.586	0.578	0.589
GE	0.400	0.391	0 377	0.363
GM	0.418	0.400	0.455	0.413
GPS	0.184	0.174	0.124	0.062
HM	0.321	0 322	0.367	0.414
HNZ	0.244	0.247	0.267	0.249
HWP	0.437	0.425	0.530	0.399
I	0.606	0.586	0.588	0.460
IBM	0.592	0.582	0.564	0.632
JNJ	0.499	0.486	0.489	0.336
KM	0.299	0.299	0.303	0.221
KO	0.454	0.441	0.143	0.463
LA	0.766	0.767	0.840	0.835
LTD	0.409	0.404	0.402	0.108
MCD	0.445	0.443	0.434	0.389
MMM	0.443	0.443	0.472	0.512
MOB	0.251	0.232	0.266	0.204
MRK	0.366	0.356	0.278	0.364
NCR	0.568	0.572	0.640	0.588
OXY	0.441	0.431	0.443	0.511
PCI	0.594	0.588	0.606	0.498
PEP	0.451	0.447	0.483	0.245
S	0.428	0.413	0.375	0.405
SLB	0.217	0.216	0.239	0.455
STK	0.544	0.526	0.594	0.517
SYN	0.418	0.407	0.363	0.387
T	0.436	0.434	0.488	0.390
TOY	0.304	0.306	0.234	0.283
TXN	0.563	0.554	0.556	0.518
UAL	0.431	0.430	0.540	0.391
UPJ	0.428	0.419	0.436	0.607
WMT	0.401	0.385	0.342	0.392
XON	0.336	0.312	0.317	0.409
XRX	0.489	0.485	0.523	0.364
Mean	0.445	0.437	0.438	0.411

[a] **Absolute value of price changes divided by the average daily stock price.**

Correlations Results For Standardized[a] Positive Open to Close Price Changes with Volume

Co.	OVOL	NOVOL	SOVOL	SSVOL
ARC	0 422	0.402	0.359	0.264
AVP	0 467	0.452	0 418	0 455
BA	0.260	0.243	0 275	0.241
BAC	0.449	0.421	0 345	0.341
BMY	0.315	0 294	0.287	0 524
BV	0.358	0 343	0.387	0.444
C	0.579	0.571	0 534	0.473
CCI	0.509	0.499	0.528	0.309
DOW	0.380	0.366	0.293	0.301
EK	0.654	0.636	0.653	0.561
F	0.500	0.488	0.479	0.431
FLR	0.701	0 705	0.701	0.680
GE	0 542	0.536	0.528	0.489
GM	0.338	0.330	0.382	0.383
GPS	0.243	0.235	0.321	0.394
HM	0.266	0.266	0.264	0.312
HNZ	0.475	0.491	0.519	0.306
HWP	0.260	0 237	0 236	0.201
I	0.283	0.250	0 200	0.202
IBM	0.368	0 368	0.363	0.385
JNJ	0.610	0.595	0.561	0 444
KM	0.279	0.277	0 284	0 137
KO	0.405	0.381	0.287	0.317
LA	0.764	0.766	0.803	0 715
LTD	0 443	0.428	0.398	0.249
MCD	0 514	0.509	0 525	0.390
MMM	0.234	0.226	0.160	0.184
MOB	0.321	0.299	0.341	0.317
MRK	0.375	0.360	0.313	0.418
NCR	0.442	0.422	0.455	0.266
OXY	0.520	0.510	0.529	0.550
PCI	0.709	0.698	0.677	0.603
PEP	0.285	0.280	0.334	0 263
S	0.448	0.425	0 422	0.290
SLB	0.159	0.166	0.144	0 473
STK	0.558	0.534	0.602	0.581
SYN	0.217	0 191	0.198	0.077
T	0.569	0.566	0.638	0.496
TOY	0.377	0.363	0 261	0.256
TXN	0.411	0.384	0.360	0 267
UAL	0.399	0.400	0.538	0.336
UPJ	0.536	0.523	0.520	0.614
WMT	0.373	0.348	0.324	0.410
XON	0.278	0.254	0.254	0.353
XRX	0.337	0.332	0.293	0 329
Mean	0.421	0 408	0 407	0.379

[a] **Absolute value of price changes divided by average daily stock price.**

Correlations Results For Standardized[a] Positive Close to Close Price Changes with Volume

Co.	OVOL	NOVOL	SOVOL	SSVOL
ARC	0.555	0.539	0.557	0.377
AVP	0.483	0.468	0 469	0.381
BA	0.580	0.572	0.606	0.489
BAC	0.437	0.411	0.269	0.292
BMY	0.391	0.370	0 333	0.472
BV	0.511	0.490	0 492	0 666
C	0 711	0.708	0 683	0.575
CCI	0.651	0.644	0.599	0.281
DOW	0.483	0.471	0.483	0.336
EK	0 534	0.518	0.539	0.534
F	0.516	0.508	0.504	0.547
FLR	0 667	0.662	0 675	0.579
GE	0.449	0.438	0.433	0.454
GM	0 451	0.444	0.450	0.455
GPS	0.234	0.222	0.302	0.457
HM	0 410	0.412	0 467	0.558
HNZ	0.389	0.402	0.404	0.318
HWP	0 511	0.493	0.578	0.403
I	0.355	0.307	0 294	0.221
IBM	0 346	0.341	0.337	0.356
JNJ	0.675	0 664	0 628	0.447
KM	0.419	0.417	0.424	0.270
KO	0.447	0.435	0 378	0.442
LA	0.825	0.827	0 838	0.818
LTD	0 531	0.519	0.491	0.115
MCD	0.514	0.507	0 484	0.513
MMM	0 348	0.339	0.322	0.159
MOB	0 376	0 355	0 394	0.423
MRK	0.402	0.384	0.304	0.263
NCR	0.605	0 610	0.662	0.601
OXY	0.524	0.514	0 526	0.635
PCI	0.738	0.735	0.731	0.641
PEP	0 398	0.388	0.439	0.233
S	0.515	0.500	0.473	0.457
SLB	0 262	0.253	0.267	0.520
STK	0 616	0.593	0.633	0.544
SYN	0.326	0.310	0.309	0.205
T	0.561	0.556	0.620	0.510
TOY	0 376	0.372	0.296	0.360
TXN	0.587	0.574	0.535	0.498
UAL	0 465	0.465	0.559	0.444
UPJ	0.504	0 495	0.502	0.587
WMT	0.361	0.345	0.288	0.354
XON	0.442	0 410	0.418	0.450
XRX	0 632	0.631	0 638	0.538
Mean	0 491	0 480	0 481	0 439

[a] **Absolute value of price changes divided by the average daily stock price.**

Correlation Results For Standardized[a] Open to Close Negative Price Changes with Volume

Co.	OVOL	NOVOL	SOVOL	SSVOL
ARC	0.326	0.320	0 286	0.195
AVP	0.336	0 356	0.144	0.266
BA	0.304	0.309	0.359	0 437
BAC	0 445	0.437	0 430	0.249
BMY	0.352	0.347	0 334	0 316
BV	0.774	0.764	0.694	0.644
C	0.585	0.584	0.556	0.528
CCI	0.357	0.339	0.214	0.117
DOW	0 194	0.217	0.220	0.406
EK	0.038	0.040	0.043	0 122
F	0.080	0.074	0.145	0.106
FLR	0.383	0.361	0 331	0 540
GE	0.276	0.255	0.177	0.289
GM	0.091	0.043	0 137	0 072
GPS	0.248	0.206	0 326	0.289
HM	0.285	0.290	0 392	0.108
HNZ	0.254	0.251	0.228	0.345
HWP	0.089	0 089	0.061	0.200
I	0.632	0.622	0 617	0 465
IBM	0 569	0.557	0 571	0 521
JNJ	0 113	0 102	0 063	0.027
KM	0.071	0.075	0 099	0.238
KO	0.422	0.398	-0.003	0.503
LA	0.771	0 776	0 757	0.739
LTD	0.113	0.115	0 152	0.107
MCD	0.115	0.118	0.128	0 029
MMM	0.540	0.559	0 651	0.717
MOB	0.017	0.001	0 042	-0.122
MRK	0.162	0.157	0.045	0 315
NCR	0.249	0 249	0 371	0 349
OXY	0.450	0.441	0.481	0 339
PCI	0.156	0.156	0 245	0 264
PEP	0 530	0 521	0 487	0.266
S	0.380	0.359	0.283	0 261
SLB	0.149	0.150	0 189	0.396
STK	0.253	0.255	0.327	0.354
SYN	0.344	0.339	0 270	0 376
T	0.203	0.213	0 269	0.192
TOY	0.001	0 006	-0.010	0.084
TXN	0.645	0.641	0.680	0.637
UAL	0.308	0.296	0.558	0.249
UPJ	0.382	0.370	0 519	0 744
WMT	0.488	0.479	0.350	0.525
XON	-0 029	-0.044	-0.087	0.274
XRX	-0.096	-0.101	0 025	0.085
Mean	0.297	0 291	0.292	0 315

[a] **Absolute value of price changes divided by average daily stock price.**

Correlation Results For Standardized[a] Close to Close Negative Price Changes with Volume

Co.	OVOL	NOVOL	SOVOL	SSVOL
ARC	0.222	0.220	0.135	0.281
AVP	0.531	0.489	0.587	0.517
BA	0.413	0.418	0.482	0.473
BAC	0.543	0.540	0.525	0.312
BMY	0.417	0.411	0.415	0.410
BV	0.768	0.763	0.715	0.693
C	0.543	0.534	0.548	0.366
CCI	0.280	0.265	0.227	0.166
DOW	0.942	0.106	0.137	0.314
EK	0.460	0.456	0.398	0.415
F	0.346	0.343	0.433	0.213
FLR	0.387	0.362	0.308	0.588
GE	0.326	0.319	0.269	0.200
GM	0.379	0.340	0.471	0.372
GPS	0.315	0.297	0.170	0.033
HM	0.213	0.220	0.204	0.141
HNZ	0.076	0.074	0.109	0.185
HWP	0.405	0.399	0.424	0.424
I	0.769	0.761	0.735	0.585
IBM	0.687	0.677	0.704	0.704
JNJ	0.208	0.209	0.260	0.245
KM	-0.027	-0.027	-0.029	0.069
KO	0.461	0.443	0.017	0.476
LA	0.755	0.754	0.855	0.860
LTD	0.206	0.219	0.250	0.110
MCD	0.330	0.337	0.366	0.209
MMM	0.517	0.523	0.592	0.711
MOB	-0.028	-0.055	-0.039	-0.103
MRK	0.326	0.327	0.244	0.491
NCR	0.483	0.479	0.603	0.551
OXY	0.275	0.269	0.298	0.167
PCI	0.351	0.350	0.384	0.327
PEP	0.556	0.565	0.574	0.277
S	0.305	0.288	0.200	0.313
SLB	0.158	0.165	0.197	0.367
STK	0.316	0.316	0.423	0.358
SYN	0.504	0.497	0.397	0.568
T	0.246	0.250	0.341	0.250
TOY	0.010	0.025	-0.062	0.040
TXN	0.540	0.537	0.592	0.554
UAL	0.376	0.371	0.538	0.298
UPJ	0.360	0.349	0.455	0.645
WMT	0.465	0.450	0.430	0.459
XON	0.114	-0.099	0.093	0.340
XRX	-0.148	-0.141	-0.015	-0.152
Mean	0.371	0.342	0.355	0.352

[a] **Absolute value of price changes divided by average daily stock price.**

APPENDIX C

R.A.T.S SAMPLE PROGRAM

```
allocate 0 6615
open data c:\rats\data\data.wk1
data(format=wks,org=obs) /$
cc oc mat cret ocret sovol ssvol tvol day ooi
nonlin b0 b1 a0 a1 a2 a3 a4 a5 a6 a7 a8
set eday = mat.gt.0
set dum1 = day.eq.1
set dum2 = day.eq.2
set dum4 = day.eq.4
set dum5 = day.eq.5
do i = 1,6615,147
compute num = i+146
display i num
boxjenk(ar=1,ma=4,inputs=1,noprint) ssvol i+4 num revol
# eday 0 0 0
set volexp = ssvol-revol
set volun = revol
set v = 0.0
set u = 0.0
frml garchvar = a0+a1*u{1}**2+a2*v{1}+a3*volexp+a4*volun+$
a5*dum1+a6*dum2+a7*dum4+a8*dum5
frml regresid =  (cret(t)-b0) - b1*cret(t-1)
frml garchlogl = v(t)=garchvar(t),u(t)=regresid(t),$
-.5*(log(v)+u**2/v)
linreg(noprint) cret i+4 num
# constant cret{1}
compute b0=%beta(1),b1=%beta(2),$
a0=%seesq,a1=0.6,a2=0.3,a3=0.2,a4=0.3,a5=0.1,a6=0.4,a7=0.3,a8=0.6
maximize(method=simplex,iterations=5,noprint) garchlogl i+4 num
compute coef1=a1,coef2=a2,coef3=a3,coef4=a4,$
coef5=a5,coef6=a6,coef7=a7,coef8=a8
compute b0=%beta(1),b1=%beta(2),$
a0=%seesq,a1=coef1,a2=coef2,a3=coef3,a4=coef4,a5=coef5,a6=coef6,a
7=coef7,$
a8=coef8
maximize(method=bhhh) garchlogl i+4 num
set normresid = u(t)/sqrt(v(t))
stat normresid i+4 num
endo
```