THE DYNAMIC RELATIONSHIP BETWEEN STOCK RETURNS AND TRADING VOLUME: DOMESTIC EVIDENCE

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Abstract

The idea that extreme trading activity (as measured by trading volume) contains information about the future evolution of stock prices is investigated. Previous studies have documented the positive contemporaneous correlation between a stock's trading volume and its return. This paper examines the dynamic relations between stock market trading volume and returns for domestic markets by using the daily data of Athens stock Exchange indices. Major findings are as follows: First, trading volume does Granger-cause stock market returns on most of the indices that examined. Second there exists a positive feedback relationship between trading volume and return volatility in most of the indices. Third, sub-sample analyses show evidence of relationship between stock returns and trading volume on most of the indices but this association weakens as the measurement interval shortens. Karpoff [1987] also concludes from a review of prior empirical literature that volume and changes in absolute returns are positively associated but this association weakens as the measurement interval shortens.

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1. Introduction

There is substantial interest in how trading volume is related to price movements in the stock market. Clearly, positive trading volume is needed to generate observed market prices. A naïve view of the market is that the greater the level of volume, the greater the price movement. However, instances can be found where a low level of volume is associated with large price movements and conversely, a high level of volume is associated with no change in price. Market folklore claims that the relationship between volume and price movements depends on whether the market is in a bull or bear run. In a bull market, a relatively higher level of volume is associated with a given price change in comparison to a bear market.

Numerous studies have examined the return correlation among different markets and the relationship between stock returns and trading volume. In an extensive review of theoretical and empirical research into the relationship between stock price changes and trading volume, Karpoff (1987) cites several reasons why the price –volume relationship is important and observes that much of the previous research has been about the contemporaneous relationship using correlations .Karpoff (1987) attempts to provide a theory which directly links returns with trading volume. Karpoff's model ultimately leads to an asymmetric relationship between volume and price change. Empirical tests have generally supported the model. Another model which predicts an asymmetric relationship between trading volume and price changes is that originally proposed by Epps [1975] and developed by Jennings [1981]. Gallant (1992) also point out that previous empirical work on the price-volume relationship has focused primarily on the contemporaneous relationship between price changes and volume.

Although some previews studies may have some implications for dynamic relations between returns of different national markets and between trading volume and stock returns in a domestic stock market and between different national markets, few studies examine dynamic relations between trading volume and returns both domestically and across countries to confirm or reject these implications.

However in a dynamic context an important issue should be whether information about trading volume is useful in improving forecasts of price changes and return volatility. The purpose of this paper is to empirically examine the dynamic relationship between trading volume and stock market returns.

Previews researches have found that individual stocks, whose trading activity is unusually large (small) over periods of a day or a week, as measured by trading volume during those periods, tend to experience large (small) subsequent returns. In other words, a high volume return premium seems to exist in stock prices. This premium is even larger for stocks that do not experience abnormal returns at the time of their abnormal trading volume. So, past trading volume appears to contain information that is orthogonal to that contained in past returns, which is evidenced by the return autocorrelation documented by several authors.

The high volume return premium is not the product of risk. It has been found that (i) market risk does not rise (fall) after a period of unusually large (small) trading activity (ii) the returns from trading strategies exploiting this volume effect stochastically dominate returns from diversified strategies (iii) informational risk (as measured by the bid-ask spread) goes in a direction opposite to one which would explain results. Furthermore, the results are robust to different measures of volume and are not driven by firm announcements.

Related to this paper is the work of Brennan, Chordia and Subrahmanyan (1998). These paper document the fact that large trading volume tends to be accompanied by lower expected returns. Indeed, since investors demand a premium for holding illiquid stocks, the stocks with the largest trading volumes (the most liquid stocks) will not generate returns that are quite as large as on average. In other words, a stock that has a lot of trading activity on average should yield small returns, but a stock that experiences unusually large trading activity over a particular day or a week is expected to subsequently appreciate.

As mentioned above, numerous papers have been written about the predictability of stock prices from past prices. Depending on the horizons over which returns are measured and on the way portfolios of risky securities are formed, there is vast empirical evidence that stock prices tend to display either positive or negative autocorrelation. Similarly, a number of papers have documented the empirical relationship that seems to exist between a stock's price and its trading volume. A lot of this research is preoccupied with the contemporaneous relationship between trading volume and the absolute change in stock price (or its volatility). A related but different contemporaneous positive correlation between trading volume and price changes per se has also been documented by Smirlock and Starks (1985), and Harris (1986, 1987).Although the intertemporal relationship between trading volume and prices is often neglected in these studies, a few authors have documented the Granger causality relationship between stock prices and trading volume through time (Hiemestra and Jones, 1994), as well as the fact that argue absolute and nominal price movements tend to be followed by periods of high trading volume (Gallant, Rossi and Tauchen, 1992), that large trading volume is associated with negative autocorrelation in returns (Campbell, Grossman and Wang, 1993), and that volume shocks affect the high order moments of stock prices (Tauchen, Zhang and Liu, 1996).

Prior Research

There are a number of empirical papers that provide indirect evidence on the relationship between trading volume and stock returns. Agmon (1972, 1974) for example, finds that these correlations are generally insignificant or unstable. However, Jaffe and Westerfied (1985) find that the correlations are positive and significant among national markets.

Karpoff [1987] concludes from a review of prior empirical literature that volume and changes in absolute returns are positively associated but this association weakens as the measurement interval shortens.

Karpoff's paper reviews previous and current research on the relationship between price changes and trading volume in financial markets and makes four contributions:

- Volume is positively related to the magnitude of the price change and, in equity markets, to the price change per se
- Previous theoretical research on the price-volume relation is summarized and critiqued and major insights are emphasized
- A simple model of the price-volume relation is proposed that is consistent with several seemingly unrelated or contradictory observations

- Several directions for future research are identified

Karpoff found at least four reasons why the price-volume relation is important:

- It provides insight into the structure of financial markets. The model discussed predict various price volume relations that depend on the rate of information flow to the market, the size of the market and the existence of short sales constrains
- The price volume relation is important for event studies that use a combination of price and volume data from which to draw inferences. If price changes and volume are jointly determined the price volume relation will increase the power of tests. In many tests price changes are interpreted as the market evaluation of new information while the corresponding volume is considered an indication of the extend to which investors disagree about the meaning of the information
- Third, the price volume relation is critical to the debate over the empirical distribution of speculative prices. When sampled over fixed calendar intervals rates of return appear kyrtotic compared to the normal distribution. This is explained because rates of return are best characterized by a member of a class of distributions with infinite variance and the distribution of rates of returns appears kurtotic because the data are sampled from a mixture of distributions that has different conditional variances.
- Fourth, price-volume relations have significant implications for

research into futures markets. Price variability affect the volume of trades in futures contracts. The time to delivery of a futures contract affects the volume of trading and through this effect, possibly also the variability of price

Karpoff also concludes that there is only weak evidence supporting a relationship between volume and price change *per se*. Using this evidence as a base, Karpoff [1986, 1987] develops a theoretical model linking returns and trading volume. Karpoff's [1986] initial model concludes that trading volume is influenced by two mechanisms. To explain the model, denote *i* as a seller and *j* as a buyer. In equilibrium, the seller's demand price must exceed the buyer's demand price such that $pi > pj$. A trade will then occur in the next period (t=1) if the change in the buyer's demand price (δjt) exceeds the change in the seller's demand price (δit) by an amount sufficient to offset the demand price differential at t=0. Thus, a trade will occur in t=1 *if*: $pj1 \geq pi1$ or $pj0 + \delta j1 \geq pi0 + \delta i1$ or $\delta j1 - \delta i1 \geq pi0 - pj0$

The net price change for a general investor (k) will appear as $\delta k1$ ($\delta k1 = \delta j1 - \delta i1$). If the revision in demand prices follows a stochastic process with mean μ and variance σ^2, then:$\delta k1 = \mu k + \sigma \varepsilon k$ where εk is a zero-mean variable and is independent across investors such that $E(\varepsilon k \varepsilon h) = 0$ for all $k \neq h$.

Thus, the net price revision has two components. First, there is a demand price revision incorporated in the mean μk and secondly, there is an investor specific idiosyncratic term εk which captures changes in individual investor expectations and liquidity desires. In the absence of any new public information, μk is the expected return on the stock. Hence, for any pair of buyers and sellers $\theta = \delta j1 - \delta i1 = (\mu j - \mu i) + \sigma(\varepsilon j - \varepsilon i)$

$\mu\theta = E(\theta) = \mu j - \mu i$

$\sigma\theta^2 = E(\theta - \mu\theta)^2 = 2\sigma^2$

Thus, trades will occur because of movements in $\mu\theta$, or $\sigma\theta^2$ or a combination of both. This model leads to a number of predictions. First, in the absence of any new information, trading will occur because of individual investor

idiosyncratic adjustments (i.e. $\sigma\varepsilon k > 0$). As long as one investor makes such an adjustment, expected trading volume is positive. Second, trading volume increases proportionately with the number of stock holders such that trading volume is expected to be greater in larger

markets. Third, the introduction of transaction costs (including bid-ask spreads) reduces expected trading volume as the change in demand prices ($\delta j1 - \delta i1$) must now exceed the original price difference ($pi0 - pj0$) plus the transaction costs. Fourth, information arrival may have a mean effect on demand prices but may be interpreted differently by investors such that $\sigma\theta^2$ increases leading to an increase in trading volume. Fifth, information may have a different effect on the mean revision price between buyers and sellers such that $\mu j \neq \mu i$. With constant $\sigma\theta^2$, trading volume increases if $\mu j > \mu i$, but decreases if $\mu j < \mu i$. Karpoff's example of this circumstance involves current owners (or sellers) having strong beliefs about the probability of a takeover offer such that their price revision is relatively small once the offer is announced

compared to buyers who had relatively weak beliefs about the probability of a forth coming offer. Finally , there could be simultaneous changes in $\mu\theta$ and $\sigma\theta^2$. Information could have different effects on the mean price response between sellers and buyers but heterogeneous beliefs within each of these groups affects $\sigma\theta^2$. Trading volume will increase if both $\mu\theta$ and $\sigma\theta^2$increase. However, there is no clear effect on trading volume if $\mu\theta$ decreases and $\sigma\theta^2$ increases.

The above model assumes that short sales are not possible. However, short selling can be incorporated into the model which results in an asymmetric relationship between volume and price change. If short positions are more costly than long positions, then investors require a greater demand price revision to transact in short positions. Hence, investors in short positions will be less responsive to price changes than investors in long positions. This result

leads to an expectation that the association between volume and positive price changes will be greater than the association between volume and negative price changes. Also note that short selling can only be initiated on a zero-tick in Australia whereby the sale price is at least equal to the last traded price.5 Hence, there is a lower number of potential traders in the market on down-ticks because of the restriction on short-selling.

It is an old Wall Street adage that it takes volume to make prices move. Karpoff's empirical results prompt three observations:

First, the V |and |Δp| correlation appears in both the equity and future markets.

Second, despite the almost universal finding of a positive correlation some of these tests indicate that the correlation is weak. For example the average squared correlation coefficient obtained by Crouch was 0.20 among the stock indices and 0.23 among the individual firms.

Third, this correlation appears with price and volume data measured over all calendar intervals, but it appears to be weaker in transactions data.

Karpoff found some theoretical explanations about the relationship between stock returns and trading volume.

An early but flawed attempt to explain the positive volume – price correlation is in Crouch. All trading occurs throw a dealer. In one version of the theory the dealer irrationally satisfies all demands to trade even though he expects to lose on each trade. Amending this version Crouch assumes that investors' demands change at different times and the necessary supply of securities when demands increase of when demands decrease comes from others sellers of buyers. When some investors' demands change the resulting realignment of securities causes a simultaneous increase in volume and the price revision.

With N traders, there will in general be k optimists, r pessimists, and N-k-r uniformed investors at any point in time before all investors become informed. The values of k and r depend on the order in which investors become informed. Because of the short sales prohibition, volume generated by a pessimist is generally less than that generated by an optimist (i.e., the pessimist cannot sell short upon receiving the information). So the price change and trading volume when the next trader becomes informed depend upon both (i) the previous pattern of who has been informed and (ii) whether the next trader is an optimist or pessimist. Likewise , the total volume after all traders become informed depends on the path by which the final equilibrium is reached. It is a random variable with an expected value equal to a weighted average of the total volumes under each possible path of information dispersion. Simulation tests indicate that V is highest when investors are all optimists or all pessimists. Also |Δp| is lowest at the same percentage of optimists at which V is lowest, and rises with V. This supports a positive correlation of V and |Δp|.

Another explanation of the positive correlation between V and |Δp| comes from research into the distribution of speculative prices. Daily price changes of speculative assets appear to be uncorrelated with each other and symmetrically distributed, but the distribution is kurtotic related to the normal distribution. One explanation is that daily price changes are samples from a set of distributions that are characterized by different variances. Another familiar Wall Street adage is that volume is relatively heavy in bull markets and light in bear markets.

It is likely that observation of simultaneous large volumes and large price changes – either positive or negative – can be traced to their common ties to information flows (as in the sequential information arrival model), or their common ties to a directing process that can be interpreted as the flow of information (as in the mixture of distributions hypothesis). And the relatively large cost of taking a short position provides an explanation for the observation that, in equity markets, the volume associated with a price increase generally exceeds that with an equal price decrease, since costly short sales restrict some investors' abilities to trade on new information.

Craig Hiemstra and Jonathan D. Jones used linear and nonlinear Granger causality tests to examine the dynamic relation between daily Dow Jones stock returns and percentage changes in New York Stock Exchange trading volume. They find evidence of significant bidirectional nonlinear causality between returns and volume. They also examine whether the nonlinear causality from volume to returns can be explained by volume serving as a proxy for information flow in the stochastic process generating stock return variance. The article uses linear and nonlinear Granger causality tests to examine the dynamic relation between daily aggregate stock prices and trading volume. There are several explanations for the presence of a casual relation between stock prices and trading volume. First, the sequential information arrival models of Copeland (1976) and Jennings, Starks, and Fellingham (1981) suggest a positive causal relation between stock prices and trading volume in either direction. In these asymmetric information models, new information flows into the market and is disseminated to investors one at a time. This pattern of information arrival produces a sequence of momentary equilibria consisting of various stock price – volume combinations before a final, complete information equilibrium is achieved. Due to the sequential information flow, lagged trading volume could have predictive power for current absolute stock returns and lagged absolute stock returns could have predictive power for current trading volume.

Tax and non-tax-related motives for trading are a second explanation.

A third explanation involves the mixture of distributions models of Clark (1973) and Epps and Epps (1976). These models provide differing explanations for a positive relation between current stock return variance and trading volume. In the mixture model of Epps and Epps (1976), trading volume is used to measure disagreement as traders revise their reservation prices based on the arrival of new information into the market. **The greater the degree of disagreement among traders, the larger the level of trading volume**. Their model suggests a positive causal relation running from trading volume to absolute stock returns. On the other hand, in Clark's (1973) mixture model, trading volume is a proxy for the speed of information flow, a latent common factor that affects contemporaneous stock returns and volume. There is no true causal relation from trading volume to stock returns in Clark's common – factor model.

Noise trader models provide a fourth explanation for a casual relation between stock returns and trading volume. These models can reconcile the difference between the short – and long – run autocorrelation properties of aggregate stock returns. Aggregate stock returns are positively autocorrelated in the short run, but negatively autocorrelated in the long run. Since noise traders do not trade on the basis of economic fundamentals, they impart a transitory mispricing component to stock prices in the short run. The temporary component disappears in the long run, producing mean reversion in stock returns. A positive causal relation from volume to stock returns in consistent with the assumption made in these models that the trading strategies pursued by noise traders cause stock prices to move. A positive causal relation from stock returns to volume is consistent with the positive – feedback trading strategies of noise traders, for which the decision to trade is conditioned on past stock price movements (see DeLong, Shleifer, Summers, and Waldmann (1990)).

Resent theoretical and empirical work in finance has moved away from traditional representative – agent trading models to trading models with heterogeneous agents. This change in focus has produced models in which endogenous volume plays an important role in asset price determination. Some of the work using heterogeneous agent trading models suggests and finds evidence of nonlinear dynamics in the stock price – volume relation.

Hiemstra computed returns from daily closing prices for the Dow Jones Price Index and percentage changes in NYSE trading volume over the 1915 to 1946 and 1947 to 1990 periods. The modified Baek and Brock test provides evidence of significant bidirectional nonlinear Granger causality between stock returns and trading volume in both sample periods. They also examine whether the nonlinear causality from volume to stock returns detected by the modified Baek and Brock test could be due to volume serving them a proxy for daily information flow in the stochastic process generating stock return variance. Their results contribute to the empirical literature on the stock price – volume relation by indicating the presence of bidirectional nonlinear Granger causality between aggregate daily stock prices and trading volume.

Ronald Gallant, Peter E. Rossi and George Tauchen have also investigate the relationship between stock returns and trading volume by using daily New York Stock Exchange data from 1928 to 1987. They adjust the data to take into account well-known calendar effects and long-run trends. To describe the process, they use a semi nonparametric estimate of the joint density of current price change and volume conditional on past price changes and volume. Four empirical regularities are found: (i) positive correlation between conditional volatility and volume; (ii) large price movements are followed by high volume; (iii) conditioning on lagged volume substantially attenuates the "leverage" effect; and (iv) after conditioning on lagged volume, there is a positive risk – return relation.

In their investigation they use nonparametric methods throughout. The main reason for choosing nonparametric methods is that they wish to avoid bias due to a specification error. With parametric methods, there is always a risk that specification error will seriously bias an estimate and thereby lead to a spurious result. The raw data consist of the daily closing value of the S&P composite stock index and the daily volume of shares traded on the NYSE. The raw price index series P_{it} is differenced in the logs to create the raw price change series,100*(logP_t-logP $_{t-1}$). Their analysis indicates that dividends are lumpy with payouts concentrated at certain times of each quarter. In spite of the dividend lumpiness, the S&P index itself does not show detectable movements in times of high dividend payouts .Therefore, they do not regard the failure to adjust for dividends as an important factor in modeling the daily S&P price index. Schwert (1990a) also finds that volatility estimates are not influenced appreciably by dividends.

In their research they use the model selection strategy suggested by Gallant, Hsieh, and Tauchen (1991) the Gallant, Hansen, and Tauchen (1990). The Schwarz criterion [Schwarz (1978), Potscher (1989)] is used to move along an upward expansion path until an adequate model is determined.

They conduct diagnostic tests for predictability in both the scaled residuals and the squares of the scaled residuals. As just indicated, residuals and scale factors are straightforward to compute from the fitted conditional density. Also, the diagnostics are directly interpretable. Predictability of the scaled residuals would suggest inadequacies in the conditional mean estimate implied by the fitted density, and thus such tests are termed mean tests. Similarly, predictability of the squared scaled residuals would suggest inadequacies in the implied estimate of the conditional variance, and thus such tests are termed variance tests. For both mean and variance, they conduct two types of tests for predictability: one of which is sensitive to short – term misspecification, while the other is sensitive to long – term misspecification.

The main objective has been to investigate the characteristics of price and volume movements on the stock market. Motivating this effort were the recent events on the stock market, together with a desire to provide a comprehensive set of empirical regularities that economic models of financial trading will ultimately need to confront. They organized the effort around the tasks of estimating and interpreting the conditional one – step – ahead density of joint price change and volume process. For a stationary process, the one – step – ahead density is a time invariant population statistic that subsumes all probabilistic information about the process. In particular, issues concerning predictability, volatility, and other conditional moment relationships can be addressed by examining the conditional density. Indeed, such issues seem more naturally thought of in terms of the signs and magnitudes of specific parameters.

The raw S&P price change and NYSE aggregate volume data display systematic calendar and trend effects in both mean and variance, and thus are not stationary. Prior to estimation, they undertook an extensive effort to remove these systematic effects. This effort resulted in series on adjusted logarithmic price changes and adjusted log volume that appear to be reasonably modeled as jointly stationary. All subsequent statements concerning the price changes and volume pertain to these adjusted series.

The SNP estimation technique entails fitting a series expansion to the bivariate conditional density. The leading term of the expansion is a VAR model with an ARCH – like error process; higher – order terms accommodate departures from that model. There is substantial evidence that the higher – order terms are needed to capture all of the complex structure of the data. These complexities include, among other things, the complicated structure of the bivariate conditional variance function, the thick – tailed error density characteristic of financial price change data, the nonlinear interactions between volume and prices, and the temporal dependence of the volume series.

Examination of the fitted conditional density reveals four major findings regarding the interactions between stock prices and volume.

The daily trading volume is positively and nonlinearly related to the magnitude of the daily price change. This association is a characteristic of both the unconditional distribution of price changes and volume and the conditional distribution given past price changes and volume constant. The finding of an unconditional volume – volatility relationship is consistent with many other studies [see Tauchen and Pitts (1983), Karpoff (1987)], though it was obtained with a rather different data set. They use a very long time series on changes in a marketwise index and overall volume, while other studies almost exclusively examine price changes and volume for individual financial assets.

The finding of a conditional volume – volatility relationship is more interesting. It means that the volume – volatility association is still observable after taking account of nonnormalities, stochastic volatility, and other forms of conditional heterogeneity.

Price changes lead to volume movements. The effect is fairly symmetric, with large price declines having nearly the same impact on subsequent volume as large price increases.

If volume is excluded from the analysis, then the conditional variance function of the price change given the lagged price change is found to be symmetric over most of the range of the data, but asymmetric in the extreme tails (outermost 10 percent of the data). This finding emerges from the SNP fit of the conditional density, from kernel – based estimates of the conditional variance, and from elementary locally linear fits to the data cloud. In addition, it holds up across each of three equal – size partitions of the 1928 – 1987 sample period. Overall, the finding suggests that extreme tail behavior accounts for previous findings of a leverage effect using parametric models fitted to univariate price data.

When volume is introduced into the analysis, it interacts with the asymmetry in interesting ways. The asymmetric response of volatility is found to be mainly a feature of large price movements accompanied by high volume. It is much less a feature of price movements of the same magnitude on average volume. In addition, estimates of the conditional variance function (either SNP of kernel – based) show attenuated asymmetry at all levels of volume. Attenuation occurs because extreme events appear less outlying relative to the univariate distribution of price changes alone. With the relative influence of outlying events reduced, the estimators thereby detect less asymmetry. Altogether, the manner in which volume interacts with asymmetry is consistent with the latter being a tail phenomenon.

There is evidence for a positive association between the conditional mean and the conditional variance of daily stock returns. The finding is useful in view of the fact that equilibrium asset – pricing theory is silent on the manner in which the conditional first two moments of the market return co-vary in response to shocks to the economy.

The finding of a positive conditional mean – variance relationship is also interesting in view of other empirical work on this issue. Some studies using univariate price data find a negative relationship between the conditional mean and variance [Pagan and Hong (1991), Nelson (1989, 1991)]. On the other hand, French, Schwert, and Stambaugh (1987) find evidence for a positive relationship between the risk premium and predictable volatility. Using conditional moments from our univariate estimation, we find a negative relationship. With volume incorporated into the analysis, they find a positive relationship between the conditional mean and variance.

Lawrence Blume, David Easley, and Maureen O'Hara have also investigated the informational role of volume and its applicability for technical analysis. They develop a new equilibrium model in which aggregate supply is fixed and traders received signals with differing quality. They show how volume information precision and price movements relate and demonstrate how sequences of volume can be informative. Their goal in that research was to determine how the statistical properties of volume relate to the underlying value of the asset and to the behavior of market prices. Most of the previous models (rational expectations models) was believed by Blume that volume plays the role of adding noise to the model. Allowing traders to observe volume essentially allows them to know the aggregate supply and this results in a fully revealing single price. In this framework, the informational role of volume is large, but vacuous. With no role to play other than noise, volume in these models can never provide insights into underlying economic fundamentals or give guidance to the process by which information is impounded into the price. Blume develop an alternative equilibrium approach for studying the behavior of security markets. His model is standard in that some fundamental is unknown to all traders and traders receive signals that are informative of the asset fundamental. However, in his model aggregate supply is fixed. The source of noise is the quality of the information; specifically the precision of the signal distribution. Prices alone cannot provide full information on both the magnitude of the signals and their precision. They show that volume provides information about the quality of traders' information that cannot be deduced from the price statistic. They also show how sequences of volume and prices can be informative, and demonstrate that traders who use information contained in the market statistic will do "better" than traders who do not. The difference between Blume's model and other is that in other models of volume, volume is interesting for its correlation with other variables, but in itself is unimportant. Traders never learn from volume nor use volume in any decision making. In Blume's model volume enters trader's learning problems because they use the specific volume statistic in updating their believes. Consequently Blume believes that volume matters because it affects the behavior of the market rather than merely describes it.

Blume begins his analysis by examining the role of volume and trade information in the standard rational expectations framework. He finds that the fundamental difficulty is the underlying supply structure. Whether supply is introduced by an exogenous random supply or by random endowments, if volume reveals anything it reveals the supply. Consequently, if traders is allowed to condition on contemporaneous volume, it is essentially allowing them to remove the "noise" in the pricing equation. With prices then depending only on private signals, the only known equilibrium is one in which price reveals the underlying information. So in this case, volume provides no useful information about any fundamentals relating to the asset but rather is exogenously determined. It seems more reasonable to believe that the volume statistic should capture some endogenous aspect of the trading process not necessarily incorporated in prices. In particular, since volume arises from individual demands, it may be the case that volume reflects aspects of the information structure that traders might wish to know.

A second difficulty arises in investigating this role. This is the problem created by conditioning on contemporaneous information. Even if volume has some meaningful economic role, when traders use the information conveyed by contemporaneous volume, the only revealing equilibrium is the anomalous one in which volume actually has no information. Suppose that traders have common preferences and endowments and receive payoff-relevant signals and there exists a revealing rational expectations equilibrium with conditioning on price and volume. In this equilibrium, traders have common information and they all choose the same trade. But the only such trade that is consistent with market clearing is no trade, and so regardless of the signals, volume is zero – and carries no information. Alternatively, there could be nonrevealing equilibria in which traders condition on price and volume. However, as volume is a sum of absolute values it cannot be normally distributed. So although such an equilibrium might exist there seems to be no hope of constructing it, and hence no hope of using a contemporaneous data approach to study volume.

One way to avoid these difficulties is to allow traders to condition on all information up to but no including the market statistic resulting from their desired trade. This approach, first suggested by Hellwig (1982), avoids the simultaneity problem noted above while retaining the ability to learn from market information. Blume and Easley (1984) use this approach to examine the information content of past market prices.

In Blume's model, technical analysis is valuable because current market statistics may be sufficient to reveal some information, but not all. Because the underlying uncertainty in the economy is not resolved in one period, sequences of market statistics can provide information that is not impounded in a single market price. His results are most interesting is in delineating the important role played by volume. In his model, volume provides information in a way distinct from that provided by price. In most rational expectations models, price impounds information about the average level of trader's private information. But unique to his model is the feature that volume captures the important information contained in the quality of traders' information signals. Because the volume statistic is not normally distributed, if traders condition on volume they can sort out the information implicit in volume from that implicit in price. Bume's focus on the quality, or precision, of information suggests that the value of particular market statistics may vary depending upon characteristics of the information structure. The potential applications of technical analysis for small, thinly followed stocks, it seems likely that even (or perhaps, especially) in active markets volume may play an important role. One criticism of program trading voiced by professional traders is that it distorts the information typically provided by trading volume. Blume's analysis suggests, introducing trading volume unrelated to the underlying information structure would surely weaken the ability of uninformed traders to interpret market information accurately.

Thomas Copeland was also tried to find the relationship between stock returns and trading volume. He has constructed a "sequential arrival of information" model in which information is disseminated to only one trader at a time and that implies a positive correlation between V and |Up|. The information causes a one – time upward shift in each "optimist" demand curve by a fixed amount δ and a downward shift of δ in each "pessimist's" demand curve. Trading occurs after each trader receives the information, but uniformed traders do not infer the content of the information from informed traders' actions. Also, short sales are prohibited. Copeland makes the assumption that an asset market exists where individuals receive information sequentially and in random order. Start with an initial equilibrium where they all possess an identical set of information. Then allow a single piece of news to be generated. As each individual receives it, he reacts by shifting his demand curve. Finally, when all individuals have received the news, they once again possess an identical set of information and a new equilibrium is established. He analyzes asset trading in a world with sequential information arrival. It is unlike stochastic demand analysis because the magnitude and direction of demand curve shifts are known. Only the order of shifting is unknown. If there are N people, each with a different shift, then there are N factorial possible orderings of sequential information arrival. In a world with sequential information arrival the price change between the initial and final equilibria is known with certainty (The same is true with tatonnement). However, the price adjustment paths as well as the total volume of trading are shown to be random variables. In particular, the model which is developed uses probability theory (see section IIIC) to express the expected number of trades generated by a given piece of new information. The expected number of trades is related to the absolute value of price changes. It is shown to depend on the number of individuals in the market, the number of shares of the asset, the strength of the new information, and the percentage of individuals who react by shifting their demand curves upward. The model assumes throughout that only one piece of information arrives during a trading period. The sequential information arrival model assumes that traders receive the news one at a time and each shifts his demand curve immediately. The trading period ends when all traders have shifted their demand curves. The model assumes that information reaches all traders simultaneously and that the vector of equilibrium prices is established through reconstructing by the market maker before trading takes place. Information is received without cost, there are no transactions costs, no taxes, and each infinitely divisible asset has a fixed supply.

The N traders who participate in the market for a given asset have linear, downward – sloping demand curves in a price – quantity argument plane. No technical trading is allowed. In the absence of new information a trader who observes an asset price rising will respond by passively selling some or all of his holdings. However, upon receiving new information he shifts his demand curve either up or down and actively trades in the market. Traders are restricted from holding negative quantities of assets. The short sales constraint is deemed more realistic than the alternative assumption that short sales are made as easily as purchases. The conclusions of the sequential information arrival model are:

1. There is a positive correlation between the absolute value of price changes and the expected value of trading volume with high values occurring when traders have unanimous opinions about new information and low values occurring where they disagree.
2. Trading volume is a logarithmically increasing function of the number of traders, N, and of the strength of new information, δ.
3. If the short sales constraint is binding we should observe positive skewness in the distribution of volume with the degree of skewness and it will increase with the strength of information, δ.
4. Trading volume is identical when all traders are optimists

or pessimists.

Copeland presents a new technique for demand analysis under the key assumption that individuals shift their demand curves sequentially as new information is revealed to them. The expected volume for each possible sequence between the initial and final equilibria is weighted by its probability then the probabilistically weighted paths are summed in order to derive the expected number of trades given N, the total number of traders, S, the number of shares outstanding, δ, the strength of new information, and j*, the number of optimists among N traders. It was theoretically demonstrated that the expected number of trades is a logarithmically increasing function of the number of traders and of the strength of new information. It is a concave function of changes in the number of shares outstanding, and a “U-shaped” function of the percent of optimists. By assuming that the percentage of optimists was symmetrically distributed with mean it was possible to show that the sequential information model predicted a positive correlation between the absolute value of price changes and volume, positive skewness in the distribution of volume, and increasing positive skewness as a function of the strength of new information. In each case the simultaneous information model predicted exactly the opposite. Some limited evidence of the positive correlation between the absolute value of price changes and volume was cited as being consistent with a sequential information arrival model and an operational short sales constraint.

The sequential information arrival model does not change the capital asset pricing literature in any way. Instead, it adds to it by giving a better understanding of the parameters which affect volume as well as its relationship with price changes.

Another who dealt with the relationship between stock returns and trading volume was Robert H. Jennings. The primary emphasis is on the price change-volume relationship in the presence of a margin requirement. He finds that the margin requirement significantly affects the relationship of price change to volume. Furthermore this relationship is shown to be affected by the number of investors in the market, the degree of information dissemination, differences in interpretation of information and the implicit cost of the margin requirement. The paper develops a model describing the adjustment of an asset market to new information via changes in investor’s expectations. The sequential information arrival model that Jennings provides assumes that only one trader observes the information initially. This trader interprets the news, revises his beliefs and trades to arrive at a new optimal position. The outcome of this series of events is the generation of transaction volume and a new equilibrium price. After the market arrives at this new equilibrium the next investor becomes informed and after a similar sequence of events a second temporary equilibrium is achieved. This process continues until all traders are informed and results in a series of momentary equilibria. When the last trader receives the information the market reaches a final equilibrium. Jennings's model differs from other models in that the market adjustment process is formulated in an equilibrium analysis derived from a market where each investor maximizes expected utility of terminal wealth under uncertainly. Jenning's paper has served to generalize a concept that may prove to be useful in reaching the goal of comprehending the disequilibrium process that adjusts beliefs to ex post prices. The model used by Copeland in defining the sequential information arrival process was extended by an equilibrium model that includes a margin requirement as a realistic restriction on short sales. The model illustrated that a margin requirements, like any other transaction cost, will cause investors' demand curves to contain a discontinuous segment. The costs relevant to long and short positions were shown to influence the relative slopes of the portions of the demand curve characterizing these positions. With margin requirements, the model predicts a rather complex relationship between price change, volume, and the factors which influence these two variables. Both variables were shown to be sensitive to the number of investors, the mix between optimists, pessimists, and uninformed, the costs of the margin requirement, and the actual level of the expectations of each class of investors. The model presented by Jennings obviously cannot be represented as an accurate picture of a disequilibrium adjustment process since it consists of a series of market equilibria. It is conceivable that the addition of another agent to the model to act as a specialist and to match buyers and sellers at no equilibrium prices might be a method to achieve disequilibrium trading. This would tend to move the market towards, equilibrium but perhaps not actually achieve equilibrium. The additional restriction that the prices move in discrete amounts, i.e., eighths of a unit, may force the market to settle for a pseudo equilibrium. An additional complication of the model would be to permit the market to receive more than one informational shock at a time. That is, before one item of data is perceived by all of the traders, allow another to reach the market. Even in a model with sequence of equilibria, this would prevent a "final" equilibrium from obtaining. There are also two forms of investor behavior lacking from this model.. The first of these is the assumption that uninformed investors receive no information from the change in price. How investors receive information from market prices is a field of study in itself, but the answer to this question would have a significant impact on any model of a sequence of markets. The final point to be mentioned is that informed investors moved directly to a "consumptive" optimum. They do not speculate. It is, however, possible that a trader who perceives himself as having superior information will not be content with a consumptive optimum, especially in a world of unlimited borrowing. One might think of the traders who become informed early in this process as solving a dynamic programming problem taking into account the potential reaction of other traders as they become informed. Another model which predicts an asymmetric relationship between trading volume and price changes is that originally proposed by Epps (1975). In this model, investors are classified as either "optimists" or "pessimists". Short positions are assumed to be more costly than long positions. In such a market, investors with short positions would be less responsive to price changes. When the trader is a pessimist, the trading volume is less than when the trader is an optimist. Since prices decrease with a pessimistic seller and increase with an optimistic buyer, it follows that volume is low when prices decrease and high when prices increase.

An early empirical examination of the volume-price relation was conducted by Granger and Morgenstern. Using spectral analysis of weekly data from 1939-1961 they could discern no relation between movements in a Securities and Exchange Commission composite price index and the aggregate level of volume on the New York Stock Exchange. Data from two individual stocks also displayed no price volume relation. Another finding by Granger and Morgenstern, is that daily volume correlates positively with the difference between the daily high and the daily low. This is supported by a later finding that daily volume correlates with the squared difference between the daily open and close.

Ying applied a series of chi-squared tests analyses of variance and cross-spectral methods to six-year daily series of price and volume. Prices were measured by the Standard and Poor's 500. The following list is a subset of his findings.

- A small volume is usually accompanied by a fall in price

§ A large volume is usually accompanied by arise in price

§ A large increase in volume is usually accompanied by either a large rise in price or a large fall in price.

DATA AND METHODOLOGY

The data set comprises daily market price index and trading volume series for stocks from Athens stock exchange. The data covers the period of 3 January 1997-28 January 2005 and consists of 2017 observations for most of the series.All the data we use are adapted with the method of factor. The date of report on the adaptations is the 31/12/2004. We collected the data from Athens Stock Exchange and stock returns are expressed in percent. The indices we use are:

A/A	INDEX	
1	ASE Total Return Gen. Index	GD
2	ASE Banks Price Index	DTR
3	ASE Insurance Price Index	DAS
4	ASE Investment Price Index	DEP
5	ASE Industrials Price Index	DBM
6	ASE Construction Price Index	DKT
7	ASE Holding Price Index	DSM
8	ASE Parallel Market Price Index	DPR
9	FTSE/ASE 20 INDEX	FTSE20
10	FTSE/ASE MID 40	FTSE40
11	ASE Basic Metals Price Index	DMT
12	ASE I.T. Equipment-Solutions Price Index	DEL
13	ASE Publishing & Printing Price Index	DEK
14	ASE Retail Commerce Price Index	DLE
15	ASE Non Metallic Minerals & Cement Price Index	DOT
16	ASE Information Technology Price Index	DPL

17	**ASE Telecommunications Price Index**	**DTL**
18	**ASE Food Price Index**	**DTR**
19	**ASE Wholesale Commerce Price Index**	**DXE**
20	**ASE Textiles Price Index**	**DKL**
21	**FTSE/ASE SMALLCAP 80**	**FTSES**
22	**ASE Real Estate Price Index**	**DAP**
23	**ASE Oil Refineries Price Index**	**DDL**
24	**Athex High Velocity Index**	**DYKT**
25	**Eurobank Mid Cap Private Sector 50 Index**	**EPS50**

Trend and unit root test

The vector autoregression model we use for causality tests assumes that the variables in the system are stationary. As such, we test for the stationary of index returns and trading volume data. There are two ways to achieve stationary. Some series need to be detrended (called the trend-stationary process) and the others need to be differenced (called the difference-stationary, or unit root process). Previous works reports strong evidence of both linear and nolinear time trends in trading volume series. As such, trend stationarity in trading volume is tested by regressing the series on a deterministic function of time. To allow for a nonlinear time trend as well as a linear trend, they include a quadratic time trend term $V_t=a+bt+xt^2+\varepsilon_t$ where V is trading volume in each stock market. To test for a unit root we employ both the augmented Dickey Fuller (1979) test and the Phillip and Perron (1988) test:

a) $\Delta x_t=\rho_o+\rho_{xt-1}+\Sigma\delta_i\Delta x_{t-i}$

b) Phillips-Perron regression

$x_t=a_0+axt-1+u_t$

The difference between the two unit root tests lies in their treatment of any nuisance serial correlation. The test results are shown in the next table:

A/A	Index		Prob of returns	Prob of volume
1	**ASE Total Return Gen. Index**	**GD**	**0**	**0**
2	**ASE Banks Price Index**	**DTR**	**0**	**0,0072**
3	**ASE Insurance Price Index**	**DAS**	**0**	**0**
4	**ASE Investment Price Index**	**DEP**	**0**	**0**
5	**ASE Industrials Price Index**	**DBM**	**0**	**0**
6	**ASE Construction Price Index**	**DKT**	**0**	**0**
7	**ASE Holding Price Index**	**DSM**	**0**	**0**
8	**ASE Parallel Market Price Index**	**DPR**	**0**	**0,0001**
9	**FTSE/ASE 20 INDEX**	**FTSE20**	**0**	**0**
10	**FTSE/ASE MID 40**	**FTSE40**	**0**	**0**
11	**ASE Basic Metals Price Index**	**DMT**	**0**	**0,0078**
12	**ASE I.T. Equipment-Solutions Price Index**	**DEL**	**0**	**0**
13	**ASE Publishing & Printing Price Index**	**DEK**	**0**	**0**
14	**ASE Retail Commerce Price Index**	**DLE**	**0**	**0**
15	**ASE Non Metallic Minerals & Cement Price Index**	**DOT**	**0**	**0**
16	**ASE Information Technology Price Index**	**DPL**	**0**	**0,0001**
17	**ASE Telecommunications Price Index**	**DTL**	**0**	**0**
18	**ASE Food Price Index**	**DTR**	**0**	**0**
19	**ASE Wholesale Commerce Price Index**	**DXE**	**0**	**0**
20	**ASE Textiles Price Index**	**DKL**	**0**	**0**
21	**FTSE/ASE SMALLCAP 80**	**FTSES**	**0**	**0**
22	**ASE Real Estate Price Index**	**DAP**	**0**	**0**
23	**ASE Oil Refineries Price Index**	**DDL**	**0**	**0**
24	**Athex High Velocity Index**	**DYKT**	**0**	**0**
25	**Eurobank Mid Cap Private Sector 50 Index**	**EPS50**	**0**	**0**

The test result shows that the null hypothesis that the index return series and trading volume series are nonstationary is strongly rejected .This confirms that detrended trading volume and stock return series are both stationary. The detailed test result are available upon request.

Contemporaneous relationships

The contemporaneous relationship between stock returns and trading volume has been extensively studied from a variety of perspectives (see Karpoff 1987). Many investigators tried to find the relationship between stock returns and trading volume using an instrumental variable estimator as a GMM estimator to avoid problems of simultaneity bias. In addition, the use of GMM framework produces heteroskedasticity-consistent estimates by correcting the covariance matrix of the instrumental variable estimator.

GMM robust test of contemporaneous relationship

$R_t=b_0+b_1V_t+b_2V_{t-1}+b_3R_{t-1}+\varepsilon_t$

$V_t=a_0+a_1R_t+a_2V_{t-1}+a_3V_{t-2}+u_t$

In our test we investigate the relationship between the stock returns and trading volume with a GARCH robust test. The GARCH model encompasses an autocorrelation correction and is robust to underlying nonnormality. The GARCH model also incorporates heteroskedasticity in a sensible way and can be extended to include other effects on conditional variances. Thus the model offers considerable flexibility in robust modeling of stock returns. To test whether the positive contemporaneous relationship between trading volume and stock returns still exists after controlling for nonnormality of error distribution the following GARCH (1,1) model is estimated:

$R_t = b_0 + b_1 V_t + \varepsilon_t \quad \varepsilon_t / (\varepsilon_{t-1},\ \varepsilon_{t-2,\dots\dots\dots}) \sim N(0,h_t)$

$h_t = a_0 + a_1 \varepsilon^2_{t-1} + a_2 h_{t-1}$

Our findings are shown in the next matrix:

PERIOD 02/01/1997-28/01/2005

A/A	Index		b_0 (Prob)	b_1 (Prob)	α_0 (Prob)	α_1 (Prob)	α_2 (Prob)
1	**ASE Total Return Gen. Index**	GD	**0.001229 (0.0147)**	**0.0175 (0.000)**	**7.80^{E}-6 (0)**	**0.146307 (0)**	**0.838861 (0)**
2	**ASE Banks Price Index**	DTR	**0.000796 (0.0191)**	**0.0858 (0.000)**	**6.26^{E}-06 (0)**	**0.169716 (0)**	**0.831606 (0)**
3	**ASE Insurance Price Index**	DAS	**0 (0.9099)**	**0.0381 (0.5250)**	**5.59^{E}-05 (0)**	**0.182637 (0)**	**0.716961 (0)**
4	**ASE Investment Price Index**	DEP	**0.000352 (0.3120)**	**0.0807 (0.0002)**	**6.30^{E}-06 (0)**	**0.172993 (0)**	**0.831507 (0)**
5	**ASE Industrials Price Index**	DBM	**0.000601 (0.1360)**	**0.0220 (0.0006)**	**3.50^{E}-06 (0)**	**0.103058 (0)**	**0.892344 (0)**
6	**ASE Construction Price Index**	DKT	**0.003348 (0)**	**0.2893 (0.000)**	**1.30^{E}-05 (0)**	**0.104895 (0)**	**0.879272 (0)**
7	**ASE Holding Price Index**	DSM	**0.000694 (0.3193)**	**0.1692 (0.0009)**	**2.20^{E}-05 (0)**	**0.130226 (0)**	**0.831881 (0)**
8	**ASE Parallel Market Price Index**	DPR	**0.001099 (0.0206)**	**0.0474 (0.0002)**	**7.55^{E}-06 (0)**	**0.169290 (0)**	**0.824398 (0)**
9	**FTSE/ASE 20 INDEX**	FTSE20	**0 (0.9736)**	**0.0102 (0.0043)**	**1.15^{E}-05 (0)**	**0.147309 (0)**	**0.827573 (0)**
10	**FTSE/ASE MID 40**	FTSE40	**0.001500 (0.0008)**	**0.0438 (0.0000)**	**5.36^{E}-06 (0)**	**0.132401 (0)**	**0.862134 (0)**
11	**ASE Basic Metals Price Index**	DMT	**0.000723 (0.1026)**	**0 (0.8161)**	**1.53^{E}-05 (0.0004)**	**0.107167 (0)**	**0.828404 (0)**
12	**ASE I.T. Equipment-Solutions Price Index**	DEL	**0.002026 (0.0015)**	**0.2480 (0.0021)**	**8.15^{E}-06 (0.0013)**	**0.119974 (0)**	**0.864334 (0)**
13	**ASE Publishing & Printing Price Index**	DEK	**0.003126 (0)**	**0.5016 (0.000)**	**3.37^{E}-05 (0)**	**0.119484 (0)**	**0.832881 (0)**
14	**ASE Retail Commerce Price Index**	DLE	**0 (0.9723)**	**0.0894 (0.0303)**	**1.37^{E}-05 (0)**	**0.124536 (0)**	**0.827105 (0)**
15	**ASE Non Metallic Minerals & Cement Price Index**	DOT	**0.001146 (0.0121)**	**0.5854 (0.000)**	**1.16^{E}-05 (0.0001)**	**0.153488 (0)**	**0.781191 (0)**
16	**ASE Information Technology Price Index**	DPL	**0.002847 (0.0004)**	**0.2356 (0.000)**	**1.30^{E}-05 (0)**	**0.084161 (0)**	**0.868973 (0)**
17	**ASE Telecommunications Price Index**	DTL	**0.000104 (0.8414)**	**0.0141 (0.2414)**	**1.73^{E}-05 (0.0003)**	**0.084299 (0)**	**0.824985 (0)**
18	**ASE Food Price Index**	DTR	**0.000796 (0.0191)**	**0.0858 (0.0000)**	**6.26^{E}-06 (0)**	**0.169716 (0)**	**0.831606 (0)**
19	**ASE Wholesale Commerce Price**	DXE	**0.002170 (0.0023)**	**0.2065 (0.000)**	**1.60^{E}-06 (0.0022)**	**0.076421 (0)**	**0.919469 (0)**

	Index						
20	**ASE Textiles Price Index**	DKL	0.006343 (0)	1.0904 (0.000)	3.61E-05 (0.0011)	0.116557 (0)	0.825370 (0)
21	**FTSE/ASE SMALLCAP 80**	FTSES	0.006164 (0)	0.0866 (0.000)	4.46E-06 (0.0157)	0.108848 (0)	0.878490 (0)
22	**ASE Real Estate Price Index**	DAP	0.001209 (0.0018)	0.5607 (0.0000)	1.60E-05 (0)	0.239788 (0)	0.596107 (0)
23	**ASE Oil Refineries Price Index**	DDL	0.000427 (0.3965)	0.0638 (0.1275)	1.34E-05 (0.0256)	0.038338 (0.0198)	0.876539 (0)
24	**Athex High Velocity Index**	DYKT	0.012934 (0)	0.3122 (0.000)	0.000155 (0)	0.275603 (0.0002)	0.349523 (0.0036)
25	**Eurobank Mid Cap Private Sector 50 Index**	EPS50	0.001886 (0.3361)	0.0892 (0.0167)	5.01E-06 (0.4430)	-0.123623 (0.0845)	1.042177 (0)

Some studies find structural changes in the stock markets when the sample is divided. We divide a sample period into three sub-periods. The results are shown in the following tables:

PERIOD 02/01/1997-31/12/1998

A/A	Index		b_0 (Prob)	b_1 (Prob)	α_0 (Prob)	α_1 (Prob)	α_2 (Prob)
1	**ASE Total Return Gen. Index**	GD	0.001929 (0.1399)	0.0140 (0.1071)	9.75E-05 (0.002)	0.256145 (0)	0.543207 (0)
2	**ASE Banks Price Index**	DTR	0.002549 (0.0982)	0.0444 (0.1831)	0.00124 (0.0012)	0.286557 (0)	0.537511 (0)
3	**ASE Insurance Price Index**	DAS	0.003218 (0.0008)	0.0140 (0.8841)	0.000116 (0.0062)	0.204517 (0.0025)	0.510811 (0.0006)
4	**ASE Investment Price Index**	DEP	0.002328 (0.0833)	1.0123 (0)	8.45E-05 (0.0005)	0.292117 (0)	0.542772 (0)
5	**ASE Industrials Price Index**	DBM	0.000157 (0.9279)	0.0875 (0.0918)	0.000104 (0.0009)	0.208104 (0.002)	0.564675 (0)
6	**ASE Construction Price Index**	DKT	0.011190 (0.0000)	1.1413 (0)	0.000369 (0)	0.412433 (0)	0.116406 (0.2236)
7	**ASE Holding Price Index**	DSM	0.001945 (0.0588)	0.2314 (0.0055)	7.10E-05 (0.0006)	0.218135 (0.0004)	0.656501 (0)
8	**ASE Parallel Market Price Index**	DPR	0.002285 (0.0120)	0.5415 (0)	5.81E-05 (0)	0.312803 (0)	0.519991 (0
9	**FTSE/ASE 20 INDEX**	FTSE20	0.002431 (0.0249)	0.0188 (0.0158)	0.000110 (0.0004)	0.248237 (0)	0.548539 (0)
10	**FTSE/ASE MID 40**	FTSE40	0.002077 (0.3458)	0.0108 (0.6918)	9.75E-05 (0.095)	0.251561 (0)	0.568670 (0)
11	**ASE Basic Metals Price Index**	DMT	-	-	-	-	-
12	**ASE I.T. Equipment-Solutions Price Index**	DEL	-	-	-	-	-
13	**ASE Publishing & Printing Price Index**	DEK	-	-	-	-	-
14	**ASE Retail Commerce Price Index**	DLE	-	-	-	-	-
15	**ASE Non Metallic Minerals & Cement**	DOT	-	-	-	-	-

	Price Index						
16	**ASE Information Technology Price Index**	DPL	-	-	-	-	-
17	**ASE Telecommunications Price Index**	DTL	-	-	-	-	-
18	**ASE Food Price Index**	DTR	**0.002549 (0.0982)**	**0.0444 (0.1831)**	**0.000124 (0.0012)**	**0.286557 (0)**	**0.537511 (0)**
19	**ASE Wholesale Commerce Price Index**	DXE	-	-	-	-	-
20	**ASE Textiles Price Index**	DKL	-	-	-	-	-
21	**FTSE/ASE SMALLCAP 80**	FTSES	-	-	-	-	-
22	**ASE Real Estate Price Index**	DAP	-	-	-	-	-
23	**ASE Oil Refineries Price Index**	DDL	-	-	-	-	-
24	**Athex High Velocity Index**	DYKT	-	-	-	-	-
25	**Eurobank Mid Cap Private Sector 50 Index**	EPS50	-	-	-	-	-

PERIOD 04/01/1999-31/05/2000

A/A	Index		b_0 **(Prob)**	b_1 **(Prob)**	α_0 **(Prob)**	α_1 **(Prob)**	α_2 **(Prob)**
1	**ASE Total Return Gen. Index**	GD	**0.002326 (0.3736)**	**0.0335 (0.0231)**	**6.73^{E}-05 (0.0043)**	**0.220261 (0)**	**0.658225 (0)**
2	**ASE Banks Price Index**	DTR	**0.000883 (0.65)**	**0.0979 (0.0288)**	**7.99^{E}-05 (0.0005)**	**0.218682 (0)**	**0.652265 (0)**
3	**ASE Insurance Price Index**	DAS	**0.003882 (0.0570)**	**0.0469 (0)**	**0.000199 (0.0014)**	**0.286155 (0.0012)**	**0.469369 (0.0003)**
4	**ASE Investment Price Index**	DEP	**0.004708 (0.0240)**	**0.5979 (0)**	**0.000165 (0.0158)**	**0.235737 (0.0008)**	**0.558450 (0)**
5	**ASE Industrials Price Index**	DBM	**0.002221 (0.2422)**	**0.1282 (0.0001)**	**7.86^{E}-05 (0.0101)**	**0.233060 (0)**	**0.651179 (0)**
6	**ASE Construction Price Index**	DKT	**0.001908 (0.4633)**	**0.3054 (0)**	**0.000193 (0.1361)**	**0.180190 (0.0212)**	**0.702555 (0)**
7	**ASE Holding Price Index**	DSM	**0.006729 (0.0762)**	**1.0799 (0.0016)**	**0.000195 (0.0910)**	**0.137086 (0.0118)**	**0.614642 (0.0003)**
8	**ASE Parallel Market Price Index**	DPR	**0.003556 (0.1342)**	**0.4269 (0)**	**9.85^{E}-05 (0.0482)**	**0.207394 (0.0026)**	**0.732810 (0)**
9	**FTSE/ASE 20 INDEX**	FTSE20	**0.001738 (0.1866)**	**-2.22^{E}-05 (0.7724)**	**7.97^{E}-0.5 (0.0006)**	**0.214439 (0)**	**0.636779 (0)**
10	**FTSE/ASE MID 40**	FTSE40	**0.008120 (0.0016)**	**0.1545 (0)**	**7.08^{E}-05 (0.0597)**	**0.240338 (0.0003)**	**0.680937 (0)**
11	**ASE Basic Metals Price Index**	DMT	-	-	-	-	-
12	**ASE I.T. Equipment-Solutions Price Index**	DEL	-	-	-	-	-
13	**ASE Publishing & Printing Price Index**	DEK	-	-	-	-	-
14	**ASE Retail Commerce Price**	DLE	-	-	-	-	-

	Index						
15	**ASE Non Metallic Minerals & Cement Price Index**	DOT	-	-	-	-	-
16	**ASE Information Technology Price Index**	DPL	-	-	-	-	-
17	**ASE Telecommunications Price Index**	DTL	-	-	-	-	-
18	**ASE Food Price Index**	DTR	**0.000883 (0.65)**	**0.0979 (0.0288)**	**7.99^{E}-05 (0.0005)**	**0.2182 (0)**	**0.652265 (0)**
19	**ASE Wholesale Commerce Price Index**	DXE	-	-	-	-	-
20	**ASE Textiles Price Index**	DKL	-	-	-	-	-
21	**FTSE/ASE SMALLCAP 80**	FTSES	-	-	-	-	-
22	**ASE Real Estate Price Index**	DAP	-	-	-	-	-
23	**ASE Oil Refineries Price Index**	DDL	-	-	-	-	-
24	**Athex High Velocity Index**	DYKT	-	-	-	-	-
25	**Eurobank Mid Cap Private Sector 50 Index**	EPS50	-	-	-	-	-

PERIOD 01/06/2000-28/01/2005

A/A	Index		b_0 (Prob)	b_1 (Prob)	α_0 (Prob)	α_1 (Prob)	α_2 (Prob)
1	**ASE Total Return Gen. Index**	GD	**0.001925 (0.0008)**	**0.0193 (0)**	**1.74^{E}-06 (0.0109)**	**0.064415 (0)**	**0.927523 (0)**
2	**ASE Banks Price Index**	DTR	**0.001184 (0.0020)**	**0.1507 (0.0015)**	**4.87^{E}-06 (0)**	**0.141917 (0)**	**0.846949 (0)**
3	**ASE Insurance Price Index**	DAS	**0.001692 (0.0024)**	**0.0377 (0.6060)**	**1.68^{E}-05 (0)**	**0.183913 (0)**	**0.805123 (0)**
4	**ASE Investment Price Index**	DEP	**0.000149 (0.6873)**	**0.0513 (0.0338)**	**1.92^{E}-06 (0.0088)**	**0.104796 (0)**	**0.895259 (0)**
5	**ASE Industrials Price Index**	DBM	**0.001040 (0.0185)**	**0.0216 (0.0019)**	**1.05^{E}-06 (0.0204)**	**0.054807 (0)**	**0.940459 (0)**
6	**ASE Construction Price Index**	DKT	**0.003113 (0.0003)**	**0.2195 (0.0000)**	**5.78^{E}-06 (0)**	**0.050459 (0)**	**0.935561 (0)**
7	**ASE Holding Price Index**	DSM	**0.002463 (0.0047)**	**0.2084 (0.0003)**	**6.95^{E}-06 (0.0063)**	**0.102181 (0)**	**0.885902 (0)**
8	**ASE Parallel Market Price Index**	DPR	**0.004410 (0)**	**0.1077 (0)**	**2.32^{E}-06 (0.0048)**	**0.097989 (0)**	**0.895910 (0)**
9	**FTSE/ASE 20 INDEX**	FTSE20	**0.001020 (0.0479)**	**0.0198 (0.0002)**	**4.74^{E}-06 (0.0018)**	**0.083775 (0**	**0.895613 (0)**
10	**FTSE/ASE MID 40**	FTSE40	**0.001304 (0.0086)**	**0.0294 (0)**	**3.45^{E}-06 (0.0005)**	**0.101133 (0)**	**0.889219 (0)**
11	**ASE Basic Metals Price Index**	DMT	**0.000723 (0.1026)**	**4.69^{E}-05 (0.8161)**	**1.53^{E}-05 (0.0004)**	**0.107167 (0)**	**0.828404 (0)**
12	**ASE I.T. Equipment-Solutions Price Index**	DEL	**0.002026 (0.0015)**	**0.2480 (0.0021)**	**8.15^{E}-06 (0.0013)**	**0.119974 (0)**	**0.864334 (0)**

13	**ASE Publishing & Printing Price Index**	DEK	**0.003126 (0)**	**0.5016 (0)**	**3.37E-05 (0)**	**0.119484 (0)**	**0.832881 (0)**
14	**ASE Retail Commerce Price Index**	DLE	**-1.65E-05 (0.9723)**	**0.0894 (0.0303)**	**1.37E-05 (0)**	**0.124536 (0)**	**0.827105 (0)**
15	**ASE Non Metallic Minerals & Cement Price Index**	DOT	**0.001146 (0.0121)**	**0.5854 (0)**	**1.16E-05 (0.0001)**	**0.153488 (0)**	**0.781191 (0)**
16	**ASE Information Technology Price Index**	DPL	**0.002847 (0.0004)**	**0.2356 (0)**	**1.30E-05 (0)**	**0.084161 (0)**	**0.868973 (0)**
17	**ASE Telecommunications Price Index**	DTL	**0.000104 (0.8414)**	**0.0141 (0.2414)**	**1.73E-05 (0.0003)**	**0.084299 (0)**	**0.824985 (0)**
18	**ASE Food Price Index**	DTR	**0.001184 (0.0020)**	**0.1507 (0.0015)**	**4.87E-06 (0)**	**0.141917 (0)**	**0.846949 (0)**
19	**ASE Wholesale Commerce Price Index**	DXE	**0.002170 (0.0023)**	**0.2065 (0)**	**1.60E-06 (0.0022)**	**0.076421 (0)**	**0.919469 (0**
20	**ASE Textiles Price Index**	DKL	**0.006343 (0)**	**1.0904 (0)**	**3.61E-05 (0.0011)**	**0.116557 (0)**	**0.825370 (0)**
21	**FTSE/ASE SMALLCAP 80**	FTSES	**0.006164 (0)**	**0.0866 (0)**	**4.46E-06 (0.0157)**	**0.108848 (0)**	**0.878490 (0)**
22	**ASE Real Estate Price Index**	DAP	**0.001209 (0.0018)**	**0.5607 (0)**	**1.60E-05 (0)**	**0.239788 (0)**	**0.596107 (0)**
23	**ASE Oil Refineries Price Index**	DDL	**0.000427 (0.3965)**	**0.0638 (0.1275)**	**1.34E-05 (0.0256)**	**0.038338 (0.0198)**	**0.876539 (0)**
24	**Athex High Velocity Index**	DYKT	**0.012934 (0)**	**0.3122 (0)**	**0.000155 (0)**	**0.275603 (0.0002)**	**0.349523 (0)**
25	**Eurobank Mid Cap Private Sector 50 Index**	EPS50	**0.001886 (0.3361)**	**0.0892 (0.0167)**	**5.01E-06 (0.4430)**	**-0.123623 (0.0845)**	**1.042177 (0)**

As reported in previous tables the coefficients of regressing returns on trading volume are most of them positive and significant using the GARCH (1,1) model in the whole period.When the sample is divided, in the first period analyses show evidence of relationship between stock returns and trading volume on most of the indices but this association weakens.In the other two periods we have strong relationship. The presence of GARCH effects suggests the daily time dependence in the rate of information arrival to the aggregate markets.

Dynamic relationship

Causal relationship between trading volume and return

The empirical procedure in this section tests whether trading volume precedes stock returns, and vise versa. This is the notion behind causality testing in Granger (1969), and it is based on the premise that the future cannot cause the present or the past. If an event x occurs before an event y, then we can say that x causes y. Formally, if the prediction of y using past x is more accurate than the prediction without using past x in the mean square error sense. The following bivariate autoregression is used to test for causality between the two variables among trading volume, stock returns and volatility of stock returns:

$$X_t = a_0 + \sum_{i=1}^{m} aiXt-1 \quad + \sum_{i=1}^{n} biyt-i+et$$

$$Y_t = Y_0 + \sum_{i=1}^{m} YiXt-1 \quad + \sum_{i=1}^{n} diyt-i+ht$$

Suppose that x_t and y_t are trading volume and returns, respectively. If the β_i coefficients are statistically significant, inclusion of past values of return (y), in addition to past history of volume (x), yields a better forecast of future volume and we say returns cause volume. If a standard F-test does not reject the hypothesis that β_i=0 for all i, then returns do not cause volume. Similarly, in the second equation, if causality runs from volume to returns, the y_j coefficient will jointly be different from zero. If both β and y are different from zero, there is a feedback relation between returns and trading volume.

$$\begin{pmatrix} R_t \\ V_t \end{pmatrix} = \begin{pmatrix} a_{11} \\ a_{21} \end{pmatrix} + \begin{pmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{pmatrix} * \begin{pmatrix} R_{t-1} \\ V_{t-1} \end{pmatrix} + \begin{pmatrix} u_{1t} \\ u_{2t} \end{pmatrix}$$

$$R_t = a_{11} + b_{11}R_{t-1} + b_{12}V_{t-1} + \ldots\ldots + u_{1t}$$

$$V_t = a_{21} + b_{21}R_{t-1} + b_{22}V_{t-1} + \ldots\ldots + u_{2t}$$

Next table presents the result of domestic causal relationship tests based on a bivariate model, along with lags and corresponding significance levels (whole period). The following observations, among other things are noted. First at 5% significance level the results are:

A/A	Index		LAG*	METHOD	COMMENTS	PROB
1	**ASE Total Return Gen. Index**	GD	8	A/C	$RGD \xrightarrow{G.C} VGD$ $VGD \xrightarrow{G.C} RGD$	0.3653 0.0001
2	**ASE Banks Price Index**	DTR	10	A/C	$R\ DTR \xrightarrow{G.C} V\ DTR$ $V\ DTR \xrightarrow{G.C} R\ DTR$	0.0966 0.0000
3	**ASE Insurance Price Index**	DAS	4	A/C	$R\ DAS \xrightarrow{G.C} V\ DAS$ $V\ DAS \xrightarrow{G.C} R\ DAS$	0.9993 0.9946
4	**ASE Investment Price Index**	DEP	6	A/C	$R\ DEP \xrightarrow{G.C} V\ DEP$ $V\ DEP \xrightarrow{G.C} R\ DEP$	0.9892 0.9946
5	**ASE Industrials Price Index**	DBM	2	FPE	$R\ DBM \xrightarrow{G.C} V\ DBM$ $V\ DBM \xrightarrow{G.C} R\ DBM$	0.7648 0.0553
6	**ASE Construction Price Index**	DKT	8	FPE	$R\ DKT \xrightarrow{G.C} V\ DKT$ $V\ DKT \xrightarrow{G.C} R\ DKT$	0.0845 0.0000
7	**ASE Holding Price Index**	DSM	7	LR	$RDSM \xrightarrow{G.C} V\ DSM$ $V\ DSM \xrightarrow{G.C} R\ DSM$	0.7442 0.0308
8	**ASE Parallel Market Price Index**	DPR	7	LR	$R\ DPR \xrightarrow{G.C} V\ DPR$ $V\ DPR \xrightarrow{G.C} R\ DPR$	0.8415 0.0001
9	**FTSE/ASE 20 INDEX**	FTSE20	7	LR	$RFTSE20 \xrightarrow{G.C} VFTSE20$ $V\ FTSE20 \xrightarrow{G.C} R\ FTSE20$	0.4710 0.0004

10	**FTSE/ASE MID 40**	FTSE40	6	FPE	RFTSE40 $\xrightarrow{G.C}$ VFTSE40 V FTSE40 $\xrightarrow{G.C}$ R FTSE40	0.0080 0.0016
11	**ASE Basic Metals Price Index**	DMT	3	FPE	R DMT $\xrightarrow{G.C}$ V DMT V DMT $\xrightarrow{G.C}$ R DMT	0.5188 0.5550
12	**ASE I.T. Equipment-Solutions Price Index**	DEL	3	LR	R DEL $\xrightarrow{G.C}$ V DEL V DEL $\xrightarrow{G.C}$ R DEL	0.7893 0.0002
13	**ASE Publishing & Printing Price Index**	DEK	9	FPE	R DEK $\xrightarrow{G.C}$ V DEK V DEK $\xrightarrow{G.C}$ R DEK	0.0000 0.0000
14	**ASE Retail Commerce Price Index**	DLE	4	A/C	R DLE $\xrightarrow{G.C}$ V DLE V DLE $\xrightarrow{G.C}$ R DLE	0.1638 0.0025
15	**ASE Non Metallic Minerals & Cement Price Index**	DOT	4	FPE	R DOT $\xrightarrow{G.C}$ V DOT V DOT $\xrightarrow{G.C}$ R DOT	0.0063 0.2031
16	**ASE Information Technology Price Index**	DPL	7	FPE	R DPL $\xrightarrow{G.C}$ V DPL V DPL $\xrightarrow{G.C}$ R DPL	0.30 0.3043
17	**ASE Telecommunications Price Index**	DTL	4	A/C	R DTL $\xrightarrow{G.C}$ V DTL V DTL $\xrightarrow{G.C}$ R DTL	0.3501 0.87
18	**ASE Food Price Index**	DTR	10	A/C	R DTR $\xrightarrow{G.C}$ V DTR V DTR $\xrightarrow{G.C}$ R DTR	0.1113 0.0000
19	**ASE Wholesale Commerce Price Index**	DXE	9	LR	R DXE $\xrightarrow{G.C}$ V DXE V DXE $\xrightarrow{G.C}$ R DXE	0.3742 0.0000
20	**ASE Textiles Price Index**	DKL	5	LR	R DKL $\xrightarrow{G.C}$ V DKL V DKL $\xrightarrow{G.C}$ R DKL	0.0231 0.0000
21	**FTSE/ASE SMALLCAP 80**	FTSES	5	A/C	R FTSES $\xrightarrow{G.C}$ V FTSES V FTSES $\xrightarrow{G.C}$ R FTSES	0.8514 0.0000
22	**ASE Real Estate Price Index**	DAP	6	LR	R DAP $\xrightarrow{G.C}$ V DAP V DAP $\xrightarrow{G.C}$ R DAP	0.0299 0.0535
23	**ASE Oil Refineries Price Index**	DDL	5	LR	R DDL $\xrightarrow{G.C}$ V DDL V DDL $\xrightarrow{G.C}$ R DDL	0.8699 0.0000
24	**Athex High Velocity Index**	DYKT	3	A/C	R DYKT $\xrightarrow{G.C}$ V DYKT V DYKT $\xrightarrow{G.C}$ R DYKT	0.4297 0.0090
25	**Eurobank Mid Cap Private Sector 50 Index**	EPS50	2	A/C	R EPS50 $\xrightarrow{G.C}$ V EPS50 V EPS50 $\xrightarrow{G.C}$ R EPS50	0.2377 0.1059

* indicates lag order selected by the criterion
CRITERIA:

LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Some studies find structural changes in the stock markes when the sampe is divided. We divide a sample period into three sub-periods. The results are shown in the following tables:

PERIOD 02/01/97 έως 31/12/1998

A/A	Index		LAG*	METHOD	COMMENTS	PROB
1	**ASE Total Return Gen. Index**	GD	3	A/C	RGD $\xrightarrow{G.C}$ VGD VGD $\xrightarrow{G.C}$ RGD	0.3220 0.2995
2	**ASE Banks Price Index**	DTR	3	A/C	R DTR $\xrightarrow{G.C}$ V DTR V DTR $\xrightarrow{G.C}$ R DTR	0.7189 0.0345
3	**ASE Insurance Price Index**	DAS	2	A/C	R DAS $\xrightarrow{G.C}$ V DAS V DAS $\xrightarrow{G.C}$ R DAS	0.9415 0.8950
4	**ASE Investment Price Index**	DEP	4	A/C	R DEP $\xrightarrow{G.C}$ V DEP V DEP $\xrightarrow{G.C}$ R DEP	0.4134 0.0376
5	**ASE Industrials Price Index**	DBM	3	FPE	R DBM $\xrightarrow{G.C}$ V DBM V DBM $\xrightarrow{G.C}$ R DBM	0.9023 0.0196
6	**ASE Construction Price Index**	DKT	3	FPE	R DKT $\xrightarrow{G.C}$ V DKT V DKT $\xrightarrow{G.C}$ R DKT	0.4509 0.0067
7	**ASE Holding Price Index**	DSM	5	LR	RDSM $\xrightarrow{G.C}$ V DSM V DSM $\xrightarrow{G.C}$ R DSM	0.3588 0.4659
8	**ASE Parallel Market Price Index**	DPR	4	LR	R DPR $\xrightarrow{G.C}$ V DPR V DPR $\xrightarrow{G.C}$ R DPR	0.0979 0.0006
9	**FTSE/ASE 20 INDEX**	FTSE20	2	LR	RFTSE20 $\xrightarrow{G.C}$ VFTSE20 V FTSE20 $\xrightarrow{G.C}$ R FTSE20	0.5021 0.3845
10	**FTSE/ASE MID 40**	FTSE40	2	FPE	RFTSE40 $\xrightarrow{G.C}$ VFTSE40 V FTSE40 $\xrightarrow{G.C}$ R FTSE40	0.5903 0.0734
11	**ASE Basic Metals Price Index**	DMT	-	-	R DMT $\xrightarrow{G.C}$ V DMT V DMT $\xrightarrow{G.C}$ R DMT	- -
12	**ASE I.T. Equipment-Solutions Price Index**	DEL	-	-	R DEL $\xrightarrow{G.C}$ V DEL V DEL $\xrightarrow{G.C}$ R DEL	- -
13	**ASE Publishing & Printing Price Index**	DEK	-	-	R DEK $\xrightarrow{G.C}$ V DEK V DEK $\xrightarrow{G.C}$ R DEK	- -
14	**ASE Retail Commerce Price Index**	DLE	-	-	R DLE $\xrightarrow{G.C}$ V DLE V DLE $\xrightarrow{G.C}$ R DLE	- -
15	**ASE Non Metallic Minerals & Cement Price Index**	DOT	-	-	R DOT $\xrightarrow{G.C}$ V DOT V DOT $\xrightarrow{G.C}$ R DOT	- -
16	**ASE Information Technology Price Index**	DPL	-	-	R DPL $\xrightarrow{G.C}$ V DPL V DPL $\xrightarrow{G.C}$ R DPL	- -
17	**ASE Telecommunications Price Index**	DTL	-	-	R DTL $\xrightarrow{G.C}$ V DTL V DTL $\xrightarrow{G.C}$ R DTL	- -
18	**ASE Food Price Index**	DTR	3	A/C	R DTR $\xrightarrow{G.C}$ V DTR V DTR $\xrightarrow{G.C}$ R DTR	0.7189 0.0345
19	**ASE Wholesale Commerce Price Index**	DXE	-	-	R DXE $\xrightarrow{G.C}$ V DXE V DXE $\xrightarrow{G.C}$ R DXE	- -
20	**ASE Textiles Price Index**	DKL	-	-	R DKL $\xrightarrow{G.C}$ V DKL V DKL $\xrightarrow{G.C}$ R DKL	0.0231 0.000

21	**FTSE/ASE SMALLCAP 80**	FTSES	-	-	R FTSES $\xrightarrow{G.C}$ V FTSES V FTSES $\xrightarrow{G.C}$ R FTSES	- -
22	**ASE Real Estate Price Index**	DAP	-	-	R DAP $\xrightarrow{G.C}$ V DAP V DAP $\xrightarrow{G.C}$ R DAP	- -
23	**ASE Oil Refineries Price Index**	DDL	-	-	R DDL $\xrightarrow{G.C}$ V DDL V DDL $\xrightarrow{G.C}$ R DDL	- -
24	**Athex High Velocity Index**	DYKT	-	-	R DYKT $\xrightarrow{G.C}$ V DYKT V DYKT $\xrightarrow{G.C}$ R DYKT	- -
25	**Eurobank Mid Cap Private Sector 50 Index**	EPS50	-	-	R EPS50 $\xrightarrow{G.C}$ V EPS50 V EPS50 $\xrightarrow{G.C}$ R EPS50	- -

PERIOD 04/01/99 έως 31/05/00

A/A	Index		LAG*	METHOD	COMMENTS	PROB
1	**ASE Total Return Gen. Index**	GD	7	A/C	RGD $\xrightarrow{G.C}$ VGD VGD $\xrightarrow{G.C}$ RGD	0.4211 0.049
2	**ASE Banks Price Index**	DTR	6	A/C	R DTR $\xrightarrow{G.C}$ V DTR V DTR $\xrightarrow{G.C}$ R DTR	0.0689 0.0081
3	**ASE Insurance Price Index**	DAS	3	A/C	R DAS $\xrightarrow{G.C}$ V DAS V DAS $\xrightarrow{G.C}$ R DAS	0.5486 0.1085
4	**ASE Investment Price Index**	DEP	6	A/C	R DEP $\xrightarrow{G.C}$ V DEP V DEP $\xrightarrow{G.C}$ R DEP	0.3480 0
5	**ASE Industrials Price Index**	DBM	3	FPE	R DBM $\xrightarrow{G.C}$ V DBM V DBM $\xrightarrow{G.C}$ R DBM	0.3904 0.4712
6	**ASE Construction Price Index**	DKT	3	FPE	R DKT $\xrightarrow{G.C}$ V DKT V DKT $\xrightarrow{G.C}$ R DKT	0.6003 0
7	**ASE Holding Price Index**	DSM	3	LR	RDSM $\xrightarrow{G.C}$ V DSM V DSM $\xrightarrow{G.C}$ R DSM	0.0080 0.4653
8	**ASE Parallel Market Price Index**	DPR	3	LR	R DPR $\xrightarrow{G.C}$ V DPR V DPR $\xrightarrow{G.C}$ R DPR	0.2308 0.0008
9	**FTSE/ASE 20 INDEX**	FTSE20	1	LR	RFTSE20 $\xrightarrow{G.C}$ VFTSE20 V FTSE20 $\xrightarrow{G.C}$ R FTSE20	0.8125 0.5365
10	**FTSE/ASE MID 40**	FTSE40	6	FPE	RFTSE40 $\xrightarrow{G.C}$ VFTSE40 V FTSE40 $\xrightarrow{G.C}$ R FTSE40	0.010 0.5966
11	**ASE Basic Metals Price Index**	DMT	-	-	R DMT $\xrightarrow{G.C}$ V DMT V DMT $\xrightarrow{G.C}$ R DMT	- -
12	**ASE I.T. Equipment-Solutions Price Index**	DEL	-	-	R DEL $\xrightarrow{G.C}$ V DEL V DEL $\xrightarrow{G.C}$ R DEL	- -
13	**ASE Publishing & Printing Price Index**	DEK	-	-	R DEK $\xrightarrow{G.C}$ V DEK V DEK $\xrightarrow{G.C}$ R DEK	- -
14	**ASE Retail Commerce Price Index**	DLE	-	-	R DLE $\xrightarrow{G.C}$ V DLE V DLE $\xrightarrow{G.C}$ R DLE	- -

15	**ASE Non Metallic Minerals & Cement Price Index**	DOT	-	-	R DOT $\xrightarrow{G.C}$ V DOT V DOT $\xrightarrow{G.C}$ R DOT	- -
16	**ASE Information Technology Price Index**	DPL	-	-	R DPL $\xrightarrow{G.C}$ V DPL V DPL $\xrightarrow{G.C}$ R DPL	- -
17	**ASE Telecommunications Price Index**	DTL	-	-	R DTL $\xrightarrow{G.C}$ V DTL V DTL $\xrightarrow{G.C}$ R DTL	- -
18	**ASE Food Price Index**	DTR	6	A/C	R DTR $\xrightarrow{G.C}$ V DTR V DTR $\xrightarrow{G.C}$ R DTR	0.0689 0.0081
19	**ASE Wholesale Commerce Price Index**	DXE	-	-	R DXE $\xrightarrow{G.C}$ V DXE V DXE $\xrightarrow{G.C}$ R DXE	- -
20	**ASE Textiles Price Index**	DKL	-	-	R DKL $\xrightarrow{G.C}$ V DKL V DKL $\xrightarrow{G.C}$ R DKL	- -
21	**FTSE/ASE SMALLCAP 80**	FTSES	-	-	R FTSES $\xrightarrow{G.C}$ V FTSES V FTSES $\xrightarrow{G.C}$ R FTSES	- -
22	**ASE Real Estate Price Index**	DAP	-	-	R DAP $\xrightarrow{G.C}$ V DAP V DAP $\xrightarrow{G.C}$ R DAP	- -
23	**ASE Oil Refineries Price Index**	DDL	-	-	R DDL $\xrightarrow{G.C}$ V DDL V DDL $\xrightarrow{G.C}$ R DDL	- -
24	**Athex High Velocity Index**	DYKT	-	-	R DYKT $\xrightarrow{G.C}$ V DYKT V DYKT $\xrightarrow{G.C}$ R DYKT	- -
25	**Eurobank Mid Cap Private Sector 50 Index**	EPS50	-	-	R EPS50 $\xrightarrow{G.C}$ V EPS50 V EPS50 $\xrightarrow{G.C}$ R EPS50	- -

PERIOD 01/06/00 έως 28/01/05

A/A	Index		LAG*	METHOD	COMMENTS	PROB
1	**ASE Total Return Gen. Index**	GD	5	A/C	RGD $\xrightarrow{G.C}$ VGD VGD $\xrightarrow{G.C}$ RGD	0.9163 0.0042
2	**ASE Banks Price Index**	DTR	5	LR	R DTR $\xrightarrow{G.C}$ V DTR V DTR $\xrightarrow{G.C}$ R DTR	0.0875 0.0043
3	**ASE Insurance Price Index**	DAS	4	LR	R DAS $\xrightarrow{G.C}$ V DAS V DAS $\xrightarrow{G.C}$ R DAS	0.9858 0.9625
4	**ASE Investment Price Index**	DEP	1	LR	R DEP $\xrightarrow{G.C}$ V DEP V DEP $\xrightarrow{G.C}$ R DEP	0.6168 0.2303
5	**ASE Industrials Price Index**	DBM	2	LR	R DBM $\xrightarrow{G.C}$ V DBM V DBM $\xrightarrow{G.C}$ R DBM	0.4912 0.0476
6	**ASE Construction Price Index**	DKT	4	LR	R DKT $\xrightarrow{G.C}$ V DKT V DKT $\xrightarrow{G.C}$ R DKT	0.083 0.0000
7	**ASE Holding Price Index**	DSM	7	LR	RDSM $\xrightarrow{G.C}$ V DSM V DSM $\xrightarrow{G.C}$ R DSM	0.7120 0.0011
8	**ASE Parallel Market Price Index**	DPR	7	LR	R DPR $\xrightarrow{G.C}$ V DPR V DPR $\xrightarrow{G.C}$ R DPR	0.5994 0.0001
9	**FTSE/ASE 20 INDEX**	FTSE20	5	FPE	RFTSE20 $\xrightarrow{G.C}$ VFTSE20 V FTSE20 $\xrightarrow{G.C}$ R FTSE20	0.8211 0.0104

10	**FTSE/ASE MID 40**	FTSE40	4	FPE	RFTSE40 $\xrightarrow{G.C}$ VFTSE40 V FTSE40 $\xrightarrow{G.C}$ R FTSE40	0.9822 0.0338
11	**ASE Basic Metals Price Index**	DMT	3	FPE	R DMT $\xrightarrow{G.C}$ V DMT V DMT $\xrightarrow{G.C}$ R DMT	0.5188 0.5550
12	**ASE I.T. Equipment-Solutions Price Index**	DEL	3	LR	R DEL $\xrightarrow{G.C}$ V DEL V DEL $\xrightarrow{G.C}$ R DEL	0.7893 0.0002
13	**ASE Publishing & Printing Price Index**	DEK	8	FPE	R DEK $\xrightarrow{G.C}$ V DEK V DEK $\xrightarrow{G.C}$ R DEK	0.0002 0.0000
14	**ASE Retail Commerce Price Index**	DLE	4	A/C	R DLE $\xrightarrow{G.C}$ V DLE V DLE $\xrightarrow{G.C}$ R DLE	0.1638 0.0025
15	**ASE Non Metallic Minerals & Cement Price Index**	DOT	5	FPE	R DOT $\xrightarrow{G.C}$ V DOT V DOT $\xrightarrow{G.C}$ R DOT	0.0116 0.1463
16	**ASE Information Technology Price Index**	DPL	7	LR	R DPL $\xrightarrow{G.C}$ V DPL V DPL $\xrightarrow{G.C}$ R DPL	0.30 0.3043
17	**ASE Telecommunications Price Index**	DTL	4	FPE	R DTL $\xrightarrow{G.C}$ V DTL V DTL $\xrightarrow{G.C}$ R DTL	0.3501 0.87
18	**ASE Food Price Index**	DTR	5	FPE	R DTR $\xrightarrow{G.C}$ V DTR V DTR $\xrightarrow{G.C}$ R DTR	0.0875 0.0043
19	**ASE Wholesale Commerce Price Index**	DXE	5	LR	R DXE $\xrightarrow{G.C}$ V DXE V DXE $\xrightarrow{G.C}$ R DXE	0.3060 0.0000
20	**ASE Textiles Price Index**	DKL	5	LR	R DKL $\xrightarrow{G.C}$ V DKL V DKL $\xrightarrow{G.C}$ R DKL	0.0231 0.0000
21	**FTSE/ASE SMALLCAP 80**	FTSES	5	LR	R FTSES $\xrightarrow{G.C}$ V FTSES V FTSES $\xrightarrow{G.C}$ R FTSES	0.8514 0.0000
22	**ASE Real Estate Price Index**	DAP	6	LR	R DAP $\xrightarrow{G.C}$ V DAP V DAP $\xrightarrow{G.C}$ R DAP	0.0299 0.0535
23	**ASE Oil Refineries Price Index**	DDL	5	LR	R DDL $\xrightarrow{G.C}$ V DDL V DDL $\xrightarrow{G.C}$ R DDL	0.8699 0.0000
24	**Athex High Velocity Index**	DYKT	7	A/C	R DYKT $\xrightarrow{G.C}$ V DYKT V DYKT $\xrightarrow{G.C}$ R DYKT	0.6770 0.097
25	**Eurobank Mid Cap Private Sector 50 Index**	EPS50	2	A/C	R EPS50 $\xrightarrow{G.C}$ V EPS50 V EPS50 $\xrightarrow{G.C}$ R EPS50	0.2377 0.1059

* indicates lag order selected by the criterion
CRITERIA:

LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Once we have estimated a VAR, EViews provides various views to work with the estimated VAR. These views help us to check the appropriateness of the estimated VAR. First of all after the estimation we use the <Lag Length Criteria>. The method computes various criteria to select the lag order of an unrestricted VAR. We specify the maximum lag to "test" for and we re-estimate the Var. The table indicates the selected lag from each column criterion by an asterisk "*". All the criteria are discussed in Lütkepohl (1991, Section 4.3). The sequential modified likelihood ratio (LR) test is carried out as follows. Starting from the maximum lag, test the hypothesis that the coefficients on lag are jointly zero using the statistics where is the number of parameters per equation under the alternative. Note that we employ Sims' (1980) small sample modification which uses () rather than. We compare the modified LR statistics to the 5% critical values starting from the maximum lag, and decreasing the lag one at a time until we first get a rejection. The alternative lag order from the first rejected test is marked with an asterisk (if no test rejects, the minimum lag will be marked with an asterisk). It is worth emphasizing that even though the individual tests have size 0.05, the overall size of the test will not be 5%; see the discussion in Lütkepohl (1991, pp. 125-126). To see if we use the correct lags we use the residual tests (Autocorrelation LM Test). This test reports the multivariate LM test statistics for residual serial correlation up to the specified order. The test statistic for lag order is computed by running an auxiliary regression of the residuals on the original right-hand regressors and the lagged residual, where the missing first values of are filled with zeros. See Johansen

(1995a, p. 22) for the formula of the LM statistic. Under the null hypothesis of no serial correlation of order, the LM statistic is asymptotically distributed with degrees of freedom. Then we use the Pairwise Granger Causality Tests. This test carries out pairwise Granger causality tests and tests whether an endogenous variable can be treated as exogenous. For each equation in the VAR, the output displays (Wald) statistics for the joint significance of each of the other lagged endogenous variables in that equation.

At a 5% significant level, trading volume does Granger-cause stock market returns on most of the indices we examine.

When we divide a sample period into three sub-periods we have the same results in the third period. At a 5% significant level, trading volume does Granger-cause stock market returns on most of the indices. In the first two periods trading volume does Granger-cause stock market returns on most of the indices but this cause weakens.

CONCLUDING REMARKS

It is likely that observations of simultaneous large volumes and large price changes-either positive or negative –can be traced to their common ties to information flows (as in the sequential information arrival model), or their common ties to a directing process that can be interpreted as the flow of information. And the relatively large cost of taking a short position provides an explanation for the observation that, in equity markets, the volume associated with a price increase generally exceeds that with an equal price decrease, since costly short sales restrict some investors abilities to trade on new information.

In this paper, we have examined empirical dynamic relations between stock market trading volume and returns for domestic market by using the daily data of Athens stock Exchange. A main issue has been whether information about trading volume is useful in improving forecasts of returns and return volatility in a dynamic context.

We find that, at a 5%, trading volume does Granger-cause stock market returns on most of the indices. Also there exists a positive feedback relationship between trading volume and return volatility in most of the indices.

When we divide a sample period into three sub-periods we have the same results in the third period. At a 5% significant level, trading volume does Granger-cause stock market returns on most of the indices. In the first two periods trading volume does Granger-cause stock market returns on most of the indices but this cause weakens.

When the sample is divided, in the GARCH (1,1) model, in the first period analyses show evidence of relationship between stock returns and trading volume on most of the indices but this association weakens.In the other two periods we have strong relationship.

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APPENDIX

STATIONARY

Null Hypothesis: GOD has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=25)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-38.07667	0.0000
Test critical values:	1% level	-3.433395	
	5% level	-2.862771	
	10% level	-2.567472	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(GD)
Method: Least Squares
Date: 02/22/05 Time: 19:51
Sample(adjusted): 2 2017
Included observations: 2016 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GD(-1)	-0.836774	0.021976	-38.07667	0.0000
C	0.000604	0.000398	1.519260	0.1289

R-squared	0.418563	Mean dependent var	-9.06E-06
Adjusted R-squared	0.418274	S.D. dependent var	0.023392
S.E. of regression	0.017842	Akaike info criterion	-5.213582
Sum squared resid	0.641098	Schwarz criterion	-5.208018
Log likelihood	5257.291	F-statistic	1449.833
Durbin-Watson stat	1.993387	Prob(F-statistic)	0.000000

Null Hypothesis: DTR has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=25)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-36.77306	0.0000
Test critical values:	1% level	-3.433395	
	5% level	-2.862771	
	10% level	-2.567472	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DTR)
Method: Least Squares
Date: 02/22/05 Time: 19:52
Sample(adjusted): 2 2017
Included observations: 2016 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DTR(-1)	-0.803110	0.021840	-36.77306	0.0000
C	0.000440	0.000445	0.989116	0.3227

R-squared	0.401710	Mean dependent var	-5.10E-06
Adjusted R-squared	0.401413	S.D. dependent var	0.025805

S.E. of regression	0.019965	Akaike info criterion	-4.988674
Sum squared resid	0.802788	Schwarz criterion	-4.983110
Log likelihood	5030.584	F-statistic	1352.258
Durbin-Watson stat	1.990803	Prob(F-statistic)	0.000000

Null Hypothesis: DAS has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=25)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-37.13703	0.0000
Test critical values:	1% level	-3.433395	
	5% level	-2.862771	
	10% level	-2.567472	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DAS)
Method: Least Squares
Date: 02/22/05 Time: 19:52
Sample(adjusted): 2 2017
Included observations: 2016 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DAS(-1)	-0.813479	0.021905	-37.13703	0.0000
C	0.000506	0.000493	1.026730	0.3047

R-squared	0.406453	Mean dependent var	1.26E-05
Adjusted R-squared	0.406158	S.D. dependent var	0.028696
S.E. of regression	0.022114	Akaike info criterion	-4.784264
Sum squared resid	0.984861	Schwarz criterion	-4.778700
Log likelihood	4824.539	F-statistic	1379.159
Durbin-Watson stat	1.996698	Prob(F-statistic)	0.000000

Null Hypothesis: DEP has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=25)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-37.70055	0.0000
Test critical values:	1% level	-3.433395	
	5% level	-2.862771	
	10% level	-2.567472	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DEP)
Method: Least Squares
Date: 02/22/05 Time: 19:53
Sample(adjusted): 2 2017
Included observations: 2016 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DEP(-1)	-0.827235	0.021942	-37.70055	0.0000
C	0.000619	0.000456	1.356695	0.1750

R-squared	0.413739	Mean dependent var	-1.19E-05
Adjusted R-squared	0.413448	S.D. dependent var	0.026729
S.E. of regression	0.020471	Akaike info criterion	-4.938606
Sum squared resid	0.844005	Schwarz criterion	-4.933042
Log likelihood	4980.115	F-statistic	1421.332

Durbin-Watson stat	1.991620	Prob(F-statistic)	0.000000

Null Hypothesis: DBM has a unit root			
Exogenous: Constant			
Lag Length: 0 (Automatic based on SIC, MAXLAG=25)			
			Prob.*
Augmented Dickey-Fuller test statistic			0.0000
Test critical values:	1% level		
	5% level		
	10% level		
*MacKinnon (1996) one-sided p-values.			

Augmented Dickey-Fuller Test Equation			
Dependent Variable: D(DBM)			
Method: Least Squares			
Date: 02/22/05 Time: 19:53			
Sample(adjusted): 2 2017			
Included observations: 2016 after adjusting endpoints			
Variable	Coefficient Std. Error		Prob.
DBM(-1)	-0.849905 0.022031		0.0000
C	0.000399 0.000410		0.3299
R-squared	0.424946	Mean dependent var	3.02E-07
Adjusted R-squared	0.424661	S.D. dependent var	0.024242
S.E. of regression	0.018388	Akaike info criterion	-5.153238
Sum squared resid	0.680976	Schwarz criterion	-5.147674
Log likelihood	5196.464	F-statistic	1488.282
Durbin-Watson stat	1.988363	Prob(F-statistic)	0.000000

Null Hypothesis: DKT has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=25)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-35.83343	0.0000
Test critical values:	1% level	-3.433395	
	5% level	-2.862771	
	10% level	-2.567472	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DKT)
Method: Least Squares
Date: 02/22/05 Time: 19:54
Sample(adjusted): 2 2017
Included observations: 2016 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DKT(-1)	-0.778692	0.021731	-35.83343	0.0000
C	0.000495	0.000599	0.825773	0.4090

R-squared	0.389333	Mean dependent var	1.69E-06
Adjusted R-squared	0.389030	S.D. dependent var	0.034416
S.E. of regression	0.026901	Akaike info criterion	-4.392295
Sum squared resid	1.457488	Schwarz criterion	-4.386731
Log likelihood	4429.433	F-statistic	1284.035
Durbin-Watson stat	1.986291	Prob(F-statistic)	0.000000

Null Hypothesis: DSM has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=25)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-39.21411	0.0000
Test critical values:	1% level	-3.433395	
	5% level	-2.862771	
	10% level	-2.567472	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DSM)
Method: Least Squares
Date: 02/22/05 Time: 19:54
Sample(adjusted): 2 2017
Included observations: 2016 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DSM(-1)	-0.865899	0.022081	-39.21411	0.0000
C	0.000585	0.000510	1.147682	0.2512

R-squared	0.432955	Mean dependent var	-1.17E-06
Adjusted R-squared	0.432673	S.D. dependent var	0.030381
S.E. of regression	0.022883	Akaike info criterion	-4.715845
Sum squared resid	1.054603	Schwarz criterion	-4.710280
Log likelihood	4755.571	F-statistic	1537.746
Durbin-Watson stat	1.984742	Prob(F-statistic)	0.000000

Null Hypothesis: DPR has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=25)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-34.47454	0.0000
Test critical values:	1% level	-3.433395	
	5% level	-2.862771	
	10% level	-2.567472	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DPR)
Method: Least Squares
Date: 02/22/05 Time: 19:55
Sample(adjusted): 2 2017
Included observations: 2016 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DPR(-1)	-0.742137	0.021527	-34.47454	0.0000
C	0.000465	0.000524	0.887205	0.3751

R-squared	0.371115	Mean dependent var	-3.23E-06

Adjusted R-squared	0.370803	S.D. dependent var	0.029639
S.E. of regression	0.023511	Akaike info criterion	-4.661747
Sum squared resid	1.113227	Schwarz criterion	-4.656182
Log likelihood	4701.041	F-statistic	1188.494
Durbin-Watson stat	1.982613	Prob(F-statistic)	0.000000

Null Hypothesis: FTSE20 has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=25)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-37.71559	0.0000
Test critical values:	1% level	-3.433395	
	5% level	-2.862771	
	10% level	-2.567472	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(FTSE20)
Method: Least Squares
Date: 02/22/05 Time: 19:56
Sample(adjusted): 2 2017
Included observations: 2016 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
FTSE20(-1)	-0.827298	0.021935	-37.71559	0.0000
C	0.000590	0.000412	1.433105	0.1520

R-squared	0.413933	Mean dependent var	-1.45E-05
Adjusted R-squared	0.413642	S.D. dependent var	0.024113
S.E. of regression	0.018464	Akaike info criterion	-5.144945
Sum squared resid	0.686647	Schwarz criterion	-5.139380
Log likelihood	5188.104	F-statistic	1422.466
Durbin-Watson stat	1.994795	Prob(F-statistic)	0.000000

Null Hypothesis: FTSE40 has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=24)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-35.43609	0.0000
Test critical values:	1% level	-3.433710	
	5% level	-2.862911	
	10% level	-2.567547	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(FTSE40)
Method: Least Squares
Date: 02/22/05 Time: 19:56
Sample(adjusted): 182 2017
Included observations: 1836 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
FTSE40(-1)	-0.812837	0.022938	-35.43609	0.0000
C	0.000414	0.000474	0.874016	0.3822

R-squared	0.406418	Mean dependent var	3.53E-08
Adjusted R-squared	0.406094	S.D. dependent var	0.026354
S.E. of regression	0.020310	Akaike info criterion	-4.954304
Sum squared resid	0.756528	Schwarz criterion	-4.948296
Log likelihood	4550.051	F-statistic	1255.717

Durbin-Watson stat	1.995618	Prob(F-statistic)	0.000000

Null Hypothesis: DMT has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=21)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-26.35913	0.0000
Test critical values:	1% level	-3.436844	
	5% level	-2.864296	
	10% level	-2.568290	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DMT)
Method: Least Squares
Date: 02/22/05 Time: 19:57
Sample(adjusted): 1044 2017
Included observations: 974 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DMT(-1)	-0.832118	0.031568	-26.35913	0.0000
C	-0.000599	0.000480	-1.247331	0.2126

R-squared	0.416848	Mean dependent var	-1.20E-05
Adjusted R-squared	0.416248	S.D. dependent var	0.019592
S.E. of regression	0.014969	Akaike info criterion	-5.563659
Sum squared resid	0.217788	Schwarz criterion	-5.553636
Log likelihood	2711.502	F-statistic	694.8037
Durbin-Watson stat	2.006883	Prob(F-statistic)	0.000000

Null Hypothesis: DEL has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=21)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-27.26115	0.0000
Test critical values:	1% level	-3.436844	
	5% level	-2.864296	
	10% level	-2.568290	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DEL)
Method: Least Squares
Date: 02/22/05 Time: 19:57
Sample(adjusted): 1044 2017
Included observations: 974 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DEL(-1)	-0.862815	0.031650	-27.26115	0.0000
C	-0.001198	0.000658	-1.819972	0.0691

R-squared	0.433292	Mean dependent var	-4.95E-05
Adjusted R-squared	0.432709	S.D. dependent var	0.027223
S.E. of regression	0.020504	Akaike info criterion	-4.934355
Sum squared resid	0.408637	Schwarz criterion	-4.924331
Log likelihood	2405.031	F-statistic	743.1702
Durbin-Watson stat	2.008117	Prob(F-statistic)	0.000000

Null Hypothesis: DEK has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=21)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-26.84727	0.0000
Test critical values:	1% level	-3.436844	
	5% level	-2.864296	
	10% level	-2.568290	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DEK)
Method: Least Squares
Date: 02/22/05 Time: 19:59
Sample(adjusted): 1044 2017
Included observations: 974 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DEK(-1)	-0.852561	0.031756	-26.84727	0.0000
C	-0.000518	0.000792	-0.654022	0.5133
R-squared	0.425795	Mean dependent var		1.73E-05
Adjusted R-squared	0.425204	S.D. dependent var		0.032597
S.E. of regression	0.024714	Akaike info criterion		-4.560866
Sum squared resid	0.593666	Schwarz criterion		-4.550842
Log likelihood	2223.142	F-statistic		720.7759
Durbin-Watson stat	1.994258	Prob(F-statistic)		0.000000

Null Hypothesis: DLE has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=21)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-27.55742	0.0000
Test critical values:	1% level	-3.436844	
	5% level	-2.864296	
	10% level	-2.568290	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DLE)
Method: Least Squares
Date: 02/22/05 Time: 19:59
Sample(adjusted): 1044 2017
Included observations: 974 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLE(-1)	-0.874598	0.031737	-27.55742	0.0000
C	0.000192	0.000528	0.363625	0.7162
R-squared	0.438608	Mean dependent var		-3.15E-05
Adjusted R-squared	0.438031	S.D. dependent var		0.021972
S.E. of regression	0.016471	Akaike info criterion		-5.372358
Sum squared resid	0.263703	Schwarz criterion		-5.362335
Log likelihood	2618.338	F-statistic		759.4112
Durbin-Watson stat	2.008994	Prob(F-statistic)		0.000000

Null Hypothesis: DOT has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=21)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-28.08066	0.0000
Test critical values:	1% level	-3.436844	
	5% level	-2.864296	
	10% level	-2.568290	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DOT)
Method: Least Squares
Date: 02/22/05 Time: 20:00
Sample(adjusted): 1044 2017
Included observations: 974 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DOT(-1)	-0.895273	0.031882	-28.08066	0.0000
C	0.000106	0.000419	0.253064	0.8003

R-squared	0.447891	Mean dependent var	-1.17E-05
Adjusted R-squared	0.447323	S.D. dependent var	0.017578
S.E. of regression	0.013068	Akaike info criterion	-5.835272
Sum squared resid	0.165987	Schwarz criterion	-5.825248
Log likelihood	2843.777	F-statistic	788.5232
Durbin-Watson stat	2.004836	Prob(F-statistic)	0.000000

Null Hypothesis: DPL has a unit root
Exogenous: Constant
Lag Length: 3 (Automatic based on SIC, MAXLAG=21)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-12.82034	0.0000
Test critical values:	1% level	-3.436864	
	5% level	-2.864305	
	10% level	-2.568294	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DPL)
Method: Least Squares
Date: 02/22/05 Time: 20:00
Sample(adjusted): 1047 2017
Included observations: 971 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DPL(-1)	-0.732829	0.057161	-12.82034	0.0000
D(DPL(-1))	-0.176287	0.051256	-3.439337	0.0006
D(DPL(-2))	-0.175022	0.042645	-4.104180	0.0000
D(DPL(-3))	-0.103736	0.031841	-3.257929	0.0012
C	-0.000538	0.000568	-0.947123	0.3438

R-squared	0.459015	Mean dependent var	-6.68E-06
Adjusted R-squared	0.456774	S.D. dependent var	0.023944
S.E. of regression	0.017647	Akaike info criterion	-5.231318
Sum squared resid	0.300843	Schwarz criterion	-5.206197
Log likelihood	2544.805	F-statistic	204.9076
Durbin-Watson stat	1.992475	Prob(F-statistic)	0.000000

Null Hypothesis: DTL has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=21)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-30.39463	0.0000
Test critical values:	1% level	-3.436844	
	5% level	-2.864296	
	10% level	-2.568290	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DTL)
Method: Least Squares
Date: 02/22/05 Time: 20:01
Sample(adjusted): 1044 2017
Included observations: 974 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DTL(-1)	-0.971985	0.031979	-30.39463	0.0000
C	0.000172	0.000449	0.383210	0.7016

R-squared	0.487297	Mean dependent var	-3.09E-05
Adjusted R-squared	0.486769	S.D. dependent var	0.019555
S.E. of regression	0.014009	Akaike info criterion	-5.696181
Sum squared resid	0.190757	Schwarz criterion	-5.686157
Log likelihood	2776.040	F-statistic	923.8335
Durbin-Watson stat	1.997844	Prob(F-statistic)	0.000000

Null Hypothesis: DTR has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=25)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-36.77306	0.0000
Test critical values:	1% level	-3.433395	
	5% level	-2.862771	
	10% level	-2.567472	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DTR)
Method: Least Squares
Date: 02/22/05 Time: 20:02
Sample(adjusted): 2 2017
Included observations: 2016 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DTR(-1)	-0.803110	0.021840	-36.77306	0.0000
C	0.000440	0.000445	0.989116	0.3227

R-squared	0.401710	Mean dependent var	-5.10E-06
Adjusted R-squared	0.401413	S.D. dependent var	0.025805
S.E. of regression	0.019965	Akaike info criterion	-4.988674
Sum squared resid	0.802788	Schwarz criterion	-4.983110
Log likelihood	5030.584	F-statistic	1352.258
Durbin-Watson stat	1.990803	Prob(F-statistic)	0.000000

Null Hypothesis: DXE has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=21)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-27.67715	0.0000
Test critical values:	1% level	-3.436844	

	5% level	-2.864296	
	10% level	-2.568290	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DXE)
Method: Least Squares
Date: 02/22/05 Time: 20:02
Sample(adjusted): 1044 2017
Included observations: 974 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DXE(-1)	-0.880027	0.031796	-27.67715	0.0000
C	-0.000460	0.000573	-0.803176	0.4221

R-squared	0.440744	Mean dependent var	-1.62E-05
Adjusted R-squared	0.440169	S.D. dependent var	0.023895
S.E. of regression	0.017879	Akaike info criterion	-5.208339
Sum squared resid	0.310705	Schwarz criterion	-5.198315
Log likelihood	2538.461	F-statistic	766.0248
Durbin-Watson stat	1.994760	Prob(F-statistic)	0.000000

Null Hypothesis: DKL has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=21)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-28.80288	0.0000
Test critical values:	1% level	-3.436844	
	5% level	-2.864296	
	10% level	-2.568290	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DKL)
Method: Least Squares
Date: 02/22/05 Time: 20:02
Sample(adjusted): 1044 2017
Included observations: 974 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DKL(-1)	-0.917990	0.031871	-28.80288	0.0000
C	-0.001461	0.000804	-1.816298	0.0696

R-squared	0.460481	Mean dependent var	-6.74E-05
Adjusted R-squared	0.459926	S.D. dependent var	0.034089
S.E. of regression	0.025052	Akaike info criterion	-4.533691
Sum squared resid	0.610020	Schwarz criterion	-4.523667
Log likelihood	2209.907	F-statistic	829.6059
Durbin-Watson stat	2.002516	Prob(F-statistic)	0.000000

Null Hypothesis: FTSES has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=20)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-25.95698	0.0000
Test critical values:	1% level	-3.437298	
	5% level	-2.864496	
	10% level	-2.568397	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(FTSES)
Method: Least Squares
Date: 02/22/05 Time: 20:03
Sample(adjusted): 1106 2017
Included observations: 912 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
FTSES(-1)	-0.850549	0.032768	-25.95698	0.0000
C	-0.000487	0.000540	-0.901038	0.3678
R-squared	0.425420	Mean dependent var		3.13E-05
Adjusted R-squared	0.424788	S.D. dependent var		0.021488
S.E. of regression	0.016297	Akaike info criterion		-5.393430
Sum squared resid	0.241701	Schwarz criterion		-5.382870
Log likelihood	2461.404	F-statistic		673.7647
Durbin-Watson stat	2.008637	Prob(F-statistic)		0.000000

Null Hypothesis: DAP has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=19)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-24.59274	0.0000
Test critical values:	1% level	-3.439696	
	5% level	-2.865555	
	10% level	-2.568965	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DAP)
Method: Least Squares
Date: 02/22/05 Time: 20:03
Sample(adjusted): 1335 2017
Included observations: 683 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DAP(-1)	-0.939569	0.038205	-24.59274	0.0000
C	-0.000527	0.000368	-1.431244	0.1528
R-squared	0.470370	Mean dependent var		-7.93E-06
Adjusted R-squared	0.469592	S.D. dependent var		0.013199
S.E. of regression	0.009613	Akaike info criterion		-6.448565
Sum squared resid	0.062925	Schwarz criterion		-6.435311
Log likelihood	2204.185	F-statistic		604.8027
Durbin-Watson stat	2.008470	Prob(F-statistic)		0.000000

Null Hypothesis: DDL has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=19)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-26.09174	0.0000
Test critical values:	1% level	-3.439696	
	5% level	-2.865555	
	10% level	-2.568965	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DDL)

Method: Least Squares
Date: 02/22/05 Time: 20:04
Sample(adjusted): 1335 2017
Included observations: 683 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DDL(-1)	-0.998019	0.038250	-26.09174	0.0000
C	0.000594	0.000491	1.211094	0.2263

R-squared	0.499919	Mean dependent var	-1.28E-05
Adjusted R-squared	0.499184	S.D. dependent var	0.018097
S.E. of regression	0.012807	Akaike info criterion	-5.874765
Sum squared resid	0.111693	Schwarz criterion	-5.861510
Log likelihood	2008.232	F-statistic	680.7788
Durbin-Watson stat	2.000661	Prob(F-statistic)	0.000000

Null Hypothesis: DYKT has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=17)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-17.52748	0.0000
Test critical values:	1% level	-3.445739	
	5% level	-2.868219	
	10% level	-2.570392	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DYKT)
Method: Least Squares
Date: 02/22/05 Time: 20:04
Sample(adjusted): 1599 2017
Included observations: 419 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DYKT(-1)	-0.843503	0.048125	-17.52748	0.0000
C	-0.001865	0.000994	-1.875866	0.0614

R-squared	0.424202	Mean dependent var	-9.30E-05
Adjusted R-squared	0.422821	S.D. dependent var	0.026654
S.E. of regression	0.020249	Akaike info criterion	-4.956612
Sum squared resid	0.170987	Schwarz criterion	-4.937339
Log likelihood	1040.410	F-statistic	307.2126
Durbin-Watson stat	2.023056	Prob(F-statistic)	0.000000

Null Hypothesis: EPS50 has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.630947	0.0000
Test critical values:	1% level	-3.511262	
	5% level	-2.896779	
	10% level	-2.585626	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EPS50)
Method: Least Squares
Date: 02/22/05 Time: 20:05
Sample(adjusted): 1935 2017

Included observations: 83 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EPS50(-1)	-0.844665	0.110689	-7.630947	0.0000
C	0.002198	0.000872	2.520355	0.0137

R-squared	0.418234	Mean dependent var	7.50E-05
Adjusted R-squared	0.411052	S.D. dependent var	0.009812
S.E. of regression	0.007530	Akaike info criterion	-6.915972
Sum squared resid	0.004593	Schwarz criterion	-6.857686
Log likelihood	289.0128	F-statistic	58.23135
Durbin-Watson stat	1.970850	Prob(F-statistic)	0.000000

GARCH 1.1

Dependent Variable: GD
Method: ML - ARCH (Marquardt)
Date: 02/16/05 Time: 17:38
Sample(adjusted): 1 2017
Included observations: 2017 after adjusting endpoints
Convergence achieved after 14 iterations
Variance backcast: ON

	Coefficient	Std. Error	z-Statistic	Prob.
VGD	0.000175	3.47E-05	5.041116	0.0000
C	-0.001229	0.000503	-2.440386	0.0147
Variance Equation				
C	7.80E-06	1.55E-06	5.029198	0.0000
ARCH(1)	0.146307	0.012231	11.96202	0.0000
GARCH(1)	0.838861	0.011742	71.44341	0.0000

R-squared	0.010866	Mean dependent var	0.000735
Adjusted R-squared	0.008900	S.D. dependent var	0.018082
S.E. of regression	0.018001	Akaike info criterion	-5.429461
Sum squared resid	0.651973	Schwarz criterion	-5.415556
Log likelihood	5480.612	F-statistic	5.525829
Durbin-Watson stat	1.688775	Prob(F-statistic)	0.000201

Dependent Variable: DTR
Method: ML - ARCH (Marquardt)
Date: 02/16/05 Time: 17:40
Sample(adjusted): 1 2017
Included observations: 2017 after adjusting endpoints
Convergence achieved after 13 iterations
Variance backcast: ON

	Coefficient	Std. Error	z-Statistic	Prob.
VDTR	0.000858	0.000140	6.126852	0.0000
C	-0.000796	0.000339	-2.344434	0.0191
Variance Equation				
C	6.26E-06	1.15E-06	5.423425	0.0000
ARCH(1)	0.169716	0.013275	12.78452	0.0000
GARCH(1)	0.831606	0.010617	78.32979	0.0000

R-squared	0.011017	Mean dependent var	0.000564
Adjusted R-squared	0.009051	S.D. dependent var	0.020365
S.E. of regression	0.020273	Akaike info criterion	-5.251489

Sum squared resid	0.826890	Schwarz criterion	-5.237584
Log likelihood	5301.127	F-statistic	5.603292
Durbin-Watson stat	1.624002	Prob(F-statistic)	0.000175

Dependent Variable: DAS
Method: ML - ARCH (Marquardt)
Date: 02/16/05 Time: 17:41
Sample(adjusted): 1 2017
Included observations: 2017 after adjusting endpoints
Convergence achieved after 45 iterations
Variance backcast: ON

	Coefficient	Std. Error	z-Statistic	Prob.
VDAS	0.000381	0.000600	0.635712	0.5250
C	5.46E-05	0.000482	0.113113	0.9099
Variance Equation				
C	5.59E-05	6.72E-06	8.319450	0.0000
ARCH(1)	0.182637	0.017040	10.71804	0.0000
GARCH(1)	0.716961	0.023599	30.38037	0.0000

R-squared	0.000880	Mean dependent var	0.000624
Adjusted R-squared	-0.001106	S.D. dependent var	0.022498
S.E. of regression	0.022511	Akaike info criterion	-4.866707
Sum squared resid	1.019528	Schwarz criterion	-4.852801
Log likelihood	4913.074	F-statistic	0.443051
Durbin-Watson stat	1.626636	Prob(F-statistic)	0.777545

Dependent Variable: DEP
Method: ML - ARCH (Marquardt)
Date: 02/16/05 Time: 17:41
Sample(adjusted): 1 2017
Included observations: 2017 after adjusting endpoints
Convergence achieved after 16 iterations
Variance backcast: ON

	Coefficient	Std. Error	z-Statistic	Prob.
VDEP	0.000807	0.000216	3.739823	0.0002
C	0.000352	0.000348	1.011061	0.3120
Variance Equation				
C	6.30E-06	1.31E-06	4.794202	0.0000
ARCH(1)	0.172993	0.012611	13.71730	0.0000
GARCH(1)	0.831507	0.010511	79.10493	0.0000

R-squared	0.006726	Mean dependent var	0.000761
Adjusted R-squared	0.004751	S.D. dependent var	0.020779
S.E. of regression	0.020729	Akaike info criterion	-5.213005
Sum squared resid	0.864565	Schwarz criterion	-5.199099
Log likelihood	5262.315	F-statistic	3.405935
Durbin-Watson stat	1.660297	Prob(F-statistic)	0.008746

Dependent Variable: DBM
Method: ML - ARCH (Marquardt)
Date: 02/16/05 Time: 17:42
Sample(adjusted): 1 2017
Included observations: 2017 after adjusting endpoints
Convergence achieved after 19 iterations
Variance backcast: ON

	Coefficient	Std. Error	z-Statistic	Prob.
VDBM	0.000220	6.39E-05	3.445421	0.0006
C	-0.000601	0.000403	-1.490986	0.1360
Variance Equation				
C	3.50E-06	8.32E-07	4.208713	0.0000
ARCH(1)	0.103058	0.009441	10.91591	0.0000

GARCH(1)	0.892344	0.008772	101.7268	0.0000

R-squared	0.004909	Mean dependent var	0.000477
Adjusted R-squared	0.002931	S.D. dependent var	0.018592
S.E. of regression	0.018565	Akaike info criterion	-5.394093
Sum squared resid	0.693444	Schwarz criterion	-5.380187
Log likelihood	5444.942	F-statistic	2.481357
Durbin-Watson stat	1.704070	Prob(F-statistic)	0.042042

Dependent Variable: DKT
Method: ML - ARCH (Marquardt)
Date: 02/16/05 Time: 17:43
Sample(adjusted): 1 2017
Included observations: 2017 after adjusting endpoints
Convergence achieved after 22 iterations
Variance backcast: ON

	Coefficient	Std. Error	z-Statistic	Prob.
VDKT	0.002893	0.000222	13.04868	0.0000
C	-0.003348	0.000613	-5.465102	0.0000
		Variance Equation		
C	1.30E-05	1.64E-06	7.959427	0.0000
ARCH(1)	0.104895	0.010116	10.36968	0.0000
GARCH(1)	0.879272	0.009601	91.57925	0.0000

R-squared	0.033680	Mean dependent var	0.000640
Adjusted R-squared	0.031759	S.D. dependent var	0.027572
S.E. of regression	0.027131	Akaike info criterion	-4.627829
Sum squared resid	1.481021	Schwarz criterion	-4.613924
Log likelihood	4672.166	F-statistic	17.53134
Durbin-Watson stat	1.611858	Prob(F-statistic)	0.000000

Dependent Variable: DSM
Method: ML - ARCH (Marquardt)
Date: 02/16/05 Time: 17:44
Sample(adjusted): 1 2017
Included observations: 2017 after adjusting endpoints
Convergence achieved after 11 iterations
Variance backcast: ON

	Coefficient	Std. Error	z-Statistic	Prob.
VDSM	0.001692	0.000511	3.311846	0.0009
C	-0.000694	0.000697	-0.995942	0.3193
		Variance Equation		
C	2.20E-05	3.58E-06	6.155341	0.0000
ARCH(1)	0.130226	0.014140	9.209967	0.0000
GARCH(1)	0.831881	0.017023	48.86922	0.0000

R-squared	0.004403	Mean dependent var	0.000679
Adjusted R-squared	0.002424	S.D. dependent var	0.023081
S.E. of regression	0.023053	Akaike info criterion	-4.860248
Sum squared resid	1.069223	Schwarz criterion	-4.846343
Log likelihood	4906.560	F-statistic	2.224747
Durbin-Watson stat	1.735583	Prob(F-statistic)	0.064071

Dependent Variable: DPR
Method: ML - ARCH (Marquardt)
Date: 02/16/05 Time: 17:45
Sample(adjusted): 1 2017
Included observations: 2017 after adjusting endpoints
Convergence achieved after 17 iterations
Variance backcast: ON

	Coefficient	Std. Error	z-Statistic	Prob.
VDPR	0.000474	0.000127	3.727389	0.0002
C	-0.001099	0.000475	-2.315334	0.0206

Variance Equation				
C	7.55E-06	1.18E-06	6.410645	0.0000
ARCH(1)	0.169290	0.015276	11.08181	0.0000
GARCH(1)	0.824398	0.012294	67.05565	0.0000

R-squared	0.002196	Mean dependent var	0.000637
Adjusted R-squared	0.000213	S.D. dependent var	0.024326
S.E. of regression	0.024323	Akaike info criterion	-5.125804
Sum squared resid	1.190326	Schwarz criterion	-5.111899
Log likelihood	5174.373	F-statistic	1.107223
Durbin-Watson stat	1.485726	Prob(F-statistic)	0.351386

Dependent Variable: FTSE20
Method: ML - ARCH (Marquardt)
Date: 02/16/05 Time: 17:45
Sample(adjusted): 1 2017
Included observations: 2017 after adjusting endpoints
Convergence achieved after 13 iterations
Variance backcast: ON

	Coefficient	Std. Error	z-Statistic	Prob.
VFTSE20	0.000102	3.58E-05	2.854984	0.0043
C	1.34E-05	0.000403	0.033144	0.9736
Variance Equation				
C	1.15E-05	2.12E-06	5.426901	0.0000
ARCH(1)	0.147309	0.012638	11.65635	0.0000
GARCH(1)	0.827573	0.013068	63.33033	0.0000

R-squared	0.002759	Mean dependent var	0.000730
Adjusted R-squared	0.000776	S.D. dependent var	0.018748
S.E. of regression	0.018741	Akaike info criterion	-5.318368
Sum squared resid	0.706631	Schwarz criterion	-5.304463
Log likelihood	5368.574	F-statistic	1.391579
Durbin-Watson stat	1.657151	Prob(F-statistic)	0.234385

Dependent Variable: FTSE40
Method: ML - ARCH (Marquardt)
Date: 02/16/05 Time: 17:46
Sample(adjusted): 181 2017
Included observations: 1837 after adjusting endpoints
Convergence achieved after 12 iterations
Variance backcast: ON

	Coefficient	Std. Error	z-Statistic	Prob.
VFTSE40	0.000438	4.77E-05	9.171380	0.0000
C	-0.001500	0.000448	-3.350878	0.0008
Variance Equation				
C	5.36E-06	1.24E-06	4.311233	0.0000
ARCH(1)	0.132401	0.013381	9.894866	0.0000
GARCH(1)	0.862134	0.012113	71.17565	0.0000

R-squared	0.019866	Mean dependent var	0.000518
Adjusted R-squared	0.017726	S.D. dependent var	0.020667
S.E. of regression	0.020483	Akaike info criterion	-5.236988
Sum squared resid	0.768650	Schwarz criterion	-5.221975
Log likelihood	4815.173	F-statistic	9.283216
Durbin-Watson stat	1.656454	Prob(F-statistic)	0.000000

Dependent Variable: DMT
Method: ML - ARCH (Marquardt)
Date: 02/16/05 Time: 17:47
Sample(adjusted): 1043 2017
Included observations: 975 after adjusting endpoints
Convergence achieved after 25 iterations

Variance backcast: ON

	Coefficient	Std. Error	z-Statistic	Prob.
VDMT	4.69E-05	0.000202	0.232603	0.8161
C	-0.000723	0.000443	-1.632199	0.1026
Variance Equation				
C	1.53E-05	4.34E-06	3.517675	0.0004
ARCH(1)	0.107167	0.022522	4.758237	0.0000
GARCH(1)	0.828404	0.034532	23.98937	0.0000

R-squared	0.000072	Mean dependent var	-0.000680
Adjusted R-squared	-0.004052	S.D. dependent var	0.015213
S.E. of regression	0.015244	Akaike info criterion	-5.588555
Sum squared resid	0.225408	Schwarz criterion	-5.563517
Log likelihood	2729.421	F-statistic	0.017399
Durbin-Watson stat	1.656758	Prob(F-statistic)	0.999407

Dependent Variable: DEL
Method: ML - ARCH (Marquardt)
Date: 02/16/05 Time: 17:48
Sample(adjusted): 1043 2017
Included observations: 975 after adjusting endpoints
Convergence achieved after 13 iterations
Variance backcast: ON

	Coefficient	Std. Error	z-Statistic	Prob.
VDEL	0.002480	0.000805	3.079961	0.0021
C	-0.002026	0.000640	-3.165640	0.0015
Variance Equation				
C	8.15E-06	2.53E-06	3.221833	0.0013
ARCH(1)	0.119974	0.017065	7.030353	0.0000
GARCH(1)	0.864334	0.017162	50.36247	0.0000

R-squared	0.010538	Mean dependent var	-0.001323
Adjusted R-squared	0.006457	S.D. dependent var	0.020760
S.E. of regression	0.020693	Akaike info criterion	-5.121901
Sum squared resid	0.415335	Schwarz criterion	-5.096863
Log likelihood	2501.927	F-statistic	2.582563
Durbin-Watson stat	1.738956	Prob(F-statistic)	0.035873

Dependent Variable: DEK
Method: ML - ARCH (Marquardt)
Date: 02/16/05 Time: 17:48
Sample(adjusted): 1043 2017
Included observations: 975 after adjusting endpoints
Convergence achieved after 17 iterations
Variance backcast: ON

	Coefficient	Std. Error	z-Statistic	Prob.
VDEK	0.005016	0.000514	9.762411	0.0000
C	-0.003126	0.000767	-4.077450	0.0000
Variance Equation				
C	3.37E-05	7.34E-06	4.593295	0.0000
ARCH(1)	0.119484	0.020110	5.941541	0.0000
GARCH(1)	0.832881	0.024460	34.05140	0.0000

R-squared	0.026231	Mean dependent var	-0.000583
Adjusted R-squared	0.022216	S.D. dependent var	0.024975
S.E. of regression	0.024696	Akaike info criterion	-4.656176
Sum squared resid	0.591599	Schwarz criterion	-4.631138
Log likelihood	2274.886	F-statistic	6.532481
Durbin-Watson stat	1.740684	Prob(F-statistic)	0.000035

Dependent Variable: DLE
Method: ML - ARCH (Marquardt)

Date: 02/16/05 Time: 17:49
Sample(adjusted): 1043 2017
Included observations: 975 after adjusting endpoints
Convergence achieved after 13 iterations
Variance backcast: ON

	Coefficient	Std. Error	z-Statistic	Prob.
VDLE	0.000894	0.000412	2.166266	0.0303
C	-1.65E-05	0.000474	-0.034710	0.9723
Variance Equation				
C	1.37E-05	3.22E-06	4.245926	0.0000
ARCH(1)	0.124536	0.016659	7.475804	0.0000
GARCH(1)	0.827105	0.022560	36.66188	0.0000

R-squared	0.002382	Mean dependent var	0.000263
Adjusted R-squared	-0.001732	S.D. dependent var	0.016631
S.E. of regression	0.016646	Akaike info criterion	-5.506182
Sum squared resid	0.268761	Schwarz criterion	-5.481144
Log likelihood	2689.264	F-statistic	0.579082
Durbin-Watson stat	1.748234	Prob(F-statistic)	0.677867

Dependent Variable: DOT
Method: ML - ARCH (Marquardt)
Date: 02/16/05 Time: 17:50
Sample(adjusted): 1043 2017
Included observations: 975 after adjusting endpoints
Convergence achieved after 11 iterations
Variance backcast: ON

	Coefficient	Std. Error	z-Statistic	Prob.
VDOT	0.005854	0.000796	7.356669	0.0000
C	-0.001146	0.000457	-2.508262	0.0121
Variance Equation				
C	1.16E-05	2.94E-06	3.949993	0.0001
ARCH(1)	0.153488	0.021349	7.189330	0.0000
GARCH(1)	0.781191	0.031039	25.16803	0.0000

R-squared	0.011126	Mean dependent var	0.000133
Adjusted R-squared	0.007048	S.D. dependent var	0.013134
S.E. of regression	0.013087	Akaike info criterion	-5.982222
Sum squared resid	0.166135	Schwarz criterion	-5.957184
Log likelihood	2921.333	F-statistic	2.728400
Durbin-Watson stat	1.789899	Prob(F-statistic)	0.028138

Dependent Variable: DPL
Method: ML - ARCH (Marquardt)
Date: 02/16/05 Time: 17:50
Sample(adjusted): 1043 2017
Included observations: 975 after adjusting endpoints
Convergence achieved after 20 iterations
Variance backcast: ON

	Coefficient	Std. Error	z-Statistic	Prob.
VDPL	0.002356	0.000539	4.368334	0.0000
C	-0.002847	0.000805	-3.534772	0.0004
Variance Equation				
C	1.30E-05	2.95E-06	4.402119	0.0000
ARCH(1)	0.084161	0.013332	6.312697	0.0000
GARCH(1)	0.868973	0.018918	45.93420	0.0000

R-squared	0.010515	Mean dependent var	-0.000588
Adjusted R-squared	0.006435	S.D. dependent var	0.017942
S.E. of regression	0.017884	Akaike info criterion	-5.378002
Sum squared resid	0.310233	Schwarz criterion	-5.352964
Log likelihood	2626.776	F-statistic	2.576970

Durbin-Watson stat	1.790845	Prob(F-statistic)	0.036207

Dependent Variable: DTL
Method: ML - ARCH (Marquardt)
Date: 02/16/05 Time: 17:51
Sample(adjusted): 1043 2017
Included observations: 975 after adjusting endpoints
Convergence achieved after 13 iterations
Variance backcast: ON

	Coefficient	Std. Error	z-Statistic	Prob.
VDTL	0.000141	0.000120	1.171599	0.2414
C	0.000104	0.000519	0.200048	0.8414
		Variance Equation		
C	1.73E-05	4.84E-06	3.582455	0.0003
ARCH(1)	0.084299	0.015265	5.522303	0.0000
GARCH(1)	0.824985	0.032852	25.11211	0.0000

R-squared	0.000958	Mean dependent var	0.000210
Adjusted R-squared	-0.003162	S.D. dependent var	0.014037
S.E. of regression	0.014059	Akaike info criterion	-5.745399
Sum squared resid	0.191725	Schwarz criterion	-5.720361
Log likelihood	2805.882	F-statistic	0.232454
Durbin-Watson stat	1.942086	Prob(F-statistic)	0.920170

Dependent Variable: DTR
Method: ML - ARCH (Marquardt)
Date: 02/16/05 Time: 17:52
Sample(adjusted): 1 2017
Included observations: 2017 after adjusting endpoints
Convergence achieved after 13 iterations
Variance backcast: ON

	Coefficient	Std. Error	z-Statistic	Prob.
VDTR	0.000858	0.000140	6.126852	0.0000
C	-0.000796	0.000339	-2.344434	0.0191
		Variance Equation		
C	6.26E-06	1.15E-06	5.423425	0.0000
ARCH(1)	0.169716	0.013275	12.78452	0.0000
GARCH(1)	0.831606	0.010617	78.32979	0.0000

R-squared	0.011017	Mean dependent var	0.000564
Adjusted R-squared	0.009051	S.D. dependent var	0.020365
S.E. of regression	0.020273	Akaike info criterion	-5.251489
Sum squared resid	0.826890	Schwarz criterion	-5.237584
Log likelihood	5301.127	F-statistic	5.603292
Durbin-Watson stat	1.624002	Prob(F-statistic)	0.000175

Dependent Variable: DXE
Method: ML - ARCH (Marquardt)
Date: 02/16/05 Time: 17:52
Sample(adjusted): 1043 2017
Included observations: 975 after adjusting endpoints
Convergence achieved after 15 iterations
Variance backcast: ON

	Coefficient	Std. Error	z-Statistic	Prob.
VDXE	0.002065	0.000431	4.791815	0.0000
C	-0.002170	0.000711	-3.051297	0.0023
		Variance Equation		
C	1.60E-06	5.23E-07	3.058013	0.0022
ARCH(1)	0.076421	0.012400	6.162964	0.0000
GARCH(1)	0.919469	0.011328	81.16893	0.0000

R-squared	0.014503	Mean dependent var	-0.000483

Adjusted R-squared	0.010439	S.D. dependent var	0.018030
S.E. of regression	0.017936	Akaike info criterion	-5.455075
Sum squared resid	0.312040	Schwarz criterion	-5.430036
Log likelihood	2664.349	F-statistic	3.568814
Durbin-Watson stat	1.765869	Prob(F-statistic)	0.006725

Dependent Variable: DKL
Method: ML - ARCH (Marquardt)
Date: 02/16/05 Time: 17:53
Sample(adjusted): 1043 2017
Included observations: 975 after adjusting endpoints
Convergence achieved after 12 iterations
Variance backcast: ON

	Coefficient	Std. Error	z-Statistic	Prob.
VDKL	0.010904	0.000903	12.06839	0.0000
C	-0.006343	0.000934	-6.794042	0.0000
		Variance Equation		
C	3.61E-05	1.10E-05	3.265722	0.0011
ARCH(1)	0.116557	0.018085	6.445001	0.0000
GARCH(1)	0.825370	0.028412	29.04979	0.0000

R-squared	0.034895	Mean dependent var	-0.001523
Adjusted R-squared	0.030915	S.D. dependent var	0.025186
S.E. of regression	0.024794	Akaike info criterion	-4.662732
Sum squared resid	0.596301	Schwarz criterion	-4.637694
Log likelihood	2278.082	F-statistic	8.767957
Durbin-Watson stat	1.873505	Prob(F-statistic)	0.000001

Dependent Variable: FTSES
Method: ML - ARCH (Marquardt)
Date: 02/16/05 Time: 17:54
Sample(adjusted): 1105 2017
Included observations: 913 after adjusting endpoints
Convergence achieved after 13 iterations
Variance backcast: ON

	Coefficient	Std. Error	z-Statistic	Prob.
VFTSES	0.000866	0.000106	8.156442	0.0000
C	-0.006164	0.000946	-6.516057	0.0000
		Variance Equation		
C	4.46E-06	1.84E-06	2.416386	0.0157
ARCH(1)	0.108848	0.015468	7.036756	0.0000
GARCH(1)	0.878490	0.017117	51.32294	0.0000

R-squared	0.035694	Mean dependent var	-0.000596
Adjusted R-squared	0.031446	S.D. dependent var	0.016474
S.E. of regression	0.016213	Akaike info criterion	-5.575064
Sum squared resid	0.238674	Schwarz criterion	-5.548686
Log likelihood	2550.017	F-statistic	8.402539
Durbin-Watson stat	1.761041	Prob(F-statistic)	0.000001

Dependent Variable: DAP
Method: ML - ARCH (Marquardt)
Date: 02/16/05 Time: 17:55
Sample(adjusted): 1334 2017
Included observations: 684 after adjusting endpoints
Convergence achieved after 26 iterations
Variance backcast: ON

	Coefficient	Std. Error	z-Statistic	Prob.
VDAP	0.005607	0.001158	4.843430	0.0000
C	-0.001209	0.000388	-3.119206	0.0018
		Variance Equation		
C	1.60E-05	2.72E-06	5.885405	0.0000

ARCH(1)	0.239788	0.044255	5.418364	0.0000
GARCH(1)	0.596107	0.053634	11.11438	0.0000

R-squared	0.000180	Mean dependent var	-0.000537
Adjusted R-squared	-0.005710	S.D. dependent var	0.009636
S.E. of regression	0.009664	Akaike info criterion	-6.643347
Sum squared resid	0.063413	Schwarz criterion	-6.610248
Log likelihood	2277.025	F-statistic	0.030535
Durbin-Watson stat	1.815126	Prob(F-statistic)	0.998205

Dependent Variable: DDL
Method: ML - ARCH (Marquardt)
Date: 02/16/05 Time: 17:56
Sample(adjusted): 1334 2017
Included observations: 684 after adjusting endpoints
Convergence achieved after 14 iterations
Variance backcast: ON

	Coefficient	Std. Error	z-Statistic	Prob.
VDDL	0.000638	0.000419	1.523970	0.1275
C	0.000427	0.000504	0.847942	0.3965
Variance Equation				
C	1.34E-05	6.00E-06	2.232303	0.0256
ARCH(1)	0.038338	0.016451	2.330496	0.0198
GARCH(1)	0.876539	0.047883	18.30566	0.0000

R-squared	0.004584	Mean dependent var	0.000636
Adjusted R-squared	-0.001280	S.D. dependent var	0.012832
S.E. of regression	0.012840	Akaike info criterion	-5.889689
Sum squared resid	0.111939	Schwarz criterion	-5.856590
Log likelihood	2019.274	F-statistic	0.781653
Durbin-Watson stat	1.984235	Prob(F-statistic)	0.537289

Dependent Variable: DYKT
Method: ML - ARCH (Marquardt)
Date: 02/16/05 Time: 17:57
Sample(adjusted): 1598 2017
Included observations: 420 after adjusting endpoints
Convergence achieved after 12 iterations
Variance backcast: ON

	Coefficient	Std. Error	z-Statistic	Prob.
VDYKT	0.003122	0.000617	5.060906	0.0000
C	-0.012934	0.002435	-5.311602	0.0000
Variance Equation				
C	0.000155	3.34E-05	4.645102	0.0000
ARCH(1)	0.275603	0.074648	3.692037	0.0002
GARCH(1)	0.349523	0.120195	2.907976	0.0036

R-squared	0.065527	Mean dependent var	-0.002095
Adjusted R-squared	0.056520	S.D. dependent var	0.020556
S.E. of regression	0.019967	Akaike info criterion	-5.052867
Sum squared resid	0.165454	Schwarz criterion	-5.004769
Log likelihood	1066.102	F-statistic	7.275116
Durbin-Watson stat	1.768358	Prob(F-statistic)	0.000011

Dependent Variable: EPS50
Method: ML - ARCH (Marquardt)
Date: 02/16/05 Time: 17:57
Sample(adjusted): 1934 2017
Included observations: 84 after adjusting endpoints
Convergence achieved after 16 iterations
Variance backcast: ON

	Coefficient	Std. Error	z-Statistic	Prob.
VEPS50	0.000892	0.000373	2.392547	0.0167

C	-0.001886	0.001960	-0.961964	0.3361
Variance Equation				
C	5.01E-06	6.53E-06	0.767129	0.4430
ARCH(1)	-0.123623	0.071670	-1.724886	0.0845
GARCH(1)	1.042177	0.096581	10.79071	0.0000

R-squared	0.061589	Mean dependent var	0.002624
Adjusted R-squared	0.014075	S.D. dependent var	0.007536
S.E. of regression	0.007483	Akaike info criterion	-6.956935
Sum squared resid	0.004423	Schwarz criterion	-6.812243
Log likelihood	297.1913	F-statistic	1.296219
Durbin-Watson stat	1.814222	Prob(F-statistic)	0.278720

VAR PAIRWISE GRANGER CAUSALITY/BLOCK EXOGENEITY WALD TESTS

VAR Pairwise Granger Causality/Block Exogeneity Wald Tests
Date: 02/13/05 Time: 21:15
Sample: 1 2018
Included observations: 2007

Dependent variable: GD

Exclude	Chi-sq	df	Prob.
VGD	10.90074	10	0.3653
All	10.90074	10	0.3653

Dependent variable: VGD

Exclude	Chi-sq	df	Prob.
GD	36.74248	10	0.0001
All	36.74248	10	0.0001

VAR Pairwise Granger Causality/Block Exogeneity Wald Tests
Date: 02/13/05 Time: 21:27
Sample: 1 2018
Included observations: 2007

Dependent variable: DTR

Exclude	Chi-sq	df	Prob.
VDTR	15.61137	10	0.1113
All	15.61137	10	0.1113

Dependent variable: VDTR

Exclude	Chi-sq	df	Prob.
DTR	51.81405	10	0.0000

VAR Pairwise Granger Causality/Block Exogeneity Wald Tests
Date: 02/13/05 Time: 21:28
Sample: 1 2018
Included observations: 2013

Dependent variable: DAS

Exclude	Chi-sq	df	Prob.
VDAS	0.298751	4	0.9899
All	0.298751	4	0.9899

Dependent variable: VDAS

Exclude	Chi-sq	df	Prob.
DAS	1.417223	4	0.8412

VAR Pairwise Granger Causality/Block Exogeneity Wald Tests
Date: 02/13/05 Time: 21:24
Sample: 1 2018
Included observations: 2011

Dependent variable: DEP

Exclude	Chi-sq	df	Prob.
VDEP	0.896397	6	0.9892
All	0.896397	6	0.9892

Dependent variable: VDEP

Exclude	Chi-sq	df	Prob.
DEP	27.88951	6	0.0001
All	27.88951	6	0.0001

VAR Pairwise Granger Causality/Block Exogeneity Wald Tests
Date: 02/13/05 Time: 21:32
Sample: 1 2018
Included observations: 2015

Dependent variable: DBM

Exclude	Chi-sq	df	Prob.
VDBM	0.536278	2	0.7648
All	0.536278	2	0.7648

Dependent variable: VDBM

Exclude	Chi-sq	df	Prob.
DBM	5.790512	2	0.0553
All	5.790512	2	0.0553

VAR Pairwise Granger Causality/Block Exogeneity Wald Tests
Date: 02/13/05 Time: 21:35
Sample: 1 2018
Included observations: 2009

Dependent variable: DKT

Exclude	Chi-sq	df	Prob.
VDKT	13.89707	8	0.0845
All	13.89707	8	0.0845

Dependent variable: VDKT

Exclude	Chi-sq	df	Prob.
DKT	99.78674	8	0.0000
All	99.78674	8	0.0000

VAR Pairwise Granger Causality/Block Exogeneity Wald Tests
Date: 02/13/05 Time: 21:38
Sample: 1 2018
Included observations: 2010

Dependent variable: DSM

Exclude	Chi-sq	df	Prob.
VDSM	4.303372	7	0.7442
All	4.303372	7	0.7442

Dependent variable: VDSM

Exclude	Chi-sq	df	Prob.
DSM	15.43530	7	0.0308
All	15.43530	7	0.0308

VAR Pairwise Granger Causality/Block Exogeneity Wald Tests
Date: 02/13/05 Time: 21:41
Sample: 1 2018
Included observations: 2010

Dependent variable: DPR

Exclude	Chi-sq	df	Prob.
VDPR	3.440720	7	0.8415
All	3.440720	7	0.8415

Dependent variable: VDPR

Exclude	Chi-sq	df	Prob.
DPR	29.34944	7	0.0001
All	29.34944	7	0.0001

VAR Pairwise Granger Causality/Block Exogeneity Wald Tests
Date: 02/13/05 Time: 21:45
Sample: 1 2018
Included observations: 2010

Dependent variable: FTSE20

Exclude	Chi-sq	df	Prob.
VFTSE20	6.606645	7	0.4710
All	6.606645	7	0.4710

Dependent variable: VFTSE20

Exclude	Chi-sq	df	Prob.
FTSE20	26.50236	7	0.0004
All	26.50236	7	0.0004

VAR Pairwise Granger Causality/Block Exogeneity Wald Tests
Date: 02/13/05 Time: 21:47
Sample: 1 2018
Included observations: 1831

Dependent variable: FTSE40

Exclude	Chi-sq	df	Prob.
VFTSE40	17.37166	6	0.0080
All	17.37166	6	0.0080

Dependent variable: VFTSE40

Exclude	Chi-sq	df	Prob.
FTSE40	21.39195	6	0.0016
All	21.39195	6	0.0016

VAR Pairwise Granger Causality/Block Exogeneity Wald Tests
Date: 02/13/05 Time: 21:54
Sample: 1 2018
Included observations: 972

Dependent variable: DMT

Exclude	Chi-sq	df	Prob.
VDMT	2.267608	3	0.5188
All	2.267608	3	0.5188

Dependent variable: VDMT

Exclude	Chi-sq	df	Prob.
DMT	2.084916	3	0.5550
All	2.084916	3	0.5550

VAR Pairwise Granger Causality/Block Exogeneity Wald Tests
Date: 02/13/05 Time: 21:52
Sample: 1 2018
Included observations: 972

Dependent variable: DEL

Exclude	Chi-sq	df	Prob.
VDEL	1.049478	3	0.7893
All	1.049478	3	0.7893

Dependent variable: VDEL

Exclude	Chi-sq	df	Prob.
DEL	20.21988	3	0.0002
All	20.21988	3	0.0002

VAR Pairwise Granger Causality/Block Exogeneity Wald Tests
Date: 02/13/05 Time: 21:59
Sample: 1 2018

Included observations: 966

Dependent variable: DEK

Exclude	Chi-sq	df	Prob.
VDEK	38.05463	9	0.0000
All	38.05463	9	0.0000

Dependent variable: VDEK

Exclude	Chi-sq	df	Prob.
DEK	48.00005	9	0.0000
All	48.00005	9	0.0000

VAR Pairwise Granger Causality/Block Exogeneity Wald Tests
Date: 02/13/05 Time: 22:01
Sample: 1 2018
Included observations: 971

Dependent variable: DLE

Exclude	Chi-sq	df	Prob.
VDLE	6.515794	4	0.1638
All	6.515794	4	0.1638

Dependent variable: VDLE

Exclude	Chi-sq	df	Prob.
DLE	16.42274	4	0.0025
All	16.42274	4	0.0025

VAR Pairwise Granger Causality/Block Exogeneity Wald Tests
Date: 02/13/05 Time: 22:07
Sample: 1 2018
Included observations: 971

Dependent variable: DOT

Exclude	Chi-sq	df	Prob.
VDOT	14.33059	4	0.0063
All	14.33059	4	0.0063

Dependent variable: VDOT

Exclude	Chi-sq	df	Prob.
DOT	5.947465	4	0.2031
All	5.947465	4	0.2031

VAR Pairwise Granger Causality/Block Exogeneity Wald Tests
Date: 02/13/05 Time: 22:05
Sample: 1 2018
Included observations: 968

Dependent variable: DPL

Exclude	Chi-sq	df	Prob.

VDPL	8.384020	7	0.3000
All	8.384020	7	0.3000

Dependent variable: VDPL

Exclude	Chi-sq	df	Prob.
DPL	8.331702	7	0.3043
All	8.331702	7	0.3043

VAR Pairwise Granger Causality/Block Exogeneity Wald Tests
Date: 02/13/05 Time: 22:09
Sample: 1 2018
Included observations: 971

Dependent variable: DTL

Exclude	Chi-sq	df	Prob.
VDTL	4.437204	4	0.3501
All	4.437204	4	0.3501

Dependent variable: VDTL

Exclude	Chi-sq	df	Prob.
DTL	1.248512	4	0.8700
All	1.248512	4	0.8700

VAR Pairwise Granger Causality/Block Exogeneity Wald Tests
Date: 02/13/05 Time: 22:15
Sample: 1 2018
Included observations: 2007

Dependent variable: DTR

Exclude	Chi-sq	df	Prob.
VDTR	15.61137	10	0.1113
All	15.61137	10	0.1113

Dependent variable: VDTR

Exclude	Chi-sq	df	Prob.
DTR	51.81405	10	0.0000
All	51.81405	10	0.0000

VAR Pairwise Granger Causality/Block Exogeneity Wald Tests
Date: 02/13/05 Time: 22:18
Sample: 1 2018
Included observations: 966

Dependent variable: DXE

Exclude	Chi-sq	df	Prob.
VDXE	9.713075	9	0.3742
All	9.713075	9	0.3742

Dependent variable: VDXE

Exclude	Chi-sq	df	Prob.
DXE	49.17730	9	0.0000
All	49.17730	9	0.0000

VAR Pairwise Granger Causality/Block Exogeneity Wald Tests
Date: 02/13/05 Time: 22:21
Sample: 1 2018
Included observations: 970

Dependent variable: DKL

Exclude	Chi-sq	df	Prob.
VDKL	13.02900	5	0.0231
All	13.02900	5	0.0231

Dependent variable: VDKL

Exclude	Chi-sq	df	Prob.
DKL	62.25746	5	0.0000
All	62.25746	5	0.0000

VAR Pairwise Granger Causality/Block Exogeneity Wald Tests
Date: 02/13/05 Time: 22:24
Sample: 1 2018
Included observations: 908

Dependent variable: FTSES

Exclude	Chi-sq	df	Prob.
VFTSES	1.983397	5	0.8514
All	1.983397	5	0.8514

Dependent variable: VFTSES

Exclude	Chi-sq	df	Prob.
FTSES	33.25338	5	0.0000
All	33.25338	5	0.0000

VAR Pairwise Granger Causality/Block Exogeneity Wald Tests
Date: 02/13/05 Time: 22:26
Sample: 1 2018
Included observations: 678

Dependent variable: DAP

Exclude	Chi-sq	df	Prob.
VDAP	13.97319	6	0.0299
All	13.97319	6	0.0299

Dependent variable: VDAP

Exclude	Chi-sq	df	Prob.
DAP	12.40420	6	0.0535
All	12.40420	6	0.0535

VAR Pairwise Granger Causality/Block Exogeneity Wald Tests
Date: 02/13/05 Time: 22:28
Sample: 1 2018
Included observations: 679

Dependent variable: DDL

Exclude	Chi-sq	df	Prob.
VDDL	1.846687	5	0.8699
All	1.846687	5	0.8699

Dependent variable: VDDL

Exclude	Chi-sq	df	Prob.
DDL	30.45414	5	0.0000
All	30.45414	5	0.0000

VAR Pairwise Granger Causality/Block Exogeneity Wald Tests
Date: 02/13/05 Time: 22:31
Sample: 1 2018
Included observations: 417

Dependent variable: DYKT

Exclude	Chi-sq	df	Prob.
VDYKT	2.762338	3	0.4297
All	2.762338	3	0.4297

Dependent variable: VDYKT

Exclude	Chi-sq	df	Prob.
DYKT	11.56676	3	0.0090
All	11.56676	3	0.0090

VAR Pairwise Granger Causality/Block Exogeneity Wald Tests
Date: 02/13/05 Time: 22:33
Sample: 1 2018
Included observations: 82

Dependent variable: EPS50

Exclude	Chi-sq	df	Prob.
VEPS50	2.873277	2	0.2377
All	2.873277	2	0.2377

Dependent variable: VEPS50

Exclude	Chi-sq	df	Prob.
EPS50	4.490083	2	0.1059
All	4.490083	2	0.1059