Macro Economic Uncertainty of 1990s and Volatility at Karachi Stock Exchange

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Abstract

The paper examines the short to medium term trends and volatility in Karachi Stock Exchange and further explore the nature of relationship between stock market activities and a set of macroeconomic variables in 1990s. The analysis is based on daily and monthly data on general stock price index and trading volume and monthly data on inter bank call rate, wholesale price index, quantum index of manufacturing sector's output and monetary aggregate M2 and it covers the period January 1992 to June 1999. The paper finds that in 1990s, the stock market at Karachi has become more volatile both on short-term (daily) and medium term (monthly) basis. Furthermore strong volatility inertia was present in stock price index, trading volume, wholesale price index, manufacturing output and money supply. The paper finds that there did not exist any systematic relation of stock price volatility with real or nominal macroeconomic volatility. Likewise, for the sample period, a volatile trading volume was neither due to a volatile stock price nor due to the fluctuations and shocks taking place in the economy. However, there was a negative long run relationship between stock price index and trading volume which suggests that the stock market has grown in size but its performance in terms of price has deteriorated. We also find that the level of real activity as indicated by manufacturing sector's output responds positively to changes in stock price index. Therefore a poor performance of the stock market was likely to have had played at least some negative effects on the performance of manufacturing sector in the said period.

Keywords: Time Series Models, Finance, Economic Development

J.E.L codes: C22, G10, E44

1. Introduction:

From the perspective of efficient market theory, or, equivalently, from the point of view of rational expectations inter-temporal asset pricing theory (Cox et al, 1976), asset prices will depend on the state variables which describe the economy, and the unanticipated component of returns will depend only on innovations in these state variables. This means that if economic variables evolve over time in a smooth manner, the stock prices will not exhibit erratic behavior either and the major cause of volatility in stock prices is the unexpected shocks in economic variables. However, Dhankar (1991) argues that stock prices do not adjust to the changing macroeconomics variables such as money supply, exchange rate, inflation rate, discount rate, deposit rate, lending rate and manufacturing sector's productions etc. Schwert (1989) analyzed the relationship of stock volatility with real and nominal macroeconomics volatility, economic activity, financial leverage and stock trading activity using monthly data from 1857 to 1987. An important finding previously noted by Officer (1973), is that stock return variability was unusually high during the 1929-39 Great Depression. Schwert (1990) finds that production growth rates explain a large fraction in stock returns. Schwert (1988) observed that volatility in stock markets increases after major financial crises. Moreover, stock volatility decreases and stock prices rise before the Federal Reserve Bank (USA) increases margin requirements. Thus, there is little reason to believe that public policies can control stock volatility.

In Pakistan, following economic liberalization in 1990, a great deal of interest has emerged among researchers to study and analyze the stock market behaviour. Nishat and Sagir (1991) built an argument to suggest that the stock market in Pakistan is fully capable of channelling the funds to productive sectors of the economy. They analyzed and measured the link between stock prices and aggregate macroeconomics activities in Pakistan through two components of aggregate demand i.e., investment and consumption expenditure, using standard Granger causality technique. Using monthly data from 1964 to 1987 for share index, investment expenditure, consumption expenditure, and industrial production, they concluded that there is a weak relationship between economic activities and stock prices. Thus the stock market in Pakistan appears to be informationally efficient with respect to real economic activity.

Khilji (1993) investigated the time series behavior of monthly stock returns in Pakistan over the period July 1981 to June 1992. The author made use of the State Bank of Pakistan share prices indices to calculate the monthly stock returns for eleven groups of stocks. The findings of the research suggested that the distribution of the returns of various series were not normal and were generally, positively skewed, leptokurtic and had positive mean. Assuming that each industry group represented an efficient and diversified portfolio, historical betas were found to be statistically different from zero but not different form one. This means that investors in Pakistan Stock Market who have diversified portfolios of stock of different industries were subject to the same amount of risk as investors with one industry portfolio. Using an error correcting, first order autoregressive model and employing the Kalman filler estimation technique the study found that expected monthly return were constant and equal to the long term expected monthly returns for all portfolios However, as pointed out by the author, this was a surprising result in the context of developing economy and needs further investigation by using weekly or daily data.

In a later study Khilji (1994), extended his previous work using same data set. The Brock, Dechirt, and Scheinkman (BDS) tests were conducted on the residuals from the autoregressive model .He found that the six of the indices display strong nonlinear dependence, where as the other five display linear dependence. The author suggested that nonlinear dependence in the data could result from a nonlinear stochastic system. The author recommended the use of nonlinear stochastic models like GARCH to estimate the returns and if it turns out that non linearity persists in the residuals from the models, then one could conclude that there is little chaos in the data

Uppal (1993) documented the transmission of changes in stock returns and their volatility from international market. The countries selected for studying the relationship to the Pakistan's stock market were Australia, India, Japan, Korea, U.K, and U.S.A. Taking sample period from July 1960 to June 1992; the author found that GARCH (1,1) model could adequately represent the monthly stock returns in the Pakistan market just as well as the other markets under study. He found that there was no evidence of spillover effects on conditional means and variances in Pakistan stock market from the international markets except the USA. Where as the volatility in Japanese and Korean markets seemed to cast its effects on the Pakistani market in recent years suggesting that regional stock markets might be exerting a greater influence on the Pakistani stock market than the more distant markets.

Ahmad and Rosser (1995) analyzed daily stock market and exchange rate data from Pakistan between July 1987 and March 1993 and found the results, which were consistent with the impression of great volatility and unpredictability thought to be prevailing in LDCs. The authors used Vector Autoregressive Regressions (VAR) techniques to estimate a presumed fundamental on the stock market indices using lagged first differences of natural logs of daily exchange rates and stock indices. Then they used the Hamilton regime-switching model and associated Wald test to see if speculative trends were present. The study also tested for ARCH effects and concluded that these effects cannot be ruled out. After controlling for ARCH effects, the study applied the Brook, Dechirt, and Scheinkman (BDS) test and found the existence of nonlinear structure. Due to nonlinear dynamics, the authors suggest that the Pakistani stock market during the period of study exhibited quite complex dynamics along with apparently strong trends that could indicate the presence of speculative bubbles.

According to Ahmad and Rosser erratic and complex dynamics of the stock market suggests that Pakistani economy may be subject to instabilities and oscillations. On the other hand, rapidly rising but volatile market prices also reflect optimism regarding future economic development. In a firm level study Farid and Ashraf (1995) analyzed the effects of trading volume on the volatility of stock prices has been studied by using average daily turnover of ten randomly selected companies for the first six months of 1994.Volatility of stock prices were found to be quite high ranging from a minimum of 26% per annum to 51% per annum. There was a strong positive correlation among the volume of trading, expected rate of return and volatility of stock prices during the first half of 1994 indicating the trend at the KSE to invest in stocks only for short term gains. It was observed in the study that majority of investors entered the market when it was rising and abandoned when it was falling, thus following their own portfolio insurance schemes. The author also suggested a more detailed study on the basis of daily fluctuation of stock prices to get more accurate results.

Hussain (1997) examined the Random Walk model for Pakistani equity market. The model was tested using daily data for 36 individual stocks, 8 sector indices and the general market index from January 1,1989 to Dec 30,1993. The independence hypothesis was tested through serial correlation. The results indicate the presence of strong serial dependence in stock returns suggesting that the Random Walk model is not appropriate to describe stock return behavior in Pakistani market. The author also pointed out that since the stock returns are not normally distributed, the calculated standard deviation of these returns underestimates the actual standard deviation. The analysis also showed that the Pakistani market, like other emerging markets adjusts slowly to new information, thus pointing to the weaknesses of the market regarding the dissemination of relevant information to potential investors. In this regard, the study suggested that setting up of an equity market research center and databases, where the pertinent information could be easily and quickly accessible to the public, would be an effective measure.

In another study Hussain and Uppal (1998) examined the distributional characteristicsof Pakistani equity market as well as the effects of the opening of market to international investors. Using daily data on 36 companies, 8 section indices, and the market index Jan 1, 1989 to Dec 30, 1993 various prepositions regarding stock return behavior was examined. The analysis shows significant returns in the market and that stock returns in the Pakistani market cannot be characterized by normal distribution. The study of distributional characteristics over time suggested that both the average return and volatility increased significantly when the market was opened but after one year dropped back.

The main equity market in Pakistan, Karachi Stock Exchange (KSE), has been in operation for almost half a century. However, it has not been an active market until the beginning of 1991. Frequent crashes of the stock market during 1994 and later periods before 1999, show that the KSE is rapidly converting into a volatile market. Heavy fluctuations in stock prices are not an unusual phenomenon however; such fluctuations have been observed at almost all big and small exchanges of the world. Focusing on the reasons for such fluctuations is intrusive, and likely to have important implications. The period of 1990s in Pakistan is also associated with macro economic uncertainty with high budget deficits, stagnant economic growth, inadequate foreign reserves and struggling financial sector. Since stock markets are the barometers of real economic activity in an economy, we want to investigate the relationship between real macroeconomic uncertainty in 1990s with stock market performance. This study is undertaken to address a number of issues pertaining to activities at the KSE. Our first objective is to study short to medium term relationship between stock market return and trading volume, which is to determine the nature of changes in stock returns to changing volume of stock market activity. Our second objective is to study the nature of volatility in stock prices, trading volume and the three economic variables namely wholesale price index, manufacturing sector's production index and money supply. The third objective is to determine inertia, stability, seasonality, and interdependence across the measures of volatility. The final objective of the study is to analyze long run relationship between stock price index, trading volume, wholesale price index, quantum index of manufacturing output and money supply. This exercise is conducted in the framework of co-integration analysis from where we shall also be able to analyze short-term adjustment dynamics in the variables when they get displaced from the long run relationships.

2. Data and Preliminary Descriptive Analysis:

Stock market indices are prepared and maintained by the State Bank of Pakistan (SBP). These indices are prepared on daily, weekly, and monthly basis. The weekly and monthly indices are published in an annual booklet titled 'Index Numbers of Stock Exchange Securities'. Daily indices are available in the files of SBP. These indices are prepared on the basis of stock prices quoted in the Ready Board, issued by the exchange, with some adjustments to correct for capital changes (dividends, right issues and bonus shares). The weights assigned to stocks in the index are proportional to the total paid-up capital of the companies.

The SBP indices are prepared for the thirteen broad sectors besides a general index with the base period 1990-91. In addition stock price indices are also prepared for the sub sectors of the sector comprising bank and other financial institutions. The general index called the State Bank general price index (SBGPI) covers all the stocks listed on the exchange and provides a complete representation of the market. In July 1992, the sectors were increased from ten to twelve, and the base period was changed from 1980-81 to 1990-91.

Our analysis covers only the general price index on daily and monthly basis. The period chosen for the study is January1992 to June1999. General price indices are converted into monthly rates of returns by taking logarithmic first differences of the index in local currency. We also computed the daily rates of return using the same procedure. Monthly standard deviations are computed from the daily rates of return. Besides, the values of daily market turn over are obtained from Securities and Exchange Commission of Pakistan (SECP). In order to capture the volatility in volume, monthly standard deviations are calculated from the daily observations on trading volume. The reason for the emphasis on daily observations when studying the volatility patterns in equity markets is that the random shocks or fluctuations experienced at a certain time only tend to persist for a short time span. These shocks may not even be remembered after a month's time in some cases.

The study analyzes the relation of stock volatility with real and nominal macroeconomic volatility and stock trading activity. For capturing real and nominal macroeconomic volatility we consider quantum indices of manufacturing sector's output, wholesale price index numbers, total monetary assets. The data for these variables are obtained for monthly basis (from January1992 to June1999) from Statistical Bulletin (State Bank of Pakistan). Call money rates are considered to be short-term risk free interest rates of the economy and are once again obtained from SBP's Statistical Bulletin. Some time profiles for stock market return and trading volume at Karachi Stock Exchange are shown graphically in figures 1.1 to1.5 (Appendix 1). In addition we have also computed correlation coefficients and the associated t-values for all the pair of variables shown in the graphs. From figure 1.1 it appears that the stock market return and its standard deviation follow time paths that resemble random walks. The correlation coefficient between the two variables is 0.078 and it is insignificant. The fluctuations in the time path of stock returns indicate month-to-month volatility, while the levels of standard deviation indicate volatility within months. From the graph it appears that stock returns are volatile not only on daily basis but also on monthly basis. However the level of volatility appears stationary, though in the recent years standard deviation has become relatively unstable.

Figure 1.2 displays the time profile of inter-bank call rate along with that of stock returns. It appears from the trends that the stock market return has remain much more volatile than the inter bank call rate through out the period. This is an expected trend due to high level of risk in stock market. No doubt both the returns are short term in nature but stock returns are more vulnerable to all types of shocks taking place in the economic, social or administrative set up of the country. The two variables also appear to move quite independent of each other as can also be seen from a low and insignificant value of their correlation coefficient (-0.083).

Monthly stock return and trading volume can be seen moving quite independent of each other in figure1.3. While the trading volume had followed an upward secular trend, the stock return has remained stationary. The correlation coefficient between two variables is also weak (0.069) and insignificant, suggesting no association on monthly basis.

Figure 1.4 presents the time profiles of growth rate and standard deviation of trading volume. The figure shows that the standard deviation of trading volume has increased quite substantially over time, in particular during the past two years, showing increased volatility in stock market activity. Like wise the rate of growth in trading volume has also increased significantly during this period suggesting that level of stock market activity has also increased. Further more, the growth rate of trading volume has also become more volatile. The correlation coefficient between the two variables is positive, reasonably high, that is 0.255, and it is statistically significant. Thus an increased level of volatility in the market turnover also accompanies the increased trading activity in the market.

Finally, the time paths of the standard deviations of trading volume and stock return are shown in figure 1.5. The figure shows that both the standard deviations have increased in the recent years indicating increased volatility both in terms of price and market turnout. The correlation coefficient between the two variables is positive and moderate (0.149) and it is marginally significant.

The overall picture that emerges from the above discussion is that the stock market has become more volatile in recent years both on short term (daily) basis and medium term (monthly) basis. It also appears that the rate of return based on the holding period of one month is not particularly correlated with inter bank call rate, trading volume or standard deviation of return. Thus the rate of return in stock market does not appear to adjust in response to changes in either the risk free interest rate or the level of risk. This pattern does not confirm to the theoretical expectation. One plausible interpretation of the results is that the information content available to market participants is either poor or not properly interpreted, thus the market remains inefficient. Another interpretation is that market activities are mostly driven by speculation and sentiments rather than rational decision-making in long-term perspective.

3. Empirical Analysis:

3.1. Volume-Return Relationship

According to Schwert (1989) there are at least three theories that predict a positive relationship between stock return, volatility, and volume. First, if investors have heterogeneous beliefs, new information will cause both price changes and trading. Second if investors use price movements as information on which to make trading decisions, large price movements will cause large trading volume. Finally, if there is short term "price pressure" due to liquidity in secondary trading markets, large trading volume that is predominantly either buy or sell orders will cause price movements.
In this section, we study the validity of the above theoretical prepositions by undertaking some empirical exercise on the two mentioned variables. First part of our empirical study consists of three models, which are estimated by employing OLS (Ordinary Least Squares) method:

$$GP = \alpha + \sum_{i=0}^{4} \beta_i . GV_{-i} + \varepsilon_i \qquad (1)$$

$$GPABS = \alpha + \sum_{i=0}^{4} \beta_i . GV_{-i} + \varepsilon_i \qquad (2)$$

$$GP^2 = \alpha + \sum_{i=0}^{4} \beta_i . GV_{-i} + \varepsilon_i \qquad (3)$$

Here GP is the growth rate of stock prices. GV is growth rate of trading volume. In the second equation GPABS depicts the absolute value of GP. While in the third equation we took the square of GP in order to capture the volatility of stock returns. In these equations we have made an assumption that the stock prices are dependent upon the trading activity in the secondary markets. By running OLS on these equations using monthly data for the period 1992-1999 we tried to capture the nature of dependency of stock returns on the trading volume. The results are presented in Table 1.

In order to obtain efficient estimates we first address the problem of auto-correlation by taking AR(1)(That is auto Regressive of the order 1) in equations 1 and 2, where as AR(1) MA(1)(That is moving average of order 1) is employed to counter the same problem in 3. Thus the resultant is D.W (Durbin-Watson) close to 2 in all the three cases, as can be seen from the table. The results show very low R-squared and adjusted R-squared values in all three cases. This is an expected result in large sample and especially when trends have been removed by considering growth rates rather than level of variables. From this we can draw the conclusion that the explanatory power of the independent variables is very low towards the dependent variable. But in case the objective of our regression analysis is not to obtain a high R-square per se but rather to obtain dependable estimates of the true population regression coefficients. In empirical analysis it is not unusual to obtain a very high R-square but find that some of the regression coefficients either are statistically insignificant or have signs that are contrary to priory expectations.

Table 1: Volume Return Relationship

Independent Variables	Dependent Variables		
	GP	GPABS	GP^2
Constant	-0.0002	0.012	0.0003
	(-0.46)	(27.34*)	(6.98*)
GV	0.003985	0.0057	0.00034
	(3.79*)	(7,97*)	(6.33*)
GV (-1)	0.004543	0.0044	0.00028
	(3.59*)	(4.56*)	(4.23*)
GV (-2)	0.0032	0.0044	0.00036
	(2.47*)	(4.19*)	(5.16*)
GV (-3)	0.0048	0.0026	0.000122
	(3.82*)	(2.67*)	(1.83)
GV (-4)	0.0039	0.0032	0.00028
	(3.78*)	(4.527*)	(5.21*)
R^2	0.0244	0.148	0.129
Adjusted R^2	0.0239	0.145	0.126
F-statistic	7.402	51.42778	37.61
Durbin-Watson statistic	2.01	2.09	2.00

Note: The t-statistics significant at 5% level are indicated by *.

The first equation says that 100 percent increase in the growth rate of buying and/or selling of stocks in the market at a certain month will cause about 0.4% increase in general stock price index within the same month and this effect is statistically significant. It may appear at the first sight that the impact period effect of changes in trading volume on stock prices is small. But it need to be understood that changes in trading volume can result in increased or decreased prices depending on whether the changes are dominated by shifts in demand or supply function. Since the regression coefficient measure the average effect, one can infer that changes in trading volume are dominated by pressure or what is known as ‘Bullish trend’. Similar results are obtained when we consider the effects of changes in the growth rate of trading volume in the previous months on the current growth rate of stock price index. In particular, the effects of, say, 100 percent increases in the growth rates of trading volumes during the past four months on the current growth rate of general price index range from 0.32% to 0.48%. The third column of Table 1 shows the effects of changes in the growth rates of trading volume during the current and past four months on the absolute value of the current growth rate of general price index. The idea here is to ignore the direction of change in stock prices and concentrate rather on fluctuations in prices. Since trading volume can change either due to buying pressure or due to selling pressure or both, one can be more certain in predicting whether is any net effect of such pressures on prices than in predicting the direction change in prices. This expectation is strongly supported by our results because the overall explanatory power for the second equation is more than six times as large as for the first equation (see the values of R^2 for the two equations). All the parameter estimates of the second equation are highly significant. Their magnitudes can be interpreted in the same way as for the first equation.

Another way to capture the effects of changes in stock market's daily turn over on the stock market price fluctuations is to take the square of the growth of general stock price index GP^2 as the dependent variable. We again find a positive relation ship of current price fluctuations with the current or past changes in the growth rate of trading volume. The results are given in the last column of Table 1. These results are qualitatively similar to the results obtained with absolute growth rate of stock price index taken as the dependent variable. The magnitudes of the parameters have reduced because the range of variation in dependent variable, which is in fractions, has been reduced while taking squares

There is a significant relationship between trading volume and stock market return on daily basis. The increase in trading volume is found to exert pressure on stock prices. Furthermore buying pressure seems to be a more frequent trend in the market as compared to the selling pressure. These assertions are based on daily data. If we compare them with the results obtained on the basis of monthly data in the previous section, the following conclusion emerges. The relationship between trading volume and rate of return is found in the short run only, that is based on holding period of one day. As the holding period is increased to one month, that is when we consider medium term analysis, the relationship becomes quite weak and insignificant. This further confirms our earlier conclusions that market activity is mostly driven by short-term speculative activities and sentiments. A similar result was found in the measurement of stock markets' integration by Ahmad (1998).

3.2. Measurement of Volatility through ARCH Variances:

Here we have four objectives to address. First we measure the volatility in stock prices and trading volume and some of the potentially related economic variables, namely wholesale price index, manufacturing production index and monetary assets. Then we study the presence and nature of inertia and seasonality in volatility in all the above variables. Towards the end of the chapter we shall study interdependence across volatility in the chosen variables. As a first step to address all these objectives we need to compute time series of volatility measure. For this purpose we shall rely on the Autoregressive Conditional Heteroskedasticity (ARCH) models originally introduced in Engle (1982). We have a sufficiently large sample size based on monthly data to estimate ARCH type models. The first inevitable step in the estimation of ARCH models is to determine stationarity property of the series under consideration. The reason is that any attempt to estimate the model with a non-stationary series will produce biased parameter estimates. Furthermore, since the estimates of the autocorrelation coefficients are downward biased, there is a great risk of making a false conclusion that the series is stationary with strong auto correlation. Analysis of the stationarity properties of a series is also called determining the order of integration as the concepts of stationarity and integrated processes are closely inter-linked.

A series is called stationary if its mean, variance and autocovariances are constant over time, though the autocovariances are allowed to vary with the lag length at which the current and past errors are related. An integrated process is a time series process that can be derived as a finite ordered integral of some stationary series. In other words, assuming discrete times, a series is called integrated process if it can be reduced to a stationary series after taking a finite number of differences. Furthermore a series is called integrated process of order d if it can be reduced to a stationary series after taking differences d times. It is trivial to note, for example, that all stationary series are integrated of order 0. The concept of integrated process is crucial for time series analysis because a nonintegrated process is of little use for estimation of stochastic models.

The order of integration can be determined by applying unit root tests. The most popular unit root test is called Dickey-Fuller (DF) test. The test is available in all the standard time series packages. The critical t values are also supplied with the test results. The typical first round of the test is based on the original series. If the series turns out to be stationary, the task is complete. Otherwise the test is applied on the first difference of the series. If the first difference is also non-stationary, the test is applied on the second difference and so on. Since most of the time series in economics and finance have stationary exponential growth, in most cases the first difference of natural log turns out to be stationary. We now move to the next step of our estimation procedure. Keeping in view that the ARCH models consist of two components, an ARMA equation and an ARCH equation, the diagnostic procedure involves four tasks. These steps are to determine the orders of autoregressive (AR) and moving average (MA) terms in the ARMA equation and the orders of ARCH and GARCH terms in the ARCH equations. The determination of ARMA process is based on Box- Jenkins procedure explained in Greene (1993) and it involves a careful study of correlograms for the autocorrelation function (ACF) and partial autocorrelation function (PACF). In addition to the study of correlogram various performance criteria such as Akaike Information Criterion (AIC) and Schwartz Bayesian Criteria (SBC) are also used to make choices when more than one specifications that look equally good. The procedure is to draw correlograms for the stationary series and make a tentative decision on the autoregressive (AR) and moving average (MA) terms on the basis of the shapes of ACF and PACF. The next step is to estimate the resulting ARIMA model and draw correlogram for the regression residuals. If some autocorrelation is still present, the ARIMA specification needs to be adjusted for re-estimation in the light of additional information. This step-wise procedure is continued until the regression residuals approximate white noise. To confirm that the residuals are white noise, Q-statistic is applied on the cumulative autocorrelation coefficients for sufficiently lengthy lags. For the residuals to be white noise the Q-statistics for all meaningful lag lengths should turn out to be insignificant. The ARCH equation in its generalized form (that is in case of GARCH model) is an ARMA model in heteroskedastic variance. The diagnostic steps for AR and MA terms in the

ARCH equation follow the same steps as for the simple ARMA model except that the correlograms are drawn for the squared residuals. Thus starting with the selected ARMA model one can study correlogram for squared residuals and step by step modify the ARCH equation until the Q-statistics for autocorrelation in squared residuals turn insignificant.

In practice the diagnostic procedure is not as simple as above. Due to non-linear relationship between residuals and squared residuals, the ACF and PACF for the residuals are related to those for squared residuals. Therefore any change in the specification for ARCH equation can affect the specification for ARMA equation and vice versa. This means that the two specifications cannot be perfectly determined in isolation of each other and the diagnostic steps should involve simultaneous study of the correlograms for residuals and squared residuals. Furthermore in addition to the above diagnostic procedure some element of hit and trial is also involved in specifying the complete model. Finally, once the ARCH model has been estimated, it is straightforward to compute ARCH variance.

The financial and macroeconomic variables chosen for the analysis are stock market general price index, trading volume, wholesale price index, quantum index of manufacturing output and money stock as measured by M2. All the data are taken at monthly level for the period month year to month year. The stationarity tests applied to the levels and logs of the variables reveal that they are all non-stationary. However stationarity is achieved when the tests are applied to the logarithmic first differences. Since the logarithmic first differences approximate growth rates in discrete, times, the stationarity results imply that the growth rate of each variable is stationary and the logs of the variables are integrated of order one. As a result the analysis in the following sections will be based on logarithmic first differences or monthly growth rates.

The results of estimated ARCH models for the five chosen variables are arranged in Table 2 (Appendix 1), which consists of two parts. The top half shows the parameter estimates of ARMA equations, while the bottom half constitutes the parameter estimates of the ARCH equations. The presence of autoregressive trends as shown by the results imply that in growth rates of trading volume and manufacturing output index there exists a strong autoregressive process of order one, that is AR(1) process. This means that the turbulence experienced through out the time period under consideration are significantly related to the occurrences in the previous period. The AR(1) process has been justified on the basis of geometric decline in the auto correlation function (ACF). This means that the shocks in the trading volume or growth in manufacturing index experienced during a period have a rigid relationship with the future growth of these variables. This effect declines in severity with the passage of time. We can also see that AR(2) is present in the growth rate of trading volume suggesting strong autocorrelation at lag length of two months. The growth rate of manufacturing output is subject to significant seasonal variations of stochastic nature as indicated by the significant AR(12) process.

The moving average (MA) or temporary disturbance terms are also present in most of the cases. The order of moving average(MA) process determines the nature of one-off relationship between the current and past fluctuations in the variables. For example with MA (1) process a shock occurring in one period will have an effect on the growth rate of manufacturing output returns in the next consecutive period. This shock is however eliminated from the system within one period. The results show that the intercepts of estimated ARIMA equations are significant in growth rates of trading-volume, wholesale price index and money supply. Since intercept measures systematic component of the growth rates of respective variables, it follows that a non-zero intercept means that the average growth rate is not zero. Only in case of stock price index the average growth rate is found to be negative, though it is not significantly different from zero. The second half of the table gives the results of the estimated ARCH equations. In this case the intercepts of all the variables are positive and with one exception they are also statistically significant. This indicates that a significant portion of volatility remains constant over time. In case of stock price index, however, the intercept is statistically insignificant, implying that the variance of stock return is mostly variable and heteroskedasticity is close to being pure, rather than mixed. The presence of ARCH (1) is an evidence of significant autocorrelation in volatility due to consecutive period lag. GARCH(1) process is also significantly present in all the variables except wholesale price index. In any case in time series context autocorrelation in variance is an evidence of volatility clusters in the stock prices, trading volume and the chosen macroeconomic variables. These ARCH estimates are autoregressive in variance. The volatility shocks occurring at a specific period of time show persistence but as time passes the size of volatility caused by a shock declines geometrically. Thus with the passage of time their impact is diminished and these shocks are soon forgotten due to market adjustments.

3.3. Evidence on Inertia, Stability, Seasonality and Interdependence

In this section we consider a simple forecasting model for volatility in Vector Autoregressive (VAR) framework to capture stochastic patterns. This framework is then extended to include seasonal effects. Thus suppose there are k stochastic variables that are to be determined simultaneously on the basis of past information on the same set of variables. Then the VAR model can be written as

$$X_t = A_0 + \sum_{i=1}^{p} A_i X_{t-i} + E_t$$

(4)

In the above specification X_t is a $k \times 1$ vector of observations on the k variable in period t, A_0 is the corresponding vector of intercepts, A_i is a $k \times k$ matrix of regression parameters associated with the variables at lag i and E_t is the vector of random disturbance terms that are assumed to be white noises.

The above framework is readily extendable to include parametric seasonal variation. Thus to include seasonal effects we replace the common intercept vector by 12 monthly intercepts that can be represented are regression coefficients of seasonal dummy variables. Thus we have:

$$X_t = \sum_{i=1}^{12} A_0^i D_{it} + \sum_{i=1}^{p} A_i X_{t-i} + E_t$$
(5)

The above VAR model is useful to study not only the inertial and seasonality in a set of chosen variables, but also stability and interdependence across the variables. Therefore there are four sets of tests that we shall apply on the above structure, one each to test inertia, stability, seasonality and interdependence. The corresponding null hypotheses along with the associated hypotheses are as follows.

$$\begin{aligned} &H_0^1: \textit{ A own lag effects on a variable are equal to zero} \\ &H_A^1: \textit{ At least one own lag effect on a variable is non zero} \end{aligned} \qquad (6)$$

$$\begin{aligned} &H_0^2: \textit{Sum of all the own lag effects on a variable is equal to one} \\ &H_A^2: \textit{Sum of all the own lag effects on a variable is less than one} \end{aligned} \qquad (7)$$

$$\begin{aligned} &H_0^3: \textit{In any particular equation all the coefficients of seaonal dummies are equal to one another} \\ &H_A^3: \textit{At least two coefficients of seaonal dummies are not equal to each other} \end{aligned} \qquad (8)$$

$$\begin{aligned} &H_0^4: \textit{In any particular equation all the cross lag effects of one varible on another variable are zero} \\ &H_A^4: \textit{At least one cross lag effect is non zero} \end{aligned} \qquad (9)$$

The second null hypothesis will be tested by t statistic, while the other three tests will be based on F statistics. Each of these null hypotheses will be tested for each equation within the same VAR model.

Table 3: Test for the Null Hypothesis that the Own Lag Effects are Zero

Variables	Volatility in stock price index	Volatility in trading volume	Volatility in wholesale price index	Volatility in manufacturing output index	Volatility in money stock
F Statistic	62.59*	34.66*	5.54*	54.54*	143.76*

Note: The F-values significant at 5% level are indicated by *.

We have estimated the VAR model extended for seasonal effects (equation. 5) in order to test for inertia, stability, seasonality and interdependence in volatility across the chosen variables. We first present the results on volatility inertia. The F statistics for the null hypothesis in (6) are presented in Table 3. The results show that all the F-values fall in the rejection range, implying that strong volatility inertia is present in all the variables.

Table 4: Test for the Null Hypothesis that the Sum of Own Lag Effects is Equal to or Greater than One

Variables	Volatility in stock price index	Volatility in trading volume	Volatility in wholesale price index	Volatility in manufacturing output index	Volatility in money stock
Sum of the Lag Effects	0.907	0.801	0.218	0.904	0.884
t Statistic	-1.40	-2.02*	-2.65*	-1.693**	-2.00*

Note: The t-values significant at 5% and 10% levels are indicated by * and ** respectively

Next, in order to apply stability tests on our variables, that is to test the null hypothesis in (equation. 7) we use t statistic. The results presented in Table 4 show that the sum of own lag effects is positive, which again confirms the presence of inertia in the variables. The t-statistics show that the sum of lag effects is significantly less than one in all but one case that is stock price index. Therefore we conclude that the volatility in these variables follows convergent path. Although the sum of lag effects in volatility in stock returns is less than one, but it does not fall short of unity significantly. This means that we are not quite sure whether or not the volatility in stock returns is convergent. In other words there is some likelihood that the time path of volatility may well be explosive. Moving now to the presence of seasonality, Table 5 shows that there is no significant evidence of seasonality in volatility in any one of the variables considered. In other words there are no month effects on volatility. It should be noted however, that since the test considers deterministic seasonality only, the acceptance of null hypothesis does not rule out the presence of stochastic seasonality.

Table 5: Test for the Null Hypothesis that the Seasonal Effects are Absent

Variables	Volatility in stock price index	Volatility in trading volume	Volatility in wholesale price index	Volatility in manufacturing output index	Volatility in money stock
F Statistic	0.701	0.702	1.143	1.690	0.899

This brings us to our final test that is on the interdependence in volatility across all the variables considered. Table 6 presents the results wherein the diagonal sell correspond to own lag effects, while the off-diagonal cells correspond to lag cross effects. Since the significance of own lag effects has already been discussed, here we shall concentrate on the cross effects only.

We observe that by-and-large the interdependence in the selected variables is weak. In particular measures of volatility in stock price index and trading volume are not only mutually independent, they are also independent of volatility in any on the other variables considered. This result enables us to comment on an important aspect of our study that there is no relation of stock price volatility with real and nominal macroeconomic volatility. A volatile trading volume is neither due to a volatile stock price nor due to the fluctuations and shocks taking place in the economy.

Table 6: Test for the Null Hypothesis that the Seasonal Effects are Absent
(The significance of lag effects of a row variable on a column variable is given by the F statistic in the corresponding rows)

Variables	Volatility in stock price index	Volatility in trading volume	Volatility in wholesale price index	Volatility in manufacturing output index	Volatility in money stock
Volatility in stock price index	62.59*	1.19	0.45	1.67	0.72
Volatility in trading volume	0.34	34.66*	0.22	3.06*	0.77
Volatility in wholesale price index	0.05	0.08	5.54*	5.02*	0.07
Volatility in manufacturing output index	0.77	0.95	0.91	54.54*	0.3
Volatility in money stock	0.45	0.61	4.52*	5.33*	143.76*

Note: F statistic in a cell measures the significance of lag effects of row variable on the column variable.

The results in the table show that the fluctuations in the level of inflation rate are certainly due to the volatile monetary assets. Thus unstable monetary policy contributes significantly to fluctuations in inflation rate. An interesting result to note here is that fluctuations in the growth rate of money supply also affect significantly the fluctuations in the growth rate of manufacturing sector's output. The two results combined mean that fluctuation in money supply affect real economic activity along with inflation rate. This result accords well with Friedman's famous fixed percentage growth rule for money supply. Thus deviations from fixed monetary growth path, especially when they take the form of fluctuations rather than persistent divergence, result in instability in the real sector. In other words inconsistency and arbitrariness in monetary policy has real implications for the economy.

We have some interesting results associated with the volatility of manufacturing index. For this particular variable we have significant F-statistics associated with all the dependent variables except stock return volatility. Thus increases in volatility in market turnover, rate of inflation and monetary growth lead to the increased volatility in the manufacturing sector's output. In other words real macroeconomic activity can be a prey to shocks and fluctuations occurring in capital markets in the form of volatile trading activity or variable economic activity due to any fluctuations taking place in general price level or the level of monetary assets in the economy.

Finally, we find that volatility in monetary assets is not influenced significantly by volatility in any of the other four variables. This suggests the State Bank of Pakistan does not respond to short term fluctuations in financial and economic variables and it sticks to its medium-to-long term goals in the conduct of monetary policy. Another implication is that the money multiplier is also stable with respect to these fluctuations, suggesting that the banking sector also does not respond abruptly to volatile economic conditions.

The results show that strong volatility inertia is present in stock price index, trading volume, wholesale price index, manufacturing output and money supply. The level of volatility follows a convergent time path for all but one variable that is stock price index, for which there is some likelihood of explosive tend. The volatility in any of the variables does not contain any notable seasonal variations of deterministic nature. Finally measures of volatility in stock price index and trading volume are not only mutually independent, they are also independent of volatility in any on the other variables considered. Thus we conclude that there does not exist any systematic relation of stock price volatility with real or nominal macroeconomic volatility. Likewise a volatile trading volume is neither due to a volatile stock price nor due to the fluctuations and shocks taking place in the economy.

3.4. Existence of Co-Integrating Relationship

This chapter analyzes the nature of long run relationship across stock price index, trading volume, wholesale price index, quantum index of manufacturing output and money supply. The relationship is analyzed in the framework of co-integrating analysis in which it is possible to study short-term adjustment mechanism when the relationship is disturbed by shocks. For the existence of co-integrating relationship we apply Johansen's test under alternative specifications for joint time series process of the variables under consideration. For each of the specifications the test is applied with zero to three period lag structure for the first difference of the variables. The test results are presented in Table 7.

Table 7: Results of Johansen's Co-Integration Tests

Lag Length	Specification 1: No intercept or trend in VEC and no drift or trend in VAR	Specification 2: Intercept but no trend in VEC and no drift or trend in VAR	Specification 3: Intercept but no trend in VEC and drift but no trend in VAR	Specification 4: Intercept and trend in VEC and drift but no trend in VAR	Specification 5: Intercept and trend in VEC and drift and trend in VAR
0					
1		CI	CI	CI	CI
2		CI	CI	CI	CI
3	CI	CI	CI	CI	CI

Note: CI means that the two variables co-integrate with each other.

The table shows that with no lagged first difference terms in the VAR model there does not exist any co-integrating relationship between the given set of variables in only two specifications under any of the specifications considered. With one or two period lagged first difference terms in the VAR model the co-integrating relationship is established in four of the five specifications. Finally when the number of lagged first difference terms is increased to three, all the specifications confirm that there exists a co-integrating relationship between the given variables. This pattern implies that the long run relationship between stock price index, trading volume, wholesale price index, quantum index of manufacturing output and money supply is established only with some lag of time and the relationship gets more firms when lag length is increased. The nature of this relationship is discussed in the following section.

We now discuss the nature of long run relationship of stock price index with the other variables. But first, in order to understand the forthcoming proceeding notice that as in the estimation of co-integration relationship the coefficient of one of the variables is normalized at one. Since the focus of our analysis is stock price index, for convenience of analysis we have normalized the coefficient of this variable in all the co-integrating relationship.

Table 8 (Appendix 1) presents results on the estimated co-integrating coefficients. The co-integration relationship between, for example, LP, LV, LWP, LQ and LM can be written as

$$LP + \pi_2\ LV + \pi_3\ LWP + \pi_4\ LQ + \pi_3\ LM = Error \tag{10}$$

The estimated coefficients presented in Table 2 represent the parameter π_2, π_3, π_4, and π_5. Since we cannot claim any particular variable to be dependent or independent categorically due to the very nature of Johansen's approach, the parameter π_2, π_3, π_4, and π_5 could be interpreted in more than one ways, depending upon which particular variable is taken as the dependent variable. If it is assumed that stock price index is endogenous, while the other variables are exogenous, these estimated coefficients are interpretable as the negative of the elasticities of stock price index with respect to trading volume, wholesale price index, manufacturing production index and money supply. Thus these coefficient measure the degree of responsiveness in stock price index to any change taking place in the other variables.

It also follows from the above interpretation that a negative (positive) value of the parameter π_2, for example, indicates a positive (negative) relationship between the stock price index and trading volume. The signs of the other co-integrating coefficients have similar interpretation.

The results in Table 8 indicate that co-integration coefficient for the trading volume is positive in all the specifications, implying a negative long run relationship between stock price index and trading volume. This result contradicts our findings in Chapter 5. The apparent contradiction can be reconciled on the basis of the difference in the holding periods considered in the two sets of results. Since the results in Chapter 5 are based on holding period of one day, they confirm more closely to the theoretical argument such as that the short term changes in trading volume trigger stock prices changes through buying or selling pressure. The results presented in this chapter are, however, based on monthly data and month is too long a period to interpret the price-volume relationship in the light of short-term dynamics in the financial markets. It is therefore more suitable to see the long run negative relationship between monthly turnover and price in the light of historic trend in the market. In recent years the stock market's performance has deteriorated and the prices of major stocks have declined, while the trading volume has increased mainly due to overall growth of the market.

The results further show that there is a strong positive long run relationship between stock price index and wholesale price index. Since the inflation rate in wholesale prices has almost always been positive, this negative associations should imply an increasing trend in the stock price index over the years. The observed data, however, do not confirm to this expectation. The reason is that we are looking at a partial association between the stock price and wholesale price indices, while controlling the other variables. Thus the inflationary effect of rising general price level on the stock prices is likely to be offset by the adverse effect of other factors. The long run relationship between stock price index and the level of manufacturing sector's output appears to be quite insignificant when we consider one period lagged first difference terms in the VAR model. However, with two period lags, we find a positive and somewhat significant relationship between the two variables. This result makes sense on theoretical grounds. The level of activity in the manufacturing sector is a key indicator of overall economic performance in the country. Besides, the manufacturing sector also contributes significantly to the size of stock market as judged by market capitalization. Thus one could expect a strong positive association between the level of activity in the manufacturing sector and stock market performance. This association is, however, established with a time lag. For example it would be unrealistic to expect that the manufacturing sector's level of activity will respond quickly to adverse trend in the stock market or the stock market will respond actively to the performance of the manufacturing sector on a permanent basis. The long run relationship based on monthly data should not be confused with the stock market's short-term responses to the news relating to manufacturing sector. The latter is a short-term phenomenon as it is based more on perception and sentiment.

Finally, the co-integrating coefficient of money supply is found to be statistically insignificant when we consider one period lagged first difference terns in the VAR model. As the lag lengths increases to two the coefficient becomes insignificant. In most of the cases where the co-integrating coefficient of money supply is significant, it is also positive. However there is no apparent theoretical argument to expect a direct negative association between stock price index and money supply, except the one that could be established through changes in market turnover. Furthermore, since in the co-integrating framework there is no unique choice of 'dependent' variable, we can attempt to interpret the positive co-integrating coefficient of money supply by looking at the implied relationship between money supply and any of the other variables. Thus the signs of co-integrating coefficient of money supply and wholesale price index imply a positive relationship between the two variables, as one could expect. Likewise there is by-and-large a positive association between price level and manufacturing sector's output. This means that during the period of analysis, which has been dominated by economic recession, monetary expansion could have had some positive effect on output along with its inflationary effect. Finally the relationship between trading volume and money supply is mixed, positive in some cases and negative in the others. This result, however, does not confirm to the expectation that increase in liquidity should have resulted in increased turnover in stock market. We can therefore conclude that according to our sample, increase in liquidity does not necessarily result in increased activity in the tock market.

So far we have discussed the existence and the nature of long run relationship between stock price index and the other variables considered. We now move to the analysis of short term or transitional dynamics. To perform this analysis we study the size and significance of error correction coefficients. Before presenting the empirical results, it is important to note the connection between co-integration relationship and error correction mechanism. In theory, it is argued that co-integration relationship and error correction mechanism are one of the same things. That is if two variables are co-integrating with each other, there must be a corresponding legitimate error correction mechanism. This connection however is based on asymptotic theory. In other words, co-integration relationship implies a legitimate error correction mechanism in large samples. However if the sample size is small the correspondence between co-integration and error correction can break down.

A sufficient, though not sufficient, conditions for the existence of a legitimate error correction process is that the algebraic signs of error correction coefficients are opposite to the signs of corresponding co-integrating coefficients. That is the product of each error correction coefficient with the corresponding co-integrating coefficient is negative. The necessary condition, however, requires that only the sum of these products is negative. It is common to find that the necessary condition is fulfilled, while for some variables the sufficient condition fails. In such a case short run variations in the variables for which the sufficient condition is satisfied are large enough to counter balance perverse movement in the variables failing the sufficient condition to produce a net variation in the right direction required for error correction. The estimated error correction coefficients of various variables under all the cases where co-integrating relationship is found are arranged in Table 9 (appendix 1). The table shows that the error correction coefficient of stock price index is statistically insignificant in all the cases, despite the fact that quite a large number of coefficients in the table are significant. On the other hand there are quite a few cases of significant error correction in trading volume, wholesale price index and quantum index of manufacturing sector's output. The error correction coefficient of money supply is insignificant in all but one case.

The above result means that over a period of one month stock prices do not adjust to macroeconomic shocks causing deviations from the long run equilibrium and they mostly follow their independent time path. At the first sight this result might seem unrealistic. But we need to keep in mind that our analysis is based on monthly data and month is too long a period for stock prices to respond to news. Although it is a well known feature of stock markets that they react too actively to economic shocks, but this reaction takes place mostly on daily basis and the resulting fluctuations in stock prices are smoothed out within a month.

Our results confirm that the necessary condition for the existence of a legitimate error correction process is satisfied in all the 13 cases in which co-integrating relationship is found to exist. The sufficient conditions are also fulfilled in the majority of cases as shown in Table 10. The most consistent error correction response is found in the manufacturing sector's output. Since the manufacturing sector's output is positively co-integrated with stock price index, the consistent error correction means that output increases (decreases) in response to rising (falling) stock price index and it also move counter cyclically with output shocks.

The incidence of perverse short-term changes is found to be most common in wholesale price index, followed by stock price index. But this happens almost always when the corresponding error correction coefficients are statistically insignificant. A meaningful interpretation of this pattern is that the two variables do not respond to shocks. The inactive response in the wholesale price index could be due to sticky expectations. For the stock price index month is too long a time period to respond, the short-term adjustments are expected to be realized within a few days. The long run relationship between stock price index, trading volume, wholesale price index, manufacturing sector's output and money supply is established only with some lag of time and the relationship gets more firm when lag length is increased. It is found that there is a negative long run relationship between stock price index and trading volume, indicating growth of the market along with deterioration in its performance. The level of real activity as indicated by manufacturing sector's output responds positively to changes in stock price index. It is further observed that increase in liquidity does not necessarily result in increased activity in the tock market. Over a period of one month stock prices do not adjust to macroeconomic shocks causing deviations from the long run path and they mostly follow their independent time path. Although it is a well known feature of stock markets that they react too actively to economic shocks, but this reaction takes place mostly on daily basis and the resulting fluctuations in stock prices are smoothed out within a month. Finally, we find that the manufacturing sector's output increases (decreases) in response to rising (falling) stock price index and it also move counter cyclically with output shocks.

4. Conclusions:

This paper has been an attempt to study the short to medium term trends and volatility in Karachi Stock Exchange and to explore the nature of relationship between stock market activities and a set of macroeconomic variables. The analysis is based on daily and monthly data on general stock price index and trading volume and monthly data on inter bank call rate, wholesale price index, quantum index of manufacturing sector's output and monetary aggregate M2 and it covers the period day month year to day month year. Some of the main findings are summarized below. The analysis of daily data shows a positive relationship between stock market return and the changes in trading volume. That is an increase in trading volume is found to exert pressure on stock prices. The nature of this relationship implies that on average buying pressure in the market has somewhat dominated the selling pressure. However when the relationship is studied on the basis of holding period of one month, it turns out to be rather weak. That is the rate of return based on the holding period of one month does not adjust in response to changes in either the risk free interest rate or the level of risk.

Therefore the relationship appears to hold only temporarily. A plausible interpretation of this pattern of relationship is that in the short run market activity at the Karachi Stock Exchange is mostly driven by speculations and sentiments rather than a long term and rational decision-making process. Another interpretation is that in short run the information content available to market participants is either poor or not properly interpreted, thus the market remains inefficient. The stock market at Karachi has become more volatile in recent years both on short-term (daily) and medium term (monthly) basis. Furthermore strong volatility inertia is present in stock price index, trading volume, wholesale price index, manufacturing output and money supply. The level of volatility follows a convergent time path for all but one variable that is stock price index, for which there is some likelihood of explosive tend in the recent years. The volatility in any of the variables does not contain notable seasonal variations of deterministic nature. The measures of volatility in stock price index and trading volume are not only mutually independent, they are also independent of volatility in any on the other variables considered. Thus we conclude that there does not exist any systematic relation of stock price volatility with real or nominal macroeconomic volatility. Likewise a volatile trading volume is neither due to a volatile stock price nor due to the fluctuations and shocks taking place in the economy. The results based on co-integration analysis involving stock price index, trading volume, inter bank call rate, wholesale price index, manufacturing sector's output and money supply indicate the presence of a long run relationship. This relationship is, however, established only with some lag of time and the relationship gets more firm when lag length is increased. The nature of long run relationship between stock price index and trading volume suggests that the stock market has grown in size but its performance in terms of price has deteriorated. The results further imply that the level of real activity as indicated by manufacturing sector's output responds positively to changes in stock price index. Therefore a poor performance of the stock market is likely to have had played at least some effects on the performance of manufacturing sector. Over a period of one month stock prices do not adjust to macroeconomic shocks causing deviations from the long run path. Although the stock market reacts too actively to economic shocks, but this reaction takes place mostly on daily basis and the resulting fluctuations in stock prices are smoothed out within a month.

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Appendix 1:

Figure 1.

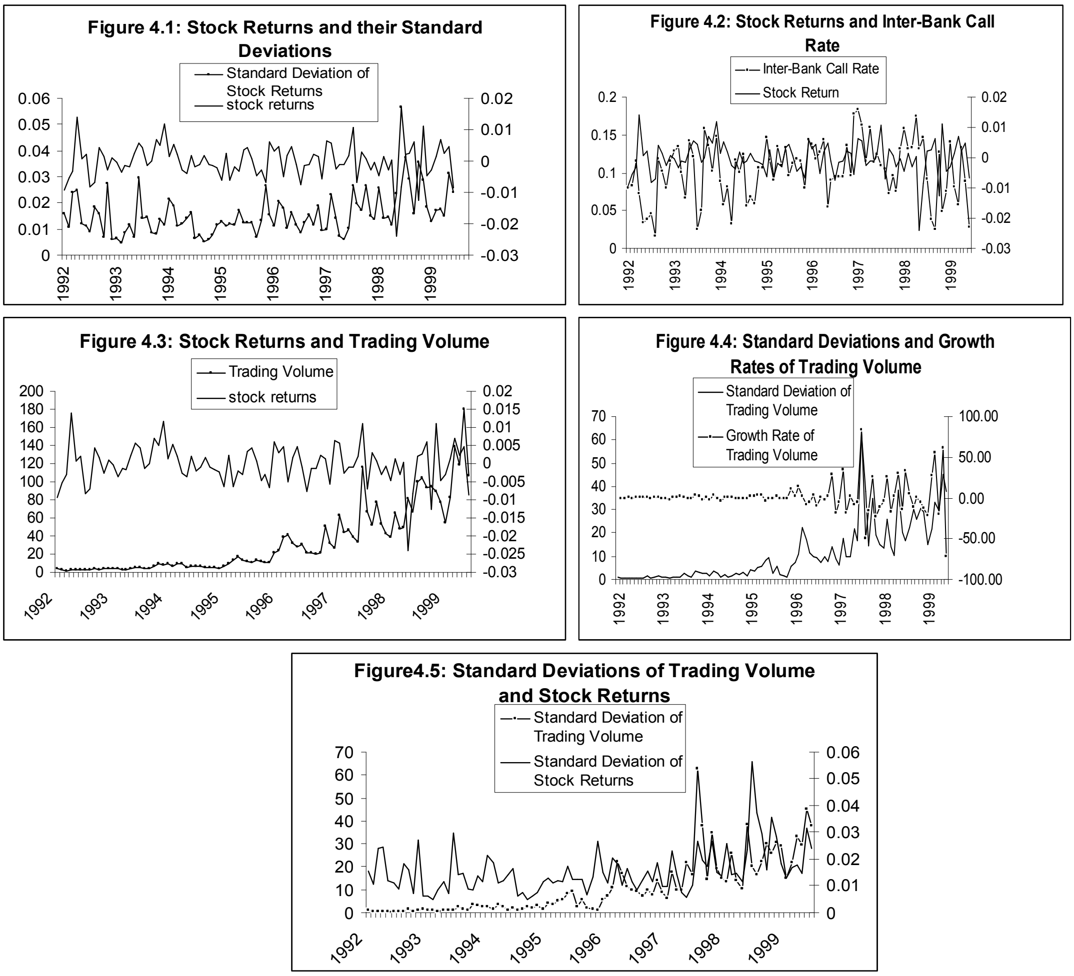

Table 2: Estimates of the ARCH Models

Variables	Growth rate of stock price index	Growth rate of trading volume	Growth rate of wholesale price index	Growth rate of manufacturing output index	Growth rate of money stock
			ARIMA Equations		
Intercept	-0.003 (-0.03)	0.036 (3.76*)	0.007 (5.26*)	0.014 (0.18)	0.0107 (5.64*)
AR(1)		-0.036 (-3.91*)		0.223 (4.59*)	
AR(2)		-0.444 (-4.87*)			
AR(12)				0.767 (12.67*)	
MA(1)				-0.98 (-28.07*)	-0.318 (-3.93*)
MA(4)		-0.3611 (-3.22*)			
MA(6)		-0.23 (-2.04*)			
			ARCH Equations		
Intercept	0.0004 (1.25)	0.0105 (12.85*)	0.0002 (6.44*)	0.0001 (2.68*)	0.0001 (2.22*)
ARCH(1)	-0.1813 (-4.37*)	-0.107 (-3.19*)	0.236 (1.33)	-0.054 (-2.61*)	-0.054 (-2.07*)
GARCH(1)	1.054 (19.10*)	1.001 (28.77*)		1.075 (68.59*)	0.979 (37.66*)

Note: The t-values significant at 5% and 10% levels are indicated by * and ** respectively

Table 8: Co-Integration Coefficients

Variables	Specification 1: No intercept or trend in VEC and no drift or trend in VAR	Specification 2: Intercept but no trend in VEC and no drift or trend in VAR	Specification 3: Intercept but no trend in VEC and drift but no trend in VAR	Specification 4: Intercept and trend in VEC and drift but no trend in VAR	Specification 5: Intercept and trend in VEC and drift and trend in VAR
Lag length 1					
Stock price index		1	1	1	1
Trading volume		1.845 (1.57)	1.556 (2.60*)	1.516 (2.82*)	1.547 (2.77*)
Wholesale price index		-5.56 (-2.15*)	-6.995 (-3.80*)	-4.798 (-2.81*)	-4.781 (-2.756*)
Manufacturing production index		0.803 (0.85)	0.166 (0.38)	0.075 (0.19)	0.0992 (0.25)
Money supply		-3.665 (-0.74)	-0.6601 (-0.32)	2.996 (1.55)	3.024 (1.54)
Lag length 2					
Stock price index		1	1	1	1
Trading volume		0.0319 (0.13)	-0.096 (-0.30)	0.199 (0.98)	0.203 (1.01)
Wholesale price index		-5.4805 (-3.98*)	-4.419 (-2.63*)	-2.977 (-2.11*)	-2.99 (-2.13*)
Manufacturing production index		-2.559 (-2.68*)	-3.656 (-2.10*)	-2.285 (-3.23*)	-2.28 (-3.23*)
Money supply		5.723 (3.77*)	5.463 (2.87*)	8.059 (3.80*)	8.001 (3.79*)
Lag length 3					
Stock price index	1	1	1	1	1
Trading volume	0.6084 (3.29*)	3.453 (0.62)	3.363 (0.63)	2.3846 (1.01)	2.438 (0.99)
Wholesale price index	-6.2144 (-3.40*)	-10.2202 (-0.94)	-10.24 (-0.64)	-6.339 (-1.40)	-6.38 (-1.37))
Manufacturing production index	-4.788 (-2.66*)	-14.214 (-0.62)	-3.28 (-0.26)	-8.87 (-1.02)	-9.066 (-1.003)
Money supply	3.9869 (3.07*)	-3.68 (-0.27)	-3.2816 (-0.26)	3.014 (0.58)	3.103 (0.58)

Note: The t-statistics significant at 5% level of significant are indicated by *

Table 9: Error Correction Coefficients

Variables	Specification 1: No intercept or trend in VEC and no drift or trend in VAR	Specification 2: Intercept but no trend in VEC and no drift or trend in VAR	Specification 3: Intercept but no trend in VEC and drift but no trend in VAR	Specification 4: Intercept and trend in VEC and drift but no trend in VAR	Specification 5: Intercept and trend in VEC and drift and trend in VAR
Lag length 1					
Stock price index		-0.002 (0.011)	0.0018 (0.07)	-0.00078 (-0.03)	-0.003 (-0.12)
Trading volume		-0.063 (-1.6)	-0.354 (-5.4*)	-0.396 (-5.82*)	-0.393 (-5.77*)
Wholesale price index		0.0076 (5.59*)	0.0064 (2.46*)	0.0068 (2.43*)	0.0061 (2.21*)
Manufacturing production index		-0.021 (-1.47)	-0.053 (-1.92*)	-0.0599 (-2.03*)	-0.062 (-2.11*)
Money supply		0.0125 (4.06*)	0.0032 (0.56)	-0.0007 (-0.12)	-0.0008 (-0.13)
Lag length 2					
Stock price index		-0.023 (-0.78)	-0.016 (-0.71)	-0.0405 (-1.16)	-0.038 (-1.11)
Trading volume		-0.274 (-3.07*)	-0.1408 (-1.99*)	-0.307 (-2.98*)	-0.307 (-2.97*)
Wholesale price index		-0.006 (-1.85*)	-0.0014 (-0.55)	-0.0027 (-0.72)	-0.0024 (-0.64)
Manufacturing production index		0.1205 (3.59*)	0.131 (5.53*)	0.166 (4.40*)	0.16 (4.40*)
Money supply		-0.012 (-1.63)	-0.00009 (-0.003)	-0.0106 (-1.21)	-0.010 (-1.19)
Lag length 3					
Stock price index	0.019 (0.92)	0.007 (1.08)	0.0077 (1.21)	0.012 (1.22)	0.0119 (1.18)
Trading volume	-0.146 (-2.27*)	-0.047 (-2.45*)	-0.049 (-2.50*)	-0.087 (-2.81*)	-0.086 (-2.80*)
Wholesale price index	-0.0005 (-0.22)	-0.0001 (-0.21)	-0.00026 (-0.33)	-0.00049 (-0.41)	-0.0006 (-0.54)
Manufacturing production index	0.128 (6.41*)	0.0380 (6.18*)	0.038 (6.12*)	0.0607 (5.97*)	0.059 (5.89*)
Money supply	0.0057 (1.01)	0.003 (1.84*)	0.0030 (1.80*)	0.004 (1.50)	0.0039 (1.50)

Note: The t-statistics significant at 5% level of significant are indicated by *

Table 10: Status of Necessary Condition for a Legitimate Error Correction Process

Variables	Specification 1: No intercept or trend in VEC and no drift or trend in VAR	Specification 2: Intercept but no trend in VEC and no drift or trend in VAR	Specification 3: Intercept but no trend in VEC and drift but no trend in VAR	Specification 4: Intercept and trend in VEC and drift but no trend in VAR	Specification 5: Intercept and trend in VEC and drift and trend in VAR
Lag length 1					
Stock price index		Pass	Fail	Pass	Pass
Trading volume		Pass	Pass	Pass	Pass
Wholesale price index		Pass	Pass	Pass	Pass
Manufacturing production index		Pass	Pass	Pass	Pass
Money supply		Pass	Pass	Pass	Pass
Lag length 2					
Stock price index		Pass	Pass	Pass	Pass
Trading volume		Pass	Fail	Pass	Pass
Wholesale price index		Fail	Fail	Fail	Fail
Manufacturing production index		Pass	Pass	Pass	Pass
Money supply		Pass	Pass	Pass	Pass
Lag length 3					
Stock price index	Fail	Fail	Fail	Fail	Fail
Trading volume	Pass	Pass	Pass	Pass	Pass
Wholesale price index	Fail	Fail	Fail	Fail	Fail
Manufacturing production index	Pass	Pass	Pass	Pass	Pass
Money supply	Fail	Pass	Pass	Fail	Fail

Note: The t-statistics significant at 5% level of significant are indicated by *