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Full Length Research Paper

The performance of Ghana stock exchange for the period 2000 to 2009

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Stock markets play a crucial role in financial development; however, the ability of stock markets to play the role that is ascribed to them depends upon the presence of market efficiency and hence the performance of the market. The essence of this paper is to estimate the performance of the capital market as Ghana is striving to attain middle income status. Using Eviews statistical software we computed market volatility, liquidity of returns and serial correlation of returns using cross – sectional data. We also took into consideration the effect of inflation on the determination of performance of the market. The finding was that the market over the period under review performed well in terms of liquidity and volatility of the market. It was also established that in the determination of market efficiency the effect of inflation is an important factor one has to consider. That could be the reason why market efficiency in most developing countries turns out to be inefficient. This is simply because of the high rate of inflation in these countries. It is recommended that in determining market efficiency or the performance of the capital market we need to work with real data rather than nominal data.

Key words: Ghana stock exchange, volatility, liquidity, real returns and nominal returns.

INTRODUCTION

Considering the rapid pace of development and change in the various capital markets in Africa, it is not surprising that investors, market practitioners, the business world, the press and academic researchers, and other stake-holders in the capital market of Ghana are currently interested in understanding the dynamics of volatility of returns on the stock market and the level of integration of stock markets on the continent. African economies strengthened in the latter half of 2004 driven by buoyant commodity prices and rapid expansion of world trade. This caused equity prices peaking ahead of the peak in gross domestic product (GDP) growth and recovering well before economies hit their trough. As most capital markets in Africa experienced a bullish economy, that of Ghana and Nigeria were exceptional due to the fact that the pace of market growth slowed in the final quarter of 2004.

Perhaps the strongest evidence of Africa's intention to be a full participant in financial architecture of the emergent global economy can be seen in the wave of stock markets that have been set up across the continent over the past two decades. Today Africa boasts of some 20 stock exchanges and some of the fastest growing economies, which is inevitably reflecting in strong equity price gains. Surprisingly, most research findings, for instance Magnus et al (2006) and Osei (1998, 2002), concluded that the market is inefficient and for that matter not performing.

The interesting thing about capital markets in Africa and in particular Ghana is their potential to perform better than other stock markets in Western Europe, North America and Asia. On the average African stock markets have done better than Standard and Poor's 500 (Business in Africa, August 2008).

According to Worthington and Higgs (2006), stock markets play a crucial role in financial development, however, the ability of stock markets to play the role that is ascribed to them depends upon the presence of market efficiency. This has important implications for the allocation of capital within an economy and hence overall financial development. A research by Databank Ghana

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Limited on Africa's biggest 14 stock markets established that 11 of these markets had positive returns since the beginning of 2008. In the report, GSE all share index climbed by 54% by the middle of June in the same year. Zimbabwe was excluded in the survey.

This problem of not performing well but not efficient is not peculiar to Ghana but almost all developing countries. Several research findings about market efficiency, predictability of returns and volatility of returns within these regions had not being in favour of efficient market hypothesis. The research findings of Worthington and Higgs (2006, 2003), confirms this assertion. One common characteristic among countries referred to as developing countries is the high rate of inflation. The inflation rate in these countries is usually more than a single digit and some could go as high as 45%, to mention the extremes. It is for this reason that this paper endeavours to really assess the performance of the Ghana Stock Market (GSM under the assumption of no inflation.

We believe that the effect of inflation on returns dictates the behavior of stock returns, making it look as if changes in stock prices are predictable. In other words, the market is not efficient. By deflating stock returns it would make it possible to properly measure risk on returns, especially in Africa where inflationary levels are mostly very high (two digits).

Relevance of the study

1. The ability of stock markets to play the role that is ascribed to them – attracting foreign investment, boosting domestic saving and improving the pricing and availability of capital – depends upon the market performing well.

2. Capital Market has come to stay and is an important determinant if the economy of any country is to perform well. A well functioning market is necessary for economic development, hence the need to ensure its proper operation.

Macroeconomic economic environment (inflation) and the stock market

There are a number of events that affect investment decisions. Whilst others cause security markets to retort, others do not. All investment decisions are made within the economic atmosphere. This atmosphere varies as the economy goes through stages of opulence. Economic activity is measured by aggregate indicators such as the level of production and national output. In the case of this thesis we are going to proxy economic indicators with volumes of stocks traded, liquidity of the capital market, volatility and others as discussed in the chapter three and four of the this thesis.

Investing in the capital market would be easier if there are a particular bond between a specific asset's return and the general economy. However, for many assets, especially common stocks, the linkages between an asset's price and the general economy are multifaceted. An escalating economy may increase the demand for a firm's product, which lead to higher earnings which intend lead to increase in dividend and growth, since the firm has more funds to reinvest. All other things being equal will lead to higher stock prices. It is interesting to note that these factors in reality are not constant and for that matter all other factors also changing may not cause an increase in demand for a firm's product to result into higher earnings. The relationship between the economy and investment selection is made more difficult when one realizes that security prices are indicator of economic activity and not a mirror. Changes in security prices tend to precede changes in economic activity. Whiles this suggests that it would be very tricky for an investor to predict the market performance; there are strategies investors may follow. For instance, changes in interest rates, changes in the rate of inflation or deflation, increased unemployment and recession, and continued economic growth may each suggest a particular strategy that is more desirable and should be followed. It is for this reason and others that thesis wants to zero in on the effect of inflation on the determination of market efficiency.

Inflation is a state in the economy of a country, when there is a price rise of goods as well as services. To meet the required price rise, individuals have to shell out more than is presumed. With increase in inflation, every sector of the economy is affected. Ranging from unemployment, interest rates, exchange rates, investment, stock markets, there is an aftermath of inflation in every sector. Inflation is bound to impact all sectors, either directly or indirectly. Inflation and stock market have a very close association. If there is inflation, stock markets are the most affected.

The anticipation of inflation implies that investors will demand higher returns for the use of their funds. The action by investors increase interest rates which implies investors should avoid interest susceptibility securities and long term debts instruments that pay fixed amounts of interest and rather they should acquire short term instruments whose yields will increase with rate of inflation. However, anticipation of inflation requires more than a passive strategy of holding short term liquid assets. They also acquire those assets that will benefit from the inflationary environment and this makes the prices of real estate and other physical assets to increase, thus making investors move out of financial assets into tangible assets.

Stocks of selected firms also do well in inflationary situation, especially companies that own substantial amounts of physical resources as their assets value increases with the general rise in prices. In general, any

firm with a rich asset base, such as real estates, metals etc., may experience rapid growth in earnings that is directly attributable to the inflationary situation. In a situation like this (inflationary environment), the investor has to stress on liquid assets, tangible assets, and common stocks of firms whose assets base will be enhanced by increased asset value and on the other hand not to acquire fixed income instruments, long term debt obligations and common stocks of firms lacking assets whose prices will rise with inflation.

Interest and inflation rates have express effects on the level of consumption and investment costs, hence the anticipated cash flow of the listed firms. Boyd et al. (2001) argue that high rates of inflation exacerbate financial market frictions, interfere with the efficiency of the financial system and thus inhibit long-run growth. On the other hand, interest rates represent the return on alternative assets to equities and they are the discount rates used in the valuation of stock returns. Thus, higher interest rates may work against stock market integration as they distract capital from equity to bond market.

Prices of stocks are determined by the net earnings of a company. It depends on how much profit the company is likely to make in the long run or the near future. If it is reckoned that a company is likely to do well in the years to come, the stock prices of the company will escalate. On the other hand, if it is observed from trends that the company may not do well in the long run, the stock prices will not be high. In other words, the price of stocks is directly proportional to the performance of the company. In the event when inflation increases, the company earnings (worth) will also subside. This will adversely affect the stock prices and eventually the returns.

Effect of inflation on stock market is also evident from the fact that it increases the rates of interest. If the inflation rate is high, the interest rate is also high. In the wake of both (inflation and interest rates) being high, the creditor will have a tendency to compensate for the rise in interest rates. Therefore, the debtor has to avail of a loan at a higher rate. This plays a significant role in prohibiting funds from being invested in stock markets.

In order to understand the structural relation between inflation and share prices, it is crucial to distinguish between the effect of a high constant rate of inflation and the effect of an increase in the rate of inflation expected for the future. When the steady-state rate of inflation is high, share prices increase at a faster rate. More specifically, when inflation rate is steady, share prices rise in proportion to the price level to maintain a constant ratio of share prices to real earnings. In contrast, an increase in the expected future rate of inflation share prices causes a concurrent fall in the ratio of share prices to current earnings.

Indicators of performing stock market

We are assessing the performance of GSE over the last nine years (2000 to 2010) on trading variables like volume, variability of return, liquidity of trading, serial correlation in returns and bid-ask spreads. There is not complete assurance that measurements of the variables before and after the year 2004 reflect the influence of a performing stock market, since other variables may intervene to affect volume, return variability, etc. There is good reason to focus on volume, volatility and liquidity. These characteristics of stock trading are linked to the expected rate of return on a common stock. Illiquid markets tend to be more volatile. In illiquid markets, investors face higher trading costs and have reduced incentives to develop information about companies. Investors demand higher returns to compensate for these undesirable features and firms end up with higher costs of capital. On the other hand, liquid markets tend to keep capital costs down.

Advocates of efficient market trading systems claim that the trading is faster and simpler. Opponents of efficient market hypothesis fear that nonperforming market reduce liquidity stocks in the market. Performing markets have the potential to alter both the volatility of a stock's returns and the trading volume.

One measure of the impact of a market that is performing is expected greater trading volume. Volume arises from liquidity trading, noise trading and information trading. Noise trading is not a well defined category of trading. Those who have used the term seem to mean traders with inferior information who misjudge the quality of the information they possess and/or trade for nonpecuniary reasons. Whether or not the distinction between noise traders and other traders is meaningful, a performing stock exchange is unlikely to discourage noise traders from trading. Noise traders who are technical traders are likely to be encouraged by the availability of previously hidden information and the greater ease of entering and exiting the market. Noise traders who are trading on fundamentals face lower costs of acting upon their expectations. Information traders seek to benefit from generating private information and trading on it. They prefer to trade in broad and anonymous markets. The increased participation of liquidity and noise traders encourages greater participation of information traders. There is also reason to expect that the amounts and types of private information generated by information traders will change if the exchange is performing. As a broader market in which to trade and realize returns, a performing market is likely to attract a greater amount of information trading and provide an incentive for traders to invest greater resources in developing private information.

As markets become more efficient, the pattern of short term volatility is likely to change. We suspect that instances of short lived increases in volatility driven by information generation are likely to rise in a stock market that is performing well. If they are not diversifiable, risk premiums will rise. However, the very factors that bring

about increased volatility - improved market access and market efficiency - also bring about increased volume of trading. This is why we examine liquidity measures that impound both volatility and volume.

METHODOLOGY

We cannot get reliable results from this paper if the data collected is not reliable. This is because data collected for this paper serves as raw material to the statistical analysis and interpretation of this work. The data sources for us to achieve our objectives were taken from secondary data source. Secondary data source is the data that has already been collected by somebody or an organization and that has been made available for statistical investigation by a third party. The secondary data in this work was the monthly inflation rate, monthly Treasury Bills rates, and Ghana Stock Exchange (GSE) All Share Index. Most of the sources were from the secondary sources because of availability of funds, time, nature and scope of investigation, and the degree of accuracy desired for this thesis.

Data type

There are broadly three types of data that can be employed in quantitative analysis of financial problems as employed in this research. They are time series data, cross sectional data, and panel data.

Time series as the name suggests, are data that have been collected over a period of time on one or more variables. Time series data have been associated with particular frequency of observation of data points.

Cross-sectional data is a type of one-dimensional data set. They are data collected by observing many subjects at the same point in time, or without regard to differences in time. Cross-sectional data differs from time series data, which follows one subject's change over the course of time. Panal data on the other hand have the dimensions of both time series and cross-sections. Panal data looks at multiple subjects and how they change over the course of time.

The data type used for this research is a time series data because GSE all share prices were collected over the period between 1991 and 2009. Time series data from Databank Share Index (DSI) was also collected for index on mutual fund for the period between 1999 and 2009.

Index comes in various forms and purposes. The stock market indexes measure the respective value of a group of company shares. In other words, they indicate the performance of stocks. Price indexes, on the other hand, typically stand for weighted averages of prices for certain categories of goods and services. They illustrate the fluctuation of prices in a particular area and during a defined period of time. Stock market indexes may be tentatively categorized as global, national, and specific. The national indexes reflect the performance of stocks in a particular state.

Collection of secondary data

The main methods used in collecting secondary data are as follows. There was direct personal investigation with workers of Ghana Stock Exchange and Data Bank personnel to collect requisite information for this work. This data were obtained from Bank of Ghana Bulletin, Ghana Stock Exchange, GSE Bulletin and bulletin form Data Bank.

The closing prices of Ghana Stock Exchange share price were collected for the period 1990 to 2009 and also DSI data from 1999 to 2009. This data was used to calculate returns on GSE all share index and DSI index. For a number of reasons, it is preferable not to work directly with the price series, so the GSE all indexes and DSI index were converted into series of returns. Another reason why returns were calculated was that returns have the additional benefit in that they are unit free.

There are methods of calculating returns from a series. They are simple returns and continuously compounded returns. In this work we used the continuously compounded returns. For us to establish the effect of inflation on market efficiency (random walk hypothesis), we developed two main data types, real data and nominal data. Real data is the present value of the nominal data with inflation as the discounting factor. So in case nominal (nominal data) and real (real data), returns were calculated.

The total returns for holding stocks or portfolio of stocks are dividends and capital gain. However, most researchers often ignore any dividend payment and assume total returns to be equal to capital gain. In the calculation of returns we also assumed that total returns from stocks or portfolio is equal to capital gain.

There are various econometric packages for modeling financial data. Popular among them are EViews QMS Software, GAUSS Aptech System, LIMDEP Econometric Software, SPSS and RATS estima. All the statistical softwares mentioned Eviews was used for the following reasons; it is simple to use, that is interactive econometric software and lastly it is the most frequently used tool in practical econometrics.

Measuring the performance of Ghana stock exchange

The GSE provided us with daily data on 13 of the 32 stocks for the period January 1st 2000 to August 30th, 2009. The 13 stocks were selected on the basis that they had been on the exchange market for the sample period January 1st 2000 to August 30th, 2009. The data are the daily prices and the units of volume traded for each security. We divide the overall time period, which contains 1892 trading days, into two sub-periods; before 2004, also referred to as B2004, and after 2004, also referred to as A2004.

Variables examined

We define the following variables associated with trading: VOL_{jf} is the daily volume of trading, that is, the number of shares traded in stock j on day t; $STDEV_{jt}$ is the volatility of daily return, measured by estimates of standard deviation of return. Standard deviation of stock j on day t is measured by a modified range estimator.

$$STDEV_{jt} = \frac{H_{jt} - L_{jt}}{0.5\ (H_{jt} + L_{jt})}$$

$TURN_{jt}$ is the Ghana cedi value of shares traded or turnover, defined as $P_{jt}\ VOL_{jt}$ where P_{jt} is the closing price of stock j on day t. LR1 is liquidity as measured by the ratio $VOL_{jt}/STDEV_{jt}$, LR2 is liquidity as measured by the ratio $TURN_{jt}$ / $STDEV_{jt}$.

We calculate the arithmetic mean of the daily data for each stock. Averages in the before and A2004 periods are distinguished with the prefixes B and A. For instance, $BVOL_J$ is the B2004 average value of VOL_{jt} for $stock_j$. Parts of the analysis involve log relatives, such as the log of $AVOL_J$ / $BVOL_j$ and they carry the prefix L, for example, $LBSTDEV_j$ is the log of the B2004 standard deviation of return of $stock_j$. The grand sample mean for all stocks over a given period is the arithmetic mean of the means for each of the 13 stocks. We are assuming no stock splits in the sample in any of the sub periods. All stock prices are in local currency units (Ghana cedi). Trading volume units provided by the exchange are divided

Table 1. Starting and ending prices and average prices for b2004 and a2004.

Listed companies	Price		Average price	
	Starting	Ending	Before	After
C1	0.046	0.12	0.047	0.123
C2	0.249	0.61	0.422	0.702
C3	0.004	0.05	0.006	0.036
C4	0.042	0.16	0.044	0.155
C5	0.188	3.14	0.371	1.501
C6	0.092	4.5	0.149	2.448
C7	0.075	0.62	0.124	0.648
C8	0.015	0.21	0.024	0.231
C9	0.052	0.21	0.053	0.275
C10	0.08	1.2	0.13	0.764
C11	1.91	38	2.752	21.607
C12	0.015	0.1	0.031	0.049
C13	0.185	4	0.181	2.329
Average	0.227	4.071	0.333	2.375
Min	0.004	0.05	0.006	0.036
Max	1.91	38	2.752	21.61

by 1,000.

TURN is a Ghana cedi value weighted measure of shares traded, which is influenced by both volume and price movements over the time periods. It is included in the analysis because the profits of exchange members depend to some extent on the Ghana cedi value of shares traded, not just on their number. Since traders are concerned with the market's liquidity and this can influence their decisions to use the exchange, we examine several measures of liquidity, LRI and LR2. Most traders prefer that their own trades do not influence prices and that they can execute orders without seeing prices fluctuate widely. In fact, liquidity is often defined as the ability to sell an asset quickly at a price similar to the prior market price assuming no new information has occurred. To capture this market feature, we define the two liquidity measures (Fouse, 1976). The intuition behind them is that if trading volume is heavy, either in number of shares or in currency valued amounts of stock traded, while the price movement is small as measured by standard deviation, then the market is more liquid and investors can trade in large amounts without influencing prices noticeably or without seeing prices move greatly while the order is being executed. More liquid markets are indicated by higher values of LR1 and LR2. By contrast, if price volatility rises without volume rising, liquidity is reduced. In this instance, the denominators of LR1 and LR2 increase and the ratios decline. If volume and volatility move together proportionately, then the liquidity ratios do not change.

RESULTS AND DISCUSSION

Performance of the market

The 13 companies on the stock market were examined. For each stock, beginning and ending prices, average daily trading volume and average daily turnover, before and after 2004 periods have being depicted in Appendix 1. Also portrayed in the table are average daily market capitalization, average daily dividend per share, average daily earnings per share, average daily dividend yield and average daily price earnings ratio. All the companies show a wide dispersion in market characteristics across firms. The average of the average stock price before 2004 was 0.047; the average after 2004 was 0.123. The average stock prices at the B2004 period was ranging between a low of 0.0006 to a high of 2.752 Ghana cedis and after 2004 period, average stock prices was from a low of 0.036 to a high of 21.61 Ghana cedis. This trend is an indication of the market improving upon its performance.

Appendix 2 shows the result from levene's test of a p-value of 0.0747 and F-test of zero (0) to four decimal places. This implies that we reject at 10% significance level the null hypothesis that variability in the average of the average stock prices for before and after 2004 are the same.

The starting and ending stock prices B2004 and A2004 respectively is portrayed in Table 1. The average starting price, in other words, the average prices at the beginning of B2004, range from 0.004 to 1.910, giving an average starting price of 0.227. The average ending stock prices for A2004 range between 0.050 and 38, giving us an average of 4.071. The total period examined was one of generally rising prices. The highest starting stock price was C13 and the lowest company C3. In the case of ending stock prices, the same companies were the highest and lowest respectively. A levene's test of p-value of 0.0491indicates that variability of the starting and ending prices are not the same at 5% significance level and that variability has increased over time, making it very difficult for investors to predict trends in the market.

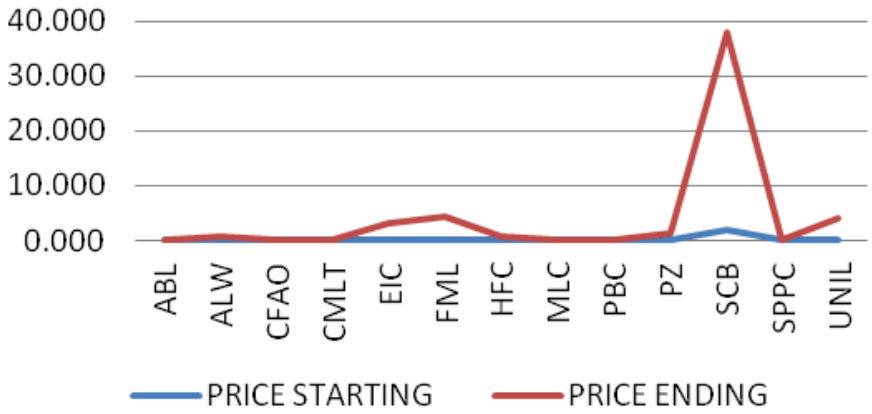

Figure 1. B2004 and A2004 starting and ending prices.

Figure 1 depicts that volatility of the starting stock prices is relatively stable as compared with the ending stock prices. The volatility seems to be high for stocks like C5, 6 and 11. The relatively volatile nature of the ending prices is a good sign of the market doing well.

The average monthly prices of stocks under review for the period under study had low of 0.02 and high of 12.72. The variability in the monthly stock prices has been high for stocks like C5, 6, 10, 11 and 13 as shown in Figure 2. The variability here was measured by the difference between the highest and lowest stock price for the period under study for each stock. The stock prices registered significant price fluctuation during the 2004 to 2005 and the second and third quarters of 2009. The fluctuation as shown in Figure 2 is an indication of high standard deviation in monthly stock prices registered by C11, 6, 13 and 5 respectively. The high volatility in these stocks was confirmed by the high volatility in their returns as well, as shown in Table 2.

The average stock prices for 13 selected companies on Ghana Stock Exchange are depicted by Table 2. The highest stock prices before 2004 was Gh¢ 2.752 (C11) and the lowest Gh¢ 0.0006 (C3). At end of the period under review the highest stock price was Gh¢ 38 (C11) and the lowest Gh¢ 0.04 (C3). The sharp change in stock price over the years is an indication of the stock market performing well over the second period (ending). All the 13 listed companies under review as shown in Table 1 recorded an appreciation in the average stock prices over the years. The average of the average stock prices of the 13 companies B2004 was 0.333 and increased to 2.375 during A2004.

The variability of the average stock prices as shown in Figure 3 is confirmed by the standard deviation computed in Appendix 1. From Figure 3, A2004 is more volatile than B2004. The average volatility during B2004 is 0.14 and that of A2004 is 1.08. The high volatility during A2004 is accounted for by the high volatility of C11 (10.01), C6 (1.29), C13 (0.99) and C5 (0.936). The increase in volatility of average stock prices over time is an indication of the market's improving performance over time.

The trend of average returns for the listed companies under study as shown in Figure 4 gives an indication of the market not doing well. The mean return, where return is defined as the log price relative of ending prices over beginning price and excludes dividends, are as depicted in Figure 4. The average of mean returns of the listed companies under study as at B2004 was 0.00151 with an average standard deviation of 0.018. For the period A2004, the average of the mean returns was 0.0009 and with a standard deviation of 0.097. Four (4) out of the thirteen (13) listed companies increased in prices over the period whiles nine (9) companies declined in prices below that of B2004 average returns. The minimum and maximum average returns for B2004 are -0.00005 and 0.0027 respectively while the minimum and maximum for A2004 are 0.0003 and 0.002 respectively.

The increase in standard deviation over the period is an indication of an improved efficiency in the market. This is because the chances of one predicting the trend of return are becoming more difficult with time. Also the trend of average returns as depicted in Figure 4 shows signs of mean reverting as the variation in the average returns are around the mean.

After stock prices have been deflated by inflation, it came out that six (6) of the companies under review experienced increase in prices after 2004, whiles seven (7) companies declined in stock prices. That is two more companies that were previously classified as not performing are now seen as companies doing well. The implication here is that an economy of low inflation rate enhances performance of companies. This could be the likely reason why most companies in developing countries which are often characterized by high inflation rate are seen not to be doing well. This could be the likely reason why most capital markets in developing countries are classified as inefficient.

Assuming dividends to be zero, return on an

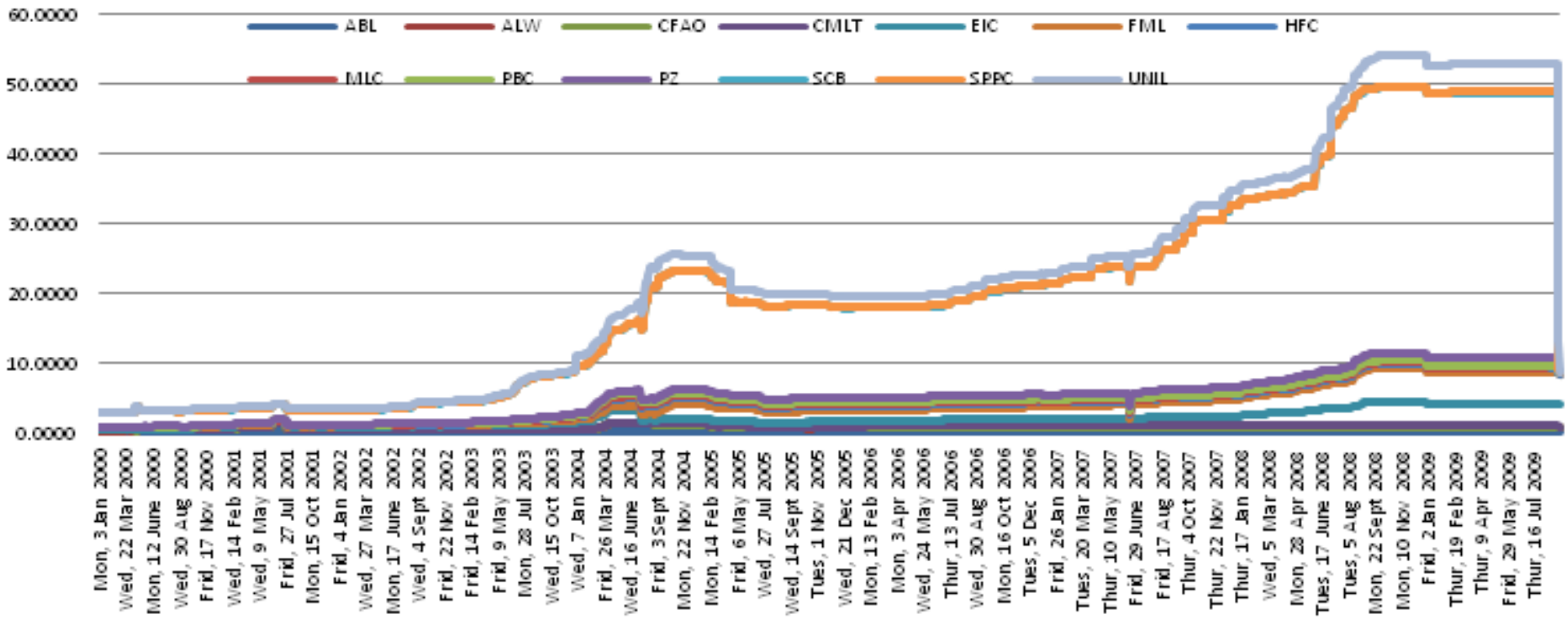

Figure 2. Daily stock prices between January 2000 and August 2009.

Table 2. cross sectional regression of volume.

	Coefficient	Standard error	t-Statistic	Prob.
C	2.388751	0.838417	2.849120	0.0158
LBVOL	0.373341	0.213345	1.749937	0.1079
R-squared	0.148089	Mean dependent variable		3.750311
Adjusted R-squared	0.070642	S.D. dependent variable		0.545501

Variable: LAVOL;
Method: Least squares;
Date: 05/22/11 Time: 22:35;
Sample: 1 13;
Included observations: 13;
White Heteroskedasticity-Consistent standard errors and covariance.

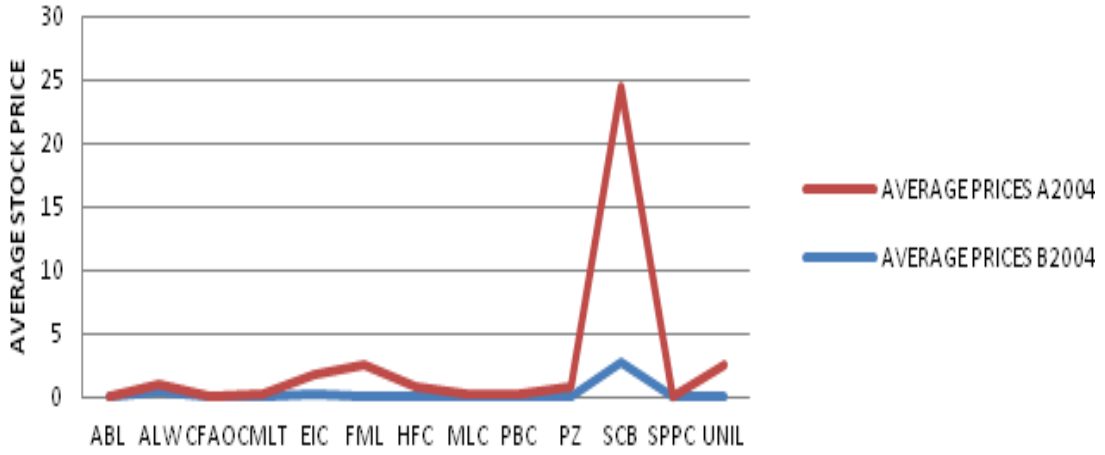

Figure 3. Average stock prices the period 2000 to 2009.

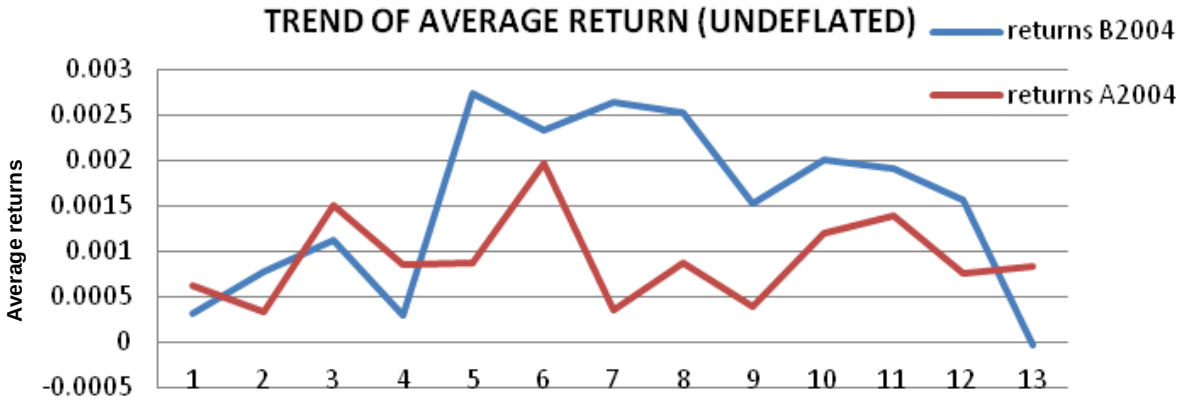

Figure 4. Trend of nominal average return.

investment will be equal to the capital gain. The mean return, where return is defined as the log price relative of current price over previous price is 0.029 with standard deviation of 0.164. The maximum and minimum returns are 0.765 and -0.670 respectively. The second and third moment of returns of the 13 stocks are 0.578 and 9.398 respectively. All the prices of 13 stocks reviewed over the entire period rise over the period.

Market liquidity

Before 2004 volume, which is the mean total volume of shares traded in the B2004 period ranged from a low of 449.836 shares per day to a high of 34689 shares. After 2004, mean total shares volume traded also ranged from a low of 475.06 shares per day to a high of 25508.601 shares per day as depicted in Appendix 3. This gives an average reduction in growth rate by 6% (constant growth rate assuming 'n' to be 5 years that is 2004 to 2009) for the maximum average shares traded for the period under review. In the case of the minimum average volume of shares traded, it grew marginally at a constant rate of 1%. The average of the mean total shares volume traded B2004 was 9210 and A2004 was 9417 shares indicating a growth rate of only 0.4 %.

Examining the behavior of volumes of stocks, since the scale of volume differs drastically from stock to stock, we calculated the log volume for each of the 13 selected listed companies for this research.

$$LVOL_j = log\ [(\frac{1}{T_A}\sum_{t=1}^{T_A} VOL_{jt})\ /(\frac{1}{T_B}\sum_{t=1}^{T_B} VOL_{jt})]$$

Where T_B and T_A are days before 2004 and after 2004 respectively.

The volumes of shares traded on the Ghana Stock

Exchange over the period under review have seen significant improvement. Of the 13 stocks, eight (8) of them experienced a reduction in volumes of shares traded whiles five (5) stocks experienced an increase over the period under review. The log mean of volumes of share B2004 is 0.13 and this decreased slightly to 0.103 after 2004. Since the scale of volume differs drastically from stock to stock, we computed the log volume relate.

The log mean of LVOL for the 13 stocks under review is 0.103 and volatility which is measured by the standard deviation was 0.615, indicating unsubstantial volume increases by a large dispersion in the magnitude of the volume increases and decreases across individual stocks. The volatility of volumes of shares traded on the market had ranged between the maximum and minimum LVOL for stocks which are 1.125 and -0.992 respectively as depicted in Appendix 3. The volatility of volume shares traded for period A2004 increased by a constant rate of 10% of the volatility of B2004.

Using the distributions of LBVOL and LAVOL, we compute cross-sectional t-values as shown in Table 2. The parametric t-statistic of 2.85 for the constant is significant in that coefficient of the constant term was estimated with a fair amount of accuracy at significant level of 1%. In other words the coefficient of the constant term is at least three times as large as its standard deviation.

In the case of the variable LBVOL, its coefficient is less than twice the standard error of the variable giving t-statistic of 1.75 with a p value of 0.11. The low t-statistic for coefficient of LBVOL implies that the coefficient is insignificant at all the traditional conventional significant levels and hence LBVOL has no significance relationship with LAVOL.

The p value of the constant term of 0.0158 implies it is significant at 1% significant level. In the case of the variable LBVOL the p value of 0.11 makes it insignificant at all the conventional significant levels. By implication LBVOL is not different from one (1). This is because P value is greater than all the conventional significant levels and hence we do not reject the null hypothesis and that the difference is not statistically significant. The R^2 of 0.15 is a statistic that gives information about goodness of fit of the model. Measuring the proportion of the variation in the dependent variable accounted for by the explanatory variable, it came out that adjusted R^2 of the regression of 0.07, indicates that LBVOL does not depend on LAVOL as shown in Table 2. This also means that one cannot predict volumes with information on previous volumes and that is a mark of efficiency.

Solving the equation for AVOL, the model is approximately $AVOL_j = e^{2.389} BVOL_j$. This means that the efficiency of the market does not tend to cause greater trading volumes increases in stocks with higher or lower volumes of trading before 2004. There are proportionate increases in trading volumes across all stocks regardless of their initial trading volumes. The estimate of the factor by which trading volumes increase is $e^{2.389} = 10.9$. In other words, there have not been significant (significant level 10%) increase in the volumes of shares traded over the period under review. This parametric test slightly conflict with the earlier nonparametric test but both reject the null hypothesis of no change in trading volume across the two periods.

Appendix 4 portrays the liquidity measure for this thesis as the daily trading range scaled by mean daily price. The volatility of the nominal average share prices for the periods before and after 2004 are 0.14 and 1.1 respectively. That gives an increase in nominal average share price volatility of more than 100% (140%). When the daily trading prices were deflated the mean values of standard deviation across stocks before and after 2004 were 0.008 and 0.515, with a standard deviation of 0.016 and 1.28 respectively which also translate into more than 300%.

The mean nominal liquidity (LR) of stock traded for the periods B2004 and A2004 are 884368 and 345109 respectively and that of real liquidity of stocks traded are 2170406 low and 544312.5 high. This translates into a decrease in nominal liquidity by 83% and that of real liquidity by 76%. The liquidity of shares has also varied over the period. In the case of the nominal data liquidity for B2004 ranges between a low of 1868.16 to high of 4480166 whiles that of real volatility ranges between a low of 114764.7 to a high of 8849970.

Hypothesis testing on equality

To make the strongest possible conclusion from limited amounts of data we need to overcome the problem of biological variability and experimental imprecision. Statistical analyses are most useful when we are looking for differences that are small compared to experimental imprecision and biological variability.

From Appendix 2, the resulting p-value of levene's test of 0.068 is greater than critical values of 5 and 1%. This means that the obtained differences in sample variances are likely to have occurred based on random sampling, hence the variance in the LR nominal for B2004 and A2004 liquidities are the same. With a critical value of 0.1 the differences in sample variances are unlikely to have occurred based on random sampling, hence the null hypothesis of the variance being the same is rejected. In the case of differences in the means of the liquidity for the two periods a t-test of a p-value of 0.229, we fail to reject the null hypothesis that they are the same under all the conventional critical values.

In the case of real liquidity (LR real), the resulting p-value of levene's test of 0.0061 is less than all conventional critical values. This means that the obtained differences in sample variances are unlikely to have occurred based on random sampling, hence the variance

Table 3. Volatility of volumes of shares traded.

	Coefficient	Standard error	t-Statistic	Prob.
C	2.388751	0.838417	2.849120	0.0158
LBVOL	0.373341	0.213345	1.749937	0.1079
R-squared	0.148089	Mean dependent variable		3.750311
Adjusted R-squared	0.070642	S.D. dependent variable		0.545501

Method: Least squares; Date: 05/26/11 Time: 08:31; Sample: 1 13; Included observations: 13; White Heteroskedasticity-consistent standard errors and covariance.

in the LR real for B2004 and A2004 are not the same, indicating a change in liquidity on the Ghana Stock Exchange (increase). In the case of differences in the means of the liquidity for the two periods a t-test of a p-value of 0.06, we do not reject the null hypothesis under the critical values of 5 and 1%, but under 10%, we reject the null hypothesis that they are the same. In other words we fail to reject the null hypothesis that they are the same under critical values of 10%.

If the resulting p-value of Levene's test is less than some critical value (typically 0.05), the obtained differences in sample variances are unlikely to have occurred based on random sampling. Thus, the null hypothesis of equal variances is rejected and it is concluded that there is a difference between the variances in the population.

Appendix 5 gives the descriptive summary of volume relative LVOL. The mean of LVOL, across the 13 stocks is 0.103348 with a standard deviation of 0.61, indicating not an impressive volume increases but a large dispersion in the magnitudes of the volume increases across individual stocks. The cross sectional distribution of LVOL is normally distributed since the p-value of Jarque-Bera test is 0.847. Seven (7) of thirteen (13) stocks under review saw an increases in the volume of stocks and six (6) stock volumes dropped. In the case of nominal turnover (LNTVER) two (2) of the thirteen (13) experienced a drop in turnover over the period and eleven (11) had their turnover increasing. Relative to real turnover (LRTVER), twelve of the thirteen companies under review had their real turnover increasing over the period.

Even though we have more stocks increasing in volumes over the period, the cross-sectional t-value using the distributions of log of mean volumes before and after 2004 (LBVOL and LAVOL) gave a t-value of 0.47565, suggesting that the change in volumes across the different stocks under review were not significant. In other words the change in volume of shares traded after 2004 is not significant even though there are some positive changes over the period as portrayed in Appendix 5.

In spite of the aforementioned findings, we regress LAVOL against LBVOL cross-sectional to see if trading volumes tends to increase proportionately across all stocks regardless of their initial trading volumes. Table 3 portrays the findings. An R^2 of 0.15 mean that the coefficient of LBVOL is not significant and must be ignored. Also t-value of 2.85 and 1.75 for the constant term and LBVOL implies that the constant term is significant at 5% significant level whiles that of LBVOL is insignificant. This confirms the earlier finding of changes in trading volumes not being significant. To put it in another way, changes in volume across the stocks is not accounted for by before 2004 volumes (BVOL) of the stocks under review. Put in another way, when BVOL is nil AVOL would increase by $e^{2.38} = 10.8$. The implication here is that the percentage increase or decrease of volatility of volumes of shares traded for 13 stocks is the same for both stocks that began with low volatility and those that began with high volatility.

Volatility returns

The behavior of volatility of the stocks under review was measured using daily trading range scaled by the mean daily price. A data showing daily trading volatility and on the liquidity ratio (LR) for each stock is presented in Appendix 4. To be consistent with volumes, we take the log of the before and after nominal (real) standard deviation, calling them N(R) LBSTDEV and N(R) LASTDEV respectively.

The maximum and minimum average volumes of shares traded Before 2004 are 373898.118 and 2281.267 and that of the period after 2004 are 413143.12 and 4177.698 respectively. The mean values shares traded across the 13 stocks for the periods B2004 and A2004 are 77115.14 and 124602.37 respectively. That gives an increase in the mean volume of shares traded by 10% at a constant growth over the period under review.

The mean nominal volatility of returns (NLBSTDV) for the period before 2004 is 4.55 and that NLASTDV went to 4.76 giving a constant growth rate of 4.6% for the period. The nominal volatility of returns for the period under review ranges from a low of 3.36 to high of 5.57 for period B2004. For the period A2004, nominal volatility of returns was between a low of 3.62 to a high of 5.62. The real mean volatility of returns (RLBSTDV) for the period B2004 is 3.25 and that of A2004 (RLASTDV) 4.24 translated into a constant growth rate of 31%. Real volatility of returns for period B2004 fluctuates between a

Table 4. volatility changes.

NLASTDV = α +β NLBSTDV				
	Coefficient	**Standard error**	**t-Statistic**	**Prob.**
C	3.304558	1.302440	2.537205	0.0276
NLBSTDV	0.320570	0.277647	1.154598	0.2727
R-squared	0.086410	Adjusted R-squared		0.003357
RLASTDV= α +β RLBSTDV				
C	2.214360	0.693435	3.193320	0.0086
LRSTDEV_B2004	0.621587	0.191053	3.253485	0.0077
R-squared	0.360463	Adjusted R-squared		0.302323

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low of 1.83 to high of 4.38 as shown in Appendix 5. For the period A2004, real volatility fluctuated from a low of 2.56 to high of 5.77. Comparing the percentage for nominal and real volatility of returns shows that volatility of returns increased significantly for real returns over the period under review.

We again regress after 2004 volatility against before 2004 volatility cross-sectional to see if trading volatility tends to increase proportionately across all stocks regardless of their initial trading volatility. In the case of the nominal volatility, we regress NLASTDV against NLBSTDV and then RLASTDV against RLBSTDV. The regression result is shown in Table 4.

The value t-statistic of 1.155 for the variable NLBSTDV is smaller than two (2) hence making the variable insignificant in explaining the variations NLASTDV. In other words the nominal volatility of B2004 does not explain the nominal volatility of A2004.

The result gave a t-test value of 1.16 with a p-value of 0.27 fail to rejects the null hypothesis that nominal volatility (NLBSTDV) is unchanging and that difference is statistically insignificant. In the case of real volatility of returns (RLBSTDV) t-value of 3.25 strongly reject the null hypothesis at all the conventional significance levels. In other words real volatility has been changing over the period.

In answering the extent to which volatility changes occur throughout the sample, we use simple regression to regress the log of after 2004 nominal (real) standard deviation (N(R) LASTDV), the criterion variable, against log of before 2004 nominal (real) standard deviation ((N(R) LBSTDV), the predictor variable to determine the extent to which N(R) LBSTDV explains N(R) LASTDV. We compare the results of the nominal variables and that of real variables as shown in Table 4. R^2 of 0.003357 for nominal volatility of returns and 0.3023 for real volatility of returns implies that volatility in returns before 2004 does not explain volatility of after 2004. The same was the finding in case of real volatility. This implies that there had being no changes in volatility over the years for both situations. Comparing the R^2 of both nominal and real volatility even though there had not been changes in volatility over the period, volatility tends to be high relatively nominal volatility. Deflating the daily stock prices improves on the explanatory power of the nominal and real variables and this point to the fact that high inflation has significant effect on market efficiency. The intercept of 3.31 in the case nominal volatility and 2.21 in the case of real volatility suggest that if the volatility for before 2004 are nail variations in after 2004 would be $e^{3.31}$ = 27.39 for nominal volatility and $e^{2.21}$= 9.12 in the case real volatility. The implication here is nominal volatility is higher than real volatility. The percentage increase of volatility in volume of shares traded is the same for both lower and higher volatility stocks in this model. For instance, if two stocks begin with volatility of 0.006 and the other 0.03, the fitted model relation predicts after 2004 volatility (LASTDV) values of 0.0527 and 0.261 respectively. This suggests that performance of the market in relation to volatility over the years have improved since changes in volatility for the thirteen stocks under investigation is accounted for by volatility B2004. Hence the resultant changes in volatility (LASTDV) can be attributed to improvement in performance of the market over the period.

The coefficients of nominal volatility of returns indicate that the percentage increase of volatility is greater for the lower volatility stocks, while in the case of real volatility of returns is the opposite. For instance if two stocks begin with STDV values of 0.006 and 0.03, the fitted model relation predicts after 2004 values in the case of the nominal volatility as 0.164 and 0.822 respectively. In the case of real data, the following results were predicted 0.055 and 0.274. Comparing the percentage change in the prediction from the model, nominal data indicates that percentage increase of volatility is greater for the lower volatility stock which gave us 7.67% points while the higher volatility stock gave us 5.33% points. The result was different for real data. Lower volatility stocks had 4.83% point whiles that of higher volatility stocks

Table 5. cross sectional regression of volumes of shares traded.

NLR_AVOL = α + β NLR_BVOL				
	Coefficient	**Standard error**	**t-Statistic**	**Prob.**
C	0.085288	0.026597	3.206651	0.0084
NLR_BVOL	0.138816	0.202067	0.686979	0.5063
R-squared	0.020988	Mean dependent variable		0.103408
Adjusted R-squared	-0.068013	S.D. dependent variable		0.036323
DLR_AVOL = α + β DLR_BVOL				
C	0.324065	0.083293	3.890661	0.0025
DLR_BVOL	0.607612	0.110460	5.500735	0.0002
R-squared	0.566108	Mean dependent variable		0.748692
Adjusted R-squared	0.526664	S.D. dependent variable		0.062329

recorded 5.3% points. The implication here is that after 2004, volatility of stocks in the case nominal data brings greater increases in volatility to the markets for the lower volatility of stocks. In the case of the real data it brings lower increases in the volatility to the markets for the lower of volatility stocks.

Liquidity

The measure of liquidity here is ratio of volume of shares traded to the volatility. The behavior of the liquidity ratio depends upon which increases more, volumes of shares traded or volatility of the shares. If the percentage changes in volume far exceed those in volatility, we expect liquidity (LR) to increase, whiles when the percentage changes in volatility far exceed those in volume, LR is expected to reduce. In computing the liquidity of the capital market Ghana we took the log of the B2004 and A2004 volumes of shares traded in all the thirteen (13) stocks been studied.

Appendix 5 again shows data on real and nominal liquidity of the market. The average liquidity of shares traded for the period B2004 (LR-BVOL) and the period A2004 (LR-AVOL) were 0.13 and 0.103 respectively depicting a fall 21% in liquidity over the period. From the real data analysis, average liquidity of shares traded for period B2004 (DLR – AVOL) and the period A2004 (DLR – AVOL) were 0.699 and 0.7487 respectively. This translates into increase of 7% at constant growth rate for the period. The real mean liquidity of shares traded for the period ranges between a low 0.551 to a high of 0.836 for DLR-BVOL and a low of 0.6244 to high of 0.8227 for DLR-AVOL.

We now look at the cross – sectional relation or both types of data (real and nominal) by regressing NLR-AVOL against NLR-BVOL and also DLR-AVOL against DLR-BVOL and the results are give in Table 5. Results from the regression, shows that the intercepts for both nominal and real liquidity were all significant. The variable NLR-BVOL with a t-value of 0.69 is insignificant and that of DLR-BVOL tend out significant with a t-value of 5.5. The adjusted R^2 of 0.53, for real liquidity indicates that DLR-BVOL does not explain DLR-AVOL. The percentage increase of nominal liquidity is higher for lower nominal liquidity stocks and lower for higher nominal liquidity stocks. In the case real liquidity the opposite was the case. For instance, if two stocks with B2004 nominal liquidity ratios of 0.03 and 0.006, the fitted model relation predicts A2004 nominal liquidity the change by the same percentage. Hence there is no tendency for stocks with lower initial liquidity to have their liquidity increase or stocks with initial high liquidity to have the tendency to drop in liquidity significantly. The same results were arrived with real liquidity. The interesting finding was that nominal liquidity for the period A2004 is more sensitive to changes in DLR-BVOL.

Returns

We then turn attention to the relation between volume changes and the accompanying returns, and changes in standard deviations. GSE over the period under study experienced high fluctuating inflation rate. To certain whether GSE has been efficient and also whether the efficiency of the market (GSE) has caused volume of shares traded to increase, we examine the cross-sectional relation between volume changes and the accompanying returns and changes in standard deviations. We also compare real and nominal data to ascertain the effect of inflation on market efficiency.

We regress the volume relative LVOL upon stock return calculated using the nominal data in the cross section. The result from the regression was as depicted in Table 6. The intercept of 0.109 measures the volume relative occurring when nominal returns are nail. With a p-value of 0.57 the intercept is significantly different from zero (t = 0.59). This suggests that volume would have risen by a factor of $e^{0.109}$ (1.115) in the case of the nominal data

Table 6. cross sectional regression:volumes relative on stocks returns.

LVOL = α + β NRETURNS + ε				
	Coefficient	**Standard error**	**t-Statistic**	**Prob.**
C	0.109231	0.186358	0.586136	0.5696
NRETURNS	0.009513	0.016043	0.592957	0.5652
R-squared	0.007063	Mean dependent variable		0.1033
Adjusted R-squared	-0.083204	S.D. dependent variable		0.6145
LVOL = α + β NRETURNS + β NRETSTDV + ε				
C	0.041129	0.237238	0.173367	0.8658
NRETURNS	0.024407	0.017012	1.434725	0.1819
NRETSTDV	0.010956	0.01063	1.03062	0.327
R-squared	0.032359	Mean dependent variable		0.1033
Adjusted R-squared	-0.16117	S.D. dependent variable		0.6145
NLR = α + β NRETURNS + ε				
C	0.859014	0.097668	8.795233	0
NRETURNS	0.023132	0.006934	3.335953	0.0066
R-squared	0.130806	Mean dependent variable		0.8447
Adjusted R-squared	0.051789	S.D. dependent variable		0.3473
LVOL = α + β RRETURNS + ε				
C	0.122466	0.150795	0.812131	0.4339
RRETURNS	0.022842	0.086915	0.262809	0.7976
R-squared	0.016508	Mean dependent variable		0.1033
Adjusted R-squared	-0.0729	S.D. dependent variable		0.6145
LVOL = α + β RRETURNS + β RRETSTDV + ε				
C	0.089524	0.214394	0.417569	0.6851
RRETURNS	0.021228	0.090534	0.234481	0.8193
RRETSTDV	0.007061	0.016315	0.432783	0.6744
R-squared	0.022788	Mean dependent variable		0.1033
Adjusted R-squared	-0.172654	S.D. dependent variable		0.6145
RLR = α + β RRETURNS + ε				
C	1.084607	0.022694	47.79192	0
RRETURNS	0.009748	0.0072	1.35381	0.203
R-squared	0.169354	Mean dependent variable		1.0764
Adjusted R-squared	0.09384	S.D. dependent variable		0.0819

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even if the market returns does not change. We then added the nominal volatility of returns (NRETSTDV) to the variable (NRETURNS) and coefficient which was initially rejected has now improved even though it is still insignificant with t- statistic of 1.44. R^2 also increased from 0.7 to 3.2% signifying an improvement in the explanatory power of the variables. If we assume that NRETURNS and NRETSTDV is nail the LVOL will change be $e^{0.0411}$ (1.042). The coefficients NRETSTDV of 0.011 with t-statistic of 1.032 was not significant and hence rejected.

We then regress nominal liquidity (NLR) to NRETURNS. Since the denominator already incorporates volatility, we only explain the variable by return. R^2 in this case is 13% the coefficient of NRETURNS was 0.0231 with t-statistic of 3.34 is significant with a p-value of 0.0066. The NRETURNS explain 13% of the cross-sectional variation in nominal liquidity of returns (NLR) relative. The intercept is 0.86 with t-statistic of 8.8 a reduction compared with looking at the mean of 0.845 of

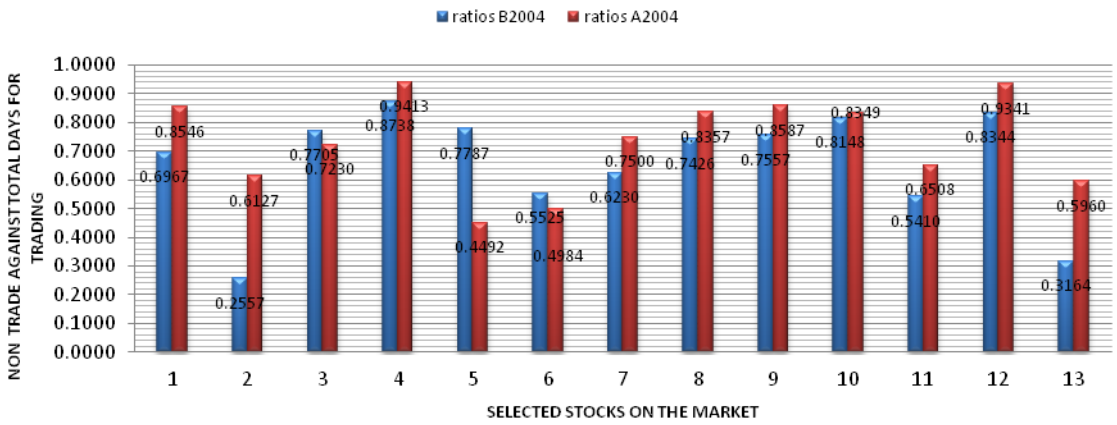

Figure 5. Ratio of non trade to total number of trading days.

NLR. What is of more importance to this paper is that there are increases in the nominal liquidity of shares traded, after taking the effect of brought about by the rise in market prices. The implication here is the liquidity of the market over the period under review had increased.

We now turn our attention to real data and perform the same regression analysis. Regressing the volume relative (LVOL), upon real stock returns (RRETURNS) in the cross section gave the following results as portrayed in Table 5. 10 level 4. From the model RRETURNS explains 1.7 of the variations in LVOL and the coefficient of RRETURNS is 0.023 with a t-statistic of 0.26. This implies that variable is not significant so is the constant term. Including the real volatility of returns to model did not improve on the explanatory powers of the variable and the constant term. To control the possible effect of returns on volumes of shares traded, regress RLR (real liquidity of returns) against returns. The result is shown in Table 5. 10 depicts that the intercept is very significant while real returns tend out to be insignificant.

Return distributions

Swee-Hock (1989) summarizes several studies of serial correlation of returns in the Singapore market that examine index of stocks and or weekly data. Hong (1985) finds that serial correlations average 0.063 for ten stocks using weekly data in the 1973 to 1976 period and also Baily et al. (1990). From these works we also extend the analysis of the efficiency of the security market of Ghana to the distribution of returns (nominal and real) themselves and to tests of random walk hypothesis, especially the serial correlation in returns. We report new findings from the Ghana Stock Exchange, using tests of daily nominal and real returns on 13 selected individual stocks on the market. Regarding theories that predict how return (nominal and real) distributions change and how serial correlation alters when nominal and real data is used, we have very little literature on it.

An important parameter of interest in this research is the extent to which stocks do not trade. If it said that an efficient market broadens the market, enhance liquidity, volume, and the development and dispersal of information, and then it is reasonable to expect that stocks not only will trade more frequently during days when they trade, but also will trade on more days as against not trading at all. This can happen because of increased chances of matching up traders. Naidu and Rozeff (1994).

Figure 5 shows the ratio of days for each stock in which the stock did not trade for B2004 and A2004. The average ratio of non trade days to total trading days for B2004 is 0.66 and that of A2004 is 0.73. The increase in the average ratio is indication of non trading days increasing during A2004 a mark of inefficiency. Even though we had increase in the average ratio, three stocks experienced a reduction non trading days and ten stocks experienced increases non trading days. The significant increase of 12% in the non trading days for A2004 is a result of a significant increase (140%) in the non trading days for stock two (2). It worth noting that even if stock two is ignored, non trading days increased for the period A2004 as against B2004. This evidence point to the fact that the capital market over the years have not being able to increase volume of trading which is expected of a performing market.

We now turn to analysis of serial correlation of real and nominal returns. Most often used statistic of interest when studying stock markets is serial correlation in returns. This is because of the ramifications that it has for studying markets. If returns (nominal and real) distributions are stationary and if returns are drawn at random from the distributions, the serial correlations are zero (0). The work of Cohen et al. (1980) revealed that none zero serial correlations are hypothesized to arise from, among other things, infrequent trading, market over reaction and market under reaction. In this analysis it is expected that

Table 7. Serial correlation of real and nominal returns.

	Serial correlation		t-Statistic of the regression (nominal)		Serial correlation (Real)		t-Statistic of the regression (Real)	
	Before	**After**	**Before**	**After**	**Before**	**After**	**Before**	**After**
C1	0.00025	0.0381	0.435024	1.602566	-0.00772	-0.01111	-0.83109	-0.604317
C2	0.0520	0.2788	0.924068	3.140731	-0.01358	0.246337	-0.273746	2.924185
C3	0.0127	0.0244	0.720515	0.694153	8.05E-05	0.027586	0.010474	1.449847
C4	-0.0185	0.0928	-1.728691	1.114383	-0.00021	0.043374	-0.086632	0.939279
C5	0.0268	0.0203	0.733063	0.997437	0.000243	0.019668	0.009923	1.051225
C6	0.0117	0.1750	0.591965	2.48671	0.009852	0.141539	0.655942	1.856943
C7	0.2168	-0.1027	2.90808	-0.559689	0.079605	-0.00808	1.744331	-0.059153
C8	-0.0085	0.4632	-1.860456	3.689918	0.011659	0.271341	0.906058	2.390654
C9	0.3185	0.4120	3.331739	3.144785	0.123637	0.389807	2.068649	2.148942
C10	-0.0068	-0.0325	-1.480767	-3.634767	0.027219	0.008832	1.561775	0.330494
C11	-0.0106	0.2311	-1.625985	1.60148	0.003452	0.096817	0.600269	1.255645
C12	-0.0093	-0.0016	-1.534629	-0.999177	-0.00147	0.016362	-0.460334	2.945902
C13	0.0000	-0.0011	-0.065576	-0.011124	0.009665	0.041139	0.942244	0.628396

if the market is perfect and efficient, serial correlation should diminish. We would be comparing serial correlation of the nominal data and that of real data to determine which has serial correlation diminishing the more.

The correlation Table 7 shows the serial correlations of returns for the 13 stocks and also the t-values of the lagged returns in the before and after periods. The table also gives information about the p-values and r^2 of the regression. When stocks do not trade, the returns for that day and the following day are not dropped from the sample but included. The serial correlation of returns over the period tends to be increasing after 2004 for nominal and real returns. Regression of nominal returns and lag nominal returns assuming white heteroskedasticity – consistent standard errors and covariance results gave five (5) significant t-values in the after 2004 and only two (2) significant t-values for before 2004. The implication here is that the ability to predict next day's nominal returns base on today's nominal return is possible. The predictability of nominal returns did not diminish after B2004 but rather became more predictable afterwards. This is an indication of efficiency in the market and became worst after 2004 as the serial correlation for the nominal returns increased in ten (10) of the thirteen (13) stocks and declined in three (3) others. The increase in the correlation was skewed to A2004. Also worth mentioning is the change in signs of the serial correlation. In the before period for the nominal returns, there were 8 positive serial correlations. The implication of this is that the market is not random and consistent with stock prices that do not fully respond to information or other trading pressures within a given day. The after period, 9 out of the 13 stocks had their signs being positive. The pattern indicates that the systematic factors causing positive correlation in the before period did not vanish after the period but rather increased marginally. In summary, the serial correlation of nominal returns give the impression that the after 2004 nominal return series does not approximate the random walk ideal. In other words the inefficiency of the market did not improve over the period.

In the case of real returns we had eleven (11) out of the thirteen stocks increasing in correlation after 2004. This is just a marginal increase over the nominal returns correlation. The result from serial correlation of the real returns was not much different from that of the nominal returns. In respect of the signs of the serial correlation coefficients four (4) were negative and nine (9) positive for the period B2004 whiles we recorded two (2) negatives and eleven (11) positives for the period A2004 confirming that returns for both real and nominal are random and predictable.

Conclusion

The average of the average stock price before 2004 was 0.047 and this increased to an average of 0.123 after 2004. This shows an increase in the market index of 261% over the period. Levene's test confirms that increase in the average prices for before 2004 and after 2004 is significant.

The volatility of the starting stock prices is relatively stable as compared with the ending stock prices. The volatility was high for stocks like C5, C6 and C11. The relatively volatile nature of the ending prices is an indication of the market doing well.

The growth rate of the maximum average number of shares for period under review reduced by 6% and that of the minimum average shares grew marginally at a constant rate of 1%. The average of the mean total shares volume traded B2004 grew at a rate of 0.4%. Of the 13 stocks, eight (8) of them experienced a reduction

in volumes of shares traded whiles five (5) stocks experienced an increase over the period under review.

There was an unsubstantial increase in the log mean of LVOL and a large dispersion in the magnitude of the volume increases and decreases across individual stocks. The volatility of volume shares traded for period A2004 increased by a constant rate of 10% of the volatility of B2004. The implication here is that after 2004, volatility of stocks in the case of nominal data brings greater increases in volatility to the markets for the lower volatility of stocks. In the case of the real data it brings lower increases in the volatility to the markets for the lower volatility stocks.

It was also realized that LBVOL does not determine LAVOL and that the efficiency of the market proportionately increases trading volumes across all stocks regardless of their initial trading volumes. This parametric test slightly conflict with the nonparametric test but both reject the null hypothesis of no change in trading volume across the two periods.

It was again established that volatility increased for both real and nominal average share prices but that real average shares prices was twice that of the nominal average share prices. In the case of liquidity, the market was more liquid for nominal data that of real data.

Seven (7) of thirteen (13) stocks under review saw an increases in the volume of stocks and six (6) stock volumes dropped. In the case of nominal turnover (LNTVER) two (2) of the thirteen (13) experienced a drop in turnover over the period and eleven (11) had their turnover increasing. Relative to real turnover (LRTVER), twelve of the thirteen companies under review had their real turnover increasing over the period.

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Appendix 1. Average stock market characteristic by firms (2000 to 2009).

	Turnover		Price		Average price (nominal)		Total shares traded		Issued shares		Market capitalization		Div per share		EPS		Per ratio	
	Before	After	Starting	Ending	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After
1	0.135	0.223	0.046	0.12	0.047	0.123	29412	19978.319	123	246.83	0.005	0.03	0.001	0.017	0.002	-0.08	51.048	32.66
2	1.003	0.869	0.249	0.61	0.422	0.702	25416	14426.232	30.79	41.815	0.013	0.028	0.05	0.678	0.123	-0.64	4.452	33.21
3	0.002	0.092	0.004	0.05	0.006	0.036	3647.5	25508.601	86.57	227.43	0.001	0.008	0	0	0.003	0.04	1.719	10.707
4	0.02	0.007	0.042	0.16	0.044	0.155	4666.9	475.06	6.54	8.089	0	0.001	0.096	0.221	0.004	0.16	23.709	42.462
5	0.106	1.231	0.188	3.14	0.371	1.501	1928.2	7557.726	5	30.034	0.002	0.038	0.017	0.253	0.095	0.1	4.053	15.274
6	0.022	1.4	0.092	4.5	0.149	2.448	1626.9	5468.455	19.78	20.093	0.003	0.046	0.008	0.768	0.029	3.37	4.811	10.24
7	0.386	1.003	0.075	0.62	0.124	0.648	34689	17254.712	66.06	100.05	0.009	0.042	0.004	0.095	0.013	0.51	9.787	31.802
8	0.062	0.072	0.015	0.21	0.024	0.231	21886	3519.713	40.08	49.205	0.001	0.011	0.002	0.067	0.005	0.46	4.981	15.988
9	0.035	0.953	0.052	0.21	0.053	0.275	3685.4	32047.44	480	479.28	0.025	0.128	0	0	0.002	0.07	22.673	0
10	0.004	0.061	0.08	1.2	0.13	0.764	449.84	724.536	28	27.992	0.004	0.022	0.004	0.175	0.03	1.33	6.744	12.923
11	0.53	3.386	1.91	38	2.752	21.607	2291.6	1620.692	16.91	17.783	0.047	0.368	0.379	1.15	0.668	26.9	4.063	13.231
12	0.01	0.024	0.015	0.1	0.031	0.049	2924.3	7926.49	18.05	22.638	0.001	0.001	0.001	0	0	0.07	11.946	17.735
13	0.271	4.518	0.185	4	0.181	2.329	15017	12317.723	62.5	62.618	0.023	0.141	0.039	0.102	0.076	4.35	5.855	12.117
AVERAGE	0.199	1.064	0.227	4.071	0.333	2.375	11357	11448.13	75.6	102.6	0.01	0.066	0.05	0.271	0.08	2.8	12	19.1
MIN	0.002	0.007	0.004	0.05	0.006	0.036	449.8	475.06	5	8.089	0	0.001	0	0	0	-0.6	1.72	0
MAX	1.003	4.518	1.91	38	2.752	21.61	34689	32047.44	480	479.3	0.047	0.368	0.38	1.15	0.67	27	51	42.5

Appendix 2. Test for equality of variances between series.

Variable	Method	P-Value
Average real prices B2004 and A2004 (AV price A and AV Prices B)	Levene's test	0.0665
	F-test	0.000
Average nominal prices B2004 and A2004 (AV Price A and AV Prices B)	Levene's test	0.0747
	F-test	0.000
Turnover (O after and O before)	Levene's test	0.0112
	F-test	0.0000
Starting and ending	Levene's test	0.0491
	F-test	0.0000
Average real and nominal prices (AV_ PN and AV_PREAL)	Levene's test	0.2521
	F-test	0.0050
Nominal prices B2004 / A2004 (PN_B2004 and PN_A2004)	Levene's test	0.0661
	F-test	0.0000
Real prices B2004 / A2004(PR_B2004 and PR_A2004)	Levene's test	0.0391
	F-test	0.0000

Appendix 2. Contd.

Market capitalization B2004 / A2204 (CAPA and CAPB)	Levene's test	0.0095
	F-test	0.0000
Nominal Liquidity B2004 / A2004 (LRN_A and LR_B)	Levene's test	0.0684
	F-test	0.0484
Real Liquidity B2004 / A2004 (LRR_A and LRR_B)	Levene's test	0.0061
	F-test	0.0082
Real and Nominal prices B2004 / B2004 (PR_B2004 and PN_B2004)	Levene's test	0.0398
	F-test	0.0000
Real and Nominal prices A2004 / A2004 (PR_A2004 and PN_A2004)	Levene's test	0.2958
	F-test	0.0133

Date: 01/31/11 Time: 15:00; Sample: 1 13; Included observations: 13.

Appendix 3. Volumes of shares traded for the period.

Listed	Before 2004		After 2004		Turnover		Lbvol	Lavol	Ltverl	Lvol
companies	Vol	Stdv	Vol	Stdv	Btver	Atver				
C1	1,497	10,726	19,978	314,267	71	2,227	3.17523	4.30056	1.49516	1.12532
C2	25,416	140,357	14,426	104,902	10,026	8,687	4.4051	4.15915	-0.06226	-0.2459
C3	3,648	20,950	25,509	413,143	21	925	3.562	4.40669	1.63389	0.84469
C4	4,667	53,382	475	4,178	202	69	3.66903	2.67675	-0.46551	-0.9923
C5	1,928	19,791	7,558	62,295	1,063	12,311	3.28515	3.87839	1.06363	0.59324
C6	1,627	12,367	5,468	40,402	217	14,004	3.21136	3.73786	1.81064	0.52651
C7	34,689	373,592	17,255	235,028	3,864	10,021	4.54019	4.23691	0.41384	-0.3033
C8	21,886	161,528	3,520	20,247	624	717	4.34016	3.54651	0.06013	-0.7937
C9	3,685	23,390	5,647	55,568	350	1,648	3.56649	3.75185	0.67267	0.18537
C10	450	2,279	725	5,953	45	606	2.65305	2.86006	1.13137	0.20701
C11	2,292	25,435	1,621	14,170	5,305	33,812	3.36014	3.2097	0.8044	-0.1504
C12	2,924	31,095	7,926	104,296	96	236	3.46602	3.89908	0.38985	0.43306
C13	15,017	126,782	12,318	245,381	2,710	45,164	4.17658	4.09053	1.22181	-0.0861
Average	9210	77051.9	9417.36	124602	1891.9	10033	3.64696	3.75031	0.78228	0.10335
Max	34689	373592	25508.6	413143	10026	45164	4.54019	4.40669	1.81064	1.12532
Min	449.8	2279.4	475.06	4177.7	21.49	69.285	2.65305	2.67675	-0.46551	-0.9923
STDV	11264	104231	7916.09	133608	2974.2	14164	0.56228	0.5455	0.69397	0.61454

Vol, Volume; STDV, standard deviation; Btver and Atver, before and after 2004 turnover; log of ratio of avol:bvol (tverl).

Appendix 4. Volumes and volatility of shares traded over the period.

Listed	Before 2004 Vol		After 2004 Vol		Volume		
Companies	**BVOL**	**STDV**	**AVOL**	**STDV**	**LR-BVOL**	**LR-AVOL**	**LVOL**
C1	1 497	10 735	19 978	314 267	0.14	0.06	1.13
C2	25 416	140 472	14 426	104 902	0.18	0.14	-0.25
C3	3 648	20 967	25 509	413 143	0.17	0.06	0.84
C4	4 667	53 426	475	4 178	0.09	0.11	-0.99
C5	1 928	19 807	7 558	62 295	0.10	0.12	0.59
C6	1 627	12 377	5 468	40 402	0.13	0.14	0.53
C7	34 689	373 898	17 255	235 028	0.09	0.07	-0.30
C8	21 886	161 660	3 520	20 247	0.14	0.17	-0.79
C9	3 685	23 409	5 647	55 568	0.16	0.10	0.19
C10	450	2 281	725	5 953	0.20	0.12	0.21
C11	2 292	25 456	1 621	14 170	0.09	0.11	-0.15
C12	2 924	31 121	7 926	104 296	0.09	0.08	0.43
C13	15 017	126 886	12 318	245 381	0.12	0.05	-0.09
Summary							
Average	9209.601	77115.143	9417.361	124602.371	0.130	0.103	0.103
MAX	34688.686	373898.118	25508.601	413143.120	0.197	0.174	1.125
MIN	449.836	2281.267	475.060	4177.698	0.087	0.050	-0.992
STDV	11263.565	104316.475	7916.092	133607.908	0.038	0.036	0.615

Appendix 5. Nominal and real stock liquidity.

	Average share price		Deflated average share price		Average share traded		Liquidity			
	Standard deviation						LR nominal		LR real	
	B2004	**A2004**	**B2004**	**A2004**	**B2004**	**A2004**	**B2004**	**A2004**	**B2004**	**A2004**
C1	0.011525	0.01913053	0.00392	0.01344	1 497	19 978	129897	1044316	381934.3	1486476
C2	0.17	0.16588005	0.060331	0.120876	25 416	14 426	148456	86967.9	421271.6	119346.9
C3	0.001235	0.00948008	0.000782	0.005948	3 648	25 509	2953247	2690757	4663935	4288621
C4	0.003369	0.03261647	0.00392	0.021623	4 667	475	1385300	14565	1190656	21970.63
C5	0.167392	0.96312860	0.00392	0.461397	1 928	7 558	11519	7847.06	491932.3	16380.1
C6	0.078150	1.29315631	0.00392	0.608217	1 627	5 468	20817.5	4228.77	415060	8990.964
C7	0.07	0.13955303	0.00392	0.093731	34 689	17 255	492308	123643	8849970	184087.2
C8	0.02	0.04179715	0.00392	0.030753	21 886	3 520	1381444	84209.4	5583563	114452.3
C9	0.02	0.04995030	0.00392	0.040135	3 685	5 647	162634	113061	940242.2	140710.8

Appendix 5. Contd.

C10	0.07	0.24551992	0.00392	0.11283	450	725	6548.58	2951.03	114764.7	6421.467
C11	1.226678	10.1026434	0.00392	4.729255	2 292	1 621	1868.16	160.423	584652.3	342.6951
C12	0.009065	0.02630881	0.00392	0.011999	2 924	7 926	322580	301287	746064.2	660604.5
C13	0.003352	0.99162990	0.00392	0.445369	15 017	12 318	4480166	12421.7	3831233	27657.36
Summary										
Avg	0.1422787	1.08313804	0.008018	0.515044	9210	9417	884368	345109	2170406	544312.5
STDV	0.3311219	2.74634431	0.015742	1.282511	11264	7916	1380399	759189	2717859	1199631
Min	0.0012351	0.00948008	0.000782	0.005948	450	475	1868.16	160.423	114764.7	342.6951
Max	1.2266776	10.1026434	0.060331	4.729255	34689	25509	4480166	2690757	8849970	4288621