Estimation of the Day of the Week Effect on Stock Market Volatility in the U.S. Manufacturing Sector using GARCH and EGARCH models

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Estimation of the Day of the Week Effect on Stock Market Volatility in the U.S. Manufacturing Sector using GARCH and EGARCH models

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Abstract: This paper carried out two main studies: Part 1 attempted to conduct a set of tests for weak form efficiency (WFE); Part 2 tried to estimate day of the week effect using GARCH and EGARCH models. The principal objective of this paper, hence, is to test the weak-form efficiency for selected three stocks (Molex Incorporated, Monro Muffler Brake, Inc., and Monterey Gourmet Foods, Inc.) and two stock indices (NYSE/AMEX/NASDAQ index capitalisation-based Deciles 1 and 10). As for Part I, this paper identified that there are negative trends on Monday and Wednesday and positive trends are found on Friday. This result also follows the general finding of existing literature. Likewise, the results for Part II showed that Monday, Wednesday, and Friday had negative trends although the sizes of coefficients are small. In addition, different from aforementioned three, returns on Tuesday is significant and positive. Overall, the results seem to provide ample evidence of day of the week effect on stock market volatility.

Key Words: Day of Weak Effect, Weak Form Efficiency, GARCH model, Stock Market

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Introduction

This paper is an individual empirical project under the Research Methods for Finance course. It consists of two parts: part 1 requires conducting a set of tests for weak form efficiency (WFE) and their interpretation; part 2 requires the estimation of GARCH models and its interpretations. The principal objective of this paper, hence, is to test the weak-form efficiency for selected three stocks (Molex Incorporated, Monro Muffler Brake, Inc., and Monterey Gourmet Foods, Inc.) and two stock indices (NYSE/AMEX/NASDAQ index capitalisation-based Deciles 1 and 10).

This paper is organized into 5 sections: Section I reviews literatures that cover the same tests and estimations with this paper; Section II describes data used in analyses, Section III explains methodologies, the results of analyses are discussed in Section IV; followed by closing summary and conclusion in Section 5.

I. Literature Review

The efficient markets hypothesis (EMH) plays an important role in modern finance. It, therefore, is not surprising that it has been widely utilized by a lot of literature. Fama (1970) defines three forms of market efficiency: the weak, semi-strong, and strong forms. These three forms are different in terms of the types of information that is related to stock prices. The weak-form hypothesis has the most narrowly defined information set, which alleges that stock prices perfectly incorporate all information which can be derived by investigating market trading data such as the historical price and trading volume. The semi-strong-form hypothesis limits information to publicly available information which contains, in addition to past prices and volumes, fundamental data of firms and macro-economic factors such as inflation and interest rates. Lastly, the strong-form of EMH includes all publicly and privately available information. Hence, no one can earn abnormal returns by stock selections, even for those who know insider information.

Since Engle (1982) introduced ARCH models, many papers have analysed volatilities using the models. Based on ARCH models, GARCH model was created by Bollerslev (1986). It is a generalized autoregressive conditional heteroskedasticity model. As for the estimation of GARCH model, in general, considering the empirical findings of literature that investigate effects of weekdays in stock markets the expected sign on the coefficient on the Monday dummy must be negative and significantly different from zero. Several articles indicate that the coeffiient on the Friday dummy must be positive (Agrawal and Tandon, 1998).

II. Data Description

The empirical analyses of this paper adopts both daily and monthly returns for the three stocks and two decile indices over the period of two and a half years between January 2007 and December 2009. There are a total of 628 observations for daily and 30 observations for monthly data, respectively.

Logarithmic (log) returns are employed throughout the analysis. However, for purposes of comparison, descriptive statistics for arithmetic returns are also reported. The daily and monthly price data for stocks, decile indices and the market index are obtained from the Center for Research in Securities Prices (CRSP) database. The continuous compounded returns are used in this paper.

Basic information of selected three companies is explained in the following paragraphs.

A. Molex Incorporated

Founded: 1938, Headquarter: Lisle, Illinois, United States, Sector: Manufacturing, Industry: Electronics, Products: Electrical connectors, molex connector, optical fiber connectors, and switches, Exchange: NASDAQ, Ticker: MOLX, Stock Indices (Molex website)

Molex Incorporated, incorporated in 1972, is a manufacturer of electronic connectors. The Company manufactures and sells electronic components. It operates in two product segments: Connector and Custom & Electrical. The Connector segment designs and manufactures products for high-speed, high-density, high signal-integrity applications, as well as fine-pitch, low-profile connectors for the consumer and commercial markets. It also designs and manufactures products that withstand environments, such as heat, cold, dust, dirt, liquid and vibration for automotive and other transportation applications. The Connector segment designs and manufactures products for high-speed, high-density, high signal-integrity applications as well as fine-pitch, low-profile connectors for the consumer and commercial markets. It also designs and manufactures products that withstand environments, such as heat, cold, dust, dirt, liquid and vibration for automotive and other transportation applications (REUTERS website).

B. Monro Muffler Brake, Inc.

Founded: 1957, Headquarter: Rochester, New York, United States, Exchange: NASDAQ, Ticker: MNRO, Sector: Manufacturing, Industry: Automobile care, Products: Brakes, mufflers and exhaust systems, steering, drive train, suspension, and wheel alignment (Monro Muffler Brake website)

Monro Muffler Brake, Inc. (Monro), incorporated in 1959, is a chain of 781 Company-operated stores (as of March 26, 2011), three franchised locations and 14 dealer-operated stores providing automotive undercar repair and tire services in the United States. As of March 26, 2011, Monro operated Company stores in New York, Pennsylvania, Ohio, Connecticut, Massachusetts, West Virginia, Virginia, Maryland, Vermont, New Hampshire, New Jersey, North Carolina, South Carolina, Indiana, Rhode Island, Delaware, Maine, Illinois and Missouri primarily under the names Monro Muffler Brake & Service, Tread Quarters Discount Tire, Mr. Tire, Autotire Car Care Center and Tire Warehouse (together, the Company Stores). Company Stores serviced approximately 4.3 million vehicles during the fiscal year ended March 26, 2011 (fiscal 2011). The Company has one wholly owned subsidiary, Monro Service Corporation (REUTERS website).

C. Monterey Gourmet Foods, Inc.

Founded: 1989, Headquarter: Salinas, California, United States, Exchange: NASDAQ, Ticker: PSTA, Sector: Manufacturing, Industry: Food and Beverage, Products: Paste, sources, and cheese, (Monterey Gourmet Foods website)

Monterey Gourmet Foods, Inc. manufactures and markets gourmet foods. It offers pastas, sauces, dips, spread able cheeses, semi-hard cheeses, prepared entrees, frozen entrees, sausages, tamales, organic dips, and organic salsas; creamy dips, pestos, soft spreadable cheeses, tapenades and toppings, tuscan bean spreads, pestos, soft spreadable cheeses, tapenades, and bruschetta toppings; salsas, hummus, and bean dips; and pasta salads and bread crumbs. The company offers its products through retail supermarkets, club stores, specialty food stores, and distributors in the United States, Canada, Mexico, Japan, Korea, and Taiwan. Monterey Gourmet Foods, Inc. was formerly known as Monterey Pasta Company and changed its name to Monterey Gourmet Foods, Inc. in October 2004. The company was founded in 1989 and is headquartered in Salinas, California. It has manufacturing facilities in California and Washington. As of December 10, 2009, Monterey Gourmet Foods Inc. operates as a subsidiary of Pulmuone Wildwood, Inc (Bloomberg website).

III. Methodology

A. Correlation Analysis

'*The autocorrelation coefficient is a natural time-series extension of the well-known correlation coefficient between two random variables x and y* (Campbell *et al.*, 1997). The autocorrelation test examines the dependence (or independence) of random variables in a time series (i.e., RW3). If reflects how quickly and completely stock prices adjust to new information. Sample autocorrelation at lag *k* is given by:

$$\rho_k = \frac{cov(r_{i,t}, r_{i,t-k})}{\sqrt{var(r_{i,t}) var(r_{i,t-k})}} + \frac{cov(r_{i,t}, r_{i,t-k})}{var(r_{i,t})} \quad (1)$$

where ρ_k is the autocorrelation at lag *k*; $r_{i,r}$ is the log-return on stock *i* at time *t*; and $r_{i,r-k}$ is the lon-return on stock I at time *t-k*. If ρ_k is greater than zero, there is positive serial correlation. If ρ_k is less than zero, there is negative serial correlation. The null hypothesis of no serial correlation in return series is rejected if ρ_k is statistically significantly different from zero.

The autocorrelation coefficients from 1 to 12 lags are computed for three stock and two indices. In addition, the joint hypothesis which all values of the autocorrelation coefficients up to certain lags are simultaneously equal to zero is tested using the Ljung-Box test.

B. Day of the Week Effect

The testing for market anomalies in stock returns has been actively studied by many researchers in recent years. One of most famous anomalies is day-of-the week effect. '*The day of the week effect is a phenomenon that constitutes a form of anomaly of the efficient capital markets theory*' (Nath and Dalvi, 2004). According to this phenomenon, the average daily return of the market is not the same for all days of the week, as we would expect on the basis of the efficient market theory. To test the day of the week effect, this paper run a following multiple regression:

$$r_t = \gamma_{Mon} D1_t + \gamma_{Tue} D2_t + \gamma_{Wed} D3_t + \gamma_{Thu} D4_t + \gamma_{Fri} D5_t + u_t \quad (2)$$

where r_t= return at time *t*. $D1_t$= 1 if it is a Monday return or 0 otherwise. $D2_t$ to $D5_t$ follow the same manner as the $D1_t$.

C. Variance Ratio Tests

The variance ratio procedure of Lo and MacKinlay (1998) is based on the assumption that if the natural logarithm of a time series ρ_t is a pure random walk, the variance of tis qth difference grows proportionally with the difference q. The variance ration, *VR9(q)*, is defined as:

$$VR(q) = \frac{\sigma^2(q)}{\sigma^2(1)} \tag{3}$$

where $\sigma^2(q)$ is the unbiased estimator of *1/q* of the variance of the qth difference of the logged security return (P_t-P_{t-q}) and $\sigma^2(q)$ is an unbiased estimator of the variance of the logged return (P_t-P_{t-1}).

The random walk null hypothesis is that *VR(q)* =1. If the null hypothesis is rejected and *VR(q)* >1, return are negatively serially correlated, which is referred to as a mean-reverting process. Two test statistics for the null hypothesis are developed by Lo and MacKnlay under the assumptions of homoscedastic and heteroscedastic increments of a random walk.

D. Estimation of GARCH type models

GARCH model is the generalized ARCH(p,q) model is designed to model and forecast the conditional variance of a time series depends upon the squared residuals of the process (Bollerslv, 1986). The GARCH model has the advantage of incorporating heteroscedasticity into the estimation procedure and provides flexible frameworks to capture various dynamic structures of conditional variance. It also allows simultaneous estimation of several parameters of interest and hypotheses. The GARCH (p,q) model that is applied to study the day of the week effect is as follows:

$$y_t = \gamma_{Mon}D1_t + \gamma_{Tue}D2_t + \gamma_{Wed}D3_t + \gamma_{Thu}D4_t + \gamma_{Fri}D5_t + u_t \tag{4}$$

where y_t is the stock return at time t . The dummy variables, Dd_t, in the returns and variance equations represent the five working days of a week. In other words, Dd_t is equal to one if the day t is a Monday (d = 1), and otherwise it is a zero. Likewise, Dd_t is equal to one or otherwise zero if the day t is a Tuesday (d = 2), and so forth. The coefficients, γ_{Mon} to γ_{Fri}, represent the size and the direction of the effect of each working day of the week on stock returns.

IV. Empirical Results

Part I

A. Descriptive Statistics and return distributions

One of the basic assumptions of the random walk model is that the distribution of the return series should be normally distributed. To test the distribution of the return series, descriptive statistics for daily and monthly returns are described in Table I and II.

A.1. Daily Returns

As can be seen from Table I, amongst three stocks and two indices, the lowest mean return are -0.001 of MOLX, PSTA, and D10 and the highest mean return are 0.000 of MNRO and D1. The lowest minimum return is -0.195 of PSTA and the highest minimum return is -0.056 of D1. On the other hand, the lowest maximum return is 0.063 of D1 and the highest maximum return is 0.307 of PSTA. The standard deviation of daily returns (a measure of dispersion) implies that 0.011 of D1 and 0.020 of D10 are the top two least volatile among three stocks and two indices.

With regard to the degree of asymmetry of the return distributions, MOLX, MNRO, PSTA, and D1 are positively skewed. The positive skewness indicates that return distributions of these three stocks and one index have a higher probability of earning positive returns, and that gains are likely to be greater than predicted by the normal distribution. On the contrary, D10 is negatively skewed, implying the higher probability of earning negative returns. The positive excess kurtosis that is observed for three stocks and two indices indicate that they have more peaked than normal (leptokurtic) return distributions. A leptokurtic distribution has more values around the mean and in the tails compared to a normal distribution. Hence, this results in more frequent large positive or negative returns. In accordance with the evidence from the measures of skewness and excess kurtosis, the Jarque-Bera test rejects the null hypothesis of normality in daily returns for all stocks and indices.

As examples, line charts of time series of returns of D1 and D10 and PSTA are shown in Figure 1 and 2, respectively. Furthermore, histograms of D10 and PSTA can be seen in Figure 3 and 4, respectively.

In conclusion, results in Table I provide considerable evidence of departures from normality in daily log-returns. The same conclusion can be obtained for the returns calculated in arithmetic returns.

A.2. Monthly Returns

As can be seen from Table II, amongst three stocks and two indices, the lowest mean return is -0.031 of PSTA and the highest mean return is 0.005 of MNRO. The lowest minimum return is -0.443 of MOLX and the highest minimum return is -0.179 of MNRO. On the other hand, the lowest maximum return is 0.203 of MOLX and the highest maximum return is 0.511 of PSTA. The standard deviation of monthly returns (a measure of dispersion) implies that 0.083 of D1 and 0.063 of D10 are the top two least volatile among three stocks and two indices.

With regard to the degree of asymmetry of the return distributions, MNRO and PSTA and D1 are positively skewed. The positive skewness indicates that return distributions of these two stocks and one index have a higher probability of earning positive returns, and that gains are likely to be greater than predicted by the normal distribution. On the contrary, MOLX and D10 are negatively skewed, showing the higher probability of earning negative returns. The positive excess kurtosis that is observed for three stocks and two indices indicate that they have more peaked than normal (leptokurtic) return distributions. A leptokurtic distribution has more values around the mean and in the tails compared to a normal distribution. Hence, this results in more frequent large positive or negative returns. In accordance with the evidence from the measures of skewness and excess kurtosis, the Jarque-Bera test rejects the null hypothesis of normality in monthly returns for all stocks and indices.

In conclusion, results in Table II provide considerable evidence of departures from normality in monthly log-returns. The same conclusion can be obtained for the returns calculated in arithmetic returns.

B. Correlation Analysis

B.1. Test for Log-Returns

Table III shows the results of autocorrelation analysis for 12 lags of daily and monthly returns for three stocks and two indices for the period of two and a half years between January 2007 and June 2009.

No coefficients of AC and PAC are significant for daily log of stock returns of all stocks and indices at 5 percent significance level. Instead of testing the statistical significance of any individual AC and PAC coefficients, the joint hypothesis that all the values of the autocorrelation coefficients up to certain lags are simultaneously equal to zero can be tested using the Ljung-Box (L-B) test statistic. Consequently, daily log of stock returns of MNRO, PSTA, D1, and D10 have significant L-B statistics (Q-values) for both the 3 and 12 lags. However, neither of the LB statistics for 3 and 12 lags are significant for MOLX. The conclusion besed on daily returns is that although the null hypothesis of no serial correlation cannot be rejected for MOLX, it is rejected with a 99 percent confidence for MNRO, PSTA, D1, and D10. These results indicate that MOLX appears to be efficient in the weak form and daily returns for the other two stocks and two decile indices exhibit serial dependence.

In contrast to the results for daily returns, few of AC and PAC coefficients are statistically significant when monthly data are utilized. According to Milionis and Moschos (2000), the results for monthly data are examined focusing on L-B statistics. It is evident that L-B statistics for 3 lags are statistically significant for only D1, and those for 12 lags are statistically significant for MOLX and D1. As a result, failures in rejections of the null hypothesis of L-B test imply that monthly return series tend to follow a random walk.

B.2. Test for Squared Log-Returns

Results of autocorrelation analysis for 12 lags of squared daily and monthly log of stock returns for three stocks and two indices are presented in Table IV. No coefficients are statistically significant for all stocks and indices as well as log of stock returns. On the other hand, all L-B statistics for daily squared log of stock returns are significant at 1 percent significance level. In terms of monthly returns, L-B statistics for 3 lags are significant only for PSTA and D1. Similarly, L-B statistics for 12 lags are significant only for D1. Therefore, the conclusions for log of returns can also be applied for squared log-returns. In addition, monthly returns are likely to be more stationary in comparison with daily returns.

B.3. Test for Absolute Values of Log-Returns

Results of autocorrelation analysis for 12 lags of absolute value of daily and monthly log of stock returns for three stocks and two indices are presented in Table V. No coefficients are statistically significant for all stocks and indices as. However, all L-B statistics for daily squared log of stock returns are significant at 1 percent significance level as well as squared log of returns. In terms of monthly returns, L-B statistics for 3 and12 lags are significant only for PSTA and D1.

In summary, the results indicate that the evidence of autocorrelation is much stronger for the absolute value of daily returns, where the zero autocorrelation hypothesis is rejected for all stocks and indices. With regard to monthly returns, series independence is observed throughout the correlation analysis.

B.3. Correlation Matrix

Table VI presents correlation matrix of daily and monthly log of returns for three stocks and two indices. Panel A shows the results for daily returns. The degree of correlations is different between individual stocks, ranging from 0.107 (MNRO-PSTA) to 0.402 (MOLX-MNRO). All correlation are positive. Stock-index correlations are also positive, ranging from 0.163 (PSTA-D1) to 0.779 (MOLX-D10).

The correlations amongst monthly returns are shown in Panel B. Two out of three stock-stock correlations are negative and the lowest value is -0.160 (PSTA-MNRO). The remaining one correlation is positive, which is 0.370 (MOLX-PSTA). Regarding stock-index correlations, one value is negative which is -0.158 (D10-MNRO) and the others are positive, ranging from 0.112 (D1-MNRO) to 0.824 (D10-MOLX).

C. Day of the Week Effect

The results of the test for a day of the week effect are reported in Table VII. In consistent with the general phenomina, the analysis finds that two out of five coefficients of Monday are significant and negative; -0.005 (MOLX) at 10 percent significance level and -0.004 (D10) at 5 percent significance level. With regard to PSTA, coefficients of Wednesday and Friday are significant; Wednesday:-0.008 at 5 percent significance level and Friday:0.008 at 10 percent significance level. In summary, this analysis finds that there are negative trends on Monday and Wednesday and positive trends are found on Friday. This result also follows the general finding of existing literature.

D. Variance Ratio Tests

In order to test to see if the daily and monthly log of returns follow a random walk, variance ratio tests are carried for three stocks and two indices. Variance tatios are computed for different lag orders (2, 4, 8, and 16) of daily and monthly returns. Panel A of Table VIII indicates the results for daily returns and results for monthly returns are shown in Panel B. Values in parentheses are z-statistics.

The results clearly present that all the variance ratios significantly differ from one another within daily data. Similar results are obtained for monthly data. While all variance ratios are statistically significant at 1 percent level for daily returns, with respect to monthly data, none of variance ratios are statistically significant except for two ratios: lag orders 2 and 4 for MNRO. Hence, based on the results shown in Table VIII, there appears to be negative serial correlation. Three stock returns and decile indices returns are likely to behave similarly based on the analytical results.

Part II

A. Data

Log of daily stock returns of three stocks and two decile indices from January 2007 to June 2009 are applied in this paper. There are a total of 628 observations for daily return data. Logarithmic (log) returns are employed throughout the analysis. The daily price data for stocks, decile indices and the market index are obtained from the Center for Research in Securities Prices (CRSP) database. The continuous compounded returns are used in this paper.

B. Estimation of GARCH type models

Table X presents results from the GARCH(1,1) model that investigates the day of the week effect on stock returns and volatility. As Table IX shows, the ARCH process is significant in all residuals because the size of the ARCH coefficient is less than unity in all cases. As stated above, expected returns are not affected by volatility if shocks to volatility are transitory.

Results from the GARCH model and the results of the test for a day of the week effect are reported in Table VII are not identical but can be thought of as being similar. The similar results can be seen for results on Monday, Wednesday, and Friday although the sizes of coefficients are small. However, stocks and indices being significant are different (Table X). In addition, in the results of GARCH model, returns on Tuesday is significant and positive; 0.005 for MNRO at 1 percent significance level.

This paper also conducted tests for day of the week effects using EGARCH model. Table XI indicates the results of the investigation utilizing EGARCH model, which basically show very similar results with those of analysis using GARCH model. Coefficients on Monday and Wednesday are statistically significant and negative, while those on Tuesday are statistically significant and positive. The difference is that though the coefficient of PSTA on Friday is significant and positive under GARCH model, it is insignificant under EGARCH model. This might imply the existence of asymmetric effects in Friday' returns.

All in all, the results seem to provide ample evidence of day of the week effect on stock market volatility.

V. Conclusion

This paper carried out two main studies: Part 1 attempted to conduct a set of tests for weak form efficiency (WFE); Part 2 tried to estimate day of the week effect using GARCH and EGARCH models. The principal objective of this paper, hence, is to test the weak-form efficiency for selected three stocks (Molex Incorporated, Monro Muffler Brake, Inc., and Monterey Gourmet Foods, Inc.) and two stock indices (NYSE/AMEX/NASDAQ index capitalisation-based Deciles 1 and 10).

As for Part I, this paper identified that there are negative trends on Monday and Wednesday and positive trends are found on Friday. This result also follows the general finding of existing literature. Likewise, the results for Part II showed that Monday, Wednesday, and Friday had negative trends although the sizes of coefficients are small. In addition, different from aforementioned three, returns on Tuesday is significant and positive. Overall, the results seem to provide ample evidence of day of the week effect on stock market volatility.

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Table I

Descriptive Statistics of Daily Returns

This table shows the descriptive statistics of the monthly retuns for three stocks and two decile indices for two and a half years between January 2007 and June 2009. The lower-case letter r denotes a logarithmic (log) return. The upper-case letter R denotes an arithmetic (simple) return. D1 and D10 denote NYSE/AMEX/NASDAQ Decile 1 and 10.

	MOLX		MNRO		PSTA		D1		D10	
	r	R	r	R	r	R	r	R	r	R
Mean	-0.001	-0.001	0.000	0.001	-0.001	0.000	0.000	0.000	-0.001	0.000
Median	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.001
Maximum	0.142	0.152	0.095	0.100	0.307	0.360	0.063	0.065	0.112	0.118
Minimum	-0.105	-0.100	-0.137	-0.128	-0.195	-0.177	-0.056	-0.055	-0.095	-0.091
Std. Dev.	0.028	0.028	0.029	0.029	0.046	0.047	0.011	0.011	0.020	0.020
Skewness	0.131	0.381	0.047	0.187	0.586	1.259	0.148	0.282	-0.163	0.061
Kurtosis	6.800	7.228	4.353	4.255	10.548	13.427	8.898	9.147	8.385	8.612
Jarque-Bera	379.7	483.0	48.13	44.89	1526.8	3010.7	912.6	996.9	761.5	824.6
Probability	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Sum	-0.710	-0.457	0.094	0.350	-0.941	-0.276	-0.093	-0.053	-0.348	-0.223
Sum Sq. Dev.	0.504	0.506	0.511	0.513	1.316	1.365	0.080	0.080	0.251	0.250
Observations	628	628	628	628	628	628	628	628	628	628

Table II

Descriptive Statistics of Monthly Returns

This table shows the descriptive statistics of the monthly retuns for three stocks and two decile indices for two and a half years between January 2007 and June 2009. The lower-case letter r denotes a logarithmic (log) return. The upper-case letter R denotes an arithmetic (simple) return. D1 and D10 denote NYSE/AMEX/NASDAQ Decile 1 and 10.

	MOLX		MNRO		PSTA		D1		D10	
	r	R	r	R	r	R	r	R	r	R
Mean	-0.024	-0.015	0.005	0.010	-0.031	-0.016	-0.001	0.002	-0.012	-0.010
Median	-0.017	-0.017	-0.027	-0.025	-0.051	-0.050	-0.001	-0.001	-0.005	-0.005
Maximum	0.203	0.225	0.223	0.249	0.511	0.667	0.175	0.191	0.093	0.097
Minimum	-0.443	-0.358	-0.179	-0.164	-0.341	-0.289	-0.161	-0.149	-0.198	-0.180
Std. Dev.	0.119	0.114	0.098	0.100	0.172	0.191	0.083	0.084	0.063	0.061
Skewness	-0.955	-0.136	0.410	0.568	1.208	1.946	0.158	0.429	-0.836	-0.637
Kurtosis	6.840	5.071	2.322	2.470	5.446	7.594	3.256	3.395	3.898	3.472
Jarque-Bera	22.994	5.454	1.416	1.963	14.769	45.321	0.207	1.117	4.500	2.308
Probability	0.000	0.065	0.493	0.375	0.001	0.000	0.901	0.572	0.105	0.315
Sum	-0.710	-0.443	0.144	0.314	-0.941	-0.474	-0.037	0.062	-0.350	-0.292
Sum Sq. Dev.	0.412	0.376	0.276	0.292	0.862	1.059	0.198	0.202	0.115	0.107
Observations	30	30	30	30	30	30	30	30	30	30

Table III

The Results of Autocorrelation and Partial Autocorrelation Tests for Log-Returns

This table shows the autocorrelation and partial autocorrelation coefficients up to 12 lags for the log-returns for each stock and decile index. Ljung-Box test statistics are reported for 3 and 12 lags. AC stands for autocorrelation. PAC stands for partial autocorrelation. L-B stands for Ljung-Box test statistics. Asterisk symbols indicate significance levels: (*:10%, **:5%, and ***:1%).

Panel A: Results for Daily Log-Returns

	MOLX		MNRO		PSTA		D1		D10	
Lag	AC	PAC	AC	PAC	AC	PAC	AC	PAC	AC	PAC
1	-0.065	-0.065	-0.205	-0.205	-0.249	-0.249	0.284	0.284	-0.130	-0.130
2	-0.027	-0.031	-0.011	-0.056	0.116	0.058	0.230	0.162	-0.120	-0.139
3	0.005	0.001	0.033	0.021	-0.125	-0.089	0.236	0.151	0.102	0.069
4	0.001	0.000	-0.087	-0.079	0.099	0.047	0.147	0.028	-0.039	-0.033
5	0.013	0.013	0.044	0.011	-0.039	0.010	0.103	0.003	-0.041	-0.031
6	0.064	0.066	-0.033	-0.029	-0.014	-0.042	0.080	-0.001	0.043	0.018
7	-0.008	0.002	0.032	0.026	-0.016	-0.015	0.055	-0.003	-0.034	-0.030
8	0.016	0.019	0.009	0.012	0.000	-0.01	-0.008	-0.055	0.039	0.044
9	0.044	0.046	-0.054	-0.045	-0.016	-0.022	0.013	0.005	0.006	0.002
10	0.080	0.088	0.068	0.044	0.101	0.103	0.036	0.036	0.046	0.066
11	-0.065	-0.054	-0.034	-0.009	-0.180	-0.147	-0.004	-0.012	-0.069	-0.063
12	-0.013	-0.021	0.027	0.025	0.088	0.004	0.036	0.038	0.050	0.048
L-B(3)	3.1328		27.408***		57.637***		111.03***		26.339***	
L-B(12)	14.225		40.852***		111.03***		147.80***		37.350***	

Panel B: Results for Monthly Log-Returns

	MOLX		MNRO		PSTA		D1		D10	
Lag	AC	PAC	AC	PAC	AC	PAC	AC	PAC	AC	PAC
1	0.110	0.110	-0.294	-0.294	0.168	0.168	0.419	0.419	0.397	0.397
2	-0.337	-0.353	-0.028	-0.126	0.039	0.011	0.201	0.031	-0.121	-0.331
3	0.009	0.113	0.193	0.164	-0.250	-0.266	0.137	0.052	0.057	0.336
4	0.279	0.164	0.066	0.197	-0.186	-0.112	0.052	-0.034	0.242	0.017
5	-0.208	-0.294	0.090	0.223	-0.159	-0.100	-0.117	-0.169	-0.153	-0.369
6	-0.429	-0.262	-0.159	-0.112	0.123	0.125	-0.387	-0.359	-0.421	-0.109
7	0.005	-0.044	0.073	-0.094	0.123	0.037	-0.257	0.034	-0.124	0.057
8	0.054	-0.238	-0.028	-0.154	-0.054	-0.194	-0.092	0.121	0.045	-0.128
9	-0.019	0.118	-0.208	-0.296	-0.079	-0.045	-0.138	-0.059	-0.086	0.114
10	-0.116	-0.121	0.211	0.108	-0.202	-0.140	-0.051	0.070	-0.087	0.058
11	0.128	0.015	-0.252	-0.098	0.005	0.075	0.040	0.004	0.095	-0.081
12	0.118	-0.045	0.084	0.145	0.028	-0.014	-0.032	-0.283	0.077	-0.073
L-B(3)	4.293		4.225		3.209		7.866**		5.837	
L-B(12)	18.555*		13.654		9.095		18.731*		18.196	

Table IV

The Results of Autocorrelation and Partial Autocorrelation Tests for Squared Log-Returns

This table shows the autocorrelation and partial autocorrelation coefficients up to 12 lags for the squared log-returns for each stock and decile index. Ljung-Box test statistics are reported for 3 and 12 lags. AC stands for autocorrelation. PAC stands for partial autocorrelation. L-B stands for Ljung-Box test statistics. Asterisk symbols indicate significance levels: (*:10%, **:5%, and ***:1%).

Panel A: Results for Daily Squared Log-Returns

	MOLX		MNRO		PSTA		D1		D10	
Lag	AC	PAC	AC	PAC	AC	PAC	AC	PAC	AC	PAC
1	0.112	0.112	0.096	0.096	0.167	0.167	0.267	0.267	0.174	0.174
2	0.123	0.112	0.081	0.073	0.194	0.171	0.292	0.238	0.385	0.366
3	0.143	0.122	0.151	0.139	0.102	0.05	0.194	0.081	0.143	0.044
4	0.159	0.126	-0.002	-0.034	0.128	0.079	0.097	-0.028	0.300	0.166
5	0.23	0.189	-0.003	-0.021	0.118	0.070	0.164	0.096	0.343	0.287
6	0.211	0.154	0.051	0.036	0.072	0.011	0.206	0.150	0.316	0.159
7	0.141	0.066	0.044	0.045	0.114	0.066	0.111	-0.014	0.325	0.136
8	0.125	0.037	0.037	0.028	0.143	0.098	0.162	0.048	0.180	-0.019
9	0.189	0.098	0.043	0.019	0.046	-0.031	0.143	0.061	0.299	0.090
10	0.124	0.013	0.023	0.003	0.118	0.064	0.140	0.054	0.263	0.101
11	0.213	0.109	0.025	0.013	0.224	0.188	0.093	-0.033	0.397	0.181
12	0.197	0.099	0.075	0.066	0.137	0.039	0.109	0.019	0.276	0.071
L-B(3)	30.524***		24.493***		47.961***		122.83***		125.77***	
L-B(12)	217.78***		33.768***		146.13***		236.22***		660.21***	

Panel B: Results for Monthly Squared Log-Returns

	MOLX		MNRO		PSTA		D1		D10	
Lag	AC	PAC	AC	PAC	AC	PAC	AC	PAC	AC	PAC
1	0.112	0.112	0.096	0.096	0.167	0.167	0.267	0.267	0.174	0.174
2	0.123	0.112	0.081	0.073	0.194	0.171	0.292	0.238	0.385	0.366
3	0.143	0.122	0.151	0.139	0.102	0.050	0.194	0.081	0.143	0.044
4	0.159	0.126	-0.002	-0.034	0.128	0.079	0.097	-0.028	0.300	0.166
5	0.230	0.189	-0.003	-0.021	0.118	0.070	0.164	0.096	0.343	0.287
6	0.211	0.154	0.051	0.036	0.072	0.011	0.206	0.150	0.316	0.159
7	0.141	0.066	0.044	0.045	0.114	0.066	0.111	-0.014	0.325	0.136
8	0.125	0.037	0.037	0.028	0.143	0.098	0.162	0.048	0.180	-0.019
9	0.189	0.098	0.043	0.019	0.046	-0.031	0.143	0.061	0.299	0.090
10	0.124	0.013	0.023	0.003	0.118	0.064	0.140	0.054	0.263	0.101
11	0.213	0.109	0.025	0.013	0.224	0.188	0.093	-0.033	0.397	0.181
12	0.197	0.099	0.075	0.066	0.137	0.039	0.109	0.019	0.276	0.071
L-B(3)	0.4947		1.4303		10.888**		20.235***		2.8111	
L-B(12)	4.8568		4.8456		14.169		36.536***		7.3469	

Table V

The Results of Autocorrelation and Partial Autocorrelation Tests for Absolute Value of Log-Returns

This table shows the autocorrelation and partial autocorrelation coefficients up to 12 lags for the absolute value of log-returns for each stock and decile index. Ljung-Box test statistics are reported for 3 and 12 lags. AC stands for autocorrelation. PAC stands for partial autocorrelation. L-B stands for Ljung-Box test statistics. Asterisk symbols indicate significance levels: (*:10%, **:5%, and ***:1%).

Panel A: Results for Daily Absolute Value of Log-Returns

	MOLX		MNRO		PSTA		D1		D10	
Lag	AC	PAC	AC	PAC	AC	PAC	AC	PAC	AC	PAC
1	0.214	0.214	0.09	0.09	0.338	0.338	0.357	0.357	0.248	0.248
2	0.236	0.2	0.123	0.116	0.323	0.236	0.358	0.264	0.365	0.323
3	0.284	0.219	0.136	0.118	0.278	0.137	0.344	0.192	0.289	0.176
4	0.261	0.161	0.052	0.021	0.3	0.153	0.265	0.060	0.337	0.189
5	0.31	0.196	0.048	0.015	0.26	0.082	0.320	0.144	0.420	0.282
6	0.308	0.17	0.094	0.069	0.197	0.003	0.317	0.124	0.369	0.189
7	0.239	0.069	0.106	0.084	0.207	0.045	0.266	0.041	0.403	0.195
8	0.257	0.072	0.097	0.064	0.309	0.18	0.284	0.064	0.299	0.055
9	0.29	0.105	0.064	0.017	0.182	-0.029	0.289	0.082	0.333	0.053
10	0.253	0.056	0.055	0.009	0.276	0.124	0.277	0.060	0.304	0.010
11	0.301	0.107	0.08	0.045	0.290	0.127	0.214	-0.040	0.380	0.093
12	0.275	0.075	0.075	0.044	0.313	0.103	0.256	0.051	0.337	0.041
L-B(3)	114.97***		26.326***		186.87***		236.53***		175.93***	
L-B(12)	559.51***		60.782***		586.13***		680.63***		903.38***	

Panel B: Results for Monthly Absolute Value of Log-Returns

	MOLX		MNRO		PSTA		D1		D10	
Lag	AC	PAC	AC	PAC	AC	PAC	AC	PAC	AC	PAC
1	0.214	0.214	0.090	0.090	0.338	0.338	0.357	0.357	0.248	0.248
2	0.236	0.200	0.123	0.116	0.323	0.236	0.358	0.264	0.365	0.323
3	0.284	0.219	0.136	0.118	0.278	0.137	0.344	0.192	0.289	0.176
4	0.261	0.161	0.052	0.021	0.300	0.153	0.265	0.060	0.337	0.189
5	0.310	0.196	0.048	0.015	0.260	0.082	0.320	0.144	0.420	0.282
6	0.308	0.170	0.094	0.069	0.197	0.003	0.317	0.124	0.369	0.189
7	0.239	0.069	0.106	0.084	0.207	0.045	0.266	0.041	0.403	0.195
8	0.257	0.072	0.097	0.064	0.309	0.180	0.284	0.064	0.299	0.055
9	0.290	0.105	0.064	0.017	0.182	-0.029	0.289	0.082	0.333	0.053
10	0.253	0.056	0.055	0.009	0.276	0.124	0.277	0.060	0.304	0.010
11	0.301	0.107	0.080	0.045	0.290	0.127	0.214	-0.040	0.380	0.093
12	0.275	0.075	0.075	0.044	0.313	0.103	0.256	0.051	0.337	0.041
L-B(3)	0.300		1.347		11.843***		22.963***		4.089	
L-B(12)	9.348		7.105		20.895*		40.458***		12.46	

Table VI

Correlation Matrix

This table shows the correlation matrix of the log-return for stocks and indices over the period from January 2007 to June 2009.

Panel A: Results for Daily Log-Returns

	MOLX	MNRO	PSTA	D1	D10
MOLX	1.000				
MNRO	0.402	1.000			
PSTA	0.132	0.107	1.000		
D1	0.486	0.205	0.163	1.000	
D10	0.779	0.505	0.164	0.554	1.000

Panel B: Results for Monthly Log-Returns

	MOLX	MNRO	PSTA	D1	D10
MOLX	1.000				
MNRO	-0.137	1.000			
PSTA	0.370	-0.160	1.000		
D1	0.535	0.112	0.422	1.000	
D10	0.824	-0.158	0.540	0.739	1.000

Table VII

Results of Day of the Week Effect

This table shows the results of day of the week effect for three stock returns and two decile index returns for the period from January 2007 to June 2009. Values in parentheses are probabilities. Asterisk symbols indicate significance levels: (*:10%, **:5%, and ***:1%).

Coefficient	MOLX	MNRO	PSTA	D1	D10
Monday	-0.005*	-0.004	-0.006	-0.001	-0.004**
	(-0.056)	(-0.106)	(-0.149)	(-0.606)	(0.047)
Tuesday	0.000	0.006	0.004	0.000	0.001
	(-0.974)	(-0.011)	(-0.335)	(-0.977)	(0.564)
Wednesday	-0.003	-0.004	-0.008**	-0.001	-0.002
	(-0.235)	(-0.102)	(-0.049)	(-0.224)	(0.215)
Thursday	0.003	0.002	-0.005	0.000	0.001
	(-0.313)	(-0.427)	(-0.210)	(-0.729)	(0.528)
Friday	0.000	0.001	0.008*	0.001	0.001
	(-0.920)	(-0.833)	(-0.061)	(-0.187)	(0.634)

Table VIII

The Results of Variance Ratio Tests

This table shows the results of the variance ratio test for each stock and decile index over the period between January 2007 and June 2009. Variance ratios are computed for lag orders 2, 4, 8, and 16. Values in parentheses are z statistics. Asterisk symbols indicate significance levels: (*:10%, **:5%, and ***:1%).

Panel A: Results for Daily Log-Returns

	Observation	Lag Orders			
		2	4	8	16
MOLX	627	0.483	0.235	0.117	0.054
		(-7.15)***	(-6.306)***	(-5.063)***	(-3.798)***
MNRO	627	0.420	0.226	0.103	0.0511
		(-9.867)***	(-7.624)***	(-6.095)***	(-4.688)***
PSTA	627	0.354	0.181	0.100	0.048
		(-6.687)***	(-4.975)***	(-3.926)***	(-3.118)***
D1	627	0.538	0.299	0.178	0.085
		(-7.458)***	(-6.103)***	(-4.550)***	(-3.458)***
D10	627	0.496	0.231	0.108	0.051
		(-6.583)***	(-5.660)***	(-4.372)***	(-3.158)***

Panel B: Results for Monthly Log-Returns

	Observation	Lag Orders			
		2	4	8	16
MOLX	29	0.806	0.206	0.191	0.183
		(-0.845)	(-1.970)	(-1.318)	(-0.947)
MNRO	29	0.417	0.209	0.133	0.123
		(-2.609)***	(-2.102)**	(-1.582)	(-1.145)
PSTA	29	0.556	0.346	0.181	0.211
		(-1.575)	(-1.303)	(-1.147)	(-0.861)
D1	29	0.667	0.399	0.281	0.279
		(-1.009)	(-1.080)	(-0.945)	(-0.771)
D10	29	0.978	0.329	0.265	0.265
		(-0.121)	(-1.856)	(-1.226)	(-0.872)

Table IX

Summary Statistics for Daily Returns

This table shows the descriptive statistics of the monthly retuns for three stocks and two decile indices for two and a half years between January 2007 and June 2009.

	MOLX	MNRO	PSTA	D1	D10
Observations	628	628	628	628	628
Mean	-0.001	0.000	-0.001	0.000	-0.001
Median	0.000	0.000	0.000	0.001	0.001
Maximum	0.142	0.095	0.307	0.063	0.112
Minimum	-0.105	-0.137	-0.195	-0.056	-0.095
Std. Dev.	0.028	0.029	0.046	0.011	0.020
Skewness	0.131	0.047	0.586	0.148	-0.163
Kurtosis	6.800	4.353	10.548	8.898	8.385
Jarque-Bera	379.7	48.13	1526.8	912.6	761.5
Probability	0.000	0.000	0.000	0.000	0.000
Sum	-0.710	0.094	-0.941	-0.093	-0.348
Sum Sq. Dev.	0.504	0.511	1.316	0.080	0.251
F-statistic	0.187	0.022	0.525	1.236	3.701
Prob. F(1,625)	0.665	0.879	0.468	0.266	0.054
Obs*R-squared	0.187	0.022	0.526	1.237	3.691
Prob. Chi-Square(1)	0.664	0.879	0.468	0.265	0.054

Table X

Results of Day of the Week Effect: GARCH model

This table shows the results of day of the week effect using GARCH model for the period between January 2007 and June 2009. Values in parentheses are probabilities. Asterisk symbols indicate significance levels: (*:10%, **:5%, and ***:1%).

Coefficient	MOLX	MNRO	PSTA	D1	D10
Monday	-0.000	-0.004**	-0.005	-0.000	-0.001
	(0.973)	(0.048)	(0.148)	(0.847)	(0.535)
Tuesday	-0.002	0.005***	0.003	0.0001	0.001
	(0.228)	(0.004)	(0.335)	(0.716)	(0.558)
Wednesday	0.001	-0.003*	-0.008**	-0.001	-0.001*
	(0.757)	(0.098)	(0.048)	(0.102)	(0.057)
Thursday	0.003	0.001	-0.005	0.001	0.001
	(0.143)	(0.723)	(0.210)	(0.301)	(0.136)
Friday	-0.001	0.001	0.007*	0.000	0.001
	(0.571)	(0.672)	(0.061)	(0.602)	(0.506)

Table XI

Results of Day of the Week Effect: EGARCH model

This table shows the results of day of the week effect using EGARCH model for the period between January 2007 and June 2009. Values in parentheses are probabilities. Asterisk symbols indicate significance levels: (*:10%, **:5%, and ***:1%).

Coefficient	MOLX	MNRO	PSTA	D1	D10
Monday	-0.001	-0.004*	-0.003*	0.000	-0.001
	(0.691)	(0.072)	(0.073)	(0.768)	(0.390)
Tuesday	-0.002	0.005***	-0.001	0.000	0.001*
	(0.207)	(0.007)	(0.738)	(0.502)	(0.085)
Wednesday	-0.001	-0.004*	-0.002	-0.001	-0.002**
	(0.445)	(0.063)	(0.202)	(0.187)	(0.012)
Thursday	0.001	0.000	-0.003	0.001	0.001
	(0.448)	(0.887)	(0.134)	(0.294)	(0.549)
Friday	-0.001	0.000	0.001	0.000	0.001
	(0.579)	(0.864)	(0.506)	(0.686)	(0.156)

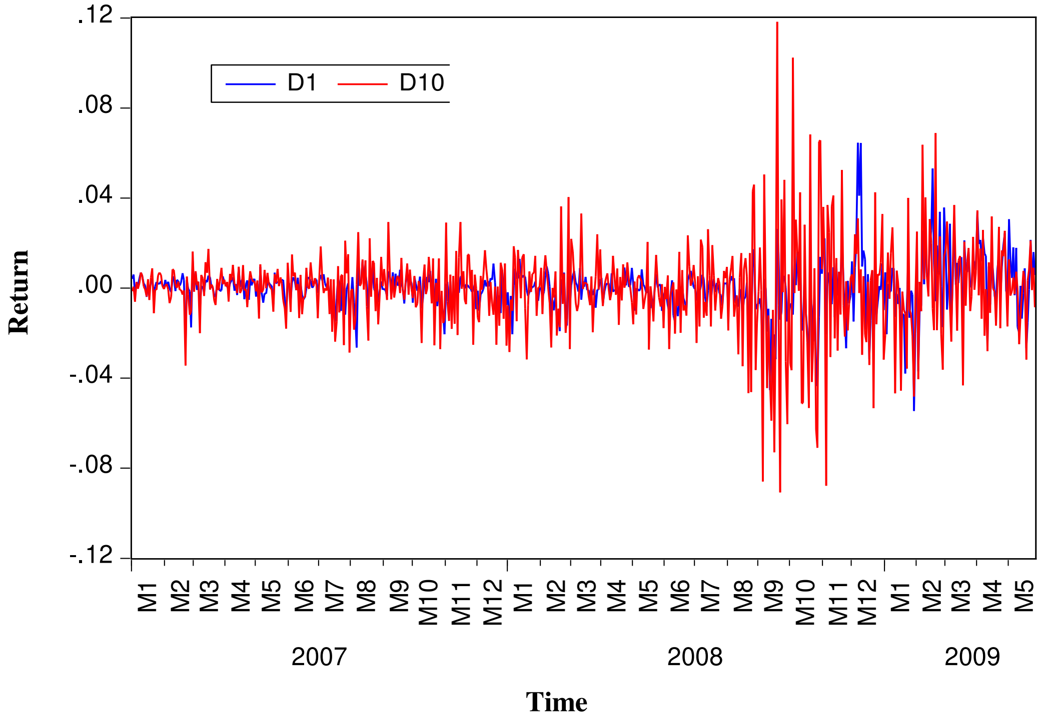

Figure 1. Time Series of Returns of NYSE/AMEX/NASDAQ Decile 1 and Decile 10 for the period from 1 Jan 2007 to 30 Jun 2009.

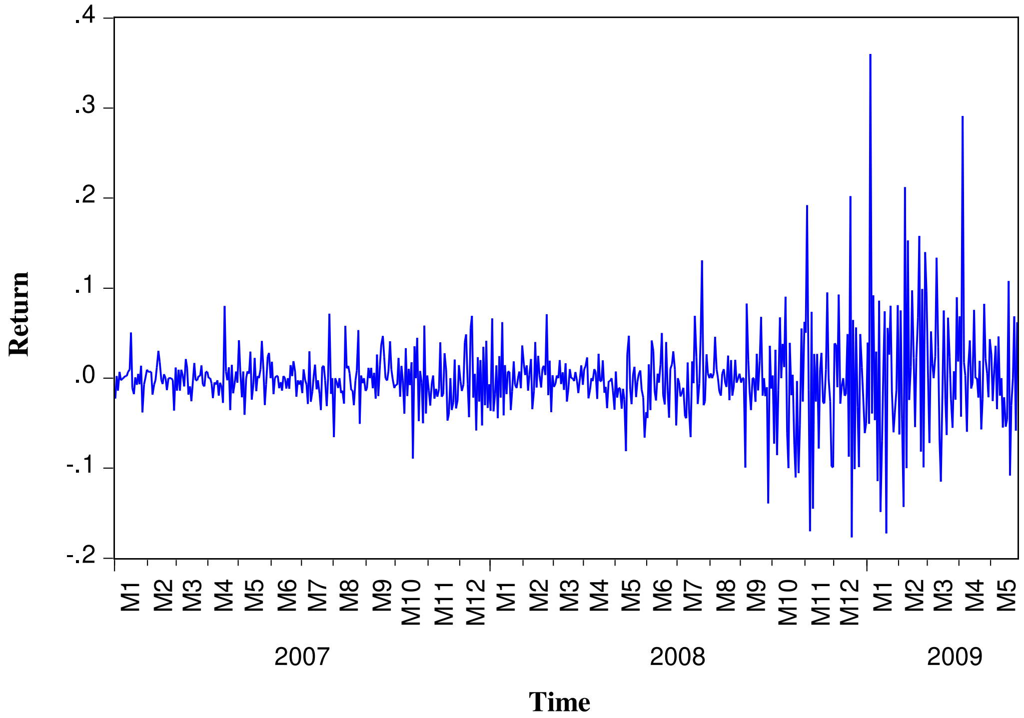

Figure 2. Time Series of Returns of PSTA for the period from 1 Jan 2007 to 30 Jun 2009.

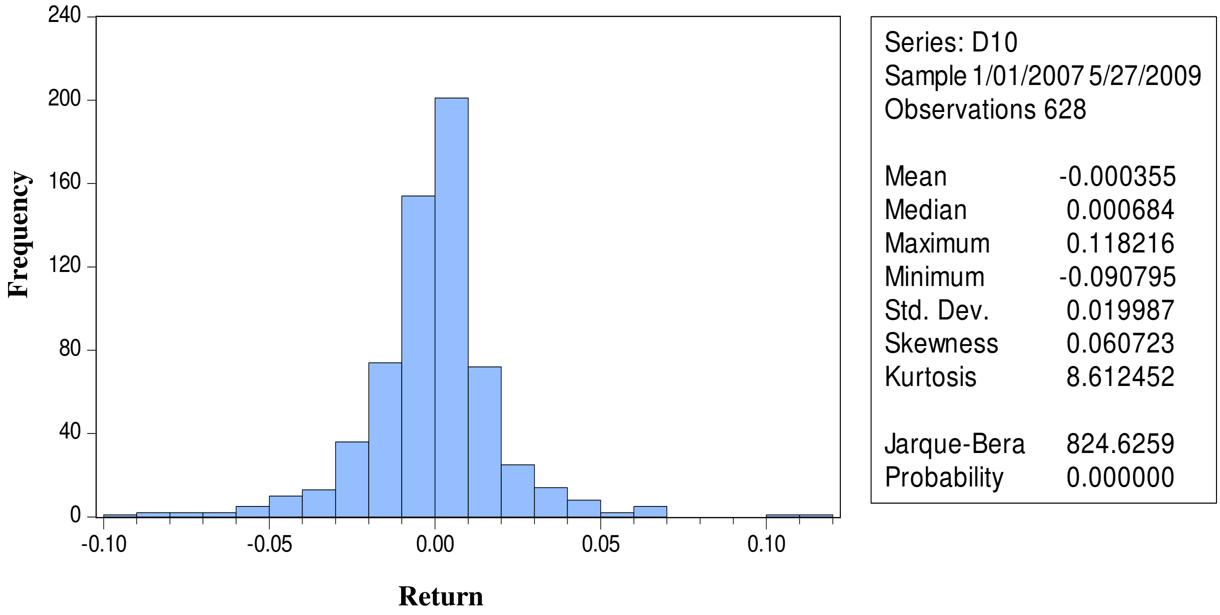

Figure 3. The Histgram of NYSE/AMEX/NASDAQ Decile 10 for the period from 1 Jan 2007 to 30 Jun 2009.

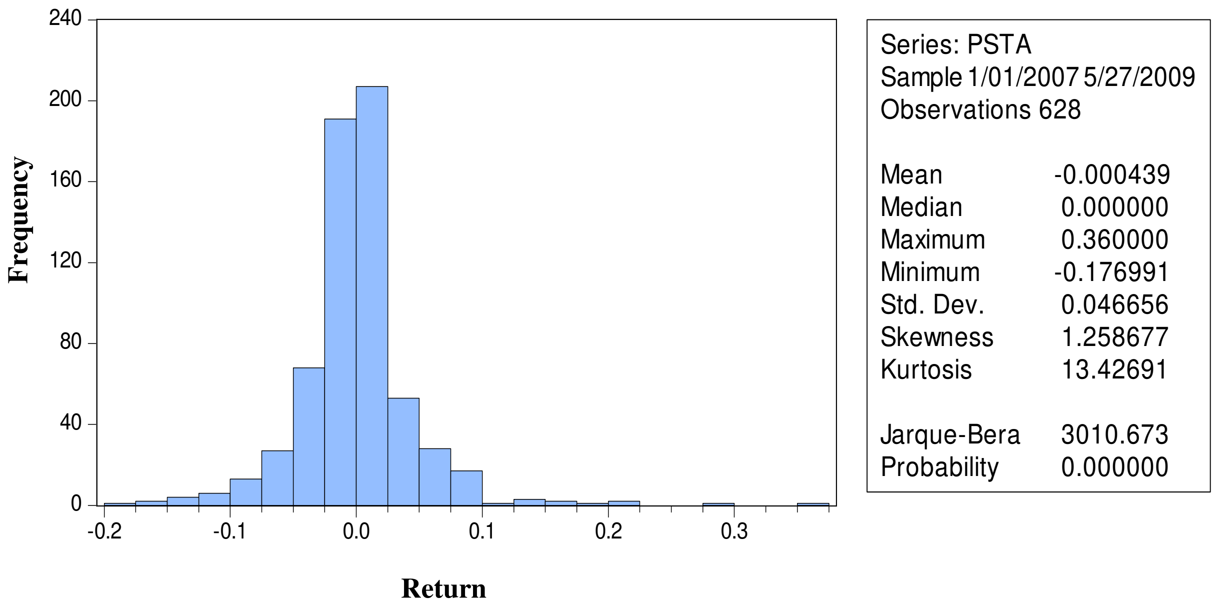

Figure 4. The Histgram of PSTA for the period from 1 Jan 2007 to 30 Jun 2009.