Chapter 4

Evidence on the Existence and Pervasiveness of Nonlinear Serial Dependencies on the Taiwan Stock Exchange

4.1. Data Available for Study

The goal of this chapter is to examine whether the time series of returns of securities listed on Taiwan's stock exchange exhibit significant nonlinear serial dependencies, as do those of other stock exchanges throughout the world, and, if so, to examine the pervasiveness of such dependencies across the individual stocks trading on the Taiwan Stock Exchange. First, an examination of the characteristics of the Taiwan Stock Exchange Stock Index will be undertaken to provide a general answer to the question of whether nonlinear serial dependencies exist among the returns on the Taiwan Stock Exchange. Next, each of the stocks trading on the Taiwan Stock Exchange will be examined individually to determine how widespread or pervasive such nonlinear serial dependencies are cross-sectionally.

The data available for examining these questions were obtained from the E.P.S. data base, which is maintained by the Department of Education of the Republic of China on Taiwan. The data used in this study include the daily closing values for the Taiwan Stock Exchange Weighted Stock Index (the Taiex) from January 5, 1982, through February 28, 1993, along with the daily closing prices for the total of 258 common and preferred stocks that traded on the Taiwan Stock Exchange at some time between January 1984 and December 1992.

The Taiwan Stock Exchange Weighted Stock Index is computed according to the "Paasche Formula." It includes the majority of the issues listed on the Taiwan Stock Exchange (TSE) and weights each security by the number of shares outstanding. In calculation, it is equivalent to the U.S.'s S&P 500 Index or the Tokyo Stock Exchange's Stock Price Index.

For the individual stock data, the longest price series is 2,581 observations and the shortest is 2 observations. About 20% of the stocks have observations over the full sample period. However, the economic growth of Taiwan and the high values on the TSE led many firms to become listed at some point during the sample period.

By the S.E.C.'s classification standards, the firms all fall into one of three categories. "Category A" firms are the largest, most profitable companies with the most diverse shareholders, roughly equivalent to NYSE stocks in the U.S. "Category B" firms are somewhat smaller, more analogous to AMEX stocks. "Stocks requiring full delivery" are the shares of financially distressed firms, including some bankrupt firms and others with no ongoing business, for which traders must make full advance payment with full advance delivery of share certificates and are not allowed any margin lending. For categorical purposes of this research, the "stocks requiring full delivery" have been combined with firms whose shares have been trading for less than two years.

The price series obtained from the E.P.S. data base are used to calculate series of returns for the Taiex and each of the individual stocks, using the relationship:

$$R_t = \ln\left(\frac{P_t + D_t}{P_{t-1}}\right),$$

where P_t is the closing price of the stock on day t and D_t is the (NT) dollar value of a dividend for which day t is the ex-dividend day. Table 4.1 provides a list of the TSE stocks used in this study, categorized by industry, along with their stock numbers and the number of return observations available for each stock.

4.2. Preliminary Analysis of Taiwan Stock Exchange Weighted Stock Index (Taiex) Data

Before turning to the individual stock return data, the returns of the Taiex will be examined first. Plots of the time series of Taiex daily closing values are shown in Figures 3.1. In these figures, the market decline of 1990 is clearly visible, as well as the prior run-up in stock values that commenced in 1987. Figure 4.1 shows the log values for the Taiex, while the daily and weekly sampled returns from this series are shown in Figures 4.2. Some of the descriptive statistics for these daily and weekly returns are shown in the table below:

Summary Statistics	Daily Taiex Returns	Weekly Taiex Returns
No. of Observations	3142	538
Mean	0.00066	0.00374
Variance	0.00037	0.00304
Skewness	-0.33142	-0.50987
Excess Kurtosis	2.17881	2.91542
Kurtosis Test Statistic	621.49	190.53
p-value	0.000	0.000
Normality Test Statistic	679.01	213.85
p-value	0.000	0.000

The upper portion of this table show the estimated moments for these data series, including the third and fourth central moments. The third central moment, the skewness, is estimated via the formula:

$$\hat{\alpha}_3 = \frac{\frac{1}{T}\sum_{t=1}^{T}(R_t - \overline{R})^3}{\left(\frac{1}{T}\sum_{t=1}^{T}(R_t - \overline{R})^2\right)^{\frac{3}{2}}}$$

Normal distributions exhibit zero skewness, so a non-zero estimate of skewness levels, whether in the positive or the negative directions, is an indication of possible non-normality wthin a data series. The fourth central moment, kurtosis, is estimated as follows:

$$\hat{\alpha}_4 = \frac{\frac{1}{T}\sum_{t=1}^{T}(R_t - \overline{R})^4}{\left(\frac{1}{T}\sum_{t=1}^{T}(R_t - \overline{R})^2\right)^2}$$

This moment has a value of three for the normal distribution. Thus, the degree of "excess kurtosis" a series exhibits is the coefficient of kurtosis for the series, α_4, minus three. A series for which this value is positive, i.e., a series that exhibits excess kurtosis, is said to be *leptokurtic*, in which case the tails of its distribution taper down to zero more gradually than do the tails of a normal distribution of the same variance. A series for which this value is negative, on the other hand, is categorized as *platykurtic*, and its tails taper down more rapidly than do those for the equivalent normal distribution.

It is interesting to note that the weekly returns appear to be more leptokurtic than the daily returns. For many financial time series, this relationship is reversed, with the more frequently sampled series exhibiting higher levels of kurtosis. The opposite pattern observed in the Taiex returns could be a result of the daily price limits that were imposed on stock returns by the Taiwan Stock Exchange, which caused a truncation of some of the daily returns, especially during periods when the limits were the tightest. Nonetheless, both the daily and weekly return series do exhibit a significant degree of leptokurtosis, as measured by the Bera-Jarque test statistic for kurtosis,

$$\frac{T}{24}(\hat{\alpha}_4 - 3)^2 \xrightarrow{D} \chi_1^2 .$$

In addition to being leptokurtic, both sets of returns are also slightly left-skewed. However, the extent of this negative skewness is very small compared to the degree of excess kurtosis in the data.

The Bera-Jarque skewness-kurtosis test for normality (cf., Spanos (1986)) utilizes the estimated values for these descriptive statistics, skewness an kurtosis, to test the normality of a data series. Under the null hypothesis of normality,

$$\frac{T}{6}\hat{\alpha}_3^2 + \frac{T}{24}(\hat{\alpha}_4 - 3)^2 \xrightarrow{D} \chi_2^2$$

where T is the number of observations in the data series. For the daily returns, this normality test statistic has a value of 679.01, so that normality is easily rejected for this series. The weekly returns exhibit greater skewness and kurtosis than the daily returns, but there are substantially fewer weekly than daily observations, with a concomitant reduction in test statistic significance levels for the weekly returns. Nonetheless, the normality test statistic still achieves a value of 213.85 for these returns, so that normality is still strongly rejected.

The following table shows the autocorrelations, up to lag six, for the daily and weekly Taiex returns (Figures 4.3 graphically depict the corresponding autocorrelation functions for these two series). The daily returns exhibit significant autocorrelations at lags one and three, and the Box-Pierce $Q_x(6)$ statistic for this data series is 115.48, which is highly significant. Thus, linear serial dependencies seem to play a significant role in the dynamics of Taiex daily returns. For the weekly returns, the autocorrelation function is somewhat better behaved. The autocorrelations taper down quickly, and only the autocorrelation at lag one appears to be significant. The Box-Pierce statistic for this less frequently sampled series is smaller than that for the daily data, but it nevertheless still appears to be significant, with a value for $Q_x(6)$ of 14.16, for which the corresponding p-value would be 0.028.

Autocorrelations	Daily Taiex Returns	Weekly Taiex Returns
ϕ_1	0.145	0.125
ϕ_2	0.019	0.079
ϕ_3	0.111	0.051
ϕ_4	0.051	-0.011
ϕ_5	0.010	-0.035
ϕ_6	-0.005	0.023
$Q_X(6)$	115.28	14.16
p-value	0.000	0.028

The results thus far indicate that, regardless of sampling interval, the marginal distribution of Taiex returns is not normal, and, furthermore, that these returns are linearly serially dependent. But before proceeding to test for the existence of nonlinear serial dependencies, the daily return series was briefly examined for the presence of structural day-of-the-week and holiday effects. To capture day-of-the-week effects, dummy variables were included for the days of the week during which trading occurred, including Saturday. To capture any holiday return effects, another dummy variable was included whose values, ranging from zero to seven, denoted the number of days of trading missed due to holidays since the last day during which trading occurred. The results of fitting a dynamic linear model that incorporates these additional effects for the daily Taiex returns are shown in the table below. None of the day-of-the-week variables appears to have any significant explanatory power, so that the day-of-the-week effect does not seem to play a role in the daily return dynamics of the Taiex. (As will be shown in Chapter Six, these results are similar to those for DJIA returns for the same time period, but different from those for a number of other international indices, all of which exhibit significant day-of-the-week effects.) Similarly, the holiday variable also does not seem to play any significant role in explaining these return dynamics. Thus, the only clearly significant structural or serial linear dependencies within Taiex daily returns are the autocorrelation effects, especially at the first and third lags. As a consequence of this finding, any possible structural effects will be set aside for the time being.

Autoregressive Model Coefficients for Taiex Daily Returns:

Variable	Est. Coefficient	Std. Error	T-Statistic	p-value
β_0	0.000351	0.00084	0.419	0.6752
β_{Monday}	0.000291	0.00107	0.272	0.7855
$\beta_{Tuesday}$	0.000333	0.00112	0.297	0.7668
$\beta_{Wednesday}$	-0.000398	0.00108	-0.368	0.7126
β_{Friday}	0.000641	0.00108	0.594	0.5523
$\beta_{Saturday}$	0.001410	0.00117	1.201	0.2300
$\beta_{Holiday}$	-0.000542	0.00064	-0.845	0.3983
ϕ_1	0.14401	0.01760	8.18	0.0000
ϕ_3	0.10954	0.01759	6.23	0.0000

4.3. Testing for the Existence of Nonlinearity within Taiex Returns

The McLeod and Li Test and the Autocorrelation Function of Squared Returns

The results up to this point indicate that linear serial dependencies do in fact play a significant role in Taiex daily and weekly returns. The next question, and the more important one for this study, is, do these returns also exhibit nonlinear serial dependencies? One of the quickest and easiest ways to answer this question is by examining the autocorrelation behavior of the squared daily and weekly returns or return residuals. The autocorrelation functions for the squared residuals from first-order autoregressions are shown for daily and weekly Taiex returns in the table below and are plotted in Figures 4.4. These autocorrelograms indicate strong serial dependencies among the squared residuals for both series. The strength of these dependencies are quantified by the McLeod and Li test statistics, with values for $Q_{xx}(6)$ of 2,581.52 for the daily returns and 259.05 for the weekly returns, both of which are highly significant. And, notably, these results change little, regardless of the extent to which serial linear dependencies are pre-filtered out of the data. For the daily data, $Q_{xx}(6)$ is equal to 2938.25 ($p = 0.000$) for the raw returns and 2401.26 ($p = 0.000$) for AR(6) residuals, while the comparable figures for the weekly data are 265.83 ($p = 0.000$) for the raw returns and 225.14 ($p = 0.000$) for the AR(6) residuals.

ACF - Squared AR(1) Res.	Daily Taiex Return Series	Weekly Taiex Return Series
$\phi_1(e^2)$	0.360	0.211
$\phi_2(e^2)$	0.408	0.396
$\phi_3(e^2)$	0.411	0.191
$\phi_4(e^2)$	0.367	0.219
$\phi_5(e^2)$	0.363	0.347
$\phi_6(e^2)$	0.344	0.231
$Q_{xx}(6)$	2676.52	249.43
p-value	0.000	0.000

As these statistics suggest, there is very strong evidence of nonlinear serial dependencies within both the daily and weekly sampled Taiex return series. These results are consistent with the hypothesis that these returns are being generated by some sort of nonlinear stochastic process, such as either a bilinear process or a GARCH- or STAR-type process. However, additional testing would need to be performed before the form and specification of a nonlinear return-generating process could be determined.

Testing for Nonlinearity with Hinich's Bispectrum Test

The McLeod and Li test is one of the more general tests available for nonlinearity. A somewhat more specific and elaborate test for nonlinearity, and one which may also be better suited for detecting such dependencies that manifest themselves only over a longer horizon, is Hinich's (1982) bispectrum test. A key difference between the two types of tests is that the McLeod and Li test, in effect, looks for linear dependencies (e.g., autocorrelation) among nonlinear (square) transformations of the original data series, while the bispectrum test looks directly for (additive) nonlinear dependencies (e.g., bicorrelation) among the original data series itself, or among linear transformations of this original data series.

The bispectrum test procedure makes use of the "squared skewness function," essentially a standardized and squared form of the bispectrum, to jointly test for Gaussianity and linearity. The test for Gaussianity examines whether the squared skewness function is both constant and equal to zero, while the test for nonlinearity concentrates solely on whether this function is constant, or "flat," across frequency pairs, with a non-flat squared skewness function being indicative of a non-linear stochastic process. These two tests are nested as a consequence of the fact that a Gaussian stochastic process must also necessarily be a linear process (including pure white noise as a special case), but a linear process need not be Gaussian.

As shown in Hinich and Patterson (1985a), for daily returns on the DJIA and a sample of individual U.S. stock returns the bispectrum test yields significant test results for both non-Gaussianity and nonlinearity for all of the sampled data series. As shown in the table below, similar characteristics are exhibited by the Taiex returns, whether sampled at daily or weekly intervals. For the daily Taiex returns, the Gaussianity test statistic, which follows a chi-squared distribution under the null hypothesis, has a value of 4,530.68. The normal distribution approximation for this test statistic yields a Z-statistic of 62.28. Thus, as with the skewness-kurtosis test, normality is strongly rejected. The Z-statistic for the linearity test is 22.67, which is also highly significant. This test indicates the existence of nonlinear dependencies within the daily returns in the form of multiplicative interactions across previous returns, i.e., of nonzero bicovariances. The results for the weekly Taiex returns are similar, though somewhat less dramatic. The Gaussianity test statistic has a value of 460.15, with a normal distribution approximation Z-value of 15.95, while the Z-statistic for the nonlinearity test has a value of 3.42. While this latter Z-statistic is much smaller than the Z-statistics, it is nonetheless still highly significant, with a p-value of 0.0003.

Bispectrum Test Results	Daily Taiex Returns	Weekly Taiex Returns
Gaussianity:		
χ^2-Statistic	4530.68	460.15
Approx. Z-Stat.	62.28	15.95
p-value	0.000	0.000
Linearity:		
Approx. Z-Stat.	22.67	3.42
p-value	0.000	0.000

The plots of the bispectra for these two series are shown in Figures 4.5 and 4.6. For purposes of comparison, the estimated bispectra for simulated random walk data series of approximately the same lengths as these two data series are also shown. For the longer of these two simulated random walk series (which contains 3000 observations), the Gaussianity Z-statistic is 0.1821 and the nonlinearity Z-statistic is 0.02209, while for the shorter series (with 538 observations), the Gaussianity Z-statistic is -0.0659 and the nonlinearity Z-statistic is -0.41927.

The results of the bispectrum tests for the daily and weekly Taiex returns indicate that, as the skewness-kurtosis test results implied, the stochastic processes followed by daily and weekly Taiex returns are not Gaussian processes. Furthermore, in addition to being non-Gaussian, these stochastic processes are characterized by significant nonlinear dependencies. Thus, the results of the bispectrum test are consistent with the results found previously with the McLeod and Li tests. These bispectrum test results, however, do yield additional information beyond merely confirming the results of the earlier tests. Because the bispectrum test has relatively low power against simple ARCH effects, the test results of highly significant nonlinear dependencies for both of the return series indicates that these returns are likely being generated by a process that is more complicated than a simple ARCH-type process. Such a process, for example, may be much more likely to exhibit more dramatic bursts of volatility that taper down again much more quickly than would be the case for an ARCH-type process. Another possibility, however, that is ever present when examining economic time series, is that the Taiex returns are being generated by some sort of nonstationary process, or, in other words, that there is no single stationary process that is underlying and driving these returns. Under this possibility, any observed ‘bursts of volatility’ that would trigger significant test results for ARCH-effects could actually be a reflection of episodes of transient serial dependence that have briefly appeared within the data and temporarily altered their dynamics. Hinich and Patterson’s (1996) windowed test procedure will be used to examine this issue in the next chapter.

4.4. Testing for Nonlinearity within Individual Stock Return Series

The previous sections provide clear evidence that, similar to most (if not all) of the world’s other major financial time series, and in spite of its relative financial isolation, the returns for Taiwan’s stock market index are subject to significant nonlinear serial dependencies. But this finding opens up another avenue of questioning, namely, what is the source of this nonlinearity in the index returns? Does this nonlinearity in the index returns reflect the widespread occurrence of nonlinear serial dependencies among the stocks listed on the Taiwan Stock Exchange, or are there, for example, only a few large stocks with nonlinear return dynamics whose returns are driving the results for the index? In this section, the daily returns for all the stocks that traded on the Taiwan Stock Exchange at some time between January 1984 and December 1992 will be examined (assuming there were a sufficient number of observations to perform an empirical examination) to determine whether the returns for these stocks follow a random walk or instead exhibit linear or nonlinear serial dependencies and, if they do exhibit such serial dependencies, how widespread or pervasive such dependencies are throughout these stocks.

The results of the initial examination of the Taiwan stock returns for linear serial dependencies are shown in Table 4.2. The third column of this table lists the estimates of the autoregressive parameter of an AR(1) model that is fit to the returns of the given stock. As is shown in the summary of overall results that is provided on the last page of the table, the average estimated autoregressive parameter is a substantial 0.140, with the median being 0.138. Overall, these parameters range from -0.086 all the way up to 0.536, with values above 0.200 being fairly common. Under the assumption (unrealistic, as future results will soon show) that the returns for each of these stocks are normally distributed, nearly 84% (214 out of a total of 255) of all of these stocks exhibit significant first-order autocorrelation. And, notably, this percentage remains fairly constant across all of the 18 industry categories into which the stocks are grouped. Thus, in general, Taiwan's stocks clearly do not statistically follow a random walk, even when only linear dependencies are taken into account. Furthermore, even after first order autocorrelation has been accounted for, a majority of the stocks (149 out of 255) still exhibit significant near-term linear dependencies, as evidenced by the significant Box-Pierce $Q_x(6)$ test statistics (shown in the fifth and sixth columns of Table 4.2) for the residuals from an AR(1) autoregression. Six lags were chosen for this test for the somewhat arbitrary reason that this covers the residuals for a full week's worth of returns. Curiously, though, for many of the stocks that exhibit significant residual autocorrelation, the relevant remaining autocorrelation is at lag three. This result was also seen for the daily Taiex return series, but why autocorrelation at this particular lag should be significant is not known.

Testing for Nonlinearity via the Squared Residual Autocorrelation Function

Because these stocks' returns exhibit significant linear serial dependencies, it can be said that statistically they do not follow a random walk. This is certainly an interesting finding, and it indicates a potential for traders in Taiwan's stock market to reap excess profits. For the purposes of this research, however, even more important questions are whether and to what extent nonlinear serial dependencies also play a role in the returns for these stocks. As with the Taiex (index) returns, the first test that will be used to examine this question is the McLeod and Li test. As with the Box-Pierce test, the McLeod and Li test will be tested out to six lags, and the series tested will be the residuals obtained after pre-whitening the stock returns using an AR(1) filter.

The dramatic results of this analysis are presented in the third and fourth columns of Table 4.3. While only about three-fifths of these series of AR(1)-residuals exhibited significant $Q_x(6)$ statistics, more than four-fifths (80.8%, or 206 out of 255) of these data series exhibit $Q_{xx}(6)$ statistics that are significant at a 0.05 level, with most of these (188 out of the 255) being significant at a 0.001 level (and 183 out of the 255, or 71.8%, are significant at a .0005 level). Thus, it seems clear that nonlinear as well as linear serial dependencies play an important role in the stock return dynamics on the TSE and that this is the case for most of the stocks on the TSE. In other words, nonlinearity is both existent and pervasive or widespread among the returns of the stocks listed on the TSE.

Unlike the results for simple autocorrelation, however, the results for squared residual autocorrelation do seem to show somewhat of an "industry effect." For most of the industry categories, most (75% or more) of the stocks exhibit significant nonlinearity of this type. For the cement (1100), electrical appliance (1600), glass (1800), and department store (2900) industries, all of the stocks exhibit nonlinear serial dependencies that are significant at a 0.001 level. On the other hand, within the banking and insurance (2800) industry, which is also Taiwan's most heavily regulated industry, only 25% (four out of 16) of the stocks exhibit significant nonlinearity at a 0.001 level. And even when the cutoff significance level is increased to 0.05, the proportion of banking and insurance stocks with significant nonlinear serial dependencies is still less than half (seven out of 16, or 43.8%). The industry with the next lowest proportion of stocks with significant results at a 0.05 level for the McLeod and Li test is the plastics industry (1300), for which 72.2 % of the stocks (13 out of 18) are significant. At a 0.001 level, 10 out of 18, or 55.6%, of the stocks in this industry exhibit significant nonlinearity via the McLeod and Li test.

Testing for Nonlinearity via the Bispectrum

Bispectrum testing of the TSE stocks (see Table 4.3) yields even more dramatic results than the McLeod and Li testing. The first part of the bispectrum test procedure is the test for normality. As can be seen in column three of Table 4.3, normality is rejected for all but one (Yieh Loong Co., Ltd. Common (2014)) of the 241 stocks for which there were a sufficient number of observations to perform the bispectrum test. This rejection of normality is consistent with the findings for the Taiex daily and weekly returns, as well as with the findings for most financial time series in general.

The second part of the bispectrum test procedure is the test for linearity, the results for which are equally dramatic. While 206 of the stocks had significant $Q_{xx}(6)$ statistics, the bispectrum test rejected linearity for fully 229 of the TSE stocks, or 95% of the 241 stocks that could be tested via this procedure. Even at a 0.001 level of significance, 215 of the stocks exhibit significant nonlinearity. Thus, the bispectrum testing provides even stronger evidence for the existence and pervasiveness of nonlinearity among TSE stocks than does the McLeod and Li testing. Furthermore, these bispectrum results are more consistent across industries than are the McLeod and Li results, with fully 13 of the 18 industry categories having significant results for all of their stocks, and the remaining five industry categories having significant results for 82.4% or more of their stocks. It is particularly noteworthy that in the banking and insurance industry, linearity is rejected at a level of less than 0.005 for all 15 of the stocks tested, while the McLeod and Li test rejected linearity at this size for only four of the banks, and at a size of less than 0.05 for only three more, or a total of seven stocks out of the 15 bank stocks.

While the McLeod and Li test and the bispectrum test utilize different moments to test for the existence of nonlinearity, the McLeod and Li test is, to a certain extent, a more general test than the bispectrum test, in that it can be used as a diagnostic in the detection of both mean nonlinearity, in the form of bilinearity, and variance nonlinearity, such as GARCH effects. Thus, it is especially interesting that the bispectrum test rejects linearity in so many cases for which the McLeod and Li test does not. This result could be caused by a number of factors. One possibility is that the nonlinear dependencies in the Taiwan stock returns are driven by a relatively complex and subtle nonlinear process that does not result in squared returns that are autocorrelated. Another possibility is that the underlying process has a relatively long term memory structure whose effects do not manifest themselves within a short number of lags, such as the six lags used for the McLeod and Li test in this case. A third possibility is that the evident nonlinearity in these stock return series is a result of some sort of nonstable stochastic process that generates episodic "bursts" of strongly nonlinearly serially dependent activity that, though transient, occur with sufficient magnitude and/or sufficient frequency to cause the data series as a whole to empirically mimic the type of stable nonlinear process that the bispectrum test is designed to detect. This latter type of possibility will be examined more closely in the next chapter.

Taken altogether, the results of this section provide clear evidence that the existence of nonlinear serial dependencies within stock return time series is a phenomenon that is not limited to only a few of the larger stocks traded on the Taiwan Stock Exchange; rather, such dependencies occur among the returns of virtually all of the TSE stocks. In regard to this characteristic, Taiwan's stocks are similar to stocks the world over, in spite of the relative financial isolation in which Taiwan's stock market operates. Hence, these results provide evidence that nonlinearity is an inherent and universal feature of financial time series. Unfortunately, the results also indicate that the observed nonlinear serial dependencies may be reflections of underlying stochastic processes that, at best, may be more complicated than simple GARCH-type processes and, at worst, may not even be stable, in which case they may be impossible to model. The following three chapters will explore these issues more closely.

4.5. Conclusions on the Existence and Pervasiveness of Nonlinear Serial Dependencies among TSE Stock Returns

The results of this section clearly indicate that the returns of the Taiwan Stock Exchange Weighted Stock Index, or Taiex, do not follow a Gaussian random walk, regardless of whether such returns are calculated at a daily or a weekly interval. Normality is strongly rejected, for both time intervals, by both the skewness-kurtosis test and the bispectrum Gaussianity test. Furthermore, not only are these returns not distributed normally, but they are also not serially independent. First off, both the weekly and the daily return series exhibit significant autocorrelation, especially at the first lag. The daily returns also exhibit significant autocorrelation at the third lag. Within these daily returns, though, there does not seem to be any sort of day-of-the-week or holiday effect.

However, in addition to significant autocorrelation, both of these return series exhibit significant nonlinear serial dependencies, both in terms of autocorrelation of the squared returns of each of these series, measured by the McLeod and Li test, and in terms of bicorrelations of the untransformed returns of each of these series, as detected by the bispectrum test. Since these two tests, the McLeod and Li test and the bispectrum test, are designed to detect somewhat different types of nonlinearity, the fact that both of these tests detect highly significant nonlinearity provides much stronger evidence that nonlinear serial dependencies do in fact play a role in the dynamics of Taiex returns. Moreover, since the bispectrum test has very low power against the simpler ARCH-type models, the stong rejection of linearity from the bispectrum test provides stong evidence that whatever nonlinear dependencies are driving the dynamics of the Taiex returns are more complicated than simple ARCH-type dependencies. The actual form and duration of the nonlinear seial dependencies extant in the Taiex returns will be explored in more detail in subsequent chapters.

For the returns on individual stocks on the Taiwan Stock Exchange, the results are similar to those for the Taiex returns. Gaussianity is rejected for all but one of the stocks, and even for this stock the McLeod and Li test finds significant nonlinearity, so that none of the stocks on the TSE follows a Gaussian random walk. Furthermore, most of these stocks, 214 out of 255, exhibit significant autocorrelation, some with first-order autocorrelation as high as 0.50, indicating a possibility of using past return data to develop profitable trading rules. Finally, as did the index returns, a large majority of the TSE stocks exhibit significant nonlinearity, with the McLeod and Li test detecting nonlinearity at a 0.05 level for 206 out of 255 stocks tested, and the bispectrum test detecting nonlinearity at this level for 229 out of 241 stocks tested. (The sensitivity of these proportions to the test level chosen is shown in the table below.) Given that the bispectrum test is less general than the McLeod and Li test and is less powerful in detecting many types of nonlinearity, the fact that the bispectrum test tends to reject more frequently is especially interesting. This indicates that the bispectrum test is more powerful in detecting whatever type of nonlinearity underlies these stock returns than is the McLeod and Li test, which in turn suggests that the underlying nonlinearity is more complicated than a simple ARCH-type process.

Percentages of stocks exhibiting significant nonlinearity test results:

	McLeod and Li Test ($Q_{xx}(6)$)	Bispectrum Linearity Test
No. of Stocks Tested	255	246
Test Level (α):		
0.100	83.9%	93.9%
0.050	80.8%	93.1%
0.010	77.3%	90.2%
0.001	72.6%	87.4%

Overall these results indicate that nonlinear serial dependencies play a significant role in returns on the Taiwan Stock Exchange and, furthermore, that this nonlinearity is pervasive among the stocks trading on this exchange. Given the financial isolation of the Taiwan Stock Exchange, along with its operational differences from the New York Stock Exchange, the fact that nonlinearity is as important a factor in the returns for this market as for those of the New York Stock Exchange or the foreign currency exchanges indicates that nonlinear serial dependencies are an inherent feature of financial time series, and, especially in the case of the Taiwan Stock Exchange, not something that is simply directly imported from international financial flows.

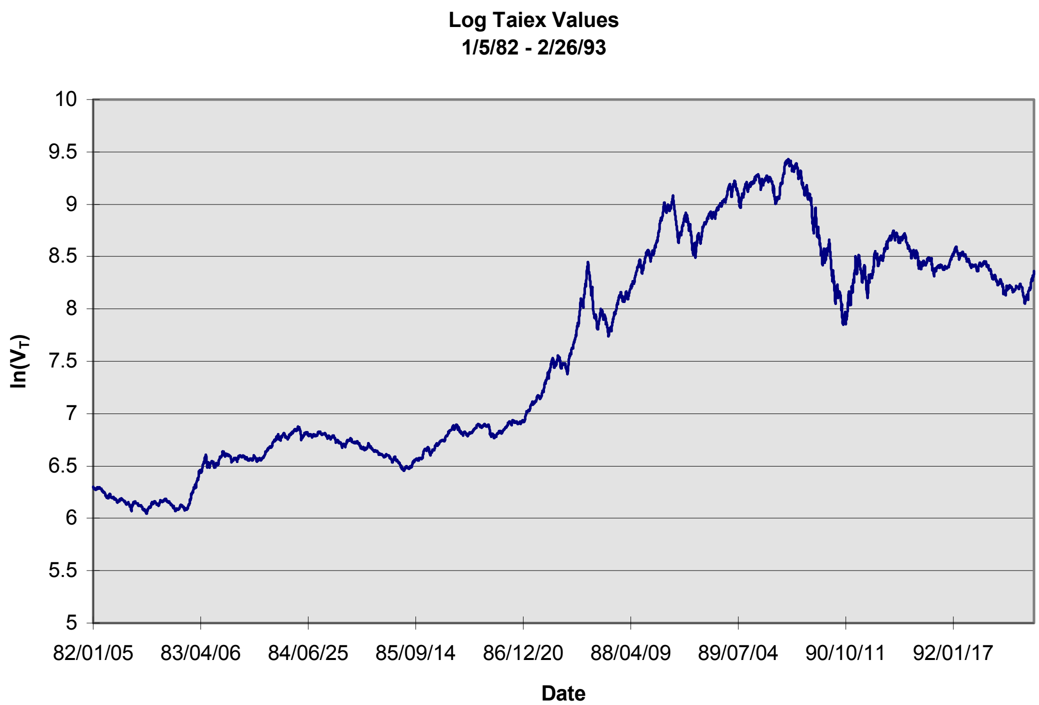
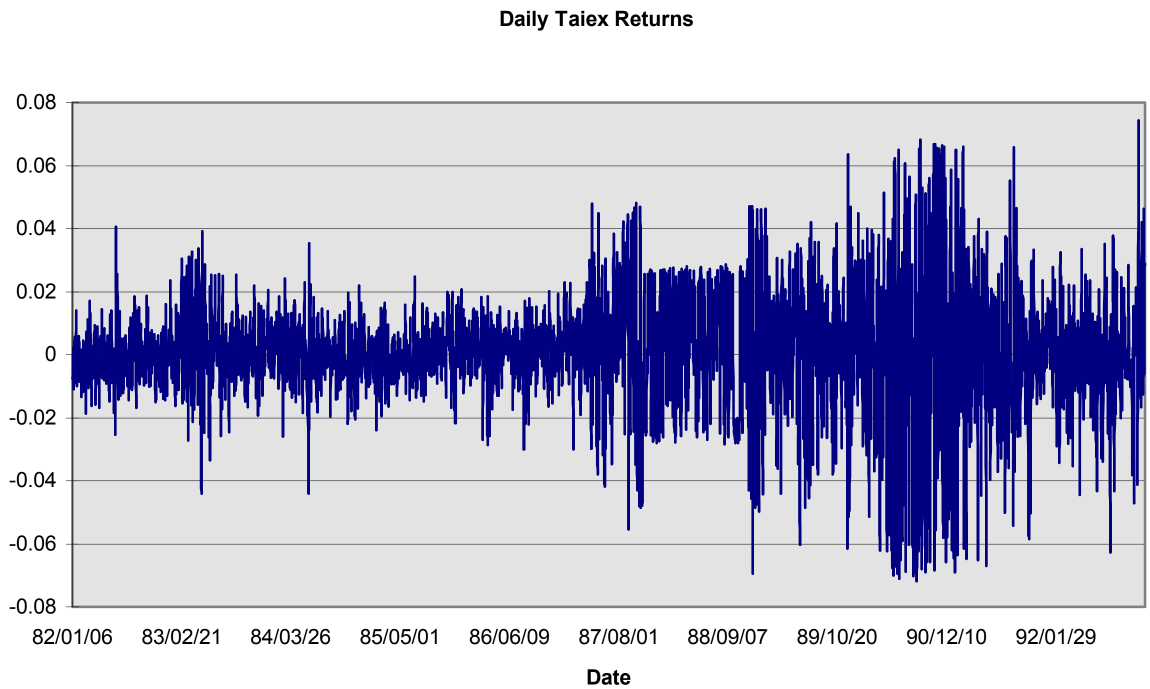
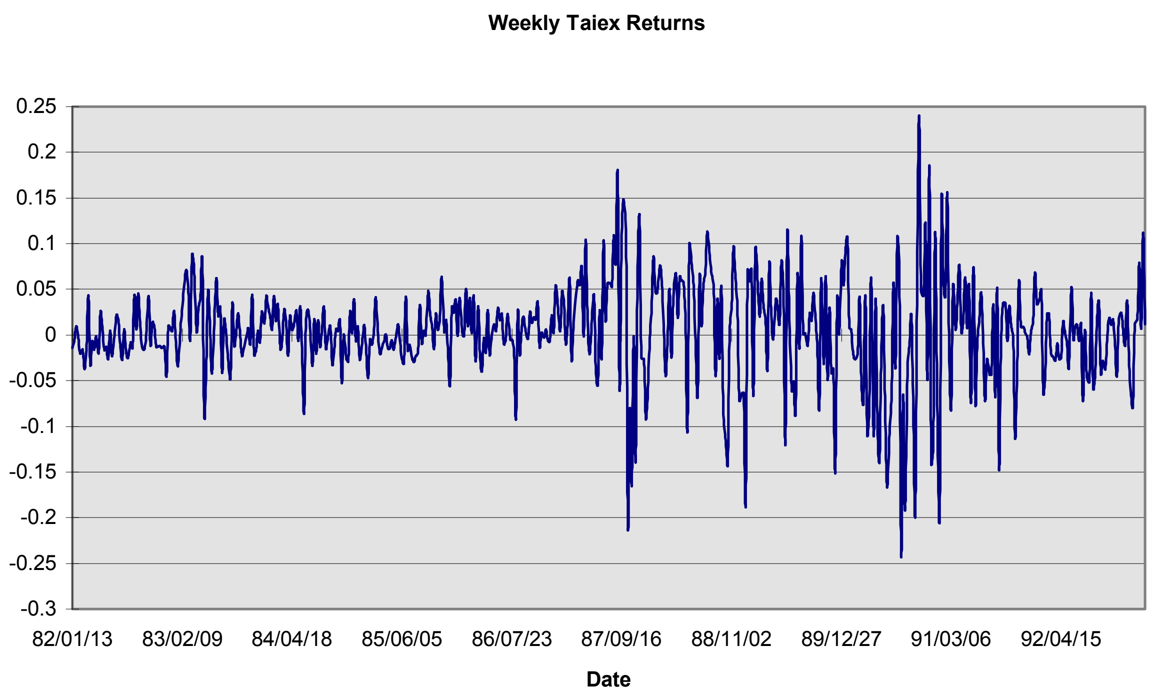
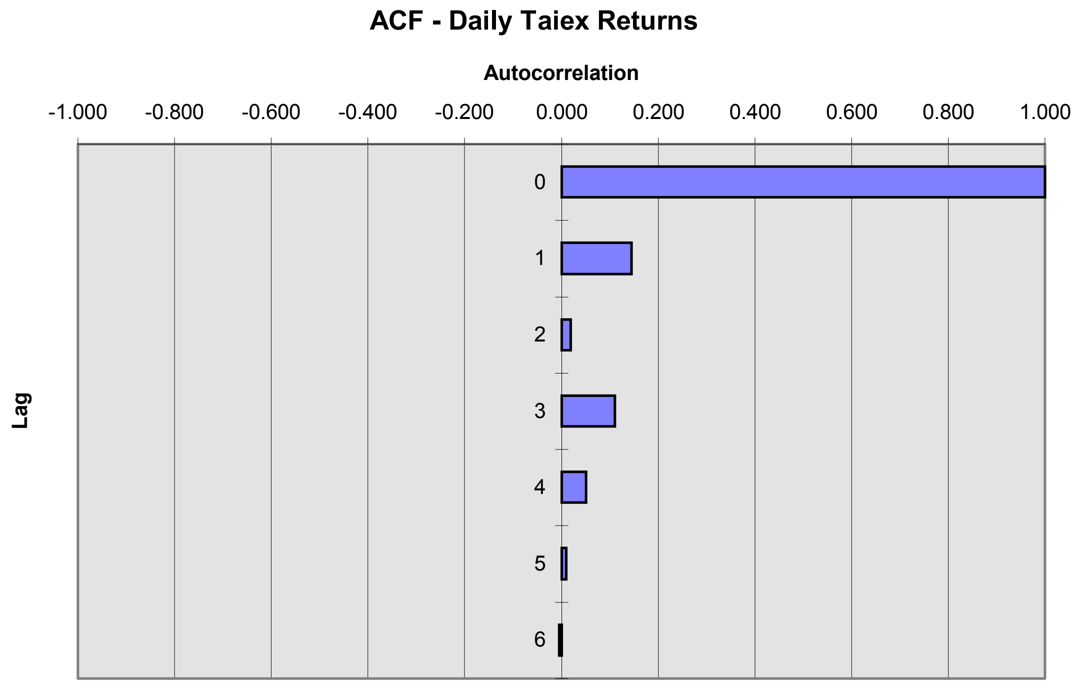


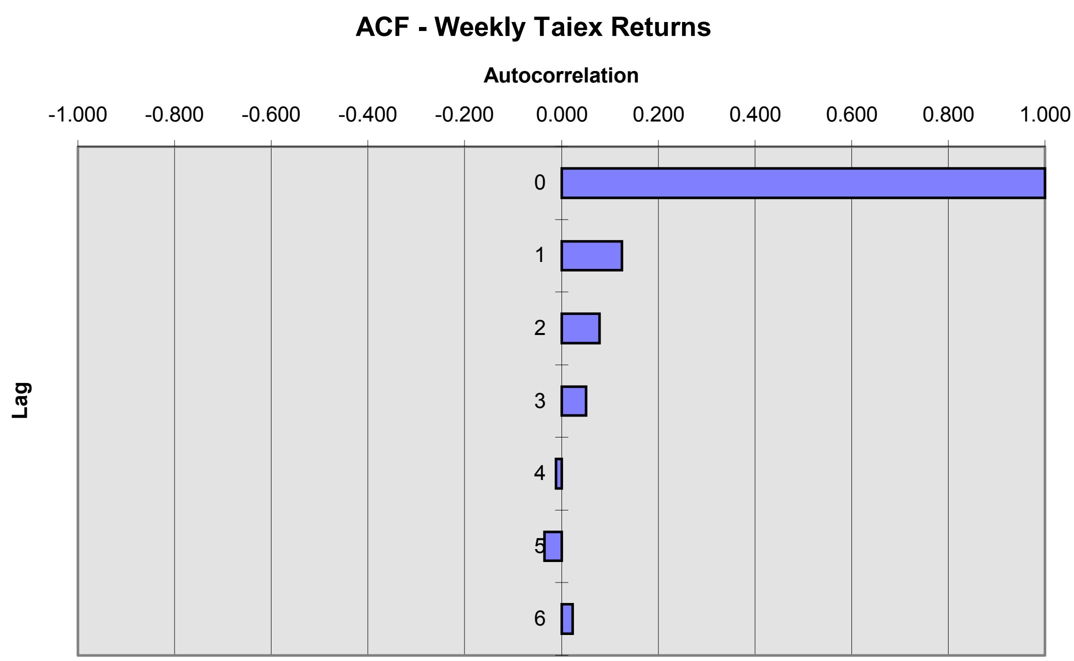
Figure 4.1
Timeplot of Log Taiex Values



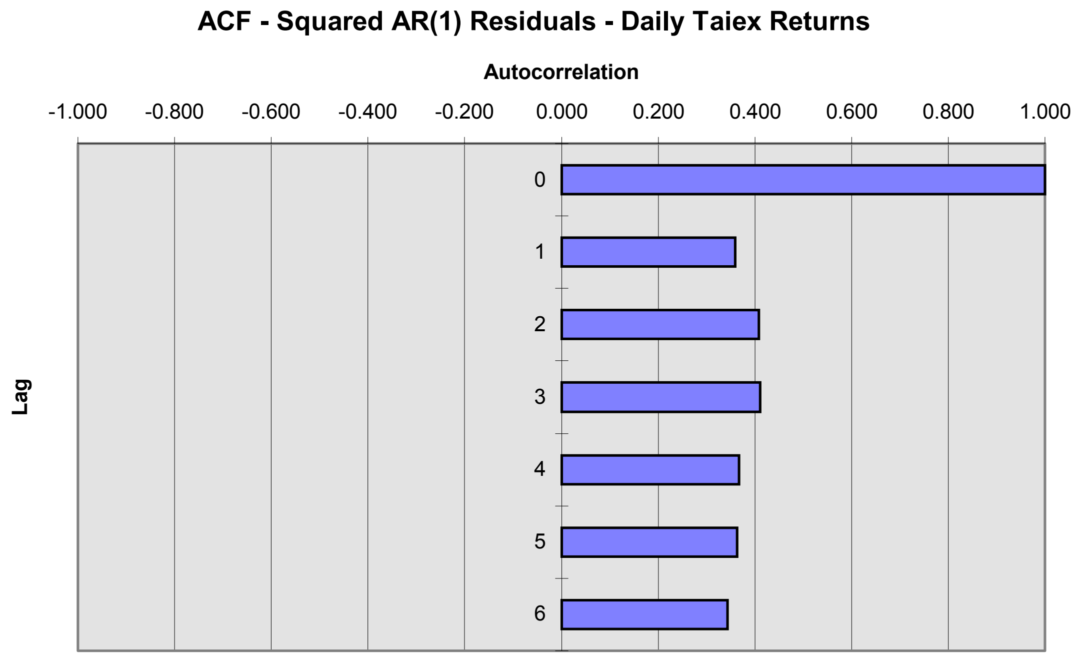


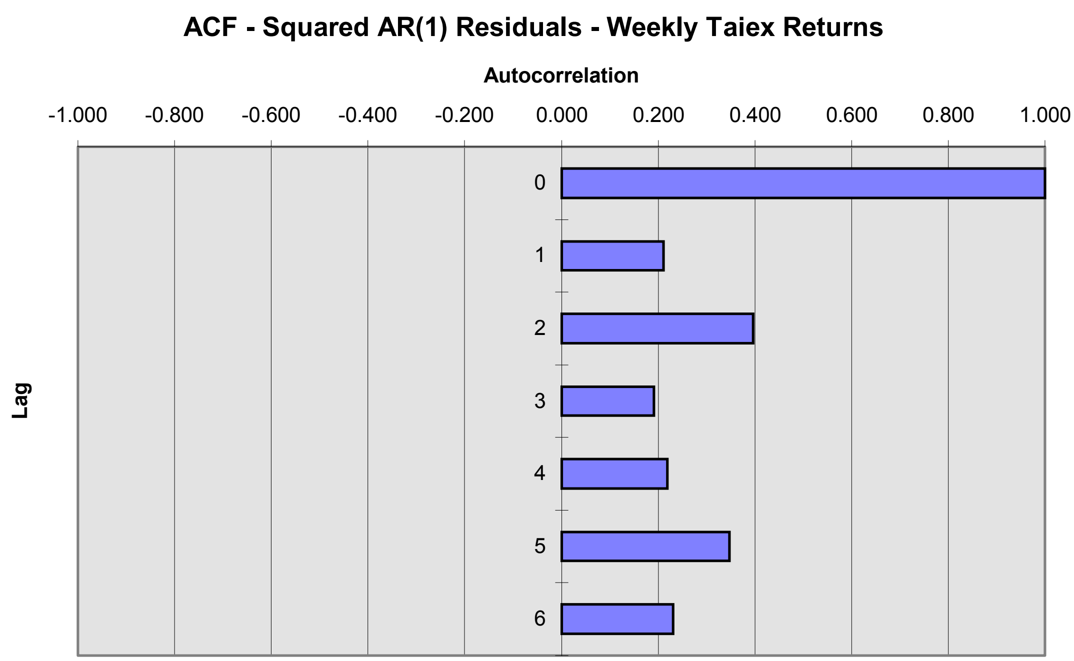
Figures 4.2
Timeplots of Daily and Weekly Taiex Returns



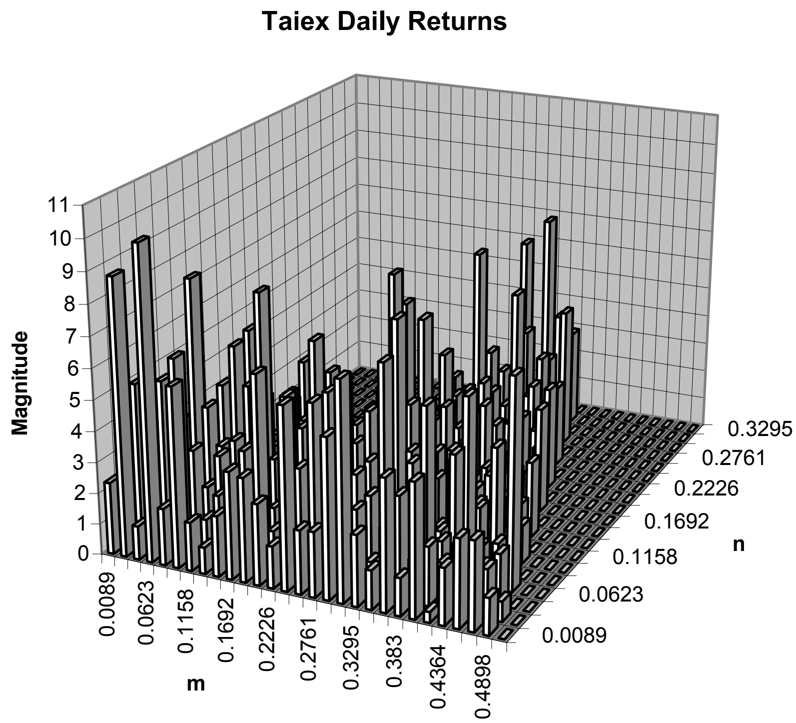


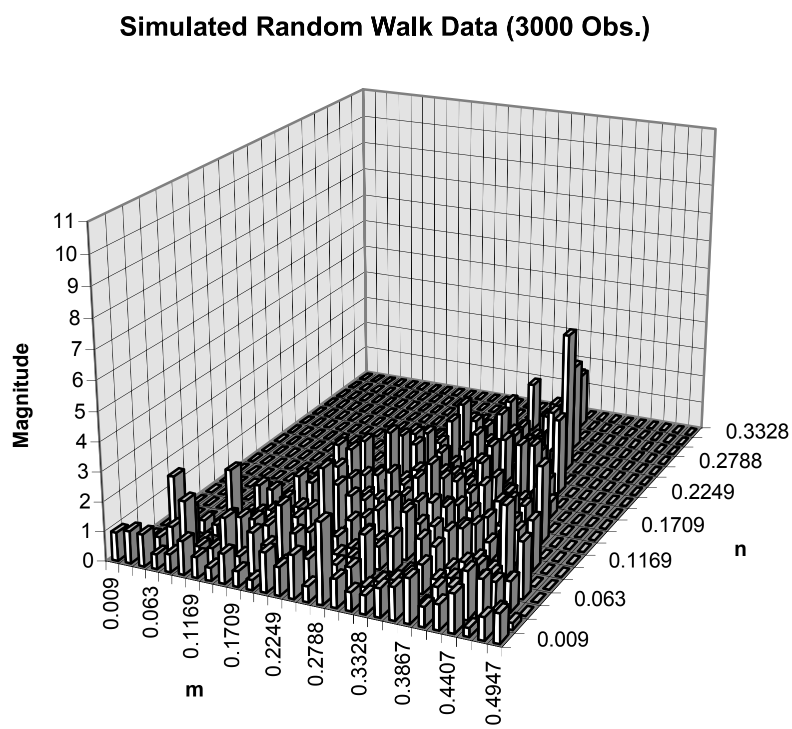
Figures 4.3
Autocorrelation Functions of Daily and Weekly Taiex Returns





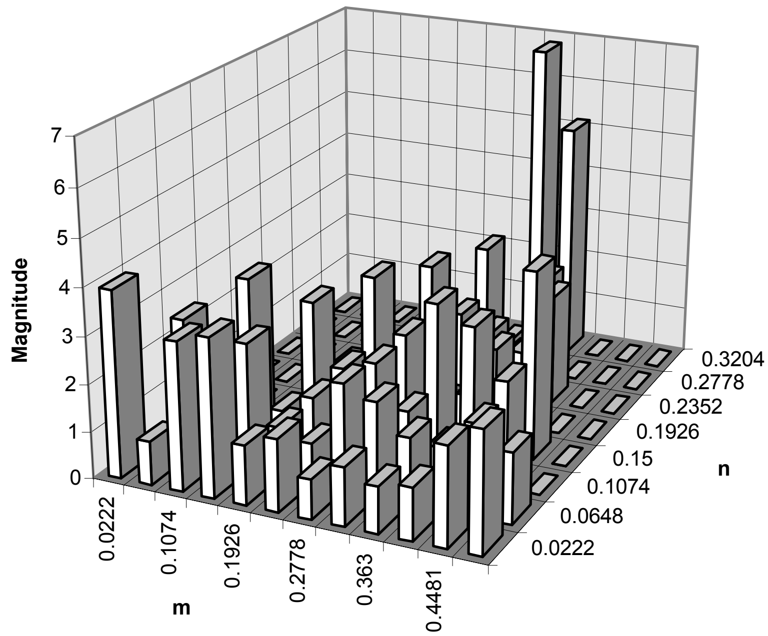
Figures 4.4
ACF's of Squared AR(1) Residuals from Daily and Weekly Taiex Returns



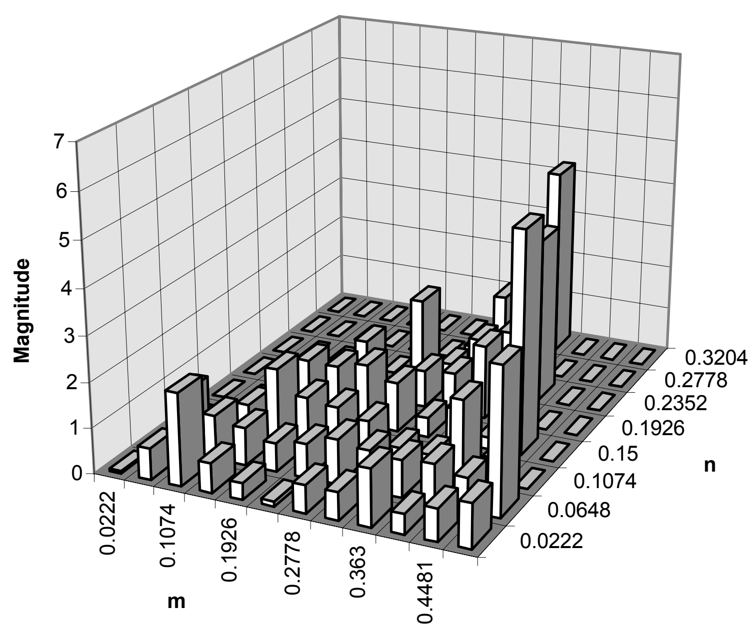


Figures 4.5
Estimated Bispectra for Daily Taiex Returns and Simulated Random Walk Data

Taiex Weekly Returns



Simulated Random Walk Data (538 Obs.)



Figures 4.6
Estimated Bispectra for Weekly Taiex Returns and Simulated Random Walk Data

Table 4.1
TSE Stocks Included in this Study

Cement Industry (1100) - 9 Stocks:

Stock Number	Company Name	No. of Observations
1101	Taiwan Cement	2577
1102	Asia Cement	2580
1103	Chia Hsin Cement	2579
1104	Universal Cement	2578
1105	China Rebar	2579
1107	Chien Tai Cement	1429
1108	Lucky Cement Corp.	730
1109	Hsing Ta Cement Co., Ltd.	302
1106		2311

Food Industry (1200) - 25 Stocks:

Stock Number	Company Name	No. of Observations
1201	Wei Chuan Food	2574
1203	Ve Wong	2574
1207	Chia Hsin Flour	2580
1209	Eagle Food	2572
1210	Great Wall Enterprise	2580
1215	Charoen Pokphand Enterprises (Taiwan)	850
1216	President Enterprises	850
1217	A.G.V. Products (Common)	850
1217A	A.G.V. Products (Preferred)	301
1218	Tay-Shan Enterprises (Common)	850
1218A	Tay-Shan Enterprises (Preferred)	27
1219	Fwu Sow Products	591
1220	Tai Roun Products Co., Ltd.	315
1221	Chou Chin Industrial Co., Ltd.	312
1202	Taiwan Tea Corp.	2579
1206	Taiwan Pineapple	1811
1211	Chia Hsin Livestock	2578
1212	Sino-Japan Feed Ind.	2579
1213	Oceanic Beverage Co., Ind.	850
1214	TaTeh Agricultural Ind.	850
1222	Yuan Yi Agricultural and Livestock	226
1204E	Tsin Tsin	1328
1208E	All Sincere Ind.	2458
1223		144
1224		69

Table 4.1
TSE Stocks Included in this Study (Cont.)

Plastics Industry (1300) - 18 Stocks:

Stock Number	Company Name	No. of Observations
1301	Formosa Plastic	2580
1303	Nan Ya Plastic	2580
1304	USI Far East	2580
1305	China General Plastics Corp.	2580
1307	San Fang Chemical	2029
1308	Asia Polymer	1867
1309	Taita Chemical	1861
1310	Taiwan Styrene Monomer	1543
1311	Taiwan Polypropylene	1194
1312	Grand Petrochemical (Common)	1144
1312A	Grand Petrochemical (Preferred)	1144
1313	Union Petrochemical	1075
1314	China Petrochemical Dev. Corp.	419
1315	Tah Hsin Industrial Corp.	184
1302	Cathay Plastic	1866
1306	Union Leather & Trinting	2230
1316		58
1317		8

Table 4.1
TSE Stocks Included in this Study (Cont.)

Textile Industry (1400) - 42 Stocks:

Stock Number	Company Name	No. of Observations
1402	Far East Textile	2580
1407	Hualon-Teijran (Common)	2577
1407A	Hualon-Teijran (Preferred)	1299
1408	Chung Shing Textile	2580
1409	Shinkong Synthetic Fibers	2580
1410	Nan-Yang Dyeing & Finishing	2542
1414	Dong Ho Textile	850
1416	Kwong Fong Ind.	850
1417	Carnival Textile	850
1420	Rurentex Ind.	2579
1423	Reward Wool	2559
1426	Pao Shiang Ind.	2512
1432	Taroko Textile	2580
1433	Formosa Chemical & Fibre	2286
1434	Formosa Taffeta Co., Ltd.	2003
1435	Chun Fu Textile	1428
1436	Fu I Ind.	1352
1438	Yu Foong Spinning Mill	1149
1439	Chu Wa Wool	850
1440	Tainan Spinning	919
1441	Tah Tong Textile	900
1443	Lily Textile	767
1444	LeaLea Enterprise	680
1446	Hong Ho Precision Textile Co., Ltd.	342
1447	Li Peng Enterprise	263
1448	Hwang Dih Lon Textile Co., Ltd.	211
1449	Chia Her Industrial Co., Ltd.	187
1401	China Manmade Fibers	2555
1413	Hung Chou Chemical	850
1418	Tong-Hwa Synthetic Fiber	850
1419	Sinkong Spinning	2342
1422	Min Hsing Cotton Mill	2528
1425	Lucky Textile	2577
1431	Shin Yen Ind.	2580
1437	G. T. M.	1176
1442	Taih Yung Enterprise	885
1445	Universal Textile Co., Ltd.	541
1405		1523
1424E	New East Textile	1209
1429	Shine Chi Woollen Mill	1877
1430	Chan Chun Textile	1297
1450		64

Table 4.1
TSE Stocks Included in this Study (Cont.)

Electrical Machinery Industry (1500) - 12 Stocks:

Stock Number	Company Name	No. of Observations
1502	Tatung	2580
1503	Shihlin Elec. & Eng.	2577
1504	Teco Elec. & Mach.	2579
1506	Taiwan Ind.	2579
1507	Yung Tay Engineering	890
1510	Taian Electric Co., Ltd.	180
1501	Taiwan Machinery	1212
1508	Taichung Machinery Works	592
1509	Ensure Co., Ltd.	312
1505	Yang Iron (Common)	872
1505E	Yang Iron (Preferred)	847
1511		28

Electrical Appliances, Wire, & Cable Industry (1600) - 11 Stocks:

Stock Number	Company Name	No. of Observations
1601	Taiwan Flourescent	2559
1602	Pacific Electric Wire	2580
1603	China Wire & Cable	2580
1604	Sampo	2580
1605	Walsin Lihwa Wire & Cable	2580
1606	Kolin	2580
1608	Hua Eng Wire & Cable	1277
1609	Ta Ya Electronic Wire & Cable	1152
1610	Tera Electronic	853
1611	China Electronic Manufacture	840
1607	New Asia	2453

Table 4.1
TSE Stocks Included in this Study (Cont.)

Chemical Industry (1700) - 14 Stocks:

Stock Number	Company Name	No. of Observations
1701	China Chemical	2576
1702	Namchow Chemical	2580
1704	Lee Chang Yung Chemical Ind.	2580
1705	Cheng Hong Chemical	2579
1708	Southeast Soda	1871
1709	Formosan Union Chemical	1844
1710	Oriental Union Chemical	1481
1711	Everlight Chemical	1140
1712	Shinung	862
1713	Cathay Chemical	834
1714	Ho Tung Chemical Corp.	378
1703	Lien Hwa Ind.	2580
1707	Grape King Ind.	2530
1706	Ta Nun	2563

Glass Industry (1800) - 6 Stocks:

Stock Number	Company Name	No. of Observations
1802	Taiwan Glass	2578
1804	Picvue Electronics	1245
1805	K. P. T.	905
1801	Hsin Chu Glass	2555
1806		71
1807		64

Pulp & Paper Industry (1900) - 10 Stocks:

Stock Number	Company Name	No. of Observations
1902	Taiwan Paper	2580
1903	Shihlin Paper	1835
1904	Cheng Loong	2580
1905	Chung Hwa Pulp	2580
1907	Yuen Foong Yu Paper Mfg. (Common)	2534
1907A	Yuen Foong Yu Paper Mfg. (A Preferred)	1209
1907B	Yuen Foong Yu Paper Mfg. (B Preferred)	1141
1908	Wan Yu Paper	2580
1909	Long Chen Paper	2032
1906E	Paolung Paper	928

Table 4.1
TSE Stocks Included in this Study (Cont.)

Iron & Steel Industry (2000) - 20 Stocks:

Stock Number	Company Name	No. of Observations
2002	China Steel	2150
2003	Tung Kuang Enterprises	1475
2004	Tahchung Iron of Superior Quality	1470
2005	U-Lead Industries	1458
2006	Tung Ho Steel	1275
2007	Yieh-Hsing (Common)	1207
2007A	Yieh-Hsing (Preferred)	784
2008	Kao Hsing Chang Iron & Steel	1139
2009	First Copper & Iron	905
2010	Chun Yuan Steel	856
2012	Chun Yu Works & Co., Ltd.	340
2014	Yieh Loong Co., Ltd. (Common)	249
2014A	Yieh Loong Co., Ltd. (Preferred)	51
2015	Feng Hsin Iron & Steel Co., Ltd.	171
2011	Ornatube Enterprise (Common)	745
2011A	Ornatube Enterprise (Preferred)	38
2013	China Steel Structure Co., Ltd.	269
2001	Taiwan Iron Manufacturing	2281
2016		157
2017		45

Rubber Industry (2100) - 8 Stocks:

Stock Number	Company Name	No. of Observations
2102	Tay Feng Tire	2575
2103	Taiwan Synthetic Rubber	2578
2104	China Synthetic Rubber	1847
2105	Cheng Shin Ind.	1444
2106	Kenda Rubber Ind.	575
2107	Formosan Rubber Group, Inc.	238
2101	Nan Kang Rubber Tire	2580
2108		49

Automobile Industry (2200) - 4 Stocks:

Stock Number	Company Name	No. of Observations
2201	Yue Loong Motor	2580
2202	San Fu Motor	1146
2203	Yeu Tyan Machinery Mfg.	1140
2204	China Motor Corp.	517

Table 4.1
TSE Stocks Included in this Study (Cont.)

Electronics Industry (2300) - 26 Stocks:

Stock Number	Company Name	No. of Observations
2301	Liton Electronic	2579
2302	Rectron Ltd.	2278
2303	United Micro Electronics (Common)	2132
2303A	United Micro Electronics (Preferred)	46
2304	A. D. I.	1490
2305	Microtek International, Inc.	1193
2306	Acer	1177
2308	Delta Electronic	1146
2309	Ko Sheng Enterprises	1142
2310	Silitek	1142
2311	A. S. E.	981
2312	Cal-Comp. Electronics, Inc.	892
2313	Compeq Manufacturing	693
2314	Microelectronics Technology, Inc.	680
2315	Mitac International Corp.	674
2316	Wus Printed Circuit Co., Ltd.	541
2317	Hou Hai Precision Industry Co., Ltd.	439
2318	Megamedia Corp.	434
2319	First Internatl. Comp., Inc. (Common)	403
2319A	First Internatl. Comp., Inc. (Preferred)	201
2321	Tecom Co., Ltd.	324
2324	Compal Electronics, Inc.	251
2307	Great Electronics	1153
2320	Chuntex Electronics Co., Ltd.	377
2322	GVC Corporation	312
2323	CMC Magnetics Corp.	252

Construction Industry (2500) - 13 Stocks:

Stock Number	Company Name	No. of Observations
2501	Cathay Const.	2552
2504	Kuochan Devel. & Const.	2580
2506	Pacific Const.	2580
2510	Tuntex Distinct	958
2511	Prince Housing Development Corp.	485
2512	Bao-Chen Construction Co., Ltd.	249
2505	Kuoyang Const.	2573
2509	Pao-Ku	1262
2513	Ruentex Const. & Devel. Co., Ltd.	192
2503	Fu Shing Mfg. & Lumber	2522
2507	Hwa Chen Ind.	1408
2508	Kuo Feng Plywood Lumber Corp.	2478
2514		72

Table 4.1
TSE Stocks Included in this Study (Cont.)

Shipping Industry (2600) - 8 Stocks:

Stock Number	Company Name	No. of Observations
2603	Evergreen Marine	1504
2604	Uniglory Marine	1143
2605	Sincere Navigation	867
2606	U-Ming Marine Transport Corp.	585
2607	Evergreen Transport	580
2608	Ta Jung Transportation	575
2609	Yang Ming Marine Transport Corp.	201
2601	First Steamship	2580

Hospitality Industry (2700) - 6 Stocks:

Stock Number	Company Name	No. of Observations
2704	Ambassador Hotel	2579
2706	First Hotel	433
2701	Wan Hwa Enterprise	2049
2702	Garden Hotel	1477
2703	Imperial Hotel	2579
2705	Leofoo Development	1141

Banking & Insurance Industry (2800) - 16 Stocks:

Stock Number	Company Name	No. of Observations
2801	Chang Hwa Bank	2560
2802	First Bank	2549
2803	Hua Nan Bank	2568
2804	China Develop	2580
2805	Cathay Life Ins.	2303
2806	I.C.B.C.	2324
2807	The Medium Business Bank of Hsin Chu	2491
2808	Taipei Business Bank	2524
2809	The Medium Business Bank of Tainan	2269
2810	The Medium Business Bank of Kaohsiung	2478
2811	The Medium Business Bank of Taitung	2395
2812	Taichung Business Bank	2440
2813	International Bills Finance	1780
2814	Chung Hsing Bills Finance	715
2815	China Trust Co., Ltd.	288
2816	Union Insurance Co., Ltd.	188

Table 4.1
TSE Stocks Included in this Study (Cont.)

Department Stores (2900) - 7 Stocks:

Stock Number	Company Name	No. of Observations
2903	Far East Dept.	2576
2905	Mercuries & Associates	1217
2907	Aurora Corporation	403
2901	Shin Shin Supermarket	2540
2904	Pan Overseas Corp.	2567
2906	Collins	853
2902E	Chun Hsin	1309

Table 4.2
Results of Tests for Linear Serial Dependencies

Cement Industry (1100) - 9 Stocks

Stock No.	No. of Obs.	Phi(1)	T-Ratio	$Q_x(6)$	p-value
1101	2577	0.12111	6.19	33.72	0
1102	2580	0.06757	3.44	14.19	0.014
1103	2579	0.05903	3.00	29.78	0
1104	2578	0.10346	5.28	24.38	0
1105	2579	0.11641	5.95	31.44	0
1107	1429	0.08202	3.11	19.16	0.002
1108	730	0.18546	5.09	12.39	0.030
1109	302	-0.04017	-0.70	6.80	0.236
1106	2311	0.26459	13.19	7.15	0.210
Average	1962.78	0.107	4.950	19.890	0.055
% Significant		88.9%		77.8%	

Food Industry (1200) - 25 Stocks

Stock No.	No. of Obs.	Phi(1)	T-Ratio	$Q_x(6)$	p-value
1201	2574	0.08900	4.53	14.40	0.013
1203	2574	0.11252	5.74	28.91	0
1207	2580	0.12187	6.24	13.27	0.021
1209	2572	0.16999	8.74	22.19	0
1210	2580	0.09940	5.07	17.74	0.003
1215	850	0.13548	3.98	5.95	0.312
1216	850	0.02204	0.64	10.15	0.071
1217	850	0.08787	2.57	11.31	0.046
1217A	301	0.20756	3.67	11.87	0.037
1218	850	0.14517	4.27	3.50	0.623
1218A	27	0.53595	3.24	6.43	0.267
1219	591	0.11897	2.91	5.48	0.360
1220	315	0.15437	2.77	1.41	0.924
1221	312	0.09670	1.71	14.96	0.011
1202	2579	0.18004	9.29	17.07	0.004
1206	1811	0.14315	6.15	15.65	0.008
1211	2578	0.13875	7.11	9.13	0.104
1212	2579	0.20011	10.37	25.23	0
1213	850	0.21104	6.29	15.16	0.010
1214	850	0.14740	4.34	10.51	0.062
1222	226	0.04011	0.60	7.58	0.181
1204E	1328	0.26862	10.15	5.68	0.338
1208E	2458	0.09272	4.62	3.79	0.580
1223	144	0.27571	3.43	5.78	0.328
1224	69	0.13043	1.08	7.29	0.200
Average	1331.92	0.157	4.780	11.618	0.180
% Significant		84.0%		48.0%	

Table 4.2
Results of Tests for Linear Serial Dependencies (Cont.)

Plastics Industry (1300) - 18 Stocks

Stock No.	No. of Obs.	Phi(1)	T-Ratio	$Q_x(6)$	p-value
1301	2580	0.05528	2.81	18.69	0.002
1303	2580	0.06249	3.18	19.93	0.001
1304	2580	0.09835	5.02	17.87	0.003
1305	2580	0.09304	4.74	12.87	0.025
1307	2029	0.13786	6.27	5.89	0.317
1308	1867	0.15497	6.77	19.43	0.002
1309	1861	0.17342	7.59	21.04	0.001
1310	1543	0.13879	5.50	19.85	0.001
1311	1194	0.15356	5.37	9.28	0.099
1312	1144	0.00202	0.07	10.50	0.060
1312A	1144	0.08862	3.01	8.79	0.118
1313	1075	0.12172	4.02	5.09	0.405
1314	419	0.17505	3.63	15.63	0.008
1315	184	0.12261	1.67	3.27	0.658
1302	1866	0.39536	18.57	25.10	0
1306	2230	0.24453	11.91	19.81	0.001
1316	58	0.34715	2.75	2.41	0.789
1317	8	-0.08643	-0.23	2.58	0.764
Average	1496.78	0.138	5.147	13.224	0.181
% Significant		83.3%		55.6%	

Table 4.2
Results of Tests for Linear Serial Dependencies (Cont.)

Textile Industry (1400) - 42 Stocks

Stock No.	No. of Obs.	Phi(1)	T-Ratio	$Q_x(6)$	p-value
1402	2580	0.07349	3.74	6.99	0.221
1407	2577	0.09058	4.62	15.34	0.009
1407A	1299	0.19486	7.16	23.36	0
1408	2580	0.07250	3.69	22.31	0
1409	2580	0.09440	4.82	12.73	0.026
1410	2542	0.12419	6.31	25.26	0
1414	850	0.13238	3.89	6.98	0.222
1416	850	0.11900	3.49	4.36	0.498
1417	850	0.15451	4.55	12.63	0.027
1420	2579	0.11544	5.90	12.32	0.031
1423	2559	0.14993	7.67	6.56	0.256
1426	2512	0.12622	6.38	6.09	0.298
1432	2580	0.11492	5.87	17.57	0.004
1433	2286	0.06105	2.92	14.82	0.011
1434	2003	0.03423	1.53	14.19	0.014
1435	1428	0.09997	3.79	7.89	0.163
1436	1352	0.11542	4.27	9.47	0.092
1438	1149	0.17181	5.91	10.70	0.058
1439	850	0.19973	5.94	11.73	0.039
1440	919	0.09107	2.77	9.92	0.078
1441	900	0.13757	4.16	26.25	0
1443	767	0.20136	5.69	12.37	0.030
1444	680	0.05790	1.51	6.17	0.290
1446	342	0.05665	1.05	2.63	0.757
1447	263	0.12648	2.06	6.34	0.274
1448	211	0.03371	0.49	2.35	0.799
1449	187	0.12478	1.71	4.24	0.516
1401	2555	0.19889	10.25	25.25	0
1413	850	0.15938	4.70	9.95	0.077
1418	850	0.10056	2.94	11.14	0.049
1419	2342	0.13808	6.74	21.52	0.001
1422	2528	0.21757	11.20	30.65	0
1425	2577	0.21439	11.14	40.47	0
1431	2580	0.21972	11.43	23.01	0
1437	1176	0.16381	5.69	8.38	0.137
1442	885	0.24888	7.64	22.19	0
1445	541	0.21060	5.00	6.19	0.289
1405	1523	0.01414	0.55	40.67	0
1424E	1209	0.17063	6.02	5.77	0.329
1429	1877	0.32578	14.92	22.56	0
1430	1297	0.14806	5.39	8.28	0.142
1450	64	0.04487	0.36	5.68	0.339
Average	1503.07	0.135	5.140	14.126	0.145
% Significant		83.3%		52.4%	

Table 4.2
Results of Tests for Linear Serial Dependencies (Cont.)

Electrical Machinery Industry (1500) - 12 Stocks

Stock No.	No. of Obs.	Phi(1)	T-Ratio	$Q_x(6)$	p-value
1502	2580	0.09088	4.63	36.73	0
1503	2577	-0.01650	-0.84	12.69	0.026
1504	2579	0.02063	1.05	19.75	0.001
1506	2579	0.17483	9.02	20.33	0.001
1507	890	0.13753	4.14	26.80	0
1510	180	0.23381	3.22	12.46	0.029
1501	1212	0.20530	7.30	24.24	0
1508	592	0.14947	3.67	2.59	0.764
1509	312	0.17106	3.06	11.89	0.036
1505	872	0.19715	5.93	3.70	0.593
1505E	847	0.15817	4.66	6.19	0.288
1511	28	0.30364	1.65	1.77	0.880
Average	1270. 67	0.152	3.958	14.928	0.218
% Significant		75.0%		66.7%	

Electrical Appliances, Wire, & Cable Industry (1600) - 11 Stocks

Stock No.	No. of Obs.	Phi(1)	T-Ratio	$Q_x(6)$	p-value
1601	2559	0.15445	7.90	19.52	0.002
1602	2580	0.11100	5.67	20.82	0.001
1603	2580	0.17900	9.24	15.67	0.008
1604	2580	0.08811	4.49	27.78	0
1605	2580	0.07221	3.68	35.66	0
1606	2580	0.07122	3.63	10.58	0.060
1608	1277	0.09825	3.52	8.85	0.115
1609	1152	0.14702	5.04	15.43	0.009
1610	853	0.21651	6.47	23.80	0
1611	840	0.21052	6.24	7.77	0.169
1607	2453	0.22778	11.58	8.98	0.110
Average	2003.09	0.143	6.133	17.715	0.043
% Significant		100.0%		63.6%	

Table 4.2
Results of Tests for Linear Serial Dependencies (Cont.)

Chemical Industry (1700) - 14 Stocks

Stock No.	No. of Obs.	Phi(1)	T-Ratio	$Q_x(6)$	p-value
1701	2576	0.14524	7.45	37.20	0
1702	2580	0.15756	8.10	12.97	0.024
1704	2580	0.12214	6.25	16.11	0.007
1705	2579	0.16947	8.73	16.42	0.006
1708	1871	0.16602	7.28	22.59	0
1709	1844	0.14511	6.30	7.86	0.164
1710	1481	0.12185	4.72	23.27	0
1711	1140	0.09498	3.22	16.45	0.006
1712	862	0.16804	5.00	26.97	0
1713	834	0.16377	4.79	13.50	0.019
1714	378	0.12615	2.47	5.33	0.377
1703	2580	0.12808	6.56	32.81	0
1707	2530	0.16194	8.25	16.80	0.005
1706	2563	0.24040	12.53	10.62	0.060
Average	1885.57	0.151	6.546	18.493	0.048
% Significant		100.0%		78.6%	

Glass Industry (1800) - 6 Stocks

Stock No.	No. of Obs.	Phi(1)	T-Ratio	$Q_x(6)$	p-value
1802	2578	0.03592	1.82	18.26	0.003
1804	1245	0.14454	5.15	8.86	0.115
1805	905	0.24074	7.46	9.71	0.084
1801	2555	0.23998	12.49	14.25	0.014
1806	71	0.16321	1.38	1.42	0.922
1807	64	0.23083	1.85	12.89	0.024
Average	1236.33	0.176	5.025	10.898	0.194
% Significant		50.0%		50.0%	

Pulp & Paper Industry (1900) - 10 Stocks

Stock No.	No. of Obs.	Phi(1)	T-Ratio	$Q_x(6)$	p-value
1902	2580	0.10663	5.45	14.06	0.015
1903	1835	0.15614	6.77	24.15	0
1904	2580	0.06620	3.37	20.36	0.001
1905	2580	0.05446	2.77	20.15	0.001
1907	2534	0.09460	4.78	16.76	0.050
1907A	1209	0.15522	5.46	13.14	0.022
1907B	1141	0.15425	5.27	3.67	0.598
1908	2580	0.11941	6.11	26.19	0
1909	2032	0.15440	7.04	17.04	0.004
1906E	928	0.10191	3.12	9.41	0.094
Average	1999.90	0.116	5.014	16.493	0.079
% Significant		100.0%		80.0%	

Table 4.2
Results of Tests for Linear Serial Dependencies (Cont.)

Iron & Steel Industry (2000) - 20 Stocks

Stock No.	No. of Obs.	Phi(1)	T-Ratio	$Q_x(6)$	p-value
2002	2150	0.10820	5.04	24.90	0
2003	1475	0.17807	6.94	11.05	0.050
2004	1470	0.16509	6.41	7.70	0.174
2005	1458	0.13879	5.35	7.93	0.160
2006	1275	0.09137	3.27	7.05	0.217
2007	1207	0.20135	7.14	9.14	0.104
2007A	784	0.22021	6.32	11.48	0.043
2008	1139	0.16283	5.57	13.01	0.023
2009	905	0.18396	5.63	18.48	0.002
2010	856	0.18177	5.41	10.79	0.056
2012	340	0.04621	0.85	9.25	0.100
2014	249	0.19660	3.16	8.17	0.147
2014A	51	0.11538	0.82	12.91	0.024
2015	171	0.07353	0.96	4.94	0.424
2011	745	0.15209	4.2	18.39	0.002
2011A	38	0.09769	0.58	2.24	0.815
2013	269	0.20183	3.37	10.37	0.065
2001	2281	0.24302	11.96	4.88	0.431
2016	157	0.23309	2.99	13.14	0.022
2017	45	0.49985	3.65	3.32	0.651
Average	853.25	0.175	4.481	10.457	0.176
% Significant		80.0%		40.0%	

Rubber Industry (2100) - 8 Stocks

Stock No.	No. of Obs.	Phi(1)	T-Ratio	$Q_x(6)$	p-value
2102	2575	0.22007	11.45	43.17	0
2103	2578	0.04538	2.31	21.12	0.001
2104	1847	-0.01492	-0.64	9.44	0.093
2105	1444	0.10121	3.86	31.57	0
2106	575	0.08473	2.04	1.72	0.886
2107	238	0.35887	5.92	26.63	0
2101	2580	0.20386	10.57	50.95	0
2108	49	-0.05399	-0.37	5.25	0.386
Average	1485.75	0.118	4.393	23.731	0.171
% Significant		75.0%		62.5%	

Table 4.2
Results of Tests for Linear Serial Dependencies (Cont.)

Automobile Industry (2200) - 4 Stocks

Stock No.	No. of Obs.	Phi(1)	T-Ratio	$Q_x(6)$	p-value
2201	2580	0.09617	4.91	33.90	0
2202	1146	0.09887	3.36	16.50	0.006
2203	1140	0.06206	2.10	9.67	0.085
2204	517	-0.00342	-0.08	2.69	0.748
Average	1345.75	0.063	2.573	15.690	0.210
% Significant		75.0%		50.0%	

Electronics Industry (2300) - 26 Stocks

Stock No.	No. of Obs.	Phi(1)	T-Ratio	$Q_x(6)$	p-value
2301	2579	0.17201	8.87	21.76	0.001
2302	2278	0.16760	8.11	16.95	0.005
2303	2132	0.11928	5.54	6.40	0.269
2303A	46	0.25021	1.72	0.54	0.991
2304	1490	0.17323	6.79	13.40	0.020
2305	1193	0.08989	3.12	10.40	0.065
2306	1177	0.06364	2.19	9.38	0.095
2308	1146	0.09441	3.21	17.33	0.004
2309	1142	0.18643	6.41	15.78	0.008
2310	1142	0.15243	5.21	21.16	0.001
2311	981	0.13039	4.12	15.97	0.007
2312	892	0.12634	3.80	22.84	0
2313	693	0.17267	4.61	15.63	0.008
2314	680	0.02789	0.73	4.24	0.516
2315	674	0.04389	1.14	14.59	0.012
2316	541	0.19463	4.61	9.13	0.104
2317	439	0.13297	2.81	6.97	0.223
2318	434	0.12863	2.70	6.43	0.266
2319	403	0.19229	3.93	1.46	0.918
2319A	201	0.23633	3.44	5.62	0.345
2321	324	0.10657	1.93	5.14	0.399
2324	251	0.14149	2.26	0.55	0.990
2307	1153	0.15251	5.24	2.73	0.742
2320	377	0.07129	1.39	3.13	0.680
2322	312	0.13850	2.46	9.43	0.093
2323	252	0.12359	1.96	9.23	0.100
Average	882.00	0.138	3.781	10.238	0.264
% Significant		76.9%		38.5%	

Table 4.2
Results of Tests for Linear Serial Dependencies (Cont.)

Construction Industry (2500) - 13 Stocks

Stock No.	No. of Obs.	Phi(1)	T-Ratio	$Q_x(6)$	p-value
2501	2552	0.12348	6.28	33.59	0
2504	2580	0.06719	3.42	19.40	0.002
2506	2580	0.07854	4.00	24.17	0
2510	958	0.19738	6.23	12.00	0.035
2511	485	0.06905	1.52	13.13	0.022
2512	249	0.34373	5.76	18.49	0.002
2505	2573	0.15682	8.05	8.18	0.147
2509	1262	0.22224	8.09	12.85	0.025
2513	192	0.18871	2.66	4.34	0.501
2503	2522	0.23018	11.88	15.95	0.007
2507	1408	0.26554	10.32	6.79	0.237
2508	2478	0.20636	10.49	12.90	0.024
2514	72	-0.07519	-0.62	12.58	0.028
Average	1531.62	0.160	6.006	14.952	0.079
% Significant		84.6%		76.9%	

Shipping Industry (2600) - 8 Stocks

Stock No.	No. of Obs.	Phi(1)	T-Ratio	$Q_x(6)$	p-value
2603	1504	0.09801	3.82	17.19	0.004
2604	1143	0.12394	4.22	14.86	0.011
2605	867	0.18202	5.45	22.57	0
2606	585	0.05287	1.28	8.87	0.114
2607	580	0.15081	3.67	7.99	0.157
2608	575	0.06338	1.52	12.14	0.033
2609	201	0.13824	1.97	6.48	0.262
2601	2580	0.18587	9.61	21.15	0.001
Average	1004.38	0.124	3.943	13.906	0.073
% Significant		75.0%		62.5%	

Hospitality Industry (2700) - 6 Stocks

Stock No.	No. of Obs.	Phi(1)	T-Ratio	$Q_x(6)$	p-value
2704	2579	0.07921	4.03	20.38	0.001
2706	433	0.04954	1.03	12.97	0.024
2701	2049	0.13890	6.35	8.80	0.117
2702	1477	0.13860	5.38	8.69	0.122
2703	2579	0.16560	8.53	19.57	0.002
2705	1141	0.14741	5.03	15.56	0.008
Average	1709.67	0.120	5.058	14.328	0.046
% Significant		83.3%		66.7%	

Table 4.2
Results of Tests for Linear Serial Dependencies (Cont.)

Banking & Insurance Industry (2800) - 16 Stocks

Stock No.	No. of Obs.	Phi(1)	T-Ratio	$Q_x(6)$	p-value
2801	2560	0.12289	6.26	35.28	0
2802	2549	0.13453	6.85	26.35	0
2803	2568	0.13353	6.83	21.63	0.001
2804	2580	0.12435	6.36	37.98	0
2805	2303	0.09431	4.54	6.89	0.229
2806	2324	0.12908	6.27	24.20	0
2807	2491	0.15463	7.81	13.46	0.019
2808	2524	0.09892	4.99	25.38	0
2809	2269	0.18658	9.04	20.09	0.001
2810	2478	0.17668	8.93	27.32	0
2811	2395	0.10994	5.41	10.52	0.062
2812	2440	0.12156	6.05	18.74	0.002
2813	1780	0.12018	5.11	20.72	0.001
2814	715	0.07589	2.03	13.79	0.017
2815	288	-0.01952	-0.33	0.50	0.992
2816	188	0.07442	1.02	3.94	0.558
Average	2028.25	0.115	5.448	19.174	0.118
% Significant		87.5%		75.0%	

Department Stores (2900) - 7 Stocks

Stock No.	No. of Obs.	Phi(1)	T-Ratio	$Q_x(6)$	p-value
2903	2576	0.05517	2.80	23.65	0
2905	1217	0.08687	3.04	18.23	0.003
2907	403	0.15057	3.05	9.28	0.098
2901	2540	0.17560	8.99	6.06	0.300
2904	2567	0.18140	9.34	29.78	0
2906	853	0.20570	6.14	21.06	0.001
2902E	1309	0.25430	9.51	11.63	0.040
Average	1637.86	0.159	6.124	17.099	0.063
% Significant		100.0%		71.4%	

Table 4.2
Results of Tests for Linear Serial Dependencies (Cont.)

Overall Results:

	No. of Obs.	Phi(1)	T-Ratio	$Q_x(6)$	p-value
mean	1456.93	0.140	4.952	14.549	0.144
median	1262	0.138	4.720	12.900	0.024
min	8	-0.086	-0.840	0.500	0.000
max	2580	0.536	18.570	50.950	0.992
% Signigicant		83.9%		58.4%	
# Significant		214		149	
# Total		255		255	

Note: the "% Significant" figures provide the percentages of stocks within a given industry or overall whose relevant test statistics, under the appropriate assumptions, would be considered significant at a 5% level.

Table 4.3
Results of Tests for Nonlinear Serial Dependencies

Cement Industry (1100) - 9 Stocks

		McLeod and Li Test		Bispectrum Test (Z-Statistics)	
Stock Number	**No. of Obs.**	**Qxx(6)**	**p-value**	**Gaussianity**	**Linearity**
1101	2577	1033.56	0	47.63	16.76
1102	2580	751.14	0	40.43	14.99
1103	2579	1362.05	0	33.24	13.90
1104	2578	1231.39	0	30.87	17.37
1105	2579	1733.33	0	27.52	13.42
1107	1429	303.72	0	15.78	10.64
1108	730	622.10	0	20.32	9.06
1109	302	25.26	0	12.61	2.70
1106	2311	903.56	0	8.74	5.77
Average	1962.78	885.123	0.000	26.349	11.623
% Significant		100.0%		100.0%	100.0%

Food Industry (1200) - 25 Stocks

		McLeod and Li Test		Bispectrum Test (Z-Statistics)	
Stock Number	**No. of Obs.**	**Qxx(6)**	**p-value**	**Gaussianity**	**Linearity**
1201	2574	873.29	0	33.69	17.82
1203	2574	2083.65	0	36.66	12.18
1207	2580	1939.26	0	34.12	11.82
1209	2572	244.70	0	31.35	9.65
1210	2580	1224.91	0	23.49	17.04
1215	850	778.23	0	14.36	4.84
1216	850	45.97	0	18.25	10.30
1217	850	330.65	0	12.96	4.78
1217A	301	104.92	0	11.89	1.62
1218	850	192.42	0	12.58	13.54
1218A	27	8.29	0.218	n.a.	n.a.
1219	591	188.75	0	11.81	7.70
1220	315	28.12	0	6.57	4.20
1221	312	21.78	0.001	6.11	0.88
1202	2579	1345.84	0	17.99	17.51
1206	1811	21.30	0.002	12.29	11.15
1211	2578	628.76	0	21.66	8.83
1212	2579	810.27	0	30.05	13.65
1213	850	58.97	0	7.93	6.94
1214	850	12.97	0.043	12.16	13.47
1222	226	1.17	0.978	12.83	1.42
1204E	1328	156.02	0	4.31	4.30
1208E	2458	0.92	0.988	14.41	10.04
1223	144	32.61	0	5.20	2.31
1224	69	32.40	0	n.a.	n.a.
Average	1443.57	446.647	0.089	17.073	8.956
% Significant		88.0%		100.0%	87.0%

Table 4.3
Results of Tests for Nonlinear Serial Dependencies (Cont.)

Plastics Industry (1300) - 18 Stocks

		McLeod and Li Test		Bispectrum Test (Z-Statistics)	
Stock Number	**No. of Obs.**	**Qxx(6)**	**p-value**	**Gaussianity**	**Linearity**
1301	2580	1075.94	0	33.63	17.93
1303	2580	1229.38	0	35.08	14.62
1304	2580	1404.72	0	34.22	13.26
1305	2580	802.12	0	32.97	14.13
1307	2029	1383.82	0	26.32	13.06
1308	1867	345.02	0	17.21	9.99
1309	1861	19.73	0.003	20.70	7.41
1310	1543	17.63	0.007	14.87	14.35
1311	1194	504.59	0	11.24	8.39
1312	1144	0.59	0.997	14.73	15.46
1312A	1144	15.35	0.018	9.68	6.49
1313	1075	486.43	0	11.40	7.31
1314	419	227.93	0	22.07	14.76
1315	184	10.86	0.093	4.02	3.37
1302	1866	839.54	0	14.81	11.41
1306	2230	7.56	0.272	12.96	10.28
1316	58	11.56	0.072	n.a.	n.a.
1317	8	5.36	0.498	n.a.	n.a.
Average	1584.35	466.007	0.109	19.744	11.389
% Significant		72.2%		100.0%	100.0%

Table 4.3
Results of Tests for Nonlinear Serial Dependencies (Cont.)

Textile Industry (1400) - 42 Stocks

		McLeod and Li Test		Bispectrum Test (Z-Statistics)	
Stock Number	**No. of Obs.**	**Qxx(6)**	**p-value**	**Gaussianity**	**Linearity**
1402	2580	279.36	0	23.17	13.50
1407	2577	1184.30	0	19.39	16.85
1407A	1299	456.42	0	5.30	3.53
1408	2580	0.23	1	18.51	19.00
1409	2580	1472.19	0	23.04	11.49
1410	2542	1705.23	0	21.89	9.20
1414	850	456.67	0	9.91	6.83
1416	850	300.00	0	7.88	5.94
1417	850	844.97	0	13.78	3.82
1420	2579	462.01	0	20.51	17.87
1423	2559	800.36	0	31.42	17.95
1426	2512	10.88	0.092	21.38	20.42
1432	2580	1537.63	0	21.65	15.16
1433	2286	1183.33	0	27.37	16.40
1434	2003	731.51	0	21.51	13.22
1435	1428	1.05	0.984	12.70	10.14
1436	1352	27.87	0	6.82	6.95
1438	1149	60.45	0	7.20	7.13
1439	850	312.38	0	3.75	1.13
1440	919	243.26	0	9.31	4.29
1441	900	212.31	0	8.03	4.51
1443	767	458.27	0	7.22	5.56
1444	680	50.23	0	11.86	15.98
1446	342	0.65	0.996	2.30	1.73
1447	263	8.72	0.19	22.79	6.06
1448	211	3.64	0.726	4.75	3.31
1449	187	7.25	0.299	2.22	1.90
1401	2555	46.94	0	17.78	17.99
1413	850	269.84	0	5.10	1.19
1418	850	569.50	0	9.65	10.18
1419	2342	490.25	0	30.97	7.50
1422	2528	477.57	0	16.90	16.84
1425	2577	482.20	0	24.54	16.32
1431	2580	1752.58	0	22.89	15.34
1437	1176	82.23	0	4.71	5.27
1442	885	260.86	0	4.79	2.68
1445	541	16.68	0.011	3.47	0.83
1405	1523	375.06	0	2.21	0.75
1424E	1209	454.19	0	6.59	2.07
1429	1877	914.92	0	17.75	10.12
1430	1297	2.15	0.905	12.00	9.50
1450	64	4.13	0.659	n.a.	n.a.
Average	1503.07	452.625	0.140	13.781	9.182
% Significant		78.6%		100.0%	90.2%

Table 4.3
Results of Tests for Nonlinear Serial Dependencies (Cont.)

Electrical Machinery Industry (1500) - 12 Stocks

		McLeod and Li Test		Bispectrum Test (Z-Statistics)	
Stock Number	**No. of Obs.**	**Qxx(6)**	**p-value**	**Gaussianity**	**Linearity**
1502	2580	1384.84	0	25.06	24.27
1503	2577	567	0	30.35	10.67
1504	2579	1431.92	0	34.26	10.17
1506	2579	1101.36	0	33.61	15.72
1507	890	18.37	0.005	12.62	5.02
1510	180	49.03	0	5.48	3.15
1501	1212	337.35	0	15.92	13.16
1508	592	93.94	0	11.59	7.94
1509	312	1.11	0.981	5.06	4.51
1505	872	136.36	0	7.16	7.63
1505E	847	17.47	0.008	8.96	6.96
1511	28	3.87	0.695	n.a.	n.a.
Average	1383.64	428.552	0.141	17.279	9.927
% Significant		83.3%		100.0%	100.0%

Electrical Appliances, Wire, & Cable Industry (1600) - 11 Stocks

		McLeod and Li Test		Bispectrum Test (Z-Statistics)	
Stock Number	**No. of Obs.**	**Qxx(6)**	**p-value**	**Gaussianity**	**Linearity**
1601	2559	180.97	0	45.15	15.66
1602	2580	329.80	0	29.50	16.09
1603	2580	2062.24	0	31.34	10.39
1604	2580	946.26	0	20.85	20.88
1605	2580	96.30	0	28.29	15.60
1606	2580	333.97	0	38.26	12.67
1608	1277	32.97	0	12.68	7.71
1609	1152	608.88	0	11.96	10.70
1610	853	325.79	0	13.52	12.38
1611	840	336.24	0	12.11	8.38
1607	2453	857.83	0	14.78	11.11
Average	2003.09	555.568	0.000	23.495	12.870
% Significant		100.0%		100.0%	100.0%

Table 4.3
Results of Tests for Nonlinear Serial Dependencies (Cont.)

Chemical Industry (1700) - 14 Stocks

		McLeod and Li Test		Bispectrum Test (Z-Statistics)	
Stock Number	**No. of Obs.**	**Qxx(6)**	**p-value**	**Gaussianity**	**Linearity**
1701	2576	206.83	0	32.03	10.55
1702	2580	709.41	0	32.57	11.78
1704	2580	1861.76	0	29.55	14.14
1705	2579	2211.14	0	30.63	7.95
1708	1871	885.21	0	18.94	11.02
1709	1844	728.71	0	20.62	21.19
1710	1481	377.08	0	16.52	14.55
1711	1140	73.70	0	15.47	8.82
1712	862	367.96	0	9.37	7.93
1713	834	77.98	0	6.92	6.17
1714	378	3.27	0.774	4.59	2.43
1703	2580	1039.57	0	23.12	9.24
1707	2530	39.94	0	26.26	9.32
1706	2563	1015.69	0	10.57	10.72
Average	1885.57	685.589	0.055	19.797	10.415
% Significant		92.9%		100.0%	100.0%

Glass Industry (1800) - 6 Stocks

		McLeod and Li Test		Bispectrum Test (Z-Statistics)	
Stock Number	**No. of Obs.**	**Qxx(6)**	**p-value**	**Gaussianity**	**Linearity**
1802	2578	511.41	0	32.05	7.64
1804	1245	745.73	0	9.85	9.18
1805	905	422.51	0	8.56	6.97
1801	2555	1042.03	0	10.98	8.82
1806	71	32.76	0	n.a.	n.a.
1807	64	21.94	0.001	n.a.	n.a.
Average	1236.33	462.730	0.000	15.360	8.153
% Significant		100.0%		100.0%	100.0%

Table 4.3
Results of Tests for Nonlinear Serial Dependencies (Cont.)

Pulp & Paper Industry (1900) - 10 Stocks

		McLeod and Li Test		Bispectrum Test (Z-Statistics)	
Stock Number	**No. of Obs.**	**Qxx(6)**	**p-value**	**Gaussianity**	**Linearity**
1902	2580	599.41	0	21.03	18.18
1903	1835	214.09	0	13.17	11.43
1904	2580	599.30	0	27.49	12.45
1905	2580	1571.48	0	33.26	11.68
1907	2534	834.06	0	41.20	11.21
1907A	1209	872.94	0	12.52	8.62
1907B	1141	595.69	0	10.22	7.96
1908	2580	52.71	0	25.94	24.08
1909	2032	193.10	0	19.40	17.44
1906E	928	0.42	0.999	2.97	2.47
Average	1999.90	553.320	0.100	20.720	12.552
% Significant		90.0%		100.0%	100.0%

Iron & Steel Industry (2000) - 20 Stocks

		McLeod and Li Test		Bispectrum Test (Z-Statistics)	
Stock Number	**No. of Obs.**	**Qxx(6)**	**p-value**	**Gaussianity**	**Linearity**
2002	2150	1203.68	0	22.38	12.79
2003	1475	26.68	0	13.45	12.75
2004	1470	21.79	0.001	14.57	10.11
2005	1458	5.46	0.486	11.94	12.77
2006	1275	44.55	0	12.24	10.20
2007	1207	191.08	0	9.37	7.69
2007A	784	372.17	0	10.35	8.24
2008	1139	616.54	0	11.88	8.86
2009	905	427.00	0	7.00	4.33
2010	856	417.48	0	10.88	11.45
2012	340	0.87	0.99	7.03	11.87
2014	249	25.61	0	-0.55	-0.17
2014A	51	23.14	0.001	n.a.	n.a.
2015	171	9.48	0.148	2.15	2.07
2011	745	561.35	0	11.62	11.29
2011A	38	12.23	0.057	n.a.	n.a.
2013	269	21.48	0.002	4.27	-0.63
2001	2281	1286.20	0	16.64	13.13
2016	157	19.27	0.004	2.25	0.34
2017	45	5.04	0.539	n.a.	n.a.
Average	995.94	264.555	0.111	9.851	8.064
% Significant		75.0%		94.1%	82.4%

Table 4.3
Results of Tests for Nonlinear Serial Dependencies (Cont.)

Rubber Industry (2100) - 8 Stocks

		McLeod and Li Test		Bispectrum Test (Z-Statistics)	
Stock Number	**No. of Obs.**	**Qxx(6)**	**p-value**	**Gaussianity**	**Linearity**
2102	2575	1760.29	0	22.40	11.78
2103	2578	1267.83	0	26.85	15.46
2104	1847	383.60	0	18.45	11.98
2105	1444	242.24	0	13.89	14.84
2106	575	38.50	0	8.37	8.19
2107	238	71.21	0	3.37	1.98
2101	2580	2214.20	0	32.47	14.30
2108	49	1.72	0.943	n.a.	n.a.
Average	1691.00	747.449	0.118	17.971	11.219
% Significant		87.5%		100.0%	100.0%

Automobile Industry (2200) - 4 Stocks

		McLeod and Li Test		Bispectrum Test (Z-Statistics)	
Stock Number	**No. of Obs.**	**Qxx(6)**	**p-value**	**Gaussianity**	**Linearity**
2201	2580	1296.14	0	22.78	13.15
2202	1146	574.64	0	10.42	9.72
2203	1140	371.80	0	9.93	9.15
2204	517	12.62	0.05	8.76	4.36
Average	1345.75	563.800	0.013	12.973	9.095
% Significant		100.0%		100.0%	100.0%

Table 4.3
Results of Tests for Nonlinear Serial Dependencies (Cont.)

Electronics Industry (2300) - 26 Stocks

		McLeod and Li Test		Bispectrum Test (Z-Statistics)	
Stock Number	**No. of Obs.**	**Qxx(6)**	**p-value**	**Gaussianity**	**Linearity**
2301	2579	376.77	0	27.69	12.43
2302	2278	1124.91	0	22.47	6.03
2303	2132	104.40	0	18.02	18.16
2303A	46	12.20	0.058	n.a.	n.a.
2304	1490	583.56	0	12.87	10.34
2305	1193	35.07	0	8.42	7.90
2306	1177	25.48	0	9.85	8.57
2308	1146	326.33	0	9.73	8.60
2309	1142	337.22	0	7.08	6.98
2310	1142	220.00	0	7.35	5.99
2311	981	42.52	0	9.40	7.54
2312	892	537.95	0	8.60	7.70
2313	693	403.76	0	11.05	10.07
2314	680	49.51	0	10.41	3.67
2315	674	468.40	0	11.72	9.63
2316	541	9.91	0.129	6.91	0.15
2317	439	23.03	0.001	8.24	4.51
2318	434	1.47	0.961	5.20	3.11
2319	403	63.71	0	8.45	6.76
2319A	201	38.38	0	4.45	2.32
2321	324	0.70	0.994	9.33	4.88
2324	251	12.92	0.044	3.99	5.55
2307	1153	8.64	0.195	6.37	3.26
2320	377	0.90	0.989	6.95	4.38
2322	312	3.57	0.735	5.06	6.73
2323	252	20.50	0.002	7.03	4.74
Average	915.44	185.839	0.158	9.866	6.800
% Significant		73.1%		100.0%	96.0%

Table 4.3
Results of Tests for Nonlinear Serial Dependencies (Cont.)

Construction Industry (2500) - 13 Stocks

		McLeod and Li Test		Bispectrum Test (Z-Statistics)	
Stock Number	**No. of Obs.**	**Qxx(6)**	**p-value**	**Gaussianity**	**Linearity**
2501	2552	137.69	0	27.97	13.21
2504	2580	176.68	0	29.13	12.71
2506	2580	72.47	0	24.03	18.02
2510	958	281.00	0	9.99	8.25
2511	485	1.17	0.978	18.17	8.38
2512	249	27.27	0	28.31	7.95
2505	2573	14.07	0.029	21.17	19.23
2509	1262	61.74	0	10.19	9.49
2513	192	1.15	0.979	9.94	1.25
2503	2522	814.24	0	8.40	6.81
2507	1408	3.73	0.714	20.67	6.31
2508	2478	1534.98	0	25.52	9.72
2514	72	56.50	0	n.a.	n.a.
Average	1531.62	244.822	0.208	19.458	10.111
% Significant		76.9%		100.0%	91.7%

Shipping Industry (2600) - 8 Stocks

		McLeod and Li Test		Bispectrum Test (Z-Statistics)	
Stock Number	**No. of Obs.**	**Qxx(6)**	**p-value**	**Gaussianity**	**Linearity**
2603	1504	462.28	0	11.84	9.93
2604	1143	12.30	0.056	12.04	9.22
2605	867	471.64	0	10.28	5.05
2606	585	154.18	0	11.86	6.54
2607	580	80.75	0	8.63	3.37
2608	575	19.72	0.003	2.89	2.63
2609	201	72.51	0	7.97	2.83
2601	2580	12.05	0.061	32.03	14.25
Average	1004.38	160.679	0.015	12.193	6.728
% Significant		75.0%		100.0%	100.0%

Hospitality Industry (2700) - 6 Stocks

		McLeod and Li Test		Bispectrum Test (Z-Statistics)	
Stock Number	**No. of Obs.**	**Qxx(6)**	**p-value**	**Gaussianity**	**Linearity**
2704	2579	1751.42	0	24.76	13.06
2706	433	62.27	0	6.85	5.13
2701	2049	141.68	0	19.63	14.22
2702	1477	9.38	0.153	13.28	14.97
2703	2579	1652.66	0	18.96	18.53
2705	1141	110.18	0	5.20	5.64
Average	1709.67	621.265	0.026	14.780	11.925
% Significant		83.3%		100.0%	100.0%

Table 4.3
Results of Tests for Nonlinear Serial Dependencies (Cont.)

Banking & Insurance Industry (2800) - 16 Stocks

		McLeod and Li Test		Bispectrum Test (Z-Statistics)	
Stock Number	**No. of Obs.**	**Qxx(6)**	**p-value**	**Gaussianity**	**Linearity**
2801	2560	11.46	0.075	31.15	13.84
2802	2549	14.41	0.025	29.22	14.10
2803	2568	7.87	0.248	25.15	11.88
2804	2580	3.35	0.764	27.31	18.50
2805	2303	4.59	0.598	26.52	26.08
2806	2324	759.79	0	22.84	11.58
2807	2491	5.03	0.539	33.12	11.87
2808	2524	7.65	0.265	24.95	11.02
2809	2269	15.19	0.019	24.22	15.51
2810	2478	1139.69	0	29.35	16.90
2811	2395	2.21	0.9	24.85	10.14
2812	2440	29.30	0	24.28	17.34
2813	1780	33.75	0	16.15	14.23
2814	715	14.56	0.024	8.52	6.29
2815	288	10.07	0.122	3.63	2.88
2816	188	0.45	0.998	28.89	5.94
Average	2028.25	128.711	0.286	23.759	13.006
% Significant		43.8%		100.0%	100.0%

Department Stores (2900) - 7 Stocks

		McLeod and Li Test		Bispectrum Test (Z-Statistics)	
Stock Number	**No. of Obs.**	**Qxx(6)**	**p-value**	**Gaussianity**	**Linearity**
2903	2576	250.13	0	27.72	16.43
2905	1217	251.48	0	6.48	6.40
2907	403	91.76	0	7.29	4.27
2901	2540	1303.89	0	15.29	11.43
2904	2567	175.52	0	33.22	11.53
2906	853	302.81	0	8.70	7.65
2902E	1309	817.99	0	19.25	14.34
Average	1637.86	456.226	0	16.850	10.293
% Significant		100.0%		100.0%	100.0%

Table 4.3
Results of Tests for Nonlinear Serial Dependencies (Cont.)

Overall Results:

		McLeod and Li Test		Bispectrum Test (Z-Statistics)	
	No. of Obs.	**Qxx(6)**	**p-value**	**Gaussianity**	**Linearity**
mean	1508.77	421.564	0.111	16.658	9.846
median	1304	193.10	0	13.45	9.72
min	58	0.23	0	-0.55	-0.63
max	2580	2214.20	1	47.63	26.08
% Significant		80.8%		99.6%	95.0%
# Significant		206		240	229
# Total		255		241	241

Note: the "% Significant" figures provide the percentages of stocks within a given industry or overall whose relevant test statistics, under the appropriate assumptions, would be considered significant at a 5% level.