AN EXAMINATION OF RETURN PREDICTABILITY ON THE TRINIDAD AND TOBAGO STOCK EXCHANGE

by

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ABSTRACT

A capital market is regarded as being efficient if the prices of securities observed at any time fully reflect all available information. Three forms of market efficiency have been defined in the literature according to whether prices fully reflect specific sub-sets of information. These are weak form efficient, semi-strong form efficient, and strong form efficient.

This study examines weak form capital market efficiency on the Trinidad and Tobago Stock Exchange (TTSE). A security market is said to be weak form efficient if current prices fully reflect any information in past prices. Tests of efficiency are applied to monthly stock return data for the period November 1981 to October 1991. Evidence suggests that the TTSE was weak form inefficient over this period. However, the evidence indicates that the TTSE was less weak form inefficient in the sub-period November 1981 to October 1986 as compared to the sub-period November 1986 to October 1991. Tests of efficiency are also applied to returns for horizons ranging from 6 to 30 months. The results provide suggestive evidence that the TTSE is also weakly inefficient with respect to long horizon returns.

DEDICATION

To Dassie, Dalini, and Nikhil

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INTRODUCTION

An important function of capital markets is the allocation of financial resources to profitable investment opportunities. Ideally, market determined prices serve as signals for resource allocation. If security prices provide accurate signals, firms are able to make correct production-investment decisions, and investors, given their individual preferences, are able to choose the most suitable securities for investment on the basis of market determined prices. These choices are only possible if the capital market is efficient; that is, the market correctly evaluates all information and adjusts asset prices instantaneously and correctly.

Significant effort has been devoted to evaluating the efficiency of capital markets in developed economies. There have however, been few studies on the capital markets of developing countries.

In developing countries the existence of properly functioning, efficient capital markets is crucial to the development process. Developing countries generally face financial and other constraints which may not be binding for developed economies. Such financial constraints are *inter alia*, low domestic savings ratios, and limited access to international capital markets. Consequently, it is imperative for developing countries to allocate their very scarce resources to the most profitable investment opportunities. If asset prices do not provide accurate signals for investment decisions, misallocation of resources can occur. It is useful therefore, to examine to what extent security prices provide accurate signals to investors; that is, to what extent capital markets are efficient in developing countries.

In this paper the capital market efficiency hypothesis is examined for Trinidad and Tobago. Section II presents a review of the capital market efficiency literature. Section III reviews studies of capital market efficiency on developing countries. Background information on the Trinidad and Tobago economy and its stock exchange is given in Section IV. The empirical analysis and results are detailed in Section V. Section VI gives the conclusion.

SECTION II

LITERATURE REVIEW ON CAPITAL MARKET EFFICIENCY

One of the seminal papers on market efficiency was published by Eugene Fama in 1965. Since then the work on market efficiency has mushroomed into a vast literature, in which there is considerable debate on the issue of capital market efficiency. A capital market is regarded as being efficient if prices "fully reflect" all available information, that is, the prices of securities observed at any time are based on "correct" evaluation of all available information.

A primary function of capital markets is the allocation of financial resources to the most profitable investment opportunities. Ideally, market determined prices serve as signals for resource allocation. If security prices provide accurate signals, firms are able to make correct production-investment decisions, and investors, given their individual preferences, are able to choose the most suitable stocks for investment on the basis of market determined prices. These choices are only possible if the capital market is efficient.

Fama (1970, 1976) has defined three categories of market efficiency according to whether prices fully reflect specific subsets of information. A market is said to be **weak form efficient** if current security prices fully reflect any information in past prices. Tests of weak form efficiency are therefore, concerned with the forecast power of past returns. Fama (1991) expands the weak form definition to include the forecast power of other variables (such as dividend yields and term structure variables) and refers to the expanded category as **return predictability**.

A more restrictive form of efficiency is semi-strong form efficiency. Here the concern is the speed of adjustment to all publicly available information. A market is said to be **semi-strong form efficient** if prices adjust fully and instantaneously to public announcements such as stock splits, earnings reports, and new issues. Fama (1991) adopts the common title of **event studies** to refer to tests of semi-strong form efficiency.

The third and most restrictive form of efficiency is strong form efficiency. If security prices fully reflect all information both publicly and privately available, the market is referred to as **strong form efficient**. Thus, tests of strong form efficiency are concerned with whether there are individuals or groups who are consistently able to earn excess or higher than normal returns. If prices fully reflect all available information the ability of specific investors to earn excess returns on a consistent basis is ruled out. Fama (1991) suggests the more descriptive title of tests of **private information** to refer to tests of strong form efficiency.

Price Formation

The description of an efficient market as one in which prices fully reflect all available information is too general to be testable. In order to test the extent to which a market is efficient we require a more detailed specification of the process of price formation. Fama (1976) describes a general model of price formation that can be used in testing the theory of capital market efficiency.

Using some or at most all of the information at *t-1*, the market assesses a joint distribution of security prices for time *t*. From this assessment of the distribution of prices at *t*, the market then determines appropriate current prices for individual securities. The appropriate current prices are determined by some model of market equilibrium, that is, by a model that determines what equilibrium current prices should be on the basis of characteristics of the joint distribution of prices at *t*. A market equilibrium at time *t-1* is achieved when prices for individual securities are determined such that the market clears.

In this model of price formation, the hypothesis that the capital market is efficient implies that the market uses all available information to determine security prices at time *t-1*. Market efficiency also implies that the market understands the implications of the available information for the joint distribution of prices.

To make the model testable we must specify how equilibrium prices at *t-1* are determined from the characteristics of the market assessed joint distribution of prices at *t*. Thus, some type of model of market equilibrium is required. This raises the issue of what has been termed the joint hypothesis problem in tests of market efficiency. This is best summarized by Fama (1976). Any test is "simultaneously a test of efficiency and of assumptions about the characteristic of market equilibrium. If the test is successful . . . then this also implies that the assumptions about market equilibrium are not rejected. If the tests are unsuccessful, we face the problem of deciding whether this reflects a true violation of market efficiency . . . or poor assumptions about the nature of market equilibrium" (Fama, 1976 p. 137).

Return Predictability over Short Horizons

One of the earlier models of market equilibrium states that at any time *t-1* the market sets the price of any security *j* in such a way that the market's expected return on the security from time *t-1* to time *t* is positive. Given this positive expected returns model, filter techniques have been used to test the claims of technical analysts that market prices adjust slowly and over long periods to new information, and that by examining patterns in the sequence of past prices it is possible to predict the future price movement of a security.

Tests of filter rules are reported by Alexander (1961, 1964) and by Fama and Blume (1966). After correcting for earlier errors Alexander (1964) concludes that filters only rarely compared favorably with buy and hold, even though the higher broker's commissions incurred under the filter rule were ignored. Fama and Blume (1966) conclude that their evidence is in favour of buy and hold, and thus, they reject the hypothesis that there is any important information in past prices that the market neglects in setting current prices. However, Fama

(1970, 1976) states that one can find evidence in the filter tests of both Alexander and Fama-Blume that is inconsistent with capital market efficiency. If efficiency is interpreted in a strict sense the results for very small filters indicate that it is possible to devise trading schemes based on very short term price swings that will on average out perform buy and hold (Fama,1976 p. 142). However, trading costs would eliminate any such profits generated.

One of the more common models of market equilibrium used in tests of market efficiency is the constant expected returns model. Under this model expected returns are constant through time but different securities are allowed to have different expected returns, based perhaps on differences in risk. Market efficiency according to this model implies that returns are unpredictable from past returns or other variables, and the best forecast of a return is its historical mean.

Tests of market efficiency based on the constant expected returns model have focused primarily on one subset of information; namely the potential information about current expected returns that appears in time series of past returns. One of the more common tests is the serial correlation test. Market efficiency under this model implies that the sample autocorrelation of the returns on any security are zero for all lagged values.

Fama (1965) computed the autocorrelations, for lags of from one to ten days, of daily returns for each of the 30 Dow Jones Industrials

(DJI) for periods that ranged from 1957 to 1962. He found that for the one period lagged daily returns, 11 of the 30 autocorrelations are more than twice their computed standard errors, and 22 were positive. Although in a strict sense the results do suggest evidence against market efficiency, Fama (1965,1970,1976) concludes that the evidence is not sufficient to reject the hypothesis of market efficiency. First, returns on individual securities are all related to the return on the market and hence returns on individual securities all reflect to some extent the sample autocorrelation of the return on the market; and second, although the true autocorrelation might be nonzero, they are close enough to zero in magnitude and in terms of proportion of variance explained to conclude that market efficiency is a reasonable description of reality.

Fama (1976) reports on sample autocorrelations of monthly returns for each of the DJI stocks, and concludes that the results are consistent with market efficiency. He points out, however, such results are somewhat "fortuitous". The autocorrelations tests are derived from a market equilibrium model that is based on the assumption of constant returns. If this assumption is incorrect, tests of market efficiency based on autocorrelations could fail even though the market is efficient (p. 149).

More recent work has uncovered evidence that returns are predictable from past returns and other variables. For example Lo and MacKinlay (1988) and Conrad and Kaul (1988) find that weekly returns on size-grouped portfolios of NYSE stocks are positively autocorrelated, and that the autocorrelation is stronger for portfolios of small stocks. French and Roll (1986) establish that stock prices are more variable when the stock market is open, and they tested the hypothesis that the higher variance of price changes during trading hours is partly transitory, the result of noise trading. Under this hypothesis pricing errors due to noise trading are eventually reversed, and this induces negative autocorrelation in daily returns. French and Roll found positive first order autocorrelations of daily returns on the individual stocks for the top three quintiles of NYSE firms. The autocorrelations of daily returns on the remaining stocks were negative and statistically significant for up to 13 lags.

Return Predictability over Long Horizons

If one takes a longer term perspective the evidence on return predictability is stronger; autocorrelation tests yield larger and economically more important correlations for longer time periods (three to seven years). Using data on nominal returns for NYSE firms for the period 1926-1985 Fama and French (1988) found strong negative autocorrelation, in the region of -.25 to -.4, for 3 to 5 year returns. This reveals considerable mean reversion. The autocorrelations are more negative for portfolios of smaller firms and for the equally weighted index than for the large firm portfolios or the value weighted index. However, the evidence of mean reversion is weaker for the sub-period 1941-1985.

Variance ratio tests by Poterba and Summers (1988) support Fama and French's results. The variance ratio test exploits the fact that if the log of the stock price follows a random walk then the return variance should be proportional to the return horizon. That is, the variance of monthly returns should be 1/12 the variance of annual returns. The variance ratios are scaled so that if returns are uncorrelated the ratios equal one. A variance ratio of less than unity implies negative serial correlation; a ratio greater than one implies positive serial correlation. Poterba and Summers find that for N from 3 to 8 years, the variances of N-year returns on diversified portfolios grow much less than in proportion to N. The variance of 8 year returns is about 4 (rather than 8) times the variance of annual returns. This is consistent with the mean reversion hypothesis. Returns for horizons of less than one year however, display some positive serial correlation.

Poterba and Summers also investigated the mean reversion hypothesis for seventeen other countries. The data for Canada and Britain display patterns similar to those found for the United States, that is, strong negative serial correlation over long time horizons and some positive serial correlation over short horizons. The eight year variance ratios are 0.585 for Canada and 0.794 for Britain. With the exception of Finland, South Africa, and Spain, the other countries also display negative serial correlation over long horizons. The average eight year variance ratio for all non-US countries is 0.754. From the international evidence Poterba and Summers conclude that mean reversion is more pronounced in less broad based and less sophisticated equity markets.

The evidence of return predictability over longer term horizons has spurred considerable debate in the efficiency literature. One line of argument is that return predictability is due to the existence of irrational bubbles in stock prices. Such bubbles are the result of systematic investor overreaction. Individual investors, in making their forecasts and judgements, tend to place too much emphasis on recent events (Kahneman and Teversky, 1973). This would cause overreaction by investors to events which have either a favorable or unfavorable impact on stock prices of specific firms. In subsequent periods, however, this overreaction would be recognized as such and returns on stocks which have experienced extreme movements should revert to their mean or fundamental values. Since the existence of irrational bubbles is due to the fact that investors do not properly evaluate available information, they necessarily imply market inefficiency.

De Bondt and Thaler (1985,1987) in an attempt to uncover irrational bubbles studied the investment performance of portfolios of long term winners or losers. They found that the returns for both losers and winners are mean reverting; the price reversals for losers are more pronounced than for winners; and most of the excess returns for losers occur in January. De Bondt and Thaler conclude that their results confirm the hypothesis of market overreaction to extreme bad or good news about firms. Jegadeesh (1990), Lehmann (1990), and Lo and MacKinlay (1990) also find reversal behavior in the weekly and monthly returns of extreme winners or losers.

Proponents of market efficiency argue that return predictability is due to the existence of time varying equilibrium expected returns on the part of rational investors. Fama and French (1989) argue that there are systematic patterns in the variation of expected returns through time that suggest that it is rational, and probably the result of variation in tastes for current versus future consumption or in the investment opportunities of firms. They find that, consistent with their intuition on the risk of securities, the variation in expected returns tracked by dividend yields (D/P) and the default spread (the spread between low grade and triple A corporate bonds) increases from high quality to low quality bonds, from bonds to stocks and from large stocks to small stocks. Fama and French further argue that the variation in expected returns on bonds and stocks captured by their forecasting variables is consistent with modern intertemporal asset pricing models (for example, Lucas 1978, Breeden 1979, Cox, Ingersoll, and Ross, 1985).

Fama (1991) states that the issue of deciding whether return predictability is the result of rational variation in expected returns or irrational bubbles is not clear cut. He expresses the opinion, "that the variation through time in expected returns is common to corporate bonds and stocks, and is related in plausible ways to business conditions, leans me toward the conclusion that it is real and rational" (Fama, 1991 p. 1577).

Summary

This brief review reveals that the issue of stock return predictability over short and long horizons is far from resolved. The early short term studies have concluded that past returns are useless in predicting future returns. More recent evidence suggests that returns are predictable from past returns and other variables. Also, there is evidence of negative serial correlation over long horizons.

SECTION III

LITERATURE REVIEW OF CAPITAL MARKET EFFICIENCY IN DEVELOPING COUNTRIES

Numerous researchers have examined the efficient capital market hypothesis in developed countries. There have been a paucity of studies on the efficiency of capital markets in developing countries or emerging stock markets. This section critically reviews, in a historical order, those studies which have been done on developing countries.

Gandhi, Saunders, and Woodward (1980) apply runs tests and serial correlation tests to evaluate the efficiency of the Kuwaiti stock market. Using stock price indices they calculate the monthly returns for an all-share index and seven sub-index portfolios for the period 1975 to 1978. The runs and serial correlations tests were applied only to the all-share and industrial indices. The actual number of runs were 9 for the all share index and 14 for the industrial index. Gandhi et al estimate the expected number of runs to be 28.6 and 27 for the all-share index and the industrial index, respectively.

The expected number of runs is given by

$$m=\frac{\left[N(N+1)-\sum_{i=1}^{3} n_i^2\right]}{N}$$

where n_i are the total number of price changes of each type; and i=1,2,3 represent the total number of positive (+), negative (-), and zero (0) price changes. Gandhi et al have, however, incorrectly applied the formula for the determination of the expected number of runs; they have used the number of positive, negative and zero runs, instead of the total price changes of each type. The effect is to grossly over estimate the expected number of runs.

Using their estimate of the expected number of runs, Gandhi et al computed the Z-statistic (the actual number of runs minus the expected, divided by the standard deviation of the actual number of runs) and found this to be significant at the 1 % level. Thus, they conclude that "prices tend to move systematically over time"(p. 344). It is not quite clear what the result would be if the proper estimate of the expected number of runs is used.

Serial correlation coefficients were calculated both for the level and change in the all-share and industrial indices. For the level of the all-share and industrial indices Gandhi et al found positive first order serial correlation coefficients of .708 and .709, respectively. The coefficients for the change in the all-share and industrial indices were .235 and .443 respectively. All of the coefficients are significant either at the 5% or 10% level. Consequently, Gandhi et al conclude that "there is evidence of inefficiency in price determination on the Kuwaiti stock market, as might be expected in a relatively thin market" (p. 347). This result of positive serial correlation is consistent with those of Lo and MacKinlay (1988), who found positive serial correlation for portfolios of small stocks on the NYSE, and may be related to the non-synchronous trading effect (Fisher, 1966).

Using data on daily prices of 28 major Hong Kong stocks Wong and Kwong (1984) apply serial correlation analysis and runs tests to evaluate the efficiency of the Hong Kong stock market. Their data cover the period 1977 to 1980.

Wong and Kwong computed the sample serial correlation coefficients for daily changes in log prices for each stock for lag k of 1 to 30 days. For lags 1 to 10, the serial correlation coefficients were almost equally divided between positive and negative signs, with 17.9% being significant at the 5% level. For lag 1, Wong and Kwong found that the majority of coefficients are negative (71.4%) and significant (53.6%) at the 5 % level. The mean absolute correlation coefficient for k=1 is .097, this is double that found by Fama (1965) for the DJI stocks. Wong and Kwong conclude that the serial correlation tests fails to support the hypothesis that the Hong Kong stock market is weakly efficient.

The application of the runs tests for the Hong Kong market yielded a preponderance of negative signs for the percentage difference between actual and expected number of runs and for the standardized variable Z. The preponderance of negative signs do not agree with the negative dependence produced by the serial correlation tests. Wong and Kwong found that the standardized variable Z was significant for 10 of the 28 stocks and the average percentage difference between the actual and the expected number of runs was -4.0%. They conclude that the evidence of the runs test agrees with the weak form efficient market model, however in "individual cases there is a number of significant discrepancies that suggest that some non-random patterns are present in stock price changes" (p. 915). Combining the results of the serial correlation and runs tests Wong and Kwong conclude that, in the case of the Hong Kong stock market, the overall evidence fails to give clear support to the weak form efficient market model.

Panas (1990) applies a number of statistical tests to investigate the weak form efficiency of the Athens stock market. The data for his study consist of monthly closing prices for 10 companies quoted on the Athens stock market over the period January 1965 to December 1984. Panas presents serial correlation coefficients for successive price changes for up to 10 lags. For the entire sample the majority of coefficients are positive in sign, with 11 significant at the 5 % level; 7 of which are for the first lag. Panas cites Working (1960) to argue that part of the autocorrelation is due to the averaging of daily random increments and concludes that the evidence supports the weak form efficient market hypothesis. It should be noted however, that the data used by Panas are monthly closing prices and hence there is no averaging process involved. Thus, his results do in fact provide evidence of inefficiency.

Panas also applies runs analysis and the rank von Neuman (RVN) ratio test to assess the randomness of log price differences. Panas concludes that his evidence indicates that for all stocks in the sample, successive changes in prices are random and that overall, the Athens stock market is weak form efficient.

Panas may have however, erred in the interpretation of the RVN statistic. The RVN ratio tests the null hypothesis that the observations in a series are randomly generated. The critical value at the 5 % level for N=240 (the number of observations used by Panas) is 1.77. The RVN ratios as presented by Panas are all less than the critical value and thus, the null hypothesis of randomness is rejected. Therefore, the results of the tests applied by Panas to the Athens stock market, do in fact provide evidence of weak form inefficiency on this market.

<u>Summary</u>

The evidence on capital market efficiency for developing countries is mixed. For Kuwait and Hong Kong it does not support the weak form efficient model. While the study on the Athens stock market concludes that it is weakly efficient, I have argued that there is evidence of inefficiency on this market.

SECTION IV

BACKGROUND TO THE TRINIDAD AND TOBAGO ECONOMY AND ITS STOCK EXCHANGE

Trinidad and Tobago is a twin island state lying at the southmost end of the Caribbean archipelago in close proximity to Venezuela. It has a total land area of 5,128 square kilometers and a population of 1.3 million. With a per capita GNP of US$3,230 (1989 estimate) Trinidad and Tobago is ranked as an upper middle income developing country by the World Bank.

The Trinidad and Tobago economy is dominated by its petroleum sector; in 1987 the petroleum sector accounted for 16% of real GDP and 37% of government revenues. Largely as a result of the oil shocks of 1973 and 1979, the Trinidad and Tobago economy experienced high growth rates during the decade of the 1970's. The average annual growth rate in real GDP was 4.8% over the period 1970 to 1980. With the softening of oil prices during the 1980's the economic fortunes of the country changed considerably. Beginning in 1983 the economy has experienced negative rates of growth for 8 consecutive years; the average annual decline in real GDP over the period 1983 to 1989 was 3.2 %. As a result of the severe economic contraction the country was forced to undergo IMF adjustment programmes in 1989 and 1990.

The Stock Exchange

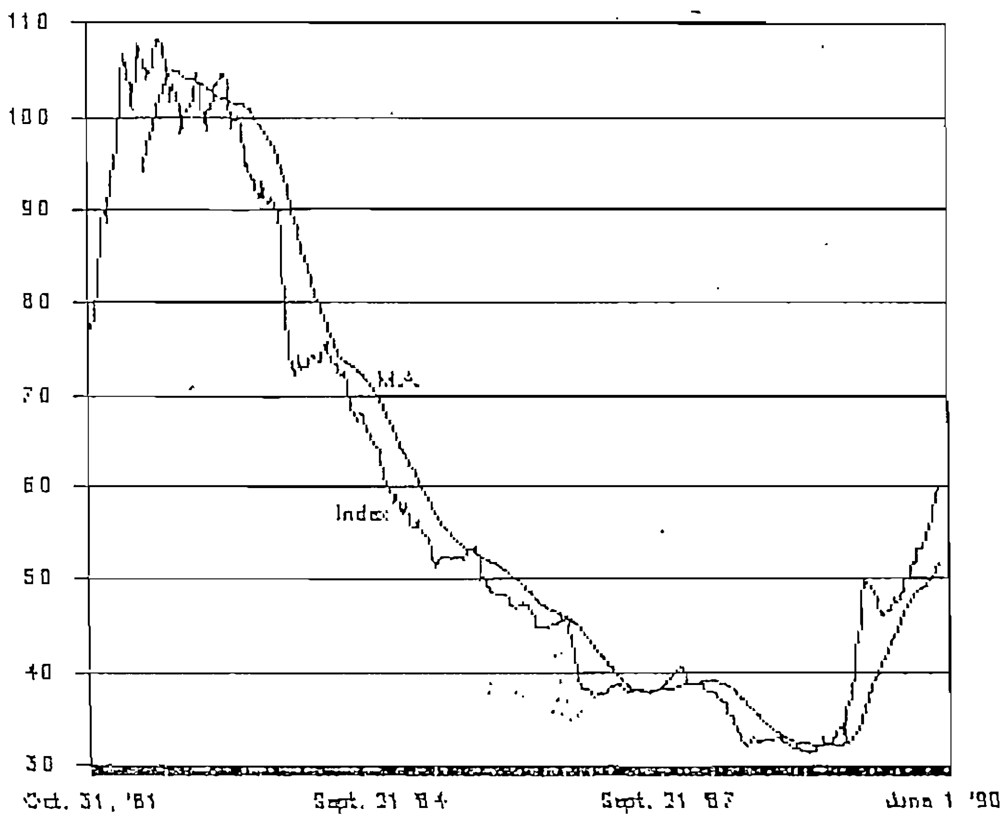
The Trinidad and Tobago Stock Exchange (TTSE) was established in October 1981. Prior to the establishment of the TTSE a call exchange which comprised of a group of non-financial intermediaries provided for the channeling of information on shares, bonds and Treasury Bills and other transactions on the domestic market. Trading on the TTSE is done on an open outcry basis; at present there is no computer trading.

As at October 25, 1991 there were 30 companies listed on the TTSE, of which 6 are engaged in commercial banking, 11 in manufacturing, 2 in property development, 3 in trading, 3 conglomerates and 5 in other areas of activity. There is a composite index which is based on the ordinary stocks of all listed companies with the exception of those in finance and insurance. Movements in the composite index over the period October 1981 to June 1990 are depicted in Figure 1. Since 1987 there has been a significant increase in the value of shares traded on the exchange. In 1987, 34.4 million shares were traded with a market value of TT$45.3 million. In 1991, 103.5 million shares were traded with a market value of TT$338.7 million.

FIGURE 1

COMPOSITE INDEX

TRINIDAD AND TOBAGO STOCK EXCHANGE



Source: Trinidad and Tobago Stock Exchange

SECTION V

EMPIRICAL ANALYSIS

DATA

The data for this study consist of the monthly closing prices of the common stocks of companies listed on the Trinidad and Tobago Stock Exchange (TTSE) over the period November 1981 to October 1991. Three stocks were excluded from the study because their time series of closing prices were not of adequate length. To prevent the introduction of possible bias into the study, those companies which were subsequently delisted through bankruptcy or otherwise, were not excluded from the study provided their series were of adequate length.

The raw data were adjusted for cash dividends, bonus issues, stock splits and rights issues. The adjustments for cash dividends and stock splits were similar to those made by Fama(1965). The adjusted price for use in a bonus issue was $P^{*}_{j,t} = rP_{j,t}/m$, where r is the number of shares after bonus for every m shares held by a stockholder. For rights issues, the value of the right was determined in the standard fashion and the adjustment to the stock price was made in a manner similar to dividends. The actual tests of the efficient market hypothesis are not performed on the adjusted prices themselves but on the monthly returns, where the return for month t for a given stock is

$$R_{j,t} = (P_{j,t} - P_{j,t-1})/P_{j,t-1}$$

where $P_{j,t-1}$ is the adjusted price per share of the common stock of firm j at the end of month $t-1$, and $P_{j,t}$ is the adjusted price at the end of month t.

Summary statistics on the monthly returns, for each stock included in the study, are presented in Table 1. The number of observations for individual stocks ranges from 32 to 120. Of the 36 stocks listed in the Table, 13 yielded negative mean returns over the sample period. As at October 1991, 7 of these 13 stocks were delisted either through mergers or bankruptcies. The minimum monthly return earned by any stock was minus 78 percent, whereas the highest was 127 percent. For the entire sample of stocks the average minimum monthly return was minus 37.6 %; the average maximum monthly return was 50.8%.

Table 1 also presents the studentized range statistic for each stock. This statistic is useful for judging whether the distribution that generated a sample is normal. The studentized range is defined as

$$SR = (\mathrm{Max}(x_i) - \mathrm{Min}(x_i)) \,/\, S(x)$$

where S(x) is the sample standard deviation; that is, the studentized range is the range of observations in the sample, the maximum minus the minimum, measured in units of the sample standard deviation.

TABLE 1
GENERAL STATISTICS ON MONTHLY RETURNS OF THE TTSE STOCKS:
SAMPLE PERIOD, NOVEMBER 1981 TO OCTOBER 1991

TICKER	MEAN	STANDARD DEVIATION	MINIMUM	MAXIMIUM	N	STUDENTIZED RANGE
AGH	0.0032	0.0674	-0.3617	0.1929	108	8.23
AGO	0.0138	0.1306	-0.2268	1.0000	113	9.39
BAT	0.0023	0.1781	-0.3922	1.2727	89	9.35
BER	0.0070	0.0989	-0.2093	0.4937	120	7.11
BOC	0.0026	0.1040	-0.4866	0.3216	120	7.77
CDC	0.0045	0.1218	-0.7822	0.7955	108	12.95
CWN	0.0099	0.1141	-0.3700	0.9964	112	11.98
FLA	-0.0095	0.0732	-0.3019	0.2182	120	7.11
FUR	-0.0025	0.1377	-0.3276	0.8443	120	8.51
GED	0.0161	0.1152	-0.2508	0.5075	119	6.58
HCN	0.0058	0.0707	-0.3698	0.2695	111	9.04
LVB	0.0059	0.0562	-0.2167	0.3100	120	9.37
MBX	-0.0079	0.1761	-0.4211	0.7943	107	6.90
MEA	0.0146	0.1724	-0.4660	0.9355	120	8.13
MEI	-0.0040	0.1995	-0.5000	1.0000	61	7.52
NBC	0.0080	0.0910	-0.4348	0.4726	120	9.97
NCB	0.0022	0.1157	-0.2887	0.4844	120	6.68
NMY	0.0071	0.1093	-0.1867	0.5889	120	7.10
PLD	0.0071	0.1004	-0.3750	0.4286	120	8.00
REP	0.0015	0.0981	-0.2563	0.4771	120	7.48
RMX	-0.0047	0.1135	-0.3671	0.3871	102	6.64
ROY	-0.0020	0.0894	-0.3000	0.3351	120	7.10
SBK	0.0008	0.0874	-0.5925	0.2138	120	9.23
STV	-0.0200	0.0887	-0.2778	0.2727	71	6.21
TCB	0.0152	0.1076	-0.5737	0.4348	120	9.37
TCL	0.0485	0.1384	-0.1625	0.6194	32	5.65
TPL	0.0046	0.1093	-0.5000	0.5283	120	9.41
TRC	-0.0410	0.2057	-0.6539	0.8026	54	7.08
UNI	0.0000	0.0629	-0.1667	0.2319	54	6.34
VAL	0.0012	0.0557	-0.2037	0.2127	120	7.48
WBD	-0.0134	0.0884	-0.3194	0.4286	87	8.46
WIT	0.0139	0.0803	-0.6090	0.3333	120	11.73
WKA	-0.0153	0.0487	-0.2267	0.1184	87	7.09
WLA	-0.0083	0.0847	-0.5600	0.2857	120	9.98
WLB	-0.0126	0.0624	-0.2738	0.2234	120	7.97
WOL	-0.0215	0.1465	-0.5161	0.4667	84	6.71
AVG	0.0009	0.1083	-0.3758	0.5083	105	8

NOTE: THE VALUES FOR THE SR ALL EXCEED THE .9 FRACTILE OF THE DISTRIBUTION OF THE STUDENTIZED RANGE.

Since the SR depends on the extreme observations in a sample it is sensitive to departures from normality where the probabilities associated with observations far from the mean are higher or lower than if the variable were normally distributed. This is relevant for distributions of stock returns which are "fat-tailed" relative to normal distributions; that is, where the frequencies of large positive and negative returns are higher than would be expected from normal distributions.

Tables of significance points for the studentized range statistic are given by Pearson and Hartley (1966). The SR statistic for the monthly returns for all the stocks are presented in the final column of Table 1. An examination of these statistics show that they all exceed the .9 fractile of the distribution of the studentized range. This result, at least for the sample considered, suggests that the distributions of monthly stock returns on the TTSE are not drawn from a normal process.

TESTS OF EFFICIENCY FOR THE PERIOD 1981 TO 1991

Analysis of Serial Correlation Tests

The serial correlation coefficient (r_k) provides a measure of the relationship between the value of a random variable at time t and its value k periods earlier; more specifically it measures the amount of linear dependence between observations in a time series that are separated by lag k, and is defined as

$$r_k = [Cov(u_t, u_{t-k})]/var(u_t)$$

where u_t is the stock return for month t, and r_k is the autocorrelation coefficient for a lag of k time units. If the distribution of u_t has finite variance the standard error of r_k for a large sample can be given as

$$SE(r_k)=[1/(n-k)]^{1/2}$$

If a set of data is independently distributed, the r_k are zero for all time lags of the monthly returns series.

Using the data for common stocks on the TTSE, the sample serial correlation coefficient were computed for each stock for lag k of from 1 to 5 months. The results are presented in Table 2. For lag 1 the majority of coefficients are positive (only 5 out of the 36 stocks are negative) and 15 (41.7%) are significant at the 5% level. All of the significant coefficients are positive in sign. The absolute values of the coefficients ranges from 0.503 to 0.023. For lags 2 to 5 the preponderance of signs remain positive, with the coefficients of 10 stocks (27.8%) and 9 stocks (25%) being significant at the 5% level for lags 2 and 3 respectively. For each of lags 4 and 5 only 2 coefficients were significant. For lag 1 the mean value of the autocorrelation coefficients is 0.14.

TABLE 2
AUTOCORRELATIONS OF MONTHLY RETURNS:
SAMPLE PERIOD; NOVEMBER 1981 TO OCTOBER 1991

TIC	LAG 1	LAG 2	LAG 3	LAG 4	LAG 5	N	LJUNG-BOX
AGH	0.2849*	0.0577	-0.0220	-0.0287	0.0015	108	9.534
AGO	0.0230	0.1250	-0.0637	0.0334	0.0187	112	2.523
BAT	-0.1333	0.2236*	0.1423	-0.0586	0.0183	88	8.464
BER	0.2365*	0.0574	0.0217	0.0560	-0.0593	119	8.126
BOC	0.3161*	0.0763	-0.2024*	-0.2355*	-0.0744	119	25.637*
CDC	0.0253	-0.3200*	0.0435	-0.1114	-0.0275	107	13.149*
CWN	0.2011*	-0.0129	-0.0059	0.0421	0.0334	111	4.974
FLA	0.1952*	0.1683	0.1448	0.0948	0.1844	119	16.158*
FUR	0.1949*	0.1851*	-0.0475	-0.0195	0.0059	119	9.184
GED	0.0372	-0.0848	-0.0208	0.0328	0.1376	118	3.605
HCN	0.2137*	-0.0580	-0.2617*	-0.0757	0.1707	110	17.516*
LVB	0.2420*	0.1367	-0.3237*	-0.0391	-0.0569	119	23.053*
MBX	0.0399	0.0914	-0.1420	-0.0513	-0.0555	106	3.979
MEA	-0.0477	-0.1927	0.2362*	0.0763	0.0060	119	12.506*
MEI	-0.1646	-0.3499*	0.4212*	0.1589	0.0753	60	23.200*
NBC	0.4502*	0.2344*	0.0743	0.0676	0.0538	119	33.117*
NCB	-0.1303	-0.0191	0.0509	0.1467	0.0972	119	6.326
NMY	0.1724	0.2027*	0.1161	0.1559	0.2378*	119	20.542*
PLD	0.5030*	0.3279*	0.2471*	0.1486	0.1851	119	58.777*
REP	0.2232*	-0.0007	-0.0471	0.0271	0.0180	119	6.487
RMX	0.1640	0.1883	0.2311*	0.0236	0.0084	101	12.261*
ROY	0.3693*	0.1024	0.0188	-0.0167	0.1347	119	20.303*
SBK	0.0382	0.0674	-0.1440	-0.0978	0.0464	119	4.781
STV	0.3055*	0.1244	0.1812	0.0395	0.1348	70	11.962*
TCB	0.1724	0.0309	-0.1099	-0.0218	-0.0474	119	5.587
TCL	0.0391	-0.0673	0.0243	0.1460	-0.1120	31	1.489
TPL	0.1353	0.1991*	-0.1170	0.0047	0.0963	119	9.986
TRC	0.0883	-0.0365	-0.0353	0.0420	0.1165	54	1.541
UNI	0.2153	-0.1373	-0.0580	-0.0434	-0.1064	53	4.672
VAL	0.2044*	0.2138*	0.1262	0.0397	0.1880*	119	17.362*
WBD	0.1241	0.1759	0.2164*	0.1196	0.1427	86	11.651*
WIT	-0.0717	0.1074	0.1369	0.0038	-0.0059	119	4.379
WKA	0.1810	0.1056	0.0094	-0.0323	0.1515	86	6.170
WLA	0.1403	0.0482	-0.0874	-0.0665	-0.0575	119	4.607
WLB	0.2812*	0.1893*	0.1773	0.2228*	0.1342	119	26.451*
WOL	0.0364	-0.0924	0.2755*	-0.1713	-0.1812	83	13.141*
AVG	0.140	0.054	0.032	0.016	0.042	99	12.19

* DENOTES SIGNIFICANCE AT THE 5 % LEVEL

The preponderance of positive signs for lag k=1 is similar to the result found by Panas (1990) for the Athens stock market. However, it does not agree with the results found by Fama (1976) for the monthly returns on the Dow Jones Industrial (DJI) stocks. For the one period lag Fama found that only 9 of the 30 DJI monthly correlations were positive; the absolute values of these coefficients ranged from 0.31 to 0.01. Moreover, only two out of the 30 coefficients were significant. The mean value of the correlation coefficients was 0.044 for the DJI stocks.

Agreement in signs among the coefficients for different stocks may indicate that there is a consistent pattern of dependence. Fama (1965, 1976) argues that the returns of different stocks are related to a certain extent to a market component common to all stocks. This means that the sample autocorrelations of the returns on individual stocks all reflect to some extent the sample autocorrelations of the return on the market. Thus, for a given lag the sample autocorrelations may be predominantly positive or negative. This reasoning together with the small magnitudes of r_k for daily and monthly returns led Fama to conclude that his results are consistent with market efficiency.

In the case of the Trinidad and Tobago Stock Exchange the results of r_k indicate that the magnitude of statistical dependence in monthly returns is much larger than that found by Fama (1976). Moreover, in the present study a large proportion of the autocorrelation coefficients are significant at the 5% level. The evidence therefore, suggests that the TTSE is weakly inefficient.

The Ljung-Box Statistic

In order to provide more evidence about the dependence of monthly stock returns, the Ljung-Box statistic (Ljung and Box, 1978) is employed. Rather than considering each autocorrelation coefficient individually the Ljung-Box statistic defined as

$$Q(k)=N(N+2)\sum_{m=1}^{k}(N-m)^{-1}r_m^2$$

presents a summary measure which can be used to evaluate independence. Under H_0: $r_1 = \ldots = r_k = 0$, Q is asymptotically chi-square distributed with *k* degrees of freedom. If H_0 is false the test statistic tends to become large, thus indicating model inadequacy.

The last column of Table 2 presents the Ljung-Box statistic for an overall test of uncorrelated data. For k=5, the critical chi-square at the 5% level is 11.1. From an examination of the results in Table 2 we see that 17 of the 36 stocks (47.2 %) are significant at the 5% level. This is consistent with the results of the serial correlation test, and thus, the evidence fails to support the hypothesis that the TTSE is weakly efficient.

Analysis of Runs Tests

A runs test is a statistical tool used to detect the presence of nonrandom trends in a series of numbers. For testing security prices, a run can be defined as a sequence of price changes of the same sign. Too many or too few runs are unlikely if the sample is random. Under the hypothesis of independence the expected number of runs is

$$m=\frac{\left[N(N+1)-\sum_{i=1}^{3} n_i^2\right]}{N}$$

where N is the total number of observations, and each n_i are the changes of each type, with i = 1,2,3 representing the total number of positive(+), negative (-) and zero(0), changes in stock returns. The variance of m is

$$\sigma^2(m)=\frac{\sum_{i=1}^{3} n_i^2\left[\sum_{i=1}^{3} n_i^2+N(N+1)\right]-2N\sum_{i=1}^{3} n_i^3-N^3}{N^2(N-1)}$$

For large N, the sampling distribution of m is approximately normal. The standardized variable may be defined as

$$Z=\frac{[(R+0.5)-m]}{\sigma(m)}$$

where the 0.5 is a discontinuity adjustment, R is the actual number or runs, and σ(m) is the standard deviation of *m*. For large samples k will be approximately normal with mean 0 and variance 1. It should be pointed out that runs tests are nonparametric and thus, does not depend on the assumption of a finite variance.

Table 3 presents the results of the runs test performed on the monthly returns for the common stocks listed on the TTSE. As shown in this Table one of the striking features of the runs analysis is that for a large number of stocks the actual number of runs is less than the expected number; for 24 of the 36 stocks (67%) the actual number of runs is less than expected. This is consistent with the findings of positive first order serial correlation presented in Table 2.

Fama (1965) in his study of successive price changes for the DJI stocks also found results for the runs tests which were consistent with the first order serial correlation of daily price changes; however he found evidence of negative dependence. Fama's results for four day and nine day price changes did not, however, support his results produced by the serial correlation coefficients. He argues that "the absolute amount of dependence in the price changes is more important than whether the dependence is positive or negative".

The amount of dependence implied by runs tests can be depicted by the standardized variable Z and (R-m)/m. Both of these measures are presented in Table 3. The values of Z show that for 8 out of the 36 stocks (22%) the actual number of runs is more than two standard

TABLE 3
SUMMARY OF RUNS AND RVN TESTS STATISTICS
SAMPLE PERIOD: 1981 - 1991

TIC	"R" ACTUAL	"m" EXPECTED	VAR(m)	Z	(R-m)/m	RVN
AGH	42	53.93	25.94	-2.245*	-0.221	1.213*
AGO	52	55.74	26.74	-0.626	-0.067	1.787
BAT	25	38.98	16.33	-3.335*	-0.359	1.643*
BER	56	58.92	28.17	-0.455	-0.049	1.472*
BOC	64	59.85	29.10	0.863	0.069	1.334*
CDC	37	52.79	25.05	-3.055*	-0.299	1.261*
CWN	31	38.53	12.58	-1.982*	-0.195	0.990*
FLA	51	51.03	20.97	0.102	-0.001	1.333*
FUR	43	58.92	28.17	-2.904*	-0.270	1.194*
GED	53	58.78	28.28	-0.992	-0.098	1.778
HCN	48	55.46	26.96	-1.340	-0.134	1.292*
LVB	66	59.85	29.10	1.233	0.103	1.338*
MBX	43	53.11	25.61	-1.900	-0.190	1.966
MEA	53	58.63	27.89	-0.971	-0.096	1.899
MEI	23	29.47	13.49	-1.627	-0.220	1.856
NBC	56	57.56	26.86	-0.204	-0.027	0.974*
NCB	60	59.98	29.23	0.096	0.000	2.257
NMY	68	59.58	28.83	1.662	0.141	1.917
PLD	62	56.19	25.56	1.249	0.103	1.014*
REP	69	59.85	29.10	1.789	0.153	1.856
RMX	51	49.00	22.79	0.524	0.041	1.446*
ROY	62	60.00	29.25	0.462	0.033	1.314*
SBK	52	57.56	26.86	-0.976	-0.097	1.667*
STV	39	35.49	16.99	0.972	0.099	1.430*
TCB	51	55.66	25.07	-0.831	-0.084	1.496*
TCL	13	14.33	5.67	-0.350	-0.093	1.533
TPL	46	56.68	26.02	-1.995*	-0.188	1.177*
TRC	32	26.74	12.24	1.647	0.197	1.858
UNI	28	26.38	12.14	0.607	0.061	1.649
VAL	57	58.63	27.89	-0.213	-0.028	1.061*
WBD	41	43.35	20.85	-0.406	-0.054	1.701
WIT	40	59.58	28.83	-3.553*	-0.329	1.299*
WKA	43	39.21	16.93	1.042	0.097	1.908
WLA	28	41.54	13.70	-3.523*	-0.326	1.171*
WLB	53	54.51	24.01	-0.206	-0.028	1.129*
WOL	34	41.39	19.64	-1.555	-0.179	1.595*
AVERAGE	46	49.92	23.13	-0.64	-0.07	1.495

* DENOTES SIGNIFICANCE AT THE 5 % LEVEL

errors less than the expected number of runs for monthly returns. Fama (1965) has pointed out that the value of Z can be slightly misleading because of its instability; the expected number of runs increases proportionately with the sample size, while its standard error increases proportionately with the square root of the sample size. Thus, the percentage difference between the actual and expected number of runs is "probably the more relevant measure of dependence" (Fama, 1965 p. 77). As depicted in Table 3 for the TTSE stocks the percentage difference between actual and expected number of runs given by (R-m)/m, ranges from 36% to 0% with a mean absolute value of 7 %. Thus, the evidence suggests that significant non-random trends may be present in monthly returns.

The Rank Version of von Neuman's Ratio Test

An alternative test procedure, the rank von Neuman ratio test will be used to test the null hypothesis of randomness in the series of monthly stock returns. Bartels (1982) has advanced the argument that runs tests should be less powerful than a test based on ranks since runs tests completely ignore the magnitudes of the observations.

The rank version of the von Neuman's ratio test procedure can be summarized as follows. Let R_i be the rank of the *i*th observation in a sequence of T observations; then the rank version of von Neuman's ratio (RVN) is defined as

$$RVN = \frac{\sum_{i=1}^{T-1} [R_i - R_{i+1}]^2}{\sum_{i=1}^{T} [R_i - \overline{R}]^2}$$

Bartels has provided tables of the critical values for the rank version of the von Neuman ratio. If the actual value is less than the critical value we reject the null hypothesis that the series follows a random walk. The last column of Table 3 presents the results of the application of the RVN ratio test to the data set for the TTSE. The results show that for 23 stocks (46%) the test statistic RVN is significant at the 5% level. This includes the 8 stocks which, under the standardized variable Z of the runs test, were identified as being significant. Consequently, the RVN confirms the results of the runs test and suggests that for a large number of stocks, monthly returns are not randomly generated.

Summary

The evidence produced by the various tests suggests patterns of dependence and non-randomness in the generation of monthly returns on the TTSE. Thus, the evidence fails to support the joint hypothesis that the TTSE is weakly efficient and that equilibrium expected returns are constant through time.

TESTS OF EFFICIENCY FOR SUB PERIODS

The analysis thus far has been conducted for the 10 year period beginning from the inception of the TTSE in 1981. Presumably one can argue that for an emerging stock market there is a learning period in which participants in the market acquire skills in predicting the appearance of new information and its effect on intrinsic values, and in performing statistical analyses of price behavior. Thus, one can expect some degree of dependence and non-randomness in returns for the first few years following the establishment of the stock exchange.

To test this hypothesis the entire period 1981 to 1991 is divided into two sub-periods of equal length, sub-period 1 from November 1981 to October 1986 and sub-period 2 from November 1986 to October 1991, and measures of independence and randomness are computed for the two sub-periods. Due to an insufficient number of observations 8 stocks were excluded from the set studied for the entire period; consequently, comparisons between the two sub-periods are made with respect to the reduced set of 28 stocks.

Serial Correlations

Serial correlation coefficients of monthly returns for the sub-set of 28 stocks for sub-periods 1 and 2 are presented in Tables 4 and 5 respectively, for up to 5 lags. For lag 1 the majority of signs are positive for both sub-periods, though more so for the second sub-period. For sub-period 1 only 4 (14%) of the first order serial correlation coefficients are significant at the 5% level, as compared to 13 (46%) for the second sub-period. The average of the first order correlation coefficients was 9% for the first sub-period; for the second period it is 22%. The evidence suggests, therefore, contrary to

TABLE 4
AUTOCORRELATIONS OF MONTHLY RETURNS
SUB-PERIOD 1: NOV 1981 TO OCT 1986

TIC	LAG 1	LAG 2	LAG 3	LAG 4	LAG 5	N	LJUNG-BOX
AGH	0.2704	-0.0491	-0.0068	0.1030	-0.1769	47	6.07
AGO	-0.0023	0.0814	-0.0625	0.0675	0.0350	51	0.92
BAT	-0.1781	0.0682	-0.3211	0.0151	0.1985	27	5.87
BER	0.1529	0.0607	-0.0302	0.1979	-0.0013	58	4.24
BOC	0.0398	0.1456	0.0244	0.0068	0.0175	58	1.47
CDC	-0.0212	-0.3841*	0.0358	-0.1319	-0.0346	58	10.48
CWN	0.1610	-0.0701	-0.2301	-0.2458	0.1154	50	8.75
FLA	-0.0046	0.0679	0.1148	0.0784	0.1117	58	2.34
FUR	0.3750*	-0.0907	-0.1192	0.0418	0.0193	58	10.13
GED	0.1138	0.0143	0.0628	0.0505	-0.1480	58	2.66
HCN	0.1460	-0.0951	-0.3441*	-0.1050	0.1681	58	11.92*
LVB	0.1385	0.1302	-0.4918*	-0.1341	-0.1630	58	20.43*
MBX	-0.1840	0.1638	-0.1847	-0.1285	-0.1244	58	7.97
MEA	0.0841	-0.2531	-0.0677	-0.0318	0.3639	58	13.46*
NBC	0.4682*	0.3179*	0.1280	0.1240	0.0951	58	22.28*
NCB	-0.0317	0.0557	-0.0755	0.0207	0.1644	58	2.42
NMY	-0.1400	0.0694	0.0366	-0.1296	0.0761	58	3.04
PLD	0.3209*	0.0953	0.0197	-0.0092	0.1380	58	8.13
REP	-0.0209	-0.0673	0.0100	0.0956	0.0730	58	1.25
RMX	-0.0730	0.1244	0.3446	0.0309	0.0001	40	6.35
ROY	0.0934	0.0576	0.0384	0.0508	0.3064*	58	7.16
SBK	-0.0746	0.0253	-0.1281	-0.0692	0.0712	58	2.06
TCB	0.1644	0.0694	-0.1081	-0.0234	-0.0834	58	1.96
TPL	0.0632	0.1961	-0.1496	0.0024	0.0613	58	4.30
VAL	0.2519	0.2991*	0.1979	0.0687	0.3121*	58	18.61*
WIT	-0.1105	0.0905	0.1149	-0.0025	-0.0030	58	2.09
WLA	0.1661	0.0212	-0.1595	-0.1185	-0.0994	58	4.88
WLB	0.2940*	0.2235	0.3249*	0.4713*	0.3738*	58	38.55*
AVG	0.088	0.049	-0.037	0.011	0.067	55	8.21

* DENOTES SIGNIFICANCE AT THE 5 % LEVEL

TABLE 5
AUTOCORRELATIONS OF MONTHLY RETURNS
SUB-PERIOD 2: NOV 1986 TO OCT 1991

TIC	LAG 1	LAG 2	LAG 3	LAG 4	LAG 5	N	LJUNG-BOX
AGH	0.2828*	0.1145	-0.0408	-0.1114	0.0883	60	7.34
AGO	0.0624	0.2128	-0.1241	-0.0685	-0.0484	60	4.63
BAT	-0.1330	0.2279	0.1542	-0.0633	0.0139	60	6.28
BER	0.2925*	0.0470	0.0554	-0.0713	-0.1109	60	6.91
BOC	0.4083*	0.0040	-0.3577*	-0.3932*	-0.1616	60	30.90*
CDC	0.4158*	0.2201	0.0783	0.0272	0.0071	48	11.73*
CWN	0.1738	-0.0480	-0.0552	-0.0584	-0.0519	60	2.66
FLA	0.3124*	0.1666	0.0669	-0.0055	0.1497	60	9.74
FUR	0.0940	-0.2573*	-0.0453	-0.0749	-0.0272	60	5.36
GED	-0.0516	-0.1916	-0.0507	0.0635	0.3043*	59	9.08
HCN	0.4421*	0.0472	0.0024	0.1178	0.1878	51	13.56*
LVB	0.4558*	0.1312	0.0505	0.1761	0.1859	60	18.77*
MBX	0.3383*	-0.0970	-0.1721	0.0479	-0.0959	47	8.39
MEA	-0.2058	-0.1338	0.1065	0.0252	-0.0637	60	4.88
NBC	0.3737*	0.0106	-0.1027	-0.1097	-0.0909	60	10.86
NCB	-0.2373	-0.1120	0.0835	0.2473	0.0251	60	8.92
NMY	0.2028	0.1721	0.0597	0.1619	0.2117	60	9.50
PLD	0.6799*	0.5419*	0.4222*	0.1809	0.0338	60	61.87*
REP	0.2510*	-0.0489	-0.1804	-0.0774	-0.0911	60	7.21
RMX	0.2120	0.0917	-0.0048	-0.2181	-0.2125	60	9.59
ROY	0.4287*	0.0281	-0.0818	-0.1380	-0.0115	60	13.35*
SBK	0.1825	0.0814	-0.2578*	-0.2232*	-0.0717	60	10.52
TCB	0.2002	-0.1204	-0.1213	-0.0051	0.3066	60	10.78
TPL	0.3963*	0.1055	-0.0700	-0.1522	0.0530	60	12.66*
VAL	0.1147	0.0873	0.0001	-0.0622	0.0317	60	1.64
WIT	0.2350	0.2430	0.3307*	0.0669	-0.0204	60	14.73*
WLA	0.1129	0.0768	-0.0110	-0.0111	-0.0114	60	1.21
WLB	0.2314	0.1174	0.0207	0.0375	-0.0783	60	4.80
AVG	0.22	0.06	-0.01	-0.02	0.02	59	11.35

* DENOTES SIGNIFICANCE AT THE 5 % LEVEL

the learning curve hypothesis, that the TTSE was less efficient in the period November 1986 to October 1991 than in the earlier period November 1981 to October 1986. Indeed, for the earlier sub-period it seems that there was little dependence in monthly returns and thus, for this sub-period, past returns may have been of little use in predicting future monthly returns.

Ljung-Box Statistic

The results of the Ljung-Box statistic are presented in the last column of Tables 4 and 5 for sub-periods 1 and 2, respectively. For sub-period 1, 6 of the stocks are significant at the 5% level, whereas for sub-period 2, 8 stocks are significant. Thus, these results confirm those of the serial correlation test that the TTSE was less efficient in the second sub-period than in the first.

Runs Tests

Tables 6 and 7 presents the results of the runs test for sub-period 1 and 2, respectively. For each sub-period the results of the runs test are consistent with those of the serial correlation test. For sub-period 1 the actual number of runs was less than the expected number for 17 stocks, this is consistent with the 17 positive signs for the first order serial correlation coefficients. A similar result was obtained for the second sub-period; the actual number of runs was less than expected for 24 out of the 28 stocks.

TABLE 6
SUMMARY OF RUNS AND RVN TESTS STATISTICS
SUB-PERIOD 1: NOV 1981 TO OCT 1986

TIC	"R" ACTUAL	"m" EXPECTED	VAR(m)	Z	(R-m)/m	RVN
AGH	21	24.40	11.40	-0.860	-0.139	1.42*
AGO	28	26.49	12.49	0.569	0.057	2.09
BAT	12	14.33	6.32	-0.729	-0.163	2.23
BER	32	29.86	14.11	0.702	0.072	1.57*
BOC	27	25.83	10.38	0.519	0.045	1.98
CDC	23	28.31	12.61	-1.355	-0.188	1.62
CWN	20	23.44	9.82	-0.938	-0.147	1.20*
FLA	25	25.03	9.71	0.149	-0.001	1.82
FUR	21	29.86	14.11	-2.226*	-0.297	1.11*
GED	29	30.00	14.25	-0.132	-0.033	1.51*
HCN	26	28.76	13.03	-0.626	-0.096	1.51*
LVB	28	29.14	13.40	-0.174	-0.039	1.48*
MBX	31	29.69	13.94	0.485	0.044	2.30
MEA	26	29.45	13.70	-0.797	-0.117	1.78
NBC	31	27.79	12.12	1.065	0.115	0.96*
NCB	33	29.45	13.70	1.095	0.121	1.91
NMY	24	29.45	13.70	-1.337	-0.185	2.13
PLD	31	27.21	11.59	1.261	0.139	1.73
REP	32	28.31	12.61	1.180	0.130	2.12
RMX	16	20.20	8.96	-1.236	-0.208	2.00
ROY	30	26.55	11.01	1.190	0.130	1.63
SBK	24	25.83	10.38	-0.412	-0.071	2.10
TCB	33	29.86	14.11	0.969	0.105	1.93
TPL	21	27.79	12.12	-1.807	-0.244	1.21*
VAL	32	29.14	13.40	0.919	0.098	1.25*
WIT	18	29.45	13.70	-2.958*	-0.389	1.17*
WLA	18	27.21	11.59	-2.558*	-0.338	1.49*
WLB	23	25.83	10.38	-0.722	-0.109	1.29*
AVERAGE	25	27.10	12.09	-0.31	-0.06	1.66

* DENOTES SIGNIFICANCE AT THE 5 % LEVEL

TABLE: 7
SUMMARY OF RUNS AND RVN TEST STATISTICS
SUB-PERIOD 2: NOV 1986 TO OCT 1991

TIC	"R" ACTUAL	"m" EXPECTED	SIGMA(m)	Z	(R-m)/m	RVN
AGH	28	30.70	14.45	-0.579	-0.088	1.02*
AGO	22	29.37	13.16	-1.893	-0.251	1.44*
BAT	15	24.47	8.94	-3.000*	-0.387	1.59
BER	26	28.30	12.17	-0.516	-0.081	1.51*
BOC	30	30.87	14.61	-0.096	-0.028	1.09*
CDC	20	24.63	11.37	-1.223	-0.188	0.92*
CWN	15	22.47	7.45	-2.553*	-0.332	1.31*
FLA	34	30.47	14.22	1.070	0.116	1.51*
FUR	16	28.87	12.69	-3.472*	-0.446	1.26*
GED	26	29.47	13.49	-0.810	-0.118	1.99
HCN	18	24.29	10.39	-1.798	-0.259	0.89*
LVB	32	30.97	14.71	0.400	0.033	1.28*
MBX	23	23.98	10.98	-0.144	-0.041	1.15*
MEA	20	28.30	12.17	-2.236*	-0.293	1.95
NBC	19	23.50	8.20	-1.397	-0.191	1.54*
NCB	25	29.37	13.16	-1.066	-0.149	2.45
NMY	33	30.47	14.22	0.804	0.083	1.80
PLD	32	26.20	10.34	1.960*	0.221	1.34*
REP	27	28.87	12.69	-0.384	-0.065	1.56
RMX	24	29.37	13.16	-1.342	-0.183	1.38*
ROY	27	30.87	14.61	-0.881	-0.125	1.13*
SBK	30	30.97	14.71	-0.122	-0.031	1.29*
TCB	18	26.20	10.34	-2.395*	-0.313	1.20*
TPL	23	28.30	12.17	-1.376	-0.187	1.20*
VAL	19	25.37	9.65	-1.889	-0.251	1.09*
WIT	29	30.97	14.71	-0.382	-0.064	1.46*
WLA	11	11.80	1.79	-0.224	-0.068	1.68
WLB	24	27.67	11.60	-0.930	-0.133	1.55*
AVERAGE	24	27.39	11.86	-0.95	-0.14	1.41

* DENOTES SIGNIFICANCE AT THE 5 % LEVEL

In terms of the standardized variable Z, for sub-period 1, there are 3 stocks for which the actual number of runs is more than 2 standard errors less than the expected number. In the case of the second sub-period 6 of the Z values are significant. The average percentage difference between the actual and expected number of runs is 6 % for sub-period 1 and 14 % for sub-period 2. Thus, monthly returns were less random in the second sub-period than in the earlier period.

The Rank Version of the von Neuman Ratio Test

Results for the rank version of the von Neuman ratio test are presented in the last columns of Tables 6 and 7 for sub-period 1 and 2, respectively. For the earlier period 1981 to 1986, 13 of the 28 stocks are significant at the 5 % level. For the latter sub-period 22 of the 28 stocks are significant. These results support the results of the runs test and it is concluded that monthly returns were less random for the period November 1986 to October 1991 as compared to the earlier period November 1981 to October 1986.

Summary

The overall evidence fails to give clear support to the weak form efficient markets hypothesis for both sub-periods. Moreover, contrary to the learning curve hypothesis, the TTSE was less weak form inefficient in the five year period immediately after its establishment, i.e. from November 1981 to October 1986, as compared to the five year period November 1986 to October 1991.

LONG HORIZON TESTS

Long Horizon Autocorrelations

In order to provide evidence on efficiency over periods longer than 1 month the Fama and French (1988) test which centers on slopes in regressions of *r(t, t+T)* on *r(t-T, t)* was employed. This test regresses multiperiod returns on lagged multiperiod returns. It should be pointed out that Ordinary Least Squares estimates have a bias that depends on the true slopes, sample sizes and the overlap of monthly data on long horizon returns. Fama and French state that proper bias adjustments are difficult to do analytically and use simulations to estimate the bias adjustments. In this study bias adjustments were not attempted.

For stocks on the TTSE long horizon returns were computed using the methodology of Fama and French. The basic data are the 1 month returns for those stocks that were listed over the entire period November 1981 to October 1991. There were 19 such stocks. The 1 month returns were transformed into continuously compounded returns and then summed to get overlapping monthly observations on longer-horizon returns.

Table 8 shows slopes in regressions of *r(t, t+T)* on *r(t-T, t)* for return horizons from 6 to 30 months for the 19 stocks. For all of the horizons there is a preponderance of positive signs, which indicates strong positive serial correlation. The slopes are generally large in

TABLE 8
LONG HORIZON FIRST ORDER AUTOCORRELATION
PERIOD 1981 TO 1991

TIC	6 MTH	12 MTH	18 MTH	24 MTH	30 MTH
BER	-0.1254	-0.1105	-0.0718	-0.6596*	-0.9851*
BOC	-0.0180	0.2359*	0.4960*	0.4339*	0.3778*
FLA	0.2521*	-0.0681	-0.2759*	-0.1494	0.1679
FUR	-0.0235	0.0717	0.1138	0.0581	-0.0490
LVB	0.0101	-0.4462*	-0.6284*	-0.7978*	-0.6882*
MEA	0.2104*	0.2204*	0.2340	0.3535*	0.4674*
NBC	0.2040*	0.2013*	-0.1538	-0.2485*	-0.1646
NCB	0.2403*	0.6617*	1.1971*	1.4333*	1.5800*
NMY	0.5037*	0.3263*	0.4193*	1.0800*	2.7371*
PLD	0.3115*	0.0458	-0.2680*	-0.4141*	-0.4523*
REP	0.3206*	0.6869*	0.9588*	1.3116*	1.6537*
ROY	0.2778*	0.4401*	0.3164*	-0.0612	-2.3184*
SBK	-0.0353	0.2856*	0.2942*	0.4815*	0.6939*
TCB	-0.0184	0.1247	-0.0033	-0.3442*	-0.3324*
TPL	0.3418*	0.2567*	0.0161	-0.1732	-0.2194
VAL	0.2469*	0.2651*	0.0984	0.0571	-0.2804
WIT	-0.0402	-0.3465*	-0.1676	-0.5666*	-0.6026*
WLA	0.0239	0.2338*	0.1501	-0.5436*	-0.9981*
WLB	0.4884*	0.4005*	0.1801	-0.4004*	-1.1277*
AVG	0.1669	0.1834	0.1529	0.0448	-0.0284

* DENOTES SIGNIFICANCE AT THE 5 % LEVEL

magnitude with 48% being significant at the 5 % level for the 12, 24 and 30 month horizons. This result is different from that of Fama and French, where they found evidence of negative serial correlation for portfolios of NYSE stocks, and that implied by the mean reversion hypothesis, where it is predicted that returns must be negatively serially correlated at some frequency if divergences from fundamental values are to be eliminated by speculative forces, or if there exist time varying equilibrium expected returns on the part of rational investors.

The Variance Ratio Test

The variance ratio test exploits the fact that if the logarithm of the stock prices follow a random walk, the return variance should be proportional to the return horizon. In this study the variability of returns at different horizons are examined in relation to the variation over a 12 month period. For monthly returns, the variance ratio statistic is therefore,

$$VR(k) = \frac{Var(R_t^k)}{k} \bigg/ \frac{Var(R_t^{12})}{12}$$

where

$$R_t^k = \sum_{i=0}^{k-1} R_{t-i}$$

R_t denoting the total return in month *t*. This statistic converges to unity if returns are uncorrelated through time. A variance ratio less than 1 implies negative serial correlation; a ratio greater than 1 implies positive serial correlation.

Table 9 presents the variance ratio statistic for horizons of 6, 18, 24, and 30 months. With the exception of the 6 month horizon the variance ratio statistics are greater than unity for all horizons. This provides evidence of positive serial correlation and thus supports the result of the long horizon regression test. However, this result of positive serial correlation for the TTSE stocks is the opposite of what Poterba and Summers found for stocks on the NYSE and for markets in the UK and Canada. For equity markets in 15 other countries, however, Poterba and Summers found evidence of positive serial correlation for 9 of these markets for horizons of 24 and 36 months; this disappeared for longer horizons. Only 3 of the 15 markets displayed positive serial correlation for the 96 month horizon.

Summary

The evidence produced by the long horizon tests indicates the existence of positive serial correlation for returns for periods ranging from 6 to 30 months. The evidence therefore, fails to support the capital market efficiency for periods longer than one month. Moreover, it is not consistent with the mean reversion hypothesis which predicts that long horizon returns should display negative serial correlation.

TABLE 9
VARIANCE RATIOS FOR TTSE MONTHLY RETURNS
1981 TO 1991

TIC	6 MONTH	18 MONTH	24 MONTH	30 MONTH
BER	1.248	1.064	1.190	1.211
BOC	1.295	0.872	0.993	1.198
FLA	0.730	1.120	0.878	0.433
FUR	0.952	0.715	0.311	0.136
LVB	0.889	0.837	0.676	0.565
MEA	0.746	1.214	1.222	0.732
NBC	0.939	1.258	1.127	0.711
NCB	0.765	1.089	1.134	1.067
NMY	0.609	1.264	1.334	1.327
PLD	0.684	1.255	1.310	0.724
REP	0.717	1.293	1.560	1.736
ROY	0.717	1.296	1.655	2.000
SBK	1.000	0.626	0.426	0.503
TCB	1.164	0.971	1.220	0.927
TPL	0.917	1.744	1.934	1.418
VAL	0.714	1.255	1.209	1.048
WIT	1.519	0.600	0.587	0.567
WLA	0.914	1.136	1.362	1.555
WLB	0.622	1.426	1.767	1.940
AVG	0.902	1.107	1.152	1.042

SECTION VI

CONCLUSION

This study examined the weak form capital market efficiency hypothesis for common stocks trading on the Trinidad and Tobago Stock Exchange. If the TTSE is weak form efficient, current security prices fully reflect any information in past prices and thus, investors are unable to predict future prices on the basis of past prices.

A number of statistical tests were applied to monthly return data for the period November 1981 to October 1991. The evidence produced by these tests suggests patterns of dependence and non-randomness in the generation of monthly returns on the TTSE, and therefore, fails to support the joint hypothesis that the TTSE is weakly efficient and equilibrium expected returns are constant through time. The capital market efficiency hypothesis was also examined for two sub-periods, November 1981 to October 1986 and November 1986 to October 1991. For both sub-periods there was evidence of positive serial correlation and non-randomness; however, the evidence was much stronger for the latter sub-period. This is contrary to the hypothesis that in an emerging stock market there is a learning period in which participants acquire the degrees of sophistication and skills necessary for the development of an efficient capital market.

The long horizon regression test and the variance ratio test were applied in examining return predictability over the longer term. The evidence indicates the existence of positive serial correlation for horizons of length 6 to 30 months. This result is the opposite of those found for the stock markets of the US, UK, and Canada, where evidence of negative serial correlation was found for 36 to 60 month horizons. Moreover, the evidence of long term positive serial correlation for the TTSE does not conform to the mean reversion hypothesis.

On the basis of the evidence for both the short and long term horizons the hypothesis that the TTSE is weakly efficient is rejected. This raises the joint hypothesis problem. As noted earlier, any test of efficiency is simultaneously a test of the assumptions about market equilibrium. Since the tests do not support the efficient capital markets hypothesis the issue is raised as to whether the TTSE is indeed weakly inefficient or the model of market equilibrium used is not an appropriate one. Moreover, the tests we have applied are based on assumptions of market equilibrium consistent with a developed economy. The failure to accept the weakly efficient capital market hypothesis for the TTSE may be due to illiquidity, low and unsteady trading volumes, and institutional arrangements. However, a relevant issue, which warrants theoretical investigation, is the degree to which models of market equilibrium constructed for developed economies are applicable to capital markets of developing economies.

REFERENCES

Bartels, R., "The Rank Version of the Von Neumann's Ratio Test for Randomness", *Journal of the American Statistical Association* 77, 1982, 40-6.

Breeden, D. "An Intertemporal Asset Pricing Model with Stochastic Consumption and Investment Opportunities", *Journal of Financial Economics* 7, 1979, 265-96.

Conrad, J. and G. Kaul, "Time-variation in Expected Returns", *Journal of Business* 61, October 1988, 409-25.

Cox, J. C., J. E. Ingersoll, and S. A. Ross, "An Intertemporal General Equilibrium Model of Asset Prices", *Econometrica* 53, March 1985, 363-84.

De Bondt, W. F. M., and R. H. Thaler, "Does the Stock Market Overreact", *Journal of Finance* 40, July 1985, 793-805.

De Bondt, W. F. M., and R. H. Thaler, "Further Evidence on Investor Overreaction and Stock Market Seasonality", *Journal of Finance* 42, July 1987, 557-81.

De Bondt, W. F. M., and R. H. Thaler, "Anomalies: A Mean Reverting Walk Down Wall Street", *Journal of Economic Perspectives* 3, Winter 1989, 189-202.

Fama, E. F., "The Behaviour of Stock Market Prices", *Journal of Business* 38, January 1965, 34-105.

Fama, E. F., "Efficient Capital Markets: A Review of Theory and Empirical Work", *Journal of Finance* 25, May 1970, 383-417.

Fama, E. F., "*Foundations of Finance*", New York: Basic Books, 1976.

Fama, E. F., "Efficient Capital Markets II", *Journal of Finance* 46, December 1991, 1575-1617.

Fama, E. F. and K. R. French, "Permanent and Temporary Components of Stock Prices", *Journal of Political Economy* 96, 1988, 246-273.

Fama, E. F. and K. R. French, "Business Conditions and Expected returns on Stocks and Bonds", *Journal of Financial Economics* 25, 1989, 23-49.

Fisher, L., "Some New Stock-market Indexes", *Journal of Business* 39, 1966, 191-225.

French, K. R. and R. Roll, "Stock Return Variances: The Arrival of Information and the Reaction of Traders", *Journal of Financial Economics* 17, September 1986, 5-26.

Gandhi, D. K., A. Saunders, and R. S. Woodward, "Thin Capital Markets: A Case Study of the Kuwaiti Stock Markets", *Applied Economics* 12, 1980, 341-9.

Jegadeesh, N., "Evidence of Predictable Behaviour of Security Returns", *Journal of Finance* 45, July 1990, 881-98.

Ljung, G. M. and G. E. P. Box, "On a Measure of Lack of Fit in Time Series Models", *Biometrika* 65, 1978, 297-303.

Kleidon, A. W., "Bubbles, Fads and Stock Price Volatility Tests: A Partial Evaluation: Discussion", *Journal of Finance* 43, July 1988, 656-59.

Lawritsen S. S., "Mean Reversion in Thinly Traded Stocks: An Examination of Stock Price Adjustment in Infrequently Traded Stocks", *MA Project*, Department of Economics, Simon Fraser University, April 1991.

Lehmann, B. N., "Fads, Martingales, and Market Efficiency", *Quarterly Journal of Economics* 105, February 1990, 1-28.

Lo, A. W. and A. C. MacKinlay, "Stock Prices do not Follow Random Walks: Evidence from a Simple Specification Test", *Review of Financial Studies* 1, 1988, 41-66.

Panas, E. E., "The Behaviour of Athens Stock Prices", *Applied Economics* 22, 1990, 1715-27.

Pearson, E. S. and H. O. Hartley, *Biometrika Tables for Statisticians*, Cambridge University Press, 1966.

Poterba, J. and L. Summers, "Mean Reversion in Stock Prices: Evidence and Implications", *Journal of Financial Economics* 22, October 1988, 27-57.

Wong, K. A. and K. S. Kwong, "The Behaviour of Hong Kong Stock Prices", *Applied Economics* 16, 1984, 905-17.

Working, H., "A Note on the Correlation of First Differences of Averages in a Random Chain", *Econometrica* 28, 1960, 916-918.