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Predicting Daily Stock Returns: A Lengthy Study of the Hong Kong and Tokyo Stock Exchanges

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Abstract

If stock markets are efficient then it should not be possible to predict stock returns, i.e., no explanatory variable in a stock market regression model should be statistically significant. In this study, we find results indicating that daily effects exist in stock market returns. These daily or calendar effects previously shown to exist by others clearly indicate the purpose of this study. Researchers often equate stock market efficiency with the non-predictability property of time series of stock returns. We explore whether this line of argument is satisfactory and aids in furthering our understanding of how markets operate. We focus on one definition of capital market efficiency and on the experience of these principles in analyzing the performance of Hong Kong and Tokyo stock exchanges. We observe that stock returns (which include closing prices and dividends) are predictable and there are explanations for short-term predictability. Hong Kong and Japan are the focus of this study because of the maturity of their financial markets and the availability of clean data on these markets from a reputable and available source.

Key words: market efficiency; prediction; stock returns; daily effects; time series

JEL classification: G10

1. Purpose

The purpose of this paper is to show the existence of certain time series characteristics in daily stock prices of securities listed on the Hong Kong and Tokyo stock exchanges. This study does not focus on index numbers of daily stock market prices but rather on the stock returns of traded securities because we wish to study whether the efficient markets hypothesis (EMH) applies in these markets. “Stock returns” refers to both the closing prices of individual securities and dividends associated with those securities. Furthermore, this study is important because market

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efficiency applies in short-term forecasting of closing returns of traded securities listed on the Hong Kong and Tokyo exchanges.

For a long time, management scientists and financial forecasters studied the sources of variations in the behavior of stock returns for firms listed on established financial markets. By the early 1970s, many suggested that stock markets were basically unpredictable. Fama (1970) provided an early, definitive statement of this position. Historically, the random walk theory of stock returns was preceded by theories relating movements in the financial markets to the business cycle. A well-known example is the interest shown by John Maynard Keynes in the variation in stock returns over the business cycle. According to Skidelsky (1992) "Keynes initiated what was entitled an *Active Investment Policy*, which coupled investing in real assets (a revolutionary concept at the time) with constant switching between short-dated and long-dated securities, based on predictions of changes in interest rates (Skidelsky, 1992, p. 26). Many studies of these phenomena appeared in the financial time series literature after that time. For example, Goh and Kok (2006) provided a simple model incorporating intraday seasonality that produced lower forecast errors than a random walk model for data of the Malaysian stock exchange.

One important issue is the empirical analysis of financial time series to determine if returns on risky assets are serially independent. This is a requirement of the EMH in its weak form, i.e., the current stock prices fully reflect all the past stock price information. A precise formulation of an empirically refutable EMH must be model specific. Historically the majority of such tests focused on the predictability of common stock returns. Hence, we classify most studies under the paradigm of the "random walk theory" of stock market prices.

In addition, the Monday effect (and other daily effects) in daily stock returns and indexes for these daily stock returns are found in Cho et al. (2007), Couts and Hayes (1999), Mehidian and Perry (2001), Pettengill (2003), and Steeley (2001). For the most part, these studies found strong evidence of Monday and other calendar effects in the index of stock returns in the exchanges studied. We focus in the this study on stock returns in two of the largest Asian markets to determine if such effects exist for individual firms as well as stock indexes. These markets are important because they are mature Asian financial markets and sources of information about them are both clean and available. If calendar effects exist, we may comment on the operational characteristics of these markets.

2. Background and Rationale

Capital market efficiency is an important research topic since Fama (1955, 1970) explained these principles as a portion of the hypothesis involving capital market efficiency. Following this work many capital markets researchers devoted themselves to investigating the randomness of stock price movements. They sought to demonstrate the efficiency of capital markets but found market inefficiencies by identifying systematic and permanent variations in stock market returns.

Lucas (1978) theoretically explained the stochastic behavior of the equilibrium asset process in a single good under a “pure exchange economy with identical consumers,” which included that one can construct rigorous economic models that do not possess the random character of stock prices as well as those that do. We investigate those that do not. Using variance-ratio statistical tests, Lo and MacKinley (1988) rejected the hypothesis that prices follow random walks for daily and weekly returns. They found no empirical evidence against the random walk hypothesis for monthly returns. They determined, however, that portfolio returns of the New York Stock Exchange (NYSE) and the American Stock Exchange stocks exhibit significant first-order serial correlations while security returns present negative first-order autocorrelation, although statistically not significant. These results corroborated French and Roll (1986). Lo and MacKinley (1990) indicated that a positive serial correlation sign between portfolios and stocks may be explained by lead-lag serial correlation across securities. Poterba and Summers (1988) found negative serial autocorrelation in monthly returns for a NYSE value-weighted index during the period 1926–1985. Lo and Mackinley (1988) obtained different results for a different time period. Jarrett and Kyper (2005a) found that many time series of closing prices of US stocks exhibited a unit root identified by the augmented Dickey-Fuller test. Hamori and Takihisa (2002) examined non-seasonal unit roots to achieve stationarity in stock price indexes of G7 nations. Moreover, calendar or time effects contradict the weak form of the EMH.

The weak form of the EMH refers to the notion that the market is efficient in past returns and volume information and we do not predict stock return movements accurately using historical information. If no systematic patterns exist, stock returns may be time invariant. By contrast, if variation in the time series of daily returns exist, market inefficiency is probably present and investors may earn abnormal rates of return not in line with the degree of risk they undertake (Francis, 1993). In addition, a large number of studies in the literature on predicting prices of traded securities confirm to some degree that patterns exist in stock market returns and prices. We know interest rates, dividend yields, and a variety of macroeconomic variables exhibit clear business cycle patterns. The emerging literature concerning studies of US securities include Balvers et al. (1990), Breen et al. (1990), Campbell (1987), Fama and French (1989), and Pesaran and Timmermann (1995). Granger (1992) provides a survey of methods and results. Studies in the UK include Clare et al. (1994, 1995), Black and Fraser (1995), and Pesaran and Timmermann (2000). Further, Caporale and Gil-Alana (2002) pointed out that the degree of predictability of US stock returns depends on the process followed by the error term.

The expansion of time series analysis as a discipline permits one to analyze stock market prices in ways not previously explored. What is the predictability of the error term and is there predictability in daily stock market returns? Peculiar problems arise when daily patterns are present in stock price data. We know that stock prices possess patterns known as daily effects. For example, Kato (1990a) found patterns in stock returns in Japanese securities. He observed low Tuesday and high Wednesday returns within weekly prices. If a week did not have trading on a

Friday, the following Monday would have low returns, indicating transference of the pattern that would have occurred on Friday. A second study by Kato (1990b) found considerable anomalies on the Tokyo Stock Exchange, which is an organized exchange similar to the ones in North America.

Some studies focused on the investigation of time series components of equity returns and the predictability of these returns. Ray et al. (1997) investigated a sample of 15 firms and found both permanent and temporary systematic components in individual time series of stock market returns of firms over a lengthy period. Moorkejee and Yu (1999) investigated seasonality in stock returns on the Shanghai and Shenzen stock markets. They documented seasonal patterns on these exchanges and the effects these factors have on risk in investing in securities listed on these exchanges. In addition, they observed that risk in investing relates to the predictability of security returns. Rothlein and Jarrett (2002) also investigated the presence of calendar seasonality in Japanese stock returns, which affect the prices of these securities. They documented seasonality in 55 randomly selected time series from the Tokyo Stock Exchange from 1975 to 1992. In addition, they indicated the accuracy of forecasts or predictions of these firms' prices are seriously decreased if one does not recognize the patterns in the time series.

Kubota and Takehara (2003) investigated whether the activity of financial firms creates value and/or risk for the economy within the asset pricing framework. They used stock return data from non-financial firms listed in the Tokyo Stock Exchange. Their value-weighted index was augmented with the index of firms from the financial sector. They estimated the multivariate asset pricing model with these two indices. We note that their procedure simultaneously accounted for cross-holding phenomena among Japanese firms, especially between the financial and non-financial sectors. Their financial sector model helps explain the return and risk structure of Japanese firms during the so-called "double-bubble" period, indicating some predictability in closing prices of Japanese securities.

Jarrett and Kyper (2005b) indicated how patterns in monthly stock prices have predictable patterns. This study differs in that we examine the predictable patterns in the closing daily prices of stock prices. We do not study the effects of cross-holding on the Japanese markets (Yonezawa and Miyake, 1998) nor on how the Hong Kong market achieved the status of number two in Asia after Japan (Ho, 1998). We go further than Caporale and Gil-Alana (2002) because we attempt to determine the patterns in daily prices of listed securities. Caporale and Gil-Alana (2002) tested for unit roots in the stock market though, unlike this study, they tested this hypothesis within fractionally integrated alternatives. Fractional differencing is generally employed to predict long-term rather than short-term properties of time series. Shum and Tang (2005) explained additional factors such as contemporaneous market excess returns relating to variation in several Asian stock markets. Finally, Jarrett and Kyper (2006) studied the predictability of daily returns on more than 50 firms listed on US stock exchanges and concluded that daily variation exists and is predictable. This model is similar to Aesii (2006), who studied Italian stock exchanges. Last, we do not study special events such as insider trading (Wong et al., 2000) in these Asian exchanges.

3. Methodology and Models

The predictive model for measuring the effects of changes in the day of the week on closing prices of a security is:

$$Y = b_0 + b_1W_1 + b_2W_2 + b_3W_3 + b_4W_4 + b_5W_5 + \varepsilon \ , \tag{1}$$

where Y is the daily return for the security (dretwd); W_2 , W_3 , W_4 , and W_5 are dummy variables for Tuesday, Wednesday, Thursday, and Friday (taking the value 1 for the specified day and 0 otherwise); and ε is a zero-mean error term.

Note we borrow from the methodology employed by Jarrett and Kyper (2006) in their study of firms listed on US stock exchanges. We collected data on firms listed on the Hong Kong Stock Exchange from 1980 to 2002. These data are from the Pacific Basin Financial Markets Research Center (PACAP) at the University of Rhode Island. Also, we collected from the same source the time series for the Tokyo Stock Exchange from 1975 to 2004. The data were for Japanese firms listed on this Tokyo Stock Exchange data base. Other Asian exchanges are considerably smaller than the two studied; however, Singapore can no longer be considered a small exchange. Data for Shanghai and Shenzhen are not available at this time from the same source. Although one study suggests costs of trading in Chinese stock markets are available for study (Tian et al., 2002), our study period included the latest available data at the beginning of this study. Each year studied contained more than 300 days of data for each firm included in the data base. Hong Kong data contained more than 600 firms and Tokyo data contained more than 2600 firms. Hence, we concluded that sufficient data was available for an extensive analysis. PACAP collects data from the stock exchanges themselves so their data is the same as if one were to follow the end of day data for each trading day for each exchange. The methodology for reporting these data are thus the same as if the researchers collected the data themselves on a day-to-day basis. Since the Tokyo Stock Exchange traded on Saturday until 1990, another dummy variable W_6 was included in the model for years 1975 to 1989 for Saturday trading days (along with the coefficient b_6).

In addition, we considered a second predictive based on data from the same source:

$$Y = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6(\text{trdvol}) + b_7(\text{trdval}) + \varepsilon \ , \tag{2}$$

where Y is the daily return for the security (dretwd); X_2 , X_3 , X_4 , and X_5 are dummy variables for Tuesday, Wednesday, Thursday, and Friday (taking the value 1 for the specified day and 0 otherwise); trdvol is the volume of daily trade; trdval is the value of daily trade; and ε is a zero-mean error term.

The second model permits further explanation of the sources of variation in daily stock market returns. In this way, we examine patterns in daily returns after accounting for these other sources of variations in returns. Again, since the Tokyo Stock Exchange traded on Saturday until 1990, we include another dummy variable X_6 (and corresponding coefficient).

4. Results

Estimation results for the ordinary least squares (OLS) models for Hong Kong time series data sets are presented in Table 1 for the response variable daily returns, dretwd. For the Hong Kong data set, the tests for significance of the dummy variables for day of the week indicate interesting results. P-values (in parentheses) are very close to 0 for almost all coefficients of the dummy variables. The exceptions include Thursday in 1980, Wednesday in 1984, Thursday in 1986, Tuesday in 1988, Thursday in 1988, Thursday in 1998, Wednesday in 1999, and Tuesday and Thursday in 2001. There is no clear explanation to this except to note the principle that if one does enough tests a certain number will show significance by chance alone. The total number of exceptions was thus small in comparison to the number of tests of significance for the regression coefficients performed. F-values for the test of overall regression for every year except 1984 were highly significant. The Durbin-Watson (DW) statistic for each regression was large enough for us to conclude that no significant serial correlation was present in the data. The conclusion for the DW statistics adds to the validity of the significance tests for the regression coefficients and tests for overall regression. These results indicate that for the Hong Kong Stock Exchange each day of the week has a separate regression resulting in five parallel lines when plotted.

Plots of residuals (not shown) did not suggest violation of the usual assumptions concerning the error term (i.e., linearity, homoscedasticity, and serial correlation) for OLS regression. Regression results are always subject to limitations on the sample study period and the elements (firms) under study. However, the compelling results indicate for the Hong Kong Stock Exchange that there is a day-of-the-week effect on the closing prices of securities. We note that the notion that closing prices of securities for these firms in the Hong Kong markets follow random walks is dubious. We do not dispute that these markets do not function well nor do we conclude that consistent abnormal profits based on public or historical information are common.

Model 2 regression results (Table 2) are very similar to those for Model 1. Although two additional variables, trdvol and trdval, included in the regression results are for the most part significant, the estimated coefficients are small, and the vast majority of coefficients for the daily dummy variables remain highly significant. Again this indicates that our notion that there are daily effects on the returns to Hong Kong stocks for the sample period studied is supported. Also, the weak form of the EMH is not supported.

Table 1. Hong Kong Stock Exchange (Model 1)

	Intercept	W_2	W_3	W_4	W_5	F-value	DW
1980	0.00627	−0.00431	−0.00155	0.00008	−0.00292	10.21	1.848
	(0.0001)	(0.0001)	(0.0645)	(0.9205)	(0.0006)	(0.0001)	
1981	−0.00350	0.00181	0.00828	0.00516	0.01227	69.82	1.935
	(0.0001)	(0.0311)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	
1982	−0.00745	0.00568	0.01103	0.00394	0.01008	69.73	1.98
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	
1983	−0.00317	0.00449	0.00496	0.00603	0.00787	24.32	1.977
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	
1984	0.00302	−0.00036	−0.00140	0.00004	−0.00113	1.6	1.973
	(0.0001)	(0.623)	(0.0598)	(0.9615)	(0.1198)	(0.1713)	
1985	0.00300	−0.00324	−0.00072	0.00241	−0.00163	23.65	1.89
	(0.0001)	(0.0001)	(0.2427)	(0.0001)	(0.0080)	(0.0001)	
1986	0.00309	0.00054	0.00009	0.00151	0.00118	2.78	1.754
	(0.0001)	(0.3426)	(0.8676)	(0.0077)	(0.0382)	(0.0254)	
1987	−0.00564	0.00808	0.01357	0.00667	0.0113	101.77	1.525
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	
1988	0.00015	0.00199	0.00400	−0.00034	0.00393	66.62	1.808
	(0.5582)	(0.0001)	(0.0001)	(0.3417)	(0.0001)	(0.0001)	
1989	−0.00354	0.00876	0.00510	0.00468	0.00572	90.68	1.972
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	
1990	−0.00254	0.00580	0.00465	0.00264	0.00541	64.57	1.755
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	
1991	−0.00286	0.00333	0.00402	0.00571	0.00717	172.76	1.941
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	
1992	−0.00038	0.00159	0.00312	−0.00010	0.00529	119.58	1.83
	(0.1078)	(0.0001)	(0.0001)	(0.0021)	(0.0001)	(0.0001)	
1993	0.00156	0.00125	0.00338	0.00159	0.00109	28.52	1.877
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0011)	(0.0001)	
1994	−0.00277	0.00177	0.00124	−0.00056	0.00264	39.37	1.938
	(0.0001)	(0.0001)	(0.0001)	(0.0584)	(0.0001)	(0.0001)	
1995	−0.00089	0.00203	0.00247	0.00121	0.00260	23.53	1.983
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	
1996	0.00184	0.00176	0.00052	−0.00005	0.00045	10.09	1.981
	(0.0001)	(0.0001)	(0.1179)	(0.8731)	(0.1684)	(0.0001)	
1997	0.00196	−0.00822	0.00213	−0.00706	0.00523	356.42	1.943
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	
1998	−0.00236	0.00202	0.00441	−0.00110	0.00383	37.62	1.829
	(0.0001)	(0.0002)	(0.0001)	(0.0447)	(0.0001)	(0.0001)	
1999	0.00422	−0.00271	−0.00010	0.00467	−0.00210	57.92	1.912
	(0.0001)	(0.0001)	(0.8454)	(0.0001)	(0.0001)	(0.0001)	
2000	−0.00172	0.00292	0.00106	−0.00095	0.00766	75.48	1.963
	(0.0001)	(0.0001)	(0.0569)	(0.0878)	(0.0001)	(0.0001)	
2001	0.00085	0.00152	−0.00112	2.0E−06	0.00836	3.25	2.001
	(0.6972)	(0.6187)	(0.7131)	(0.9993)	(0.0059)	(0.0114)	
2002	−0.00097	0.00180	0.00025	0.00361	0.00091	28.72	2.095
	(0.0005)	(0.0001)	(0.5234)	(0.0001)	(0.0193)	(0.0001)	

Table 2. Hong Kong Stock Exchange (Model 2)

	Intercept	W_2	W_3	W_4	W_5	trdvol	trdval	F-value	DW
1980	0.00369	−0.00429	−0.00146	0.00018	−0.00284	1.77E−08	−8.53E−06	59.28	1.858
	(0.0001)	(0.0001)	(0.0812)	(0.8303)	(0.0007)	(0.0001)	(0.5508)	(0.0001)	
1981	−0.00458	0.00183	0.00848	0.00514	0.01228	1.61E−09	9.30E−07	57.3	1.934
	(0.0001)	(0.0290)	(0.0001)	(0.0001)	(0.0001)	(0.0764)	(0.0001)	(0.0001)	
1982	−0.00821	0.00561	0.01117	0.00384	0.01005	4.38E−09	2.84E−07	54.24	1.982
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.1551)	(0.0001)	
1983	−0.00458	0.00451	0.00528	0.00586	0.00782	7.00E−09	5.87E−07	31.37	1.98
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0218)	(0.0001)	
1984	0.00175	−0.00031	−0.00115	−0.00003	−0.00117	4.98E−09	2.49E−07	20.94	1.976
	(0.0010)	(0.6699)	(0.1195)	(0.9676)	(0.1072)	(0.0001)	(0.1523)	(0.0001)	
1985	0.00177	−0.00322	−0.00051	0.00226	−0.00174	4.96E−09	8.76E−08	49.06	1.894
	(0.0001)	(0.0001)	(0.4099)	(0.0003)	(0.0043)	(0.0001)	(0.3871)	(0.0001)	
1986	0.00230	0.00056	0.00011	0.00146	0.00114	1.61E−09	−1.09E−07	47.24	1.763
	(0.0001)	(0.3175)	(0.8427)	(0.0097)	(0.0445)	(0.0001)	(0.0001)	(0.0001)	
1987	−0.00620	0.00813	0.01360	0.00673	0.01134	3.47E−10	−1.75E−08	85.01	1.525
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.1353)	(0.0001)	
1988	−0.00074	0.00207	0.00401	−0.00035	0.00391	4.46E−10	7.16E−08	105.97	1.808
	(0.0053)	(0.0001)	(0.0001)	(0.3355)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	
1989	−0.00410	0.00880	0.00515	0.00473	0.00573	2.17E−10	2.41E−08	85.09	1.972
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0292)	(0.0001)	
1990	−0.00385	0.00567	0.00452	0.00254	0.00529	5.38E−11	2.72E−07	184.01	1.757
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	
1991	−0.00356	0.00336	0.00405	0.00571	0.00715	1.96E−10	6.81E−08	199.25	1.944
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	
1992	−0.00130	0.00157	0.00308	−0.00100	0.00521	4.28E−10	9.68E−09	230.92	1.842
	(0.0001)	(0.0001)	(0.0001)	(0.0019)	(0.0001)	(0.0001)	(0.0052)	(0.0001)	
1993	0.00041	0.00121	0.00332	0.00152	0.00103	1.73E−10	6.25E−08	295.84	1.884
	(0.0825)	(0.0002)	(0.0001)	(0.0001)	(0.0018)	(0.0001)	(0.0001)	(0.0001)	
1994	−0.00335	0.00173	0.00117	−0.00062	0.00256	3.44E−10	5.53E−09	112.59	1.939
	(0.0001)	(0.0001)	(0.0001)	(0.0347)	(0.0001)	(0.0001)	(0.0241)	(0.0001)	
1995	−0.00212	0.00196	0.00237	0.00108	0.00246	7.74E−10	1.14E−09	242.28	1.985
	(0.0001)	(0.0001)	(0.0001)	(0.0005)	(0.0001)	(0.0001)	(0.4986)	(0.0001)	
1996	0.00086	0.00175	0.00050	−0.00006	0.00044	3.33E−10	−3.48E−09	273.23	1.989
	(0.0003)	(0.0001)	(0.1313)	(0.8643)	(0.1800)	(0.0001)	(0.0645)	(0.0001)	
1997	−0.00011	−0.00827	0.00207	−0.00726	0.00505	2.27E−10	9.06E−09	783.51	1.952
	(0.7223)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	
1998	−0.00308	0.00196	0.00432	−0.00117	0.00377	1.39E−10	4.82E−09	95.34	1.828
	(0.0001)	(0.0004)	(0.0001)	(0.0334)	(0.0001)	(0.0001)	(0.0009)	(0.0001)	
1999	0.00271	−0.00291	−0.00029	0.00442	−0.00220	1.46E−10	2.35E−08	297.03	1.915
	(0.0001)	(0.0001)	(0.5831)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	
2000	−0.00279	0.00290	0.00104	−0.00092	0.00765	6.03E−11	1.19E−08	186.09	1.962
	(0.0001)	(0.0001)	(0.0607)	(0.0985)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	
2001	0.00029	0.00146	−0.00117	−0.00006	0.00832	7.08E−11	−2.51E−09	3.59	2.001
	(0.8948)	(0.6331)	(0.7001)	(0.9848)	(0.0061)	(0.0034)	(0.8599)	(0.0014)	
2002	−0.00129	0.00176	0.00021	0.00358	0.00088	3.91E−11	4.59E−09	56.31	2.094
	(0.0001)	(0.0001)	(0.5954)	(0.0001)	(0.0232)	(0.0001)	(0.036)	(0.0001)	

Table 3 contains the results of applying Model 1 to the data for years 1975 through 2004 for Tokyo Stock Exchange. Our results for Model 1 are similar to those for Hong Kong. Only nine of the coefficients for the daily dummy variable were not highly significant. Four of these occurred in 2004, suggesting exceptional circumstances that year. Due to the largeness of sample sizes, F-values were significant except for year 2004. Again the DW statistics were large enough (except for 2004) to support the validity of the significance tests for the coefficients. Thus, for the time period covered and sample firms studied, we again conclude that there are calendar effects and the weak form of EMH is in question.

Table 3. Tokyo Stock Exchange (Model 1)

	Intercept	W_2	W_3	W_4	W_5	W_6	F−value	DW
1975	0.00056	−0.00029	0.00103	0.00079	0.00109	0.00219	45.43	2.162
	(0.0001)	(0.0951)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	
1976	0.00109	−0.00046	0.00286	−0.00065	0.00038	0.00048	115.39	2.155
	(0.0001)	(0.0054)	(0.0001)	(0.0001)	(0.0193)	(0.0070)	(0.0001)	
1977	0.00053	−0.00104	0.00156	−0.00077	0.00079	0.00048	85.89	2.147
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0033)	(0.0001)	
1978	0.00142	−0.00083	0.00203	0.00062	0.00120	0.00116	86.3	2.069
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	
1979	0.00002	−0.00089	0.00203	−0.00009	0.00026	0.00114	114.63	2.111
	(0.8416)	(0.0001)	(0.0001)	(0.5007)	(0.0586)	(0.0001)	(0.0001)	
1980	0.00016	−0.00056	0.00183	0.00047	0.00106	0.00092	78.08	2.117
	(0.1198)	(0.0001)	(0.0001)	(0.0006)	(0.0001)	(0.0001)	(0.0001)	
1981	0.00070	−0.00149	0.00093	−0.00087	−0.00002	0.00041	85.51	2.069
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.8908)	(0.0044)	(0.0001)	
1982	0.00093	−0.00133	0.00074	−0.00107	−0.00087	0.00041	76.89	2.148
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0055)	(0.0001)	
1983	0.00156	−0.00099	0.00083	0.00036	0.00012	0.00054	41.18	2.101
	(0.0001)	(0.0001)	(0.0001)	(0.0125)	(0.4029)	(0.0004)	(0.0001)	
1984	0.00127	−0.00105	0.00168	−0.00117	0.00031	0.00067	106.18	2.058
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0375)	(0.0001)	(0.0001)	
1985	0.00129	−0.00169	0.00116	−0.00016	−0.00038	0.00065	93.94	2.057
	(0.0001)	(0.0001)	(0.0001)	(0.2893)	(0.0082)	(0.0001)	(0.0001)	
1986	0.00174	−0.00231	−0.00015	−0.00026	0.00002	0.00102	95.94	2.021
	(0.0001)	(0.0001)	(0.3319)	(0.0823)	(0.9118)	(0.0001)	(0.0001)	
1987	−0.00122	0.00040	0.00423	0.00436	0.00442	0.00430	331.66	2.067
	(0.0001)	(0.0153)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	
1988	0.00159	−0.00039	0.00122	−0.00064	−0.00082	−0.00009	65.58	2.065
	(0.0001)	(0.0020)	(0.0001)	(0.0001)	(0.0001)	(0.5585)	(0.0001)	
1989	0.00114	0.00127	0.00148	0.00045	0.00071	0.00601	61.17	2.094
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	
1990	−0.00063	0.00018	0.00090	−0.00196	−0.00061		83.54	1.86
	(0.0001)	(0.3056)	(0.0001)	(0.0001)	(0.0004)		(0.0001)	
1991	−0.00261	0.00314	0.00296	0.00457	0.00425		349.27	1.959
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)		(0.0001)	
1992	−0.0023	−0.00098	−0.00082	0.00622	0.00325		859.62	1.885
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)		(0.0001)	
1993	−0.00222	0.00195	0.00239	0.00616	0.00454		707.62	1.955
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)		(0.0001)	
1994	1.2E−06	0.00122	0.00118	0.00101	0.00106		43.92	2.095
	(0.9875)	(0.0001)	(0.0001)	(0.0001)	(0.0001)		(0.0001)	
1995	−0.00141	0.00273	0.00189	0.00220	0.00171		115.55	2.046
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)		(0.0001)	
1996	−0.00167	0.00223	0.00177	0.00109	0.00194		119.07	2.173
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)		(0.0001)	
1997	−0.00172	0.00166	0.00037	−0.00134	−0.00221		163.25	2.066
	(0.0001)	(0.0001)	(0.0289)	(0.0001)	(0.0001)		(0.0001)	
1998	0.00304	−0.00185	0.00021	−0.00548	−0.00308		297.39	2.086
	(0.0001)	(0.0001)	(0.2732)	(0.0001)	(0.0001)		(0.0010)	
1999	0.00255	−0.00211	−0.00190	−0.00142	−0.00154		43.89	2.11
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)		(0.0001)	
2000	0.00237	−0.00253	−0.00239	−0.00453	−0.00081		185.04	2.144
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)		(0.0001)	
2001	−0.00313	0.00433	0.00222	0.00463	0.00458		316.87	2.131
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)		(0.0001)	
2002	−0.00044	−0.00117	−0.00045	0.00200	0.00194		101.6	2.071
	(0.0039)	(0.0001)	(0.0326)	(0.0001)	(0.0001)		(0.0001)	
2003	0.00351	−0.00208	−0.00136	−0.00307	−0.00106		113.68	1.986
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)		(0.0001)	
2004	0.00259	−0.00238	0.00059	−0.00261	0.02959		0.98	1.404
	(0.8583)	(0.9061)	(0.9768)	(0.8976)	(0.1405)		(0.4190)	2

Table 4. Tokyo Stock Exchange (Model 2)

	Intercept	W_2	W_3	W_4	W_5	W_6	trdvol	trdval	F−value	DW
1975	−0.00023	−0.00037	0.00090	0.00060	0.00085	0.00227	2.68E−09	6.2E−06	538.13	2.169
	(0.0702)	(0.0319)	(0.0001)	(0.0005)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	
1976	0.00032	−0.00053	0.00266	−0.00077	0.00023	0.00058	1.00E−09	7.8E−06	738.91	2.163
	(0.0064)	(0.0011)	(0.0001)	(0.0001)	(0.1616)	(0.0012)	(0.0001)	(0.0001)	(0.0001)	
1977	−0.00011	−0.00113	0.00139	−0.00092	0.00059	0.00055	1.81E−09	4.4E−06	686.5	2.155
	(0.3136)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0008)	(0.0001)	(0.0001)	(0.0001)	
1978	0.00050	−0.00095	0.00178	0.00046	0.00095	0.00125	1.29E−10	1.0 E−06	1019.18	2.078
	(0.0001)	(0.0001)	(0.0001)	(0.0024)	(0.0001)	(0.0001)	(0.0195)	(0.0001)	(0.0001)	
1979	−0.00042	−0.00093	0.00191	−0.00018	0.00015	0.00118	1.02E−09	1.7 E−06	689.32	2.121
	(0.0001)	(0.0001)	(0.0001)	(0.1780)	(0.2513)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	
1980	−0.00045	−0.00063	0.00168	0.00035	0.00092	0.00100	1.00E−10	5.3E−06	915.99	2.13
	(0.0001)	(0.0001)	(0.0001)	(0.0095)	(0.0001)	(0.0001)	(0.0041)	(0.0001)	(0.0001)	
1981	0.00037	−0.00155	0.00082	−0.00094	−0.00011	0.00046	1.21E−11	2.2E−06	488.83	2.076
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.3936)	(0.0013)	(0.6466)	(0.0001)	(0.0001)	
1982	0.00056	−0.00138	0.00063	−0.00117	−0.0010	0.00043	1.05E−09	1.3E−06	491.83	2.156
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0034)	(0.0001)	(0.0001)	(0.0001)	
1983	0.00093	−0.00109	0.00070	0.00020	−0.00005	0.00065	1.01E−09	2.4E−06	787.05	2.109
	(0.0001)	(0.0001)	(0.0001)	(0.1531)	(0.7016)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	
1984	0.00052	−0.00112	0.00143	−0.00133	0.00009	0.00081	1.41E−09	2.1E−06	908.09	2.068
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.5561)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	
1985	0.00072	−0.00177	0.00097	−0.00032	−0.00053	0.00079	7.83E−10	1.7E−06	747.59	2.066
	(0.0001)	(0.0001)	(0.0001)	(0.0298)	(0.0003)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	
1986	0.00133	−0.00237	−0.00029	−0.00039	−0.00013	0.00110	1.77E−10	8.68E−07	599.76	2.026
	(0.0001)	(0.0001)	(0.0554)	(0.0088)	(0.3941)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	
1987	−0.00139	0.00036	0.00416	0.00429	0.00435	0.00432	3.09E−10	1.76E−09	423.94	2.07
	(0.0001)	(0.0285)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.003)	(0.0001)	
1988	0.00140	−0.00044	0.00112	−0.00072	−0.00090	−0.00005	3.10E−10	2.02E−09	337.82	2.069
	(0.0001)	(0.0005)	(0.0001)	(0.0001)	(0.0001)	(0.7275)	(0.0001)	(0.0252)	(0.0001)	
1989	0.00065	0.00113	0.00130	0.00031	0.00058	0.00581	9.73E−10	2.99E−09	810.66	2.102
	(0.0001)	(0.0001)	(0.0001)	(0.0061)	(0.0001)	(0.0001)	(0.0001)	(0.0177)	(0.0001)	
1990	−0.00124	0.00010	0.00060	−0.00210	−0.00078		2.19E−10	1.2E−06	442.18	1.862
	(0.0001)	(0.5701)	(0.0001)	(0.0001)	(0.0001)		(0.0011)	(0.0001)	(0.0001)	
1991	−0.00323	0.00301	0.00282	0.00443	0.00405		8.96E−10	1.5E−06	815.57	1.964
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)		(0.0001)	(0.0001)	(0.0001)	
1992	−0.00280	−0.00103	−0.00094	0.00604	0.00302		1.99E−09	1.2E−06	797.52	1.89
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)		(0.0001)	(0.0001)	(0.0001)	
1993	−0.00289	0.00186	0.00225	0.00601	0.00425		2.73E−09	6.01E−07	1051.65	1.96
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)		(0.0001)	(0.0001)	(0.0001)	
1994	−0.00052	0.00116	0.00106	0.00090	0.00093		2.35E−09	3.35E−07	446.08	2.098
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)		(0.0001)	(0.0001)	(0.0001)	
1995	−0.00198	0.00270	0.00180	0.00210	0.00154		1.70E−09	0.00000108	496.59	2.053
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)		(0.0001)	(0.0001)	(0.0001)	
1996	−0.00226	0.00213	0.00161	0.00094	0.00169		2.39E−09	4.85E−07	618.85	2.18
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)		(0.0001)	(0.0001)	(0.0001)	
1997	−0.00183	0.00164	0.00034	−0.00137	−0.00224		−9.80E−10	0.00000144	254.55	2.064
	(0.0001)	(0.0001)	(0.0454)	(0.0001)	(0.0001)		(0.0001)	(0.0001)	(0.0001)	
1998	0.00271	−0.00189	0.00015	−0.00554	−0.00316		1.46E−09	−5.54E−08	281.38	2.088
	(0.0001)	(0.0001)	(0.4291)	(0.0001)	(0.0001)		(0.0001)	(0.5189)	(0.0001)	
1999	0.00173	−0.00218	−0.00201	−0.00157	−0.00180		2.23E−09	4.59E−07	631.8	2.117
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)		(0.0001)	(0.0001)	(0.0001)	
2000	0.00157	−0.00254	−0.00242	−0.00457	−0.00094		2.46E−09	−4.78E−08	579.11	2.148
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)		(0.0001)	(0.0146)	(0.0001)	
2001	−0.00345	0.00431	0.00218	0.00458	0.00450		7.34E−10	1.72E−07	326.46	2.13
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)		(0.0001)	(0.0001)	(0.0001)	
2002	−0.00068	−0.00118	−0.00046	0.00198	0.00190		5.08E−10	1.40E−07	102.31	2.071
	(0.0001)	(0.0001)	(0.0278)	(0.0001)	(0.0001)		(0.0001)	(0.0027)	(0.0001)	
2003	0.00300	−0.00212	−0.00141	−0.00311	−0.00112		7.67E−10	2.35E−07	550.49	1.986
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)		(0.0001)	(0.0001)	(0.0001)	
2004	−0.00175	−0.00250	0.00031	−0.00288	0.02903		−7.18E−10	8.6E−06	2.97	2
	(0.9040)	(0.9014)	(0.9878)	(0.8871)	(0.1482)		(0.6981)	(0.0003)	(0.0068)	

Model 2 regressions for the Tokyo Stock Exchange (Table 4) produced results similar to those in Table 3. With the exception of 2004, the results indicate the daily influences on the returns to Japanese securities listed on the Tokyo Stock Exchange were very similar to the results in Table 3. The inclusion of the trdvol and trdval variables did not alter the general conclusion of the earlier findings for Hong Kong in Tables 1 and 2. We note that of the 15 years with Saturday trading days only year 1988 did not produce a highly significant regression coefficient. Hence, Saturday, for the most part, evidenced different trading patterns from the other days of the week for these years.

The four tables containing approximately 80 multiple regressions for very large samples suggest that trading on these two large exchanges differed by day of the week. Also, the DW statistics failed to reject the hypothesis that serial correlation is present. This supports the validity of the numerous significance tests.

We should note that some researchers agree that stock return data have heavy tails and tend not to be normally distributed, so the OLS results may be suspect. In particular, outliers may result in inconsistent estimators. Some argue that autoregressive conditional heteroscedastic methods are needed to correct for correlated data and non-constant variance. Incorrect standard errors lead to incorrect significance tests. As in previous studies, we considered analyzing a portion of the data using quantile regression along the lines of Cho et al. (2007). Based on their results, we expect this analysis would be similar to our OLS results and the new analysis is unnecessary. Cho et al. (2007) contain in their studies sufficient evidence to make our results valid.

Note Tables 1-4 summarize our entire analysis. Our purpose was to analyze the results for individual firms and not for stock indexes. We could have focused on a few firms over a long period or studied a large number of sampled firms for a short period. Others have done this. The achievement of this study is not a statistical exercise but an analytical study to explain the economic behavior of markets. The Hong Kong and Tokyo stock exchanges are established markets with established regulations and a large and world-wide constituency. We established in this study the relationship between economic explanations of financial events and analytical results concerning a large sample of firms over a lengthy time period on two well-established Asian financial markets. A study of this magnitude has not been published in this journal with these data.

5. Conclusions

We document in this study that daily closing prices for a large number of firms listed on two of the largest Asian stock exchanges contain properties that one can measure, model, and use for prediction. With enough time, patience, and understanding of the underlying processes that give rise to stock return series, forecasters can properly model these data. The results permit management scientists and financial forecasters to recognize that return series of listed securities are not random and do have daily affects.

In this study, we indicate the presence of time series components in stock returns for randomly selected sets of firms. The results corroborate results of a number of earlier but less exhaustive studies. Calendar and daily effects exist in the financial time series stock returns studied. When these properties in security returns exist, one may identify and forecast patterns in financial data, and, in turn, investors may benefit from this information. Furthermore, the results indicate that the weak form of the EMH is in question when one must make decisions concerned with investing in stock market securities. Daily variation is not entirely random and possibilities exist to predict daily patterns with some degree of accuracy.

We suggest, for purposes of prediction, that forecasters model systematic time series components of security returns. In addition, one cannot understate the importance of stock returns and portfolio risk. These factors coupled with recognition of systematic time series components (daily variation in this study) in stock prices can improve price forecasting of individual securities and contribute to the literature on capital market efficiency. One last question concerns the out-of sample trading profit opportunities. Finding in-sample profit opportunities can be thought of as a "data-mining" result, that is, if you fit many models, a few will randomly have high coefficients of determination and/or statistically significant model coefficients. We suggest using parsimonious models; profit opportunities should be greater than transaction costs that may include bid-ask spreads and commissions. If so, we can find profitable trading opportunities in rapidly growing Asian markets. When the opportunity arises to examine data for Shanghai and other emerging Asian exchanges, we expect additional studies of those large and growing markets. We are only limited by our ability to collect sufficient and reliable data.

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