Chapter 4

Empirical Findings

4.1 Results of Theil-Leenders test

The summary statistics of the mean and the standard deviation of the proportions of stocks advancing, declining and remaining unchanged in price are presented in Tables 4.1.1 to Table 4.1.9. for the period 1994 to 1998 and for the yearly sub-periods for the seven main sectors of the Main Board, the Main Board and the Second Board. The mean of the proportions of stocks advancing, declining and remaining unchanged in price for the nine groups are graphically displayed in Figure 4.1.1 to Figure 4.1.9. The no-change proportion is about 20 per cent. The advancing proportion and the declining proportion is about 40 per cent. The declining proportion exceeds that of the advancing proportion due to the declining trend of the prices. The variability of the proportion unchanged is much lower than either that of the proportion advancing or declining. The standard deviation is 3 to 4 times larger for the advancing and declining proportions than for the unchanged proportion.

For purposes of comparison, the results for the Netherlands given in Theil and Leenders (1965), United States given in Fama (1965b), United Kingdom given in Dryden (1968) and Malaysia given in Kok (1994) are tabulated in Table 4.1.10 together with the results for the period 1994-1998 of this study. The results are consistent with those for the United States and the Netherlands but significantly different from those for the United Kingdom. The

20

results are also quite close to those obtained by Kok for the period 1984-1991. The means of the advancing proportions for the nine groups are close to those obtained by Kok. However the means of the declining proportions are higher while the means of the unchanged proportions in all the nine groups are lower than those obtained by Kok.

The results of the Theil-Leenders test are tabulated in Table 4.1.11. Although $\bar{I}$ was computed for values of α at intervals of 0.001, only the optimal forecast showing the average information inaccuracy $\bar{I}$ with the values of α^* for the whole period and for the yearly sub-period are presented. For the period 1994-1998, the Property sector appears to be the most efficient while the Finance sector appears to be the least efficient. Comparing with the results obtained by Kok (1994), the market as a whole has become more efficient since the α^* for all the nine groups for the full period under study is less than $\alpha^* = 0.25$ for the period 1984-1991

Figure 4.1.10 shows the variation of α^* for the nine groups. Although the values of α^* varies from year to year, the values of α^* for the Main Board and the seven sectors of the Main Board move in tandem with each other while that of the Second Board appears to buck the trend.

Table 4.1.1
Mean and standard deviation of proportions of stocks increasing (q_1), decreasing (q_2) and unchanged (q_3) in price of the Consumer Products sector

Period	Statistic	q_1	q_2	q_3
1994	Mean	0.3913	0.4608	0.1479
	SD	0.2390	0.2444	0.0702
1995	Mean	0.3679	0.4519	0.1802
	SD	0.2438	0.2375	0.0760
1996	Mean	0.3782	0.4141	0.2077
	SD	0.1869	0.1893	0.0772
1997	Mean	0.3271	0.4931	0.1797
	SD	0.2191	0.2352	0.0831
1998	Mean	0.3832	0.4554	0.1614
	SD	0.2623	0.2532	0.0751
1994 -	Mean	0.3695	0.4551	0.1754
1998	SD	0.2323	0.2339	0.0790

Figure 4.1.1
Mean of proportions of stocks increasing (q_1), decreasing (q_2) and unchanged (q_3) in price of the Consumer Products sector
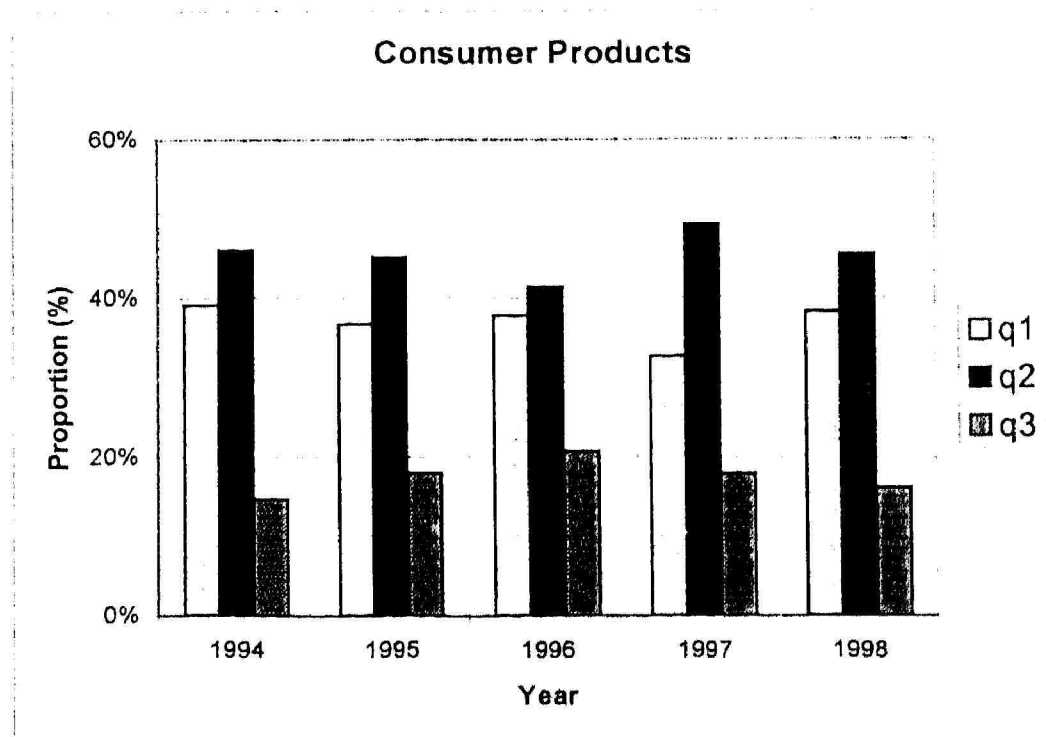

Consumer Products

22

Table 4.1.2
Mean and standard deviation of proportions of stocks increasing (q_1), decreasing (q_2) and unchanged (q_3) in price of the Industrial Products sector

Period	Statistic	q_1	q_2	q_3
1994	Mean	0.3905	0.4621	0.1474
	SD	0.2469	0.2524	0.0692
1995	Mean	0.3656	0.4450	0.1894
	SD	0.2409	0.2320	0.0738
1996	Mean	0.3708	0.4201	0.2092
	SD	0.1796	0.1874	0.0707
1997	Mean	0.3320	0.5043	0.1637
	SD	0.2215	0.2386	0.0730
1998	Mean	0.3854	0.4528	0.1618
	SD	0.2601	0.2433	0.0746
1994 -	Mean	0.3688	0.4569	0.1743
1998	SD	0.2320	0.2331	0.0755

Figure 4.1.2
Mean of proportions of stocks increasing (q_1), decreasing (q_2) and unchanged (q_3) in price of the Industrial Products sector.
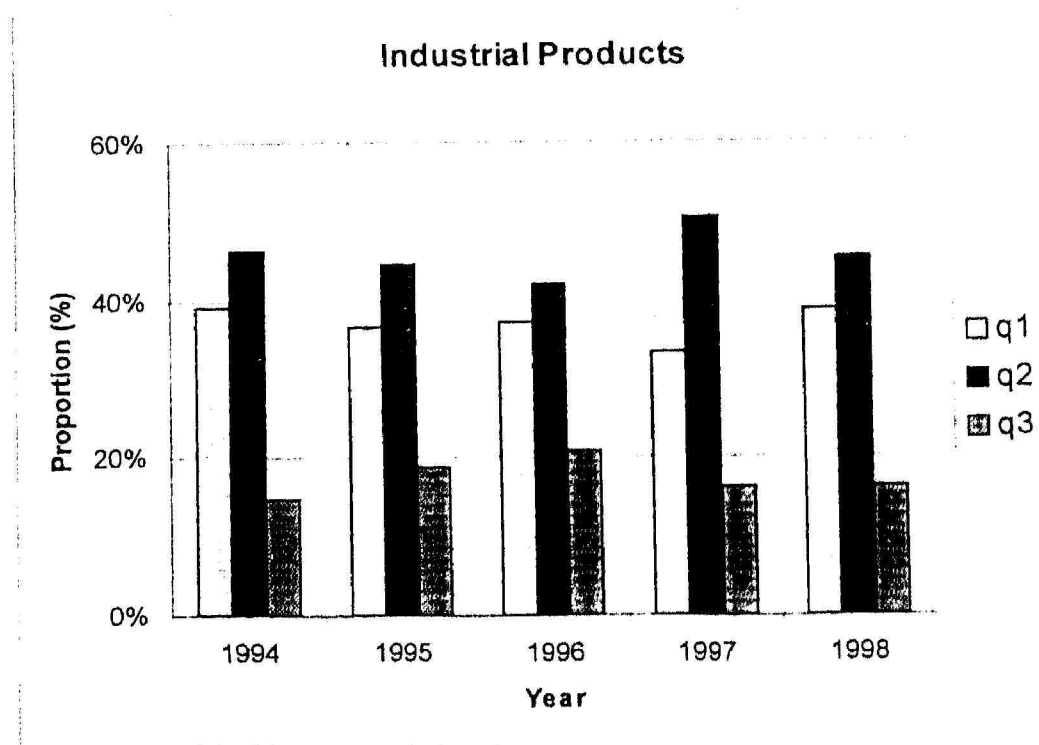
Table 4.1.3
Mean and standard deviation of proportions of stocks increasing (q_1), decreasing (q_2) and unchanged (q_3) in price of the Construction sector

Period	Statistic	q_1	q_2	q_3
1994	Mean	0.3933	0.4449	0.1619
	SD	0.2442	0.2514	0.1140
1995	Mean	0.3717	0.4465	0.1819
	SD	0.2332	0.2336	0.0961
1996	Mean	0.3942	0.4144	0.1914
	SD	0.1893	0.1950	0.1003
1997	Mean	0.3303	0.5099	0.1598
	SD	0.2243	0.2463	0.0964
1998	Mean	0.3908	0.4836	0.1256
	SD	0.2909	0.2847	0.0900
1994 - 1998	Mean	0.3760	0.4599	0.1641
	SD	0.2394	0.2457	0.1021

Figure 4.1.3
Mean of proportions of stocks increasing (q_1), decreasing (q_2) and unchanged (q_3) in price of the Construction sector
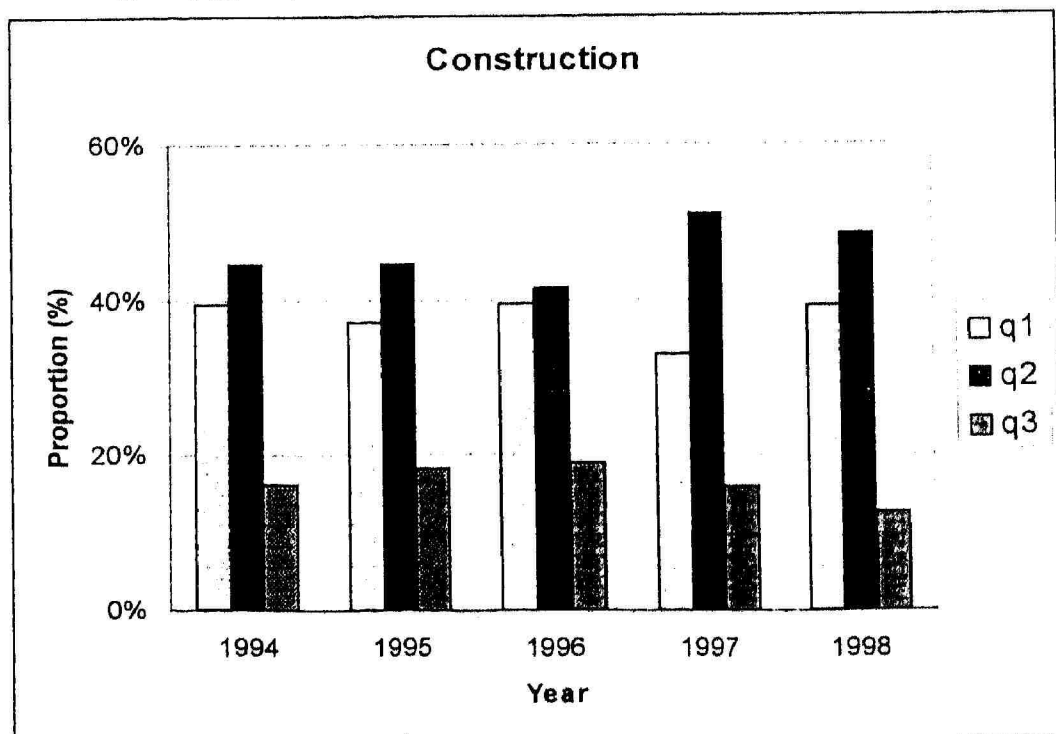

24

Table 4.1.4
Mean and standard deviation of proportions of stocks increasing (q_1), decreasing (q_2) and unchanged (q_3) in price of the Trading & Services sector

Period	Statistic	q_1	q_2	q_3
1994	Mean	0.3873	0.4722	0.1405
	SD	0.2513	0.2585	0.0693
1995	Mean	0.3694	0.4519	0.1787
	SD	0.2494	0.2443	0.0787
1996	Mean	0.3789	0.4179	0.2032
	SD	0.1835	0.1886	0.0732
1997	Mean	0.3416	0.4921	0.1664
	SD	0.2177	0.2278	0.0774
1998	Mean	0.3854	0.4698	0.1448
	SD	0.2720	0.2600	0.0691
1994 - 1998	Mean	0.3725	0.4608	0.1667
	SD	0.2369	0.2382	0.0770

Figure 4.1.4
Mean of proportions of stocks increasing (q_1), decreasing (q_2) and unchanged (q_3) in price of the Trading & Services sector
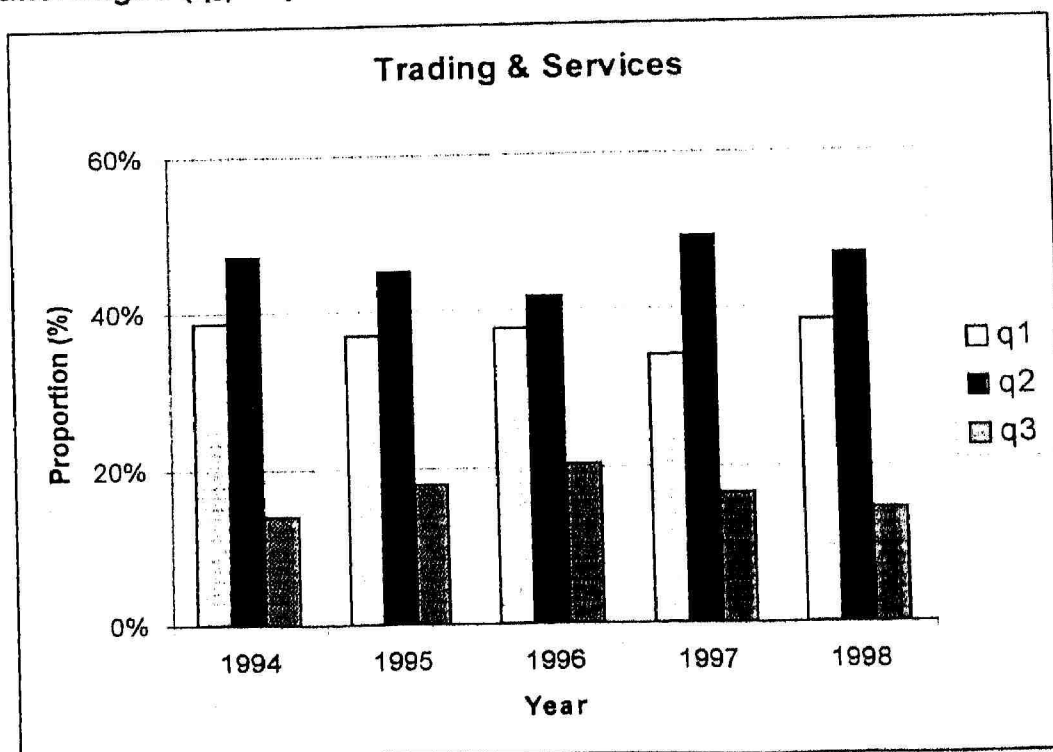
Table 4.1.5
Mean and standard deviation of proportions of stocks increasing (q_1), decreasing (q_2) and unchanged (q_3) in price of the Finance sector

Period	Statistic	q_1	q_2	q_3
1994	Mean	0.3886	0.4560	0.1554
	SD	0.2525	0.2556	0.0848
1995	Mean	0.3650	0.4326	0.2024
	SD	0.2458	0.2395	0.0898
1996	Mean	0.3834	0.3964	0.2202
	SD	0.1769	0.1805	0.0769
1997	Mean	0.3384	0.4799	0.1816
	SD	0.2269	0.2452	0.0916
1998	Mean	0.3918	0.4805	0.1277
	SD	0.3024	0.2912	0.0694
1994 -	Mean	0.3735	0.4491	0.1774
1998	SD	0.2446	0.2466	0.0891

Figure 4.1.5
Mean of proportions of stocks increasing (q_1), decreasing (q_2) and unchanged (q_3) in price of the Finance sector

Table 4.1.6
Mean and standard deviation of proportions of stocks increasing (q_1), decreasing (q_2) and unchanged (q_3) in price of the Property sector

Period	Statistic	q_1	q_2	q_3
1994	Mean	0.4039	0.4901	0.1060
	SD	0.3000	0.3050	0.0743
1995	Mean	0.3748	0.4791	0.1461
	SD	0.2810	0.2810	0.0791
1996	Mean	0.3818	0.4292	0.1891
	SD	0.1949	0.2002	0.0767
1997	Mean	0.3315	0.5084	0.1601
	SD	0.2241	0.2400	0.0739
1998	Mean	0.3753	0.4703	0.1544
	SD	0.2694	0.2586	0.0785
1994 -	Mean	0.3734	0.4754	0.1512
1998	SD	0.2573	0.2603	0.0810

Figure 4.1.6
Mean of proportions of stocks increasing (q_1), decreasing (q_2) and unchanged (q_3) in price of the Property sector
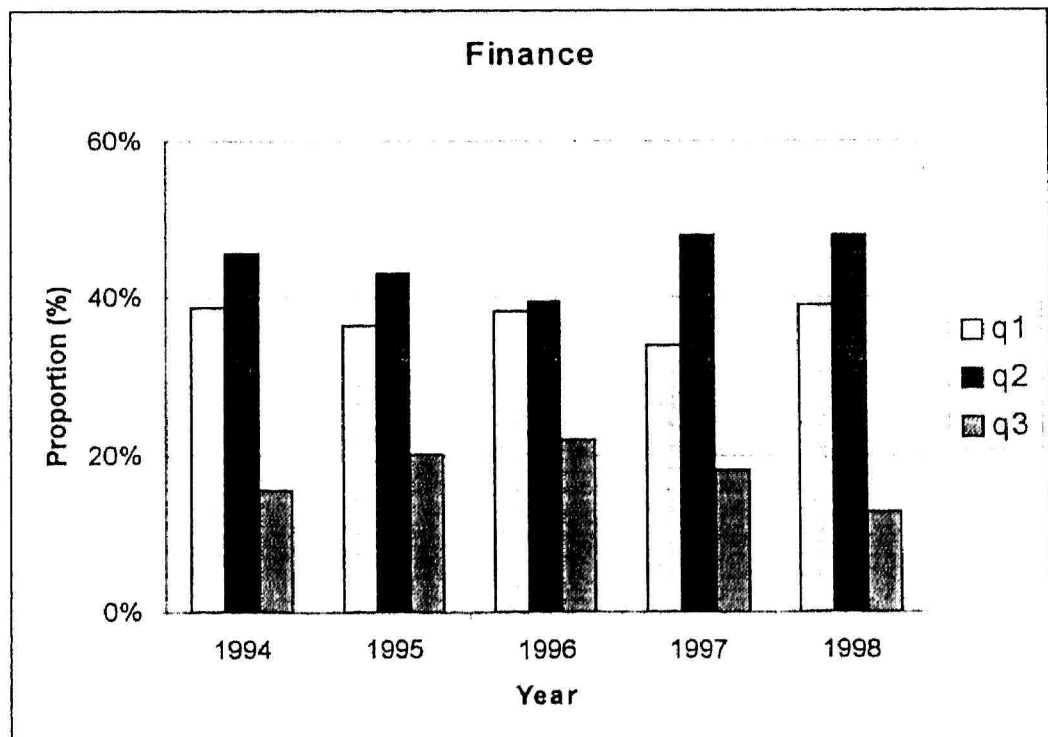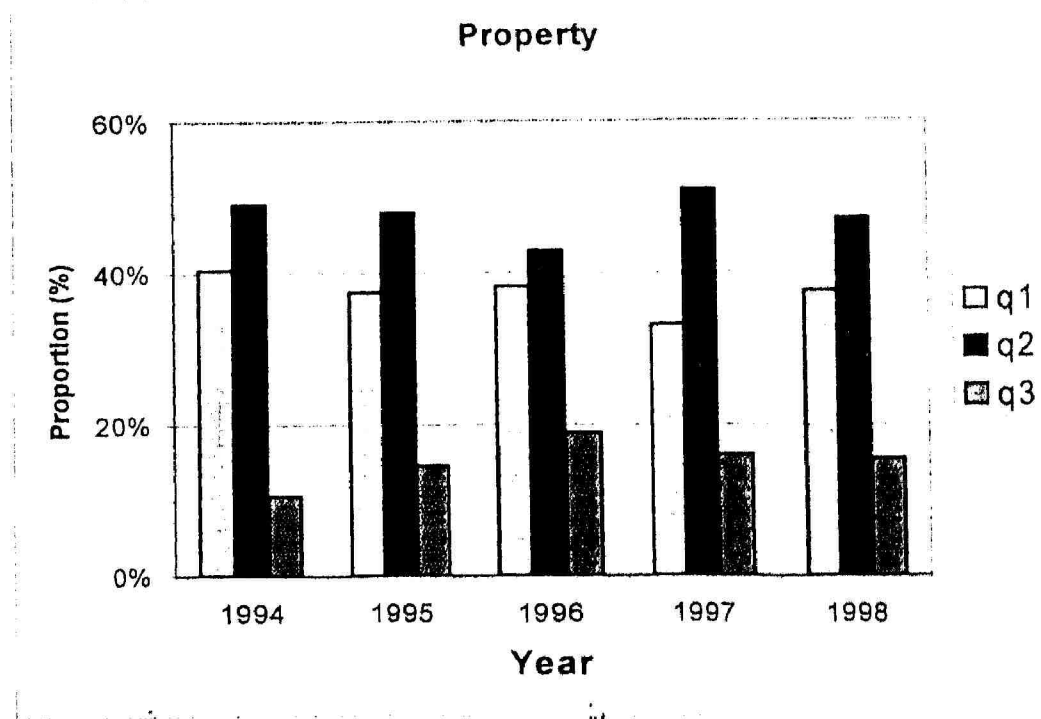
Table 4.1.7
Mean and standard deviation of proportions of stocks increasing (q_1), decreasing (q_2) and unchanged (q_3) in price of the Plantation sector

Period	Statistic	q_1	q_2	q_3
1994	Mean	0.4036	0.4471	0.1193
	SD	0.3033	0.3098	0.0819
1995	Mean	0.3603	0.4538	0.1860
	SD	0.2561	0.2545	0.0980
1996	Mean	0.3761	0.4217	0.2022
	SD	0.1993	0.1972	0.0872
1997	Mean	0.3453	0.4743	0.1804
	SD	0.2305	0.2416	0.0958
1998	Mean	0.3912	0.4424	0.1663
	SD	0.2606	0.2455	0.0814
1994 - 1998	Mean	0.3753	0.4539	0.1708
	SD	0.2528	0.2527	0.0933

Figure 4.1.7
Mean of proportions of stocks increasing (q_1), decreasing (q_2) and unchanged (q_3) in price of the Plantation sector

Table 4.1.8
Mean and standard deviation of proportions of stocks increasing (q_1), decreasing (q_2) and unchanged (q_3) in price of the Main Board

Period	Statistic	q_1	q_2	q_3
1994	Mean	0.3887	0.4610	0.1504
	SD	0.2455	0.2513	0.0562
1995	Mean	0.3661	0.4518	0.1822
	SD	0.2399	0.2353	0.0616
1996	Mean	0.3777	0.4162	0.2061
	SD	0.1735	0.1772	0.0546
1997	Mean	0.3349	0.4937	0.1714
	SD	0.2165	0.2308	0.0628
1998	Mean	0.3805	0.4560	0.1636
	SD	0.2591	0.2448	0.0630
1994-1998	Mean	0.3696	0.4557	0.1747
	SD	0.2292	0.2303	0.0626

Figure 4.1.8
Mean of proportions of stocks increasing (q_1), decreasing (q_2) and unchanged (q_3) in price of the Main Board
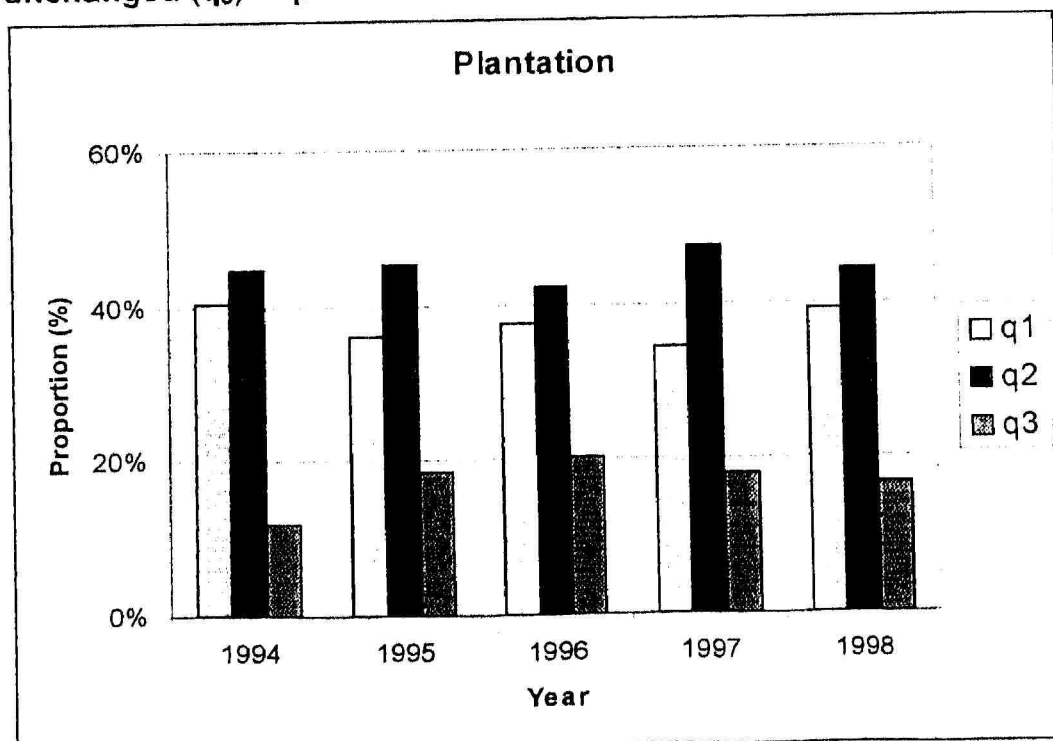
Table 4.1.9
Mean and standard deviation of proportions of stocks increasing (q_1), decreasing (q_2) and unchanged (q_3) in price of the Second Board

Period	Statistic	q_1	q_2	q_3
1994	Mean	0.3600	0.4485	0.1916
	SD	0.2052	0.2087	0.0725
1995	Mean	0.3905	0.4443	0.1652
	SD	0.2214	0.2187	0.0568
1996	Mean	0.4394	0.4586	0.1021
	SD	0.2587	0.2631	0.0455
1997	Mean	0.3490	0.5267	0.1243
	SD	0.2644	0.2735	0.0602
1998	Mean	0.3898	0.4626	0.1476
	SD	0.2698	0.2547	0.0759
1994-1998	Mean	0.3857	0.4682	0.1461
	SD	0.2469	0.2466	0.0703

Figure 4.1.9
Mean of proportions of stocks increasing (q_1), decreasing (q_2) and unchanged (q_3) in price of the Second Board
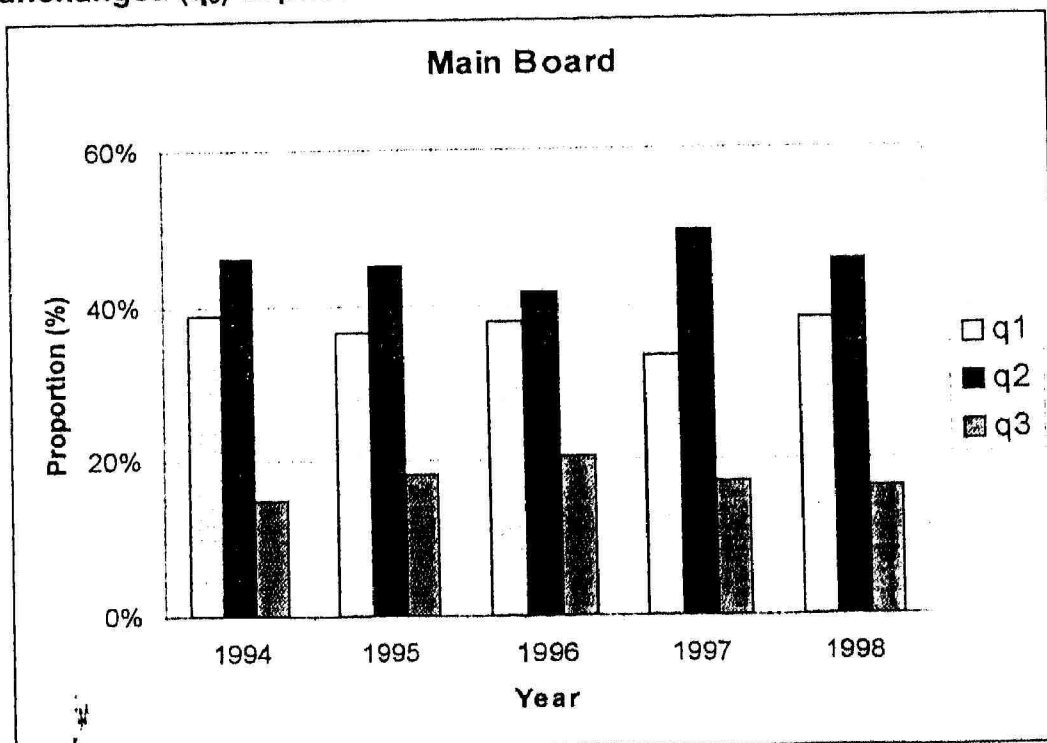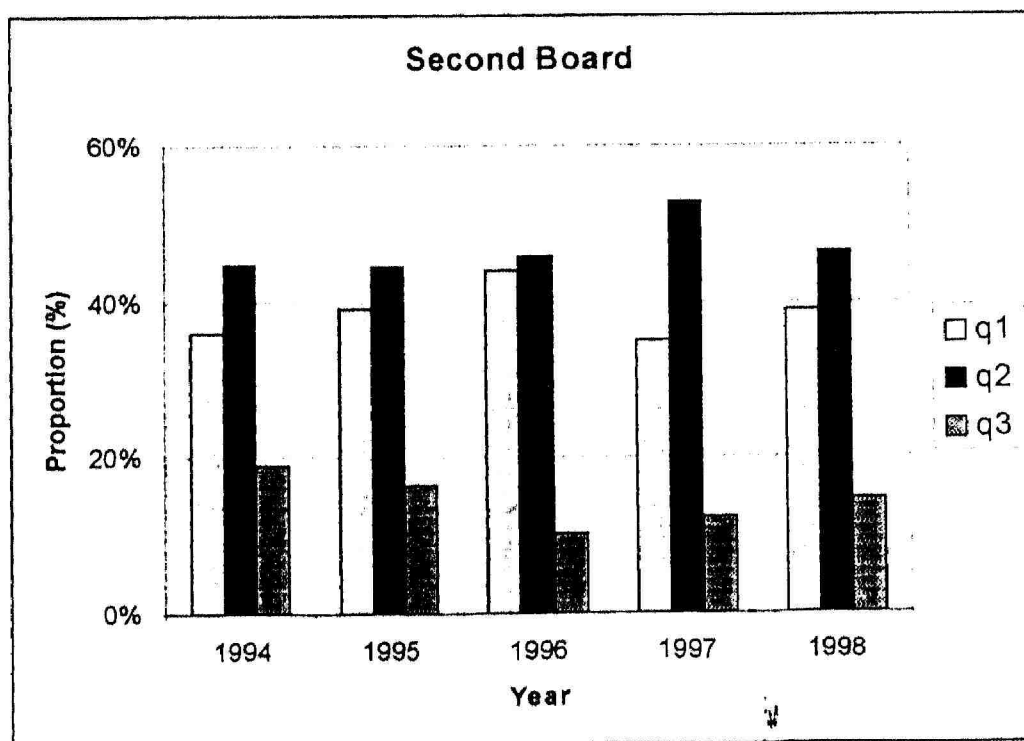
Table 4.1.10
Mean and standard deviation of proportions of stocks increasing (q_1), decreasing (q_2) and unchanged (q_3) in price for the period 1994-1998 of this study compared to earlier studies done by Theil and Leenders (1965), Fama (1965b), Dryden (1968) and Kok (1994)

	Statistic	q_1	q_2	q_3
Consumer Products	Mean	0.3695	0.4551	0.1754
	SD	0.2323	0.2339	0.0790
Industrial Products	Mean	0.3688	0.4569	0.1743
	SD	0.2320	0.2331	0.0755
Construction	Mean	0.3760	0.4599	0.1641
	SD	0.2394	0.2457	0.1021
Trading & Services	Mean	0.3725	0.4608	0.1667
	SD	0.2369	0.2382	0.0770
Finance	Mean	0.3735	0.4491	0.1774
	SD	0.2446	0.2466	0.0891
Property	Mean	0.3734	0.4754	0.1512
	SD	0.2573	0.2603	0.0810
Plantation	Mean	0.3753	0.4539	0.1708
	SD	0.2528	0.2527	0.0933
Main Board	Mean	0.3696	0.4557	0.1747
	SD	0.2292	0.2303	0.0626
Second Board	Mean	0.3857	0.4682	0.1461
	SD	0.2469	0.2466	0.0703
Malaysia (1984-1991)	Mean	0.3696	0.4394	0.1910
	SD	0.2342	0.2377	0.0689
United States (June 1952 – October 1962)	Mean	0.3979	0.3957	0.2064
	SD	0.1222	0.1267	0.0361
Netherlands (November 1959 – October 1963)	Mean	0.414	0.378	0.208
	SD	0.131	0.131	0.035
United Kingdom (January 1963 – April 1967)	Mean	0.1578	0.1533	0.6889
	SD	0.0575	0.0772	0.0543

Table 4.1.11

Average information inaccuracy ($\bar{I}$) using prediction rule:

$$p_{it} = \alpha\, q_{i,t\text{-}1} + (1\text{-}\alpha)\, \bar{q}_i$$

	Optimum Prediction	1994	1995	1996	1997	1998	1994-98
Consumer Products	α^*	0.153	0.080	0.131	0.251	0.193	0.176
	Minimum $\bar{I}$	0.2377	0.2434	0.1543	0.2138	0.2701	0.2268
Industrial Products	α^*	0.144	0.094	0.166	0.296	0.274	0.211
	Minimum $\bar{I}$	0.2517	0.2341	0.1425	0.2053	0.2447	0.2192
Construction	α^*	0.185	0.141	0.118	0.254	0.174	0.193
	Minimum $\bar{I}$	0.2933	0.2491	0.1782	0.2462	0.3510	0.2668
Trading & Services	α^*	0.133	0.116	0.154	0.273	0.195	0.186
	Minimum $\bar{I}$	0.2632	0.2565	0.1480	0.1992	0.2792	0.2318
Finance	α^*	0.193	0.154	0.228	0.339	0.208	0.241
	Minimum $\bar{I}$	0.2688	0.2547	0.1360	0.2232	0.3460	0.2504
Property	α^*	0.093	0.055	0.131	0.247	0.196	0.154
	Minimum $\bar{I}$	0.3750	0.3285	0.1671	0.2169	0.2839	0.2790
Plantation	α^*	0.093	0.077	0.213	0.250	0.180	0.167
	Minimum $\bar{I}$	0.3932	0.2904	0.1691	0.2383	0.2668	0.2761
Main Board	α^*	0.157	0.102	0.174	0.282	0.224	0.199
	Minimum $\bar{I}$	0.2382	0.2260	0.1226	0.1905	0.2432	0.2065
Second Board	α^*	0.292	0.115	0.003	0.189	0.260	0.199
	Minimum $\bar{I}$	0.1681	0.1899	0.2534	0.2791	0.2667	0.2394

Figure 4.1.10

VALUES OF ALPHA FOR MINIMUM AVERAGE INFORMATION INACCURACY
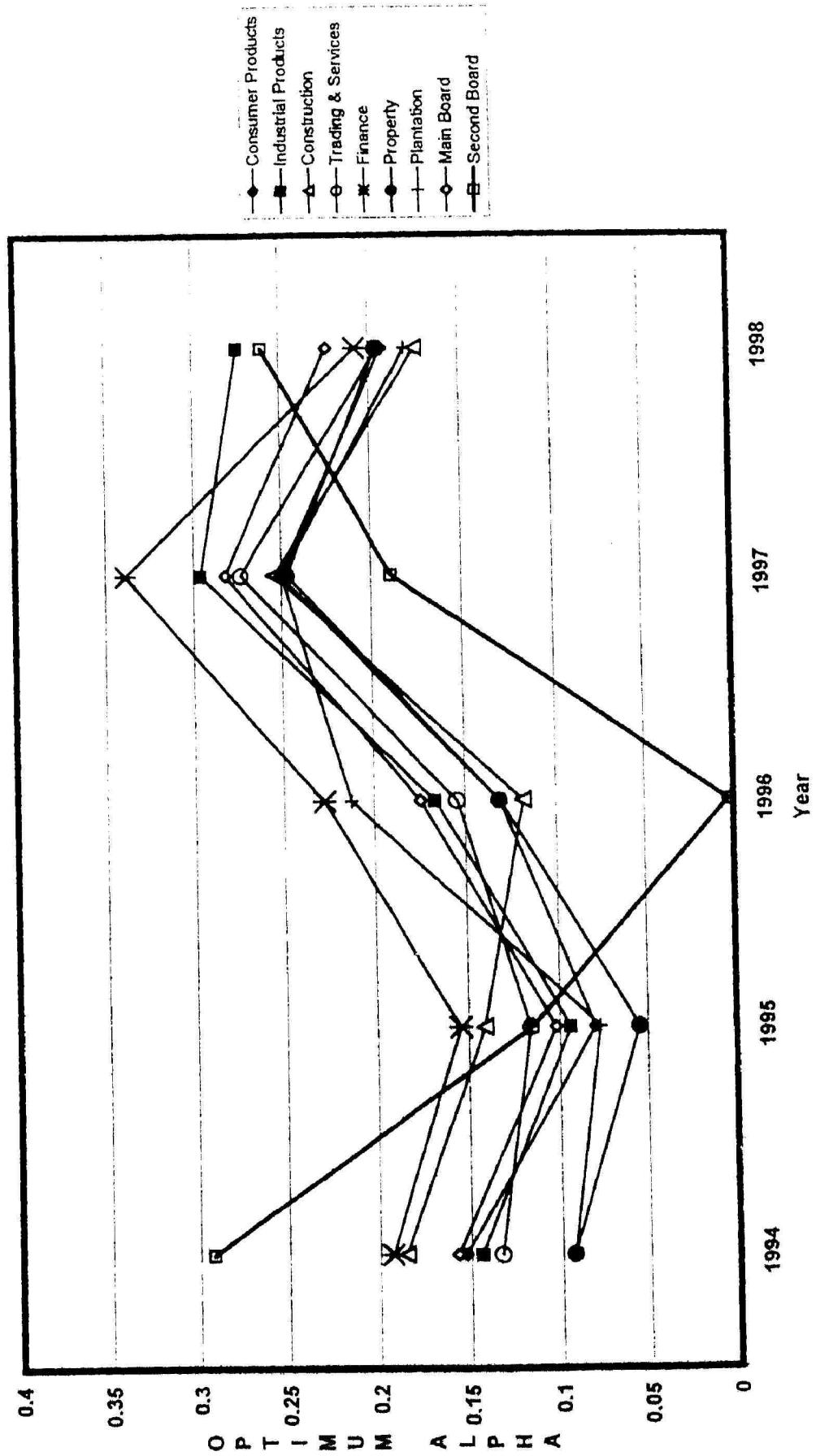
4.2 Results of Autocorrelation tests

4.2.1 Results of Autocorrelation tests on x_t, the daily difference between the proportion of stocks advancing and proportion of stocks decling in price

Serial correlation tests were done to examine dependence, if any, between successive daily difference between the proportion of stocks advancing and proportion of stocks declining in price. These tests were conducted separately for the seven sectors of the Main Board, the Second Board as well as the Main Board as a whole.

The difference between the proportion of stocks advancing and proportion of stocks declining is an indication of market sentiment. A positive value of x_t indicates that there are more stocks advancing than stocks declining in price at day t while a negative value indicates otherwise. If the number of stocks advancing in price equals the number of stocks declining in price at day t, x_t takes the value of zero.

The results of the runs test are given in Table 4.2.1a to Table 4.2.6a. The corresponding results of the serial correlation test, the Ljung-Box-Pierce Q test and the von Neumann's ratio test are presented in Table 4.2.1b to Table 4.2.6b. These results are given not only for the overall period between 1994 to1998 but also for the yearly sub-periods for each of the nine groups. This is to determine whether a significant result for the whole period could be attributed to any particular sub-period or a non-significant result for the whole period could have masked significant result in any sub-period.

34

In the runs test, only the Trading and Services sector for sub-period 1995 and the Consumer Products sector for sub-period 1996 shows actual runs which are slightly more than the expected number of runs. All the others show actual number of runs less than the expected number of runs, indicating a general tendency of persistence of market sentiments in the same direction. All the nine groups exhibit significant departures from independence for the whole period as seen in Table 4.2.6a. The results for the sub-periods as shown in Table 4.2.1a to Table 4.2.5a are mixed with more groups exhibiting significant departures from independence in the later sub-periods of 1997 and 1998.

The results of the serial correlation test show that at lag 1, all the groups exhibit significant departure from serial independence in the whole period and in the sub-period of 1997 and 1998. All the groups in the sub-period 1994 show significant departure from serial independence at lag 5. Serial correlation test also indicates pockets of significant non-zero serial correlation coefficients at other lags for some of the groups in the other sub-periods. These findings are generally consistent with the results of the Ljung-Box-Pierce Q test for serial correlation up to lag 12. The results of the von-Neumann's ratio test confirmed the results obtained from serial correlation test at lag 1.

The results from the runs test, serial correlation test, Ljung-Box-pierce Q test and von Neumann's ratio test are generally consistent. At 5%

significance level, there is sufficient evidence to reject serial independence of the time series $x_1, x_2, x_3, \ldots\ldots x_t$.

4.2.2 Results of Autocorrelation tests on y_t, the daily logarithmic returns of the stock indices.

The daily logarithmic returns of the stock indices of the seven main sectors of the Main Board, the Second Board, the Composite Index and the Emas Index of the KLSE were tested for serial dependence using the runs test, serial correlation test, Ljung-Box- Pierce Q test and von Neumann's ratio test. The results of the autocorrelation tests for the full period of 1994-1998 are shown in Table 4.2.7a and Table 4.2.7b. In the runs test, all the returns of the stock indices show significant departure from serial independence. All the returns of the stock indices have actual number of runs less than the expected number of runs indicating a tendency of persistence in price movement in the same direction.

The serial correlation test shows that at lag 1 only the Consumer Products, Construction and Property sectors, the Emas Index and the Second Board returns of the stock indices show significant departure from serial independence. The serial correlation coefficients at other lags are mixed. The results of the von Neumann's ratio test are consistent with those of serial correlation test at lag 1. The results of the Ljung-Box-pierce Q test for serial correlation up to 12 lags are consistent with those shown by the runs test with the exception of the Property sector returns of the stock index

Table 4.2.1a
Results of the Runs test on x_t, 1994

x_t	Actual Runs	Expected Runs	z
Consumer Products	123	124.30	-0.103
Industrial Products	116	122.60	-0.802
Construction	134	137.38	-0.388
Trading & Services	121	128.94	-0.994
Finance	112	126.57	-1.854*
Property	118	122.94	-0.574
Plantation	108	126.69	-2.366*
Main Board	113	122.94	-1.221
2nd Board	100	123.30	-3.125*

Table 4.2.1b
Results of the Serial Correlation, Ljung-Box-Pierce Q and von Neumann's ratio tests on x_t, 1994

x_t	Lag 1	Lag 2	Lag 3	Lag 4	Lag 5	Q(12)	V
Consumer Products	0.126*	-0.026	0.125*	0.127*	0.149*	21.085*	1.754*
Industrial Products	0.114*	-0.051	0.116*	0.160*	0.159*	22.221*	1.773*
Construction	0.174*	-0.059	0.079	0.097	0.155*	22.444*	1.657*
Trading & Services	0.121*	-0.031	0.133*	0.103	0.163*	21.777*	1.763*
Finance	0.165*	-0.042	0.097	0.183*	0.152*	29.595*	1.674*
Property	0.088	-0.076	0.099	0.136*	0.170*	20.674	1.830
Plantation	0.087	-0.033	0.073	0.115*	0.164*	17.573	1.826
Main Board	0.135*	-0.039	0.120*	0.149*	0.178*	25.267*	1.734*
2nd Board	0.262*	0.069	0.121*	0.200*	0.164*	42.119*	1.481*

* significant at 5% level

Table 4.2.2a
Results of the Runs test on x_t, 1995

x_t	Actual Runs	Expected Runs	z
Consumer Products	119	119.72	-0.030
Industrial Products	117	117.56	-0.008
Construction	120	126.04	-0.742
Trading & Services	120	118.70	0.107
Finance	115	120.83	-0.703
Property	113	118.74	-0.732
Plantation	118	118.52	-0.003
Main Board	116	118.35	-0.249
2nd Board	108	121.21	-1.652*

Table 4.2.2b
Results of the Serial Correlation, Ljung-Box-Pierce Q and von Neumann's ratio tests on x_t, 1995

x_t	Lag 1	Lag 2	Lag 3	Lag 4	Lag 5	Q(12)	V
Consumer Products	0.070	-0.026	-0.038	0.015	0.088	7.114	1.862
Industrial Products	0.069	0.006	-0.031	0.036	0.114*	7.316	1.863
Construction	0.158*	0.048	-0.076	0.037	-0.005	9.352	1.686*
Trading & Services	0.090	-0.003	-0.070	-0.012	0.071	6.299	1.824
Finance	0.142*	0.039	0.007	0.051	0.071	9.618	1.719*
Property	0.035	-0.014	-0.066	0.031	0.082	4.848	1.933
Plantation	0.045	-0.010	-0.018	0.051	0.050	4.254	1.910
Main Board	0.084	0.009	-0.047	0.033	0.082	5.990	1.835
2nd Board	0.097	0.030	0.040	0.102	0.094	9.266	1.811

* significant at 5% level

Table 4.2.3a
Results of the Runs test on x_t, 1996

x_t	Actual Runs	Expected Runs	z
Consumer Products	128	127.54	-0.005
Industrial Products	109	126.00	-2.134*
Construction	126	135.48	-1.195
Trading & Services	113	126.48	-1.691*
Finance	115	132.54	-2.233*
Property	119	127.54	-1.051
Plantation	109	129.51	-2.660*
Main Board	114	125.65	-1.429
2nd Board	120	125.99	-0.702

Table 4.2.3b
Results of the Serial Correlation, Ljung-Box-Pierce Q and von Neumann's ratio tests on x_t, 1996

x_t	Lag 1	Lag 2	Lag 3	Lag 4	Lag 5	Q(12)	V
Consumer Products	0.090	0.004	-0.021	0.037	0.063	11.145	1.825
Industrial Products	0.136*	-0.017	-0.025	0.056	0.100	16.673	1.734*
Construction	0.037	0.021	-0.022	0.009	-0.005	12.316	1.928
Trading & Services	0.126*	0.034	-0.094	-0.000	0.023	13.797	1.753*
Finance	0.210*	0.061	-0.048	0.008	0.009	23.690*	1.585*
Property	0.076	0.002	-0.017	0.044	0.064	12.279	1.842
Plantation	0.175*	0.054	-0.008	0.041	0.073	19.252	1.642*
Main Board	0.138*	0.020	-0.042	0.023	0.066	15.689	1.727*
2nd Board	-0.001	-0.017	0.100	0.103	0.086	12.058	1.998

* significant at 5% level

Table 4.2.4a
Results of the Runs test on x_t, 1997

x_t	Actual Runs	Expected Runs	z
Consumer Products	98	112.75	-2.068*
Industrial Products	96	112.06	-2.273*
Construction	105	122.77	-2.489*
Trading & Services	99	114.72	-2.197*
Finance	108	125.15	-2.298*
Property	89	111.25	-3.244*
Plantation	106	119.69	-1.866*
Main Board	89	109.39	-2.897*
2nd Board	104	113.41	-1.268

Table 4.2.4b
Results of the Serial Correlation, Ljung-Box-Pierce Q and von Neumann's ratio tests on x_t, 1997

x_t	Lag 1	Lag 2	Lag 3	Lag 4	Lag 5	Q(12)	V
Consumer Products	0.236*	0.089	0.016	0.023	-0.073	23.154*	1.533*
Industrial Products	0.257*	0.100	0.023	0.008	-0.017	24.041*	1.491*
Construction	0.239*	0.050	-0.022	-0.018	-0.010	21.941*	1.528*
Trading & Services	0.238*	0.098	0.027	-0.028	-0.046	27.002*	1.530*
Finance	0.299*	0.118*	0.003	0.004	0.009	31.220*	1.401*
Property	0.224*	0.069	0.052	0.035	-0.043	21.261*	1.557*
Plantation	0.231*	0.101	0.012	-0.034	-0.020	24.093*	1.543*
Main Board	0.251*	0.099	0.030	0.012	-0.017	23.869*	1.504*
2nd Board	0.177*	0.066	0.045	0.049	-0.008	22.904*	1.605*

* significant at 5% level

Table 4.2.5a
Results of the Runs test on x_t, 1998

x_t	Actual Runs	Expected Runs	z
Consumer Products	99	117.63	-2.443*
Industrial Products	89	116.68	-3.694*
Construction	111	123.14	-1.628
Trading & Services	109	119.14	-1.315
Finance	106	118.85	-1.668*
Property	103	118.85	-2.073*
Plantation	108	127.70	-2.553*
Main Board	103	118.39	-2.020*
2nd Board	105	118.16	-1.743*

Table 4.2.5b
Results of the Serial Correlation, Ljung-Box-Pierce Q and von Neumann's ratio tests on x_t, 1998

x_t	Lag 1	Lag 2	Lag 3	Lag 4	Lag 5	Q(12)	V
Consumer Products	0.173*	0.160*	0.042	-0.006	-0.053	19.312	1.657*
Industrial Products	0.241*	0.154*	0.065	0.011	-0.067	27.327*	1.518*
Construction	0.164*	0.153*	0.090	0.014	-0.048	20.420	1.675*
Trading & Services	0.172*	0.168*	0.045	0.007	-0.043	20.042	1.660*
Finance	0.196*	0.154*	0.081	0.012	-0.099	29.199*	1.611*
Property	0.172*	0.197*	0.088	0.029	-0.011	22.568*	1.659*
Plantation	0.180*	0.065	0.017	-0.008	-0.062	17.607	1.643*
Main Board	0.189*	0.158*	0.075	0.018	-0.054	22.277*	1.625*
2nd Board	0.200*	0.100	0.079	0.002	-0.058	19.183	1.603*

* significant at 5% level

Table 4.2.6a
Results of the Runs test on x_t, 1994-1998

x_t	Actual Runs	Expected Runs	z
Consumer Products	564	602.60	-2.286*
Industrial Products	525	595.48	-4.188*
Construction	595	645.70	-3.048*
Trading & Services	561	607.69	-2.774*
Finance	554	623.63	-4.099*
Property	541	600.74	-3.581*
Plantation	547	621.35	-4.426*
Main Board	534	597.13	-3.719*
2nd Board	535	606.42	-4.207*

Table 4.2.6b
Results of the Serial Correlation, Ljung-Box-Pierce Q and von Neumann's ratio tests on x_t, 1994-1998

x_t	Lag 1	Lag 2	Lag 3	Lag 4	Lag 5	Q(12)	V
Consumer Products	0.149*	0.054*	0.042	0.052*	0.042	44.010*	1.702*
Industrial Products	0.173*	0.050*	0.048*	0.067*	0.061*	57.413*	1.654*
Construction	0.174*	0.065*	0.038	0.045	0.030	51.740*	1.653*
Trading & Services	0.153*	0.061*	0.029	0.027	0.041	44.316*	1.695*
Finance	0.205*	0.077*	0.047	0.062*	0.025	80.101*	1.591*
Property	0.120*	0.033	0.046	0.074*	0.072*	38.638*	1.762*
Plantation	0.136*	0.027	0.028	0.049*	0.057*	36.805*	1.728*
Main Board	0.166*	0.058*	0.047	0.062*	0.058*	54.711*	1.669*
2nd Board	0.151*	0.060*	0.091*	0.091*	0.055*	62.764*	1.698*

* significant at 5% level

Table 4.2.7a

**Results of the Runs test on the daily logarithmic returns of
the stock indices for the full period 1994-1998**

Index	Actual Runs	Expected Runs	z
Consumer Products	531	591.21	-3.489*
Industrial Products	542	596.58	-3.194*
Construction	514	595.37	-4.727*
Trading & Services	555	593.72	-2.252*
Finance	514	592.14	-4.529*
Property	539	586.82	-2.799*
Plantation	511	587.79	-4.483*
Emas	518	590.49	-4.211*
Composite	537	591.62	-3.160*
2nd Board	499	590.57	-5.340*

Table 4.2.7b

**Results of the Serial Correlation, Ljung-Box-Pierce Q and von
Neumann's ratio tests on the daily logarithmic returns of the stock
indices, 1994-1998**

Index	Lag 1	Lag 2	Lag 3	Lag 4	Lag 5	Q(12)	V
Consumer Products	0.123*	-0.023	0.042	-0.042	-0.023	38.406*	1.753*
Industrial Products	0.006	-0.009	0.080*	-0.045	0.010	29.266*	1.989
Construction	0.112*	0.085*	-0.020	-0.073	-0.004	47.945*	1.778*
Trading & Services	0.037	0.011	0.008	-0.118	-0.039	56.201*	1.922
Finance	-0.089	0.015	0.043	-0.040	-0.021	29.557*	2.180
Property	0.054*	0.012	0.050	-0.006	-0.017	20.735	1.893*
Plantation	-0.151	-0.043	0.186*	-0.132	0.100*	109.45*	2.302
Emas	0.050*	0.003	0.041	-0.050	-0.032	37.702*	1.900*
Composite	0.026	0.007	0.034	-0.108	-0.008	49.996*	1.949
2nd Board	0.171*	0.066*	0.047	0.059*	-0.025	82.376*	1.659*

* significant at 5% level

4.3 Results of tests for relationship between two series

Before investigating for relationship between x_t, the series of difference between the proportion of stocks advancing and proportion of stocks declining in price and y_t, the series of logarithmic returns of the stock indices, the presence of unit roots were evaluated using the Dickey-Fuller tests. The results for stationarity for the nine x_t series are shown in Table 4.3.1 and for the ten y_t series are shown in Table 4.3.2. Nine lags of the first difference in each series were included to ensure that the residuals are not autocorrelated. The test statistic τ_α provides sufficient evidence to reject the null hypothesis of presence of a unit root, thereby indicating that all the series tested are stationary. There is no significant evidence to reject the null hypothesis of a zero deterministic trend component in all cases

After establishing the stationarity of all the series, the next step is to examine the relationship between x_t and y_t. Cross-correlation tests were done to evaluate the inter-relatedness between x_t and the corresponding y_t for each of the seven main sectors of the Main Board, the Second Board as well as for the Main Board with the Composite Index and the Main Board with the Emas Index. The results are tabulated in Table 4.3.3. The cross-correlation at lag 0 estimate the correlation between each pair of x_t and y_t. The cross-correlation coefficients at lag 0 are high indicating strong positive correlation between each pair of x_t and y_t for all the cases. This is expected since both are indicators of the market sentiment. The Second Board shows the highest correlation while the Plantation sector shows the lowest correlation between x_t

and y_t. The x_t series of the Main Board correlates higher with the y_t series of the Emas Index than the Composite Index. This is explained by the fact that the Composite Index is based on a sample of 100 stocks while the Emas Index is based on all stocks listed on the Main Board of the KLSE.

The results also show significant lead-lag relationship at lag 1. The cross-correlation coefficient $r_{xy}(-1)$ is the correlation between x_t and y_{t-1} whereas $r_{xy}(1)$ is the correlation between x_t and y_{t+1}. With the exception of the Trading & Services, Property and Plantation sectors, y_t leads x_t at lag 1. In all the groups, the cross-correlation coefficients show significantly that x_t leads y_t at lag 1. The correlation between x_t and y_{t+1} is stronger than the correlation between x_t and y_{t-1} as indicated by the higher values of $r_{xy}(1)$ as compared to the corresponding values of $r_{xy}(-1)$.

Table 4.3.4 shows the results of the Granger causality tests performed between x_t and the corresponding y_t for each of the seven main sectors of the Main Board, the Second Board as well as for the Main Board with the Composite Index and the Main Board with the Emas Index. The lag lengths in model (1) were all equal to 1 while the lag lengths in model (2) were mostly equal to 1 with the exception of the Consumer Products and the Plantation sector.

In testing the null hypothesis that the coefficients of lagged y_ts in model (1) are jointly equal to zero, the results were significant only for the Property sector and the Trading & Services sector. In testing the null hypothesis that the coefficients of lagged x_ts in model (2) are jointly equal to zero, the results

were significant for all the groups. The Granger causality results indicate that x_t Granger causes y_t in all the groups but y_t Granger causes x_t only in the Property sector and the Trading & Services sector.

Table 4.3.1
Results of Dickey-Fuller test for stationarity in the x_t series for the period 1994-1998

x_t	β	t-statistic	α	τ_α
Consumer Products	-4.38×10^{-5}	-1.125	-0.750	-9.841*
Industrial Products	-4.40×10^{-5}	-1.139	-0.722	-9.829*
Construction	-7.27×10^{-5}	-1.794	-0.745	-9.961*
Trading & Services	-3.91×10^{-5}	-0.988	-0.767	-9.953*
Finance	-4.97×10^{-5}	-1.223	-0.723	-9.909*
Property	-4.49×10^{-5}	-1.036	-0.773	-10.132*
Plantation	-1.15×10^{-5}	-0.274	-0.822	-10.521*
Main Board	-4.07×10^{-5}	-1.060	-0.728	-9.841*
Second Board	-3.96×10^{-5}	-0.960	-0.665	-9.270*

Table 4.3.2
Results of Dickey-Fuller test for stationarity in the y_t series for the period 1994-1998

y_t	β	t-statistic	α	τ_α
Consumer Products	-1.01×10^{-6}	-0.729	-0.846	-10.173*
Industrial Products	-8.55×10^{-7}	-0.487	-0.889	-10.105*
Construction	-2.52×10^{-6}	-1.089	-0.832	-10.171*
Trading & Services	-7.37×10^{-7}	-0.386	-1.045	-10.640*
Finance	-2.05×10^{-6}	-0.827	-1.043	-10.363*
Property	-1.59×10^{-6}	-0.744	-0.833	-9.956*
Plantation	-4.00×10^{-7}	-0.224	-0.979	-11.065*
Composite Index	-7.88×10^{-7}	-0.435	-0.979	-10.349*
Emas Index	-1.07×10^{-6}	-1.089	-0.910	-10.163*
Second Board	-1.61×10^{-6}	-0.806	-0.613	-8.572*

* significant at 5% level

Table 4.3.3

Cross-correlation coefficients of x_t and y_t

	$r_{xy}(-5)$	$r_{xy}(-4)$	$r_{xy}(-3)$	$r_{xy}(-2)$	$r_{xy}(-1)$	$r_{xy}(0)$	$r_{xy}(1)$	$r_{xy}(2)$	$r_{xy}(3)$	$r_{xy}(4)$	$r_{xy}(5)$
Consumer Products	-0.020	0.010	0.048	0.008	0.073	0.755	0.177	0.057	0.053	0.021	0.001
Industrial Products	0.005	0.003	0.047	0.014	0.083	0.762	0.136	0.037	0.051	0.036	0.021
Construction	-0.007	0.006	0.021	0.050	0.109	0.701	0.153	0.063	0.023	-0.007	0.009
Trading & Services	-0.008	-0.031	0.037	0.021	0.054	0.723	0.116	0.030	0.002	-0.030	-0.035
Finance	-0.003	-0.014	0.014	0.031	0.096	0.649	0.155	0.033	0.055	0.031	-0.017
Property	0.010	0.027	0.056	0.032	0.048	0.791	0.134	0.042	0.066	0.045	0.020
Plantation	0.077	-0.035	0.106	0.001	0.045	0.632	0.122	0.013	0.017	0.022	0.054
Main Board with Emas	-0.006	0.003	0.048	0.016	0.082	0.766	0.141	0.038	0.040	0.018	-0.008
Main board with Composite	0.005	-0.006	0.045	0.017	0.069	0.700	0.124	0.029	0.010	-0.004	-0.017
2nd Board	-0.007	0.064	0.047	0.044	0.115	0.843	0.183	0.090	0.095	0.083	0.020

* significant at 5% level

48

Table 4.3.4
Granger causality results of x_t and y_t in the period 1994-1998

	y_t does not Granger cause x_t		x_t does not Granger cause y_t	
	lag length	F-statistic	lag length	F-statistic
Consumer Products	1	1.397	9	4.481*
Industrial Products	1	3.812	1	51.077*
Construction	1	0.187	1	13.350*
Trading & Services	1	4.684*	1	19.925*
Finance	1	1.349	1	101.339*
Property	1	3.943*	1	26.671*
Plantation	1	2.006	7	11.995*
Main Board with Emas Index	1	2.838	1	30.567*
Main Board with Composite Index	1	2.820	1	26.668*
Second Board	1	0.000	1	6.259*

* significant at 5% level