Efficiency in a Thinly Traded Market: The Case of Pakistan

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1. Introduction

The stock market plays an important role in mobilizing domestic resources. An efficient stock market is one in which stock prices fully and instantaneously reflect all available relevant information[1]. According to Fama(1970), there are three forms of market efficiency based on the type of information available. These forms – weak form, semi-strong form, and strong form – have been tested in various equity markets. However, most of the studies on market efficiency have focused on testing the weak form efficiency which states that current stock prices reflect all information contained in past stock prices implying that no investor can consistently earn excess returns from trading rules based on historical prices.

The weak form efficiency hypothesis has been tested, for example, by Fama(1965) for USA, Dryden(1970) for UK, Solnik(1973) for 8 European markets, Conrad and Juttner (1973) for Germany, Jennergren and Korsvold (1975) for Norway and Sweden, Laurance(1986) for Malaysia and Singapore, Malaikah(1990) for Saudi Arabia and Kuwait, Aybar(1992) for Turkey, etc. These studies provide mixed results. The developed markets, e.g., USA and some of the European, are found to be weak form efficient. On the other hand, evidence from developing markets, commonly known as emerging markets, indicates that these markets, in general, do not satisfy the weak form hypothesis implying that returns in these markets are generally predictable. The reasons pointed out suggest that the emerging markets are, generally, thin markets and lack the depth, regulatory framework and structural safeguards.

The purpose of this paper is to test the weak form efficiency in the Pakistani equity market, one of the promising emerging markets identified by the International Finance Corporation (IFC). In recent years Pakistan has taken significant steps toward development of its capital markets. Measures have been taken for privatization, economic liberalization, relaxation of foreign exchange controls, and easing of regulations on repatriation of profits, investment and operation of financial institutions. The most significant step was the opening of the equity market to international investors in February 1991. Hence, it would be useful to see whether these reforms have any effect on the efficiency of the market.

[1] Efficiency in this paper represents informational efficiency

The efficiency of the Pakistani equity market was previously examined by Khilji(1993) and Jun and Uppal (1994). Khilji(1993) found the presence of serial dependence in stock returns in the Pakistani market. However, he used sector indices for his analysis and as pointed out by Laurance(1986) the use of indices may not be appropriate to test market efficiency as these indices are greatly affected by the shares which are not traded frequently. The situation seems more serious in the case of Pakistan which is characterized as thin market. On the other hand, Jun and Uppal (1994) used individual stocks and found the market to be generally efficient. However they used monthly prices which are more likely to reflect adjustment to new information than weekly or daily prices and thus may show the market to be efficient.

This paper examines the issue, in detail, using daily stock prices and sector indices from the Karachi Stock Exchange (KSE), the main equity market in Pakistan[2]. In addition, the effect of the opening of the Pakistani equity market to international investors on market efficiency is also examined. The paper is organized as follows. The next section describes the data and the sample. Section III outlines the hypotheses to be tested along with the methodology. Empirical results are evaluated in Section IV. The final section contains the summary and conclusions.

2. Data and Sample

The data consists of 36 individual stocks, 8 sector indices and the general market index, covering the period from January 1, 1989 to December 30, 1993. Information on individual stocks regarding closing prices, volumes, dividends (cash & stock), and rights issues was collected from the Exchange (KSE), the Corporate Law Authority (a body that regulates stock exchanges in Pakistan), and the Business Recorder (a daily newspaper).

The data on sector indices as well as the market index was obtained from the files of the State Bank of Pakistan, the central bank, that prepares and maintains these indices. The general market index, called the State Bank General Price Index, covers

[2] The interested readers are suggested to see Mirza (1993) and Khan (1993) for a comprehensive information regarding the evolution, regulations, and operations of the Pakistan equity market, particularly the KSE.

all the stocks listed on the exchange and therefore provides a complete representation of the market.

The analysis was done for the full sample period as well as for three sub-samples to examine the impact of liberalization measures, particularly the opening of the market to international investors, announced on February 7, 1991. The first sub-sample consists of the period before the market was opened.

The market became bullish after its opening and unprecedented trends were observed. It appears, however, that the market overreacted in that period because it was followed by a period that may be called a correction phase (IFC, 1993). This first year of the opening of the market, characterized by overreaction and/or correction phase, constitutes the second sub-sample period. Finally, the third sub-sample consists of the period from one year after opening of the market to the end of the sample period.

3. Research Hypotheses and Methodology

Weak form efficiency is examined through serial dependence in stock returns. The first hypothesis, therefore, deals with testing the existence of serial dependence in stock returns in the equity market of Pakistan. The hypothesis has an important implication for an investor since he/she is interested to know whether there are dependencies in the series which can be used to increase the expected profits.

Two techniques were used to test for the existence and nature of serial dependence, the Serial Correlation and the Runs tests.

3.1 The Serial Correlation Test

This is a parametric test that measures the relationship between the value of a random variable at time t, and its value k period earlier, that is,

$$r_k = \frac{Cov(R_t, R_{t-k})}{Var\,(R_t)} \qquad [1]$$

where R_t is the return of a stock at time t and is defined as the first difference of the natural log of stock prices (P_t), i.e.,

$$R_t = lnP'_t - lnP_{t-1} \quad [2]$$

where P'_t is the price of a stock at time t adjusted for capital changes, i.e., dividends, rights issues etc. If the distribution of R_t has finite variance, then in very large samples the standard error of r_k is:

$$SE(r_k) = \sqrt{\frac{1}{n-k}} \quad [3]$$

Significant coefficients imply serial dependence where the significance of a coefficient is judged by its t-value. In addition, the signs of serial coefficients have important implications in capital market. Positive signs reflect slow adjustment of stock prices to new information, insider information etc., whereas, negative serial correlation may be induced by thin market with wide fluctuations in prices about the intrinsic value.

Besides testing the individual coefficients, the joint hypothesis that all the correlation coefficients up to lag k are zero are tested by the Ljung-Box Q(k) statistic, computed as:

$$Q(K) = n(n+2)\sum_{k=1}^{k}\frac{r_k^2}{n-i} \quad [4]$$

which has a chi square distribution with k degrees of freedom.

3.2 The Cross Correlations

A factor that increases serial dependence in sector indices is cross correlations among stock returns. Whereas, the serial correlation implies that a stock return is affected by its own lagged values, the cross correlation implies that a stock return is affected by the lagged or lead returns of other stocks. More specifically, the cross correlation between two series X_t, and Y_t, at lag k is defined as,

$$\rho_k = \frac{COV(X_t, Y_{t-k})}{SD(X_t)\,SD(Y_t)} \quad [5]$$

Similarly the Ljung-Box statistic is defined as,

$$Q(k) = n(n+2) \sum_{k=1}^{k} \frac{\rho_k^2}{n-i} \qquad [6]$$

where ρ_k is the cross correlation.

3.3 The Runs Test

An alternative way of analyzing the serial dependence is to perform the runs test which is a non-parametric test and is independent of the normality and constancy of variance of the random variable. The test analyzes the runs in a series of data by comparing the expected number of runs with the observed number of runs. A run can be defined as a sequence of price changes of the same sign. For example, the series:

price changes ++/- - -/0/- - -/+++
Runs 1 2 3 4 5

consists of five runs. The expected number of runs can be computed as:

$$M = \frac{N(N+1) - \sum_{i=1}^{3} n_i^2}{N} \qquad [7]$$

where $N = n_1 + n_2 + n_3$ is the total number of price changes and n_i is the number of positive, negative, and zero price changes, respectively. The standard error of M is:

$$SE(M) = \sqrt{\frac{\sum_{i=1}^{3} n_i^2 [\sum_{i=1}^{3} n_i^2 + N(N+1)] - 2N \sum_{i=1}^{3} n_i^3 - N^3}{N^2 (N-1)}} \qquad [8]$$

For large samples the distribution of the total number of runs of each type is approximately normal with mean M and standard error SE(M). The difference between the actual number of runs (R), and the expected number of runs (M), can be expressed in terms of standardized variable as:

$$K = \frac{[(R + 1/2) - M]}{SE\,(M)} \qquad [9]$$

where 1/2 in the numerator is a discontinuity adjustment factor. For large samples, K is approximately normal N(0,1) and therefore, can be used to draw inferences about the statistical significance of the observed number of runs. Positive values of K implies negative serial dependencies and vice-versa.

3.4 The Activity/Size of Stocks

The second hypothesis relates the degree of serial dependence in stock returns to the characteristics of stocks, that is, testing whether the serial dependence in stock returns systematically differs by the activity and/or size of stocks. Two procedures were used to test the hypothesis. First, the serial correlation coefficients were averaged for the most active five stocks and then compared to the average of the least traded five stocks after the stocks were ranked according to trading volume. Same was done for the first five and the last five stocks, ranked according to market capitalization.

The second procedure, used to test the association between the serial dependence in stock returns and the activity/size of stocks is the rank correlation test. For this purpose, all individual stocks were ranked according to the first order serial correlation coefficients. Then using the rankings, based on volume, rank correlation was computed between serial dependence and activity as:

$$r_{s,a} = 1 - \frac{6 \sum_{i=1}^{n} D_i^2}{n\,(n^2-1)} \qquad [10]$$

Where $r_{s,a}$ = Rank correlation between serial dependence and activity.

D_i = Difference between ranks of corresponding pairs of serial dependence and activity.

The rank correlation between serial dependence and size was calculated in the same way.

3.5 The Intertemporal Behavior

Finally, the third hypothesis deals with testing the impact of liberalization measures on market efficiency. These measures, including the opening of the market to international investors, were announced in early 1991. It can be expected that these measures improve the efficiency of the market that should be reflected in declining serial dependence over time. Hence the sample was divided into three sub-samples and the serial correlation coefficients were computed and compared to one another.

4. Empirical Results

4.1 Serial Correlation Analysis

Table 1 reports the serial correlation coefficients for the sample stocks and indices up to lag 20, along with the Ljung-Box Q-values at lag 5, 10, and 20. The table reveals that the market, in general, exhibits strong serial dependence. Only one stock, LTVC, seems to be free of any serial dependence. Both the individual coefficients of LTVC at all lags and the Q-values show no signs of autocorrelation. Interestingly, it is the most active stock in the sample, where activity is represented by the trading volume.

The overwhelming majority of positive signs of the serial correlation coefficients indicate that the market, in general, adjusts slowly to new information. This is a common characteristic also observed in other markets, particularly in emerging markets. It can be observed that the serial dependence is much higher in indices than in stocks, where not only the significance of the coefficients continues to higher lags but also the magnitudes of the coefficients are higher than those of individual stocks. Among the stocks, the higher level of serial dependence is shown in ABBOTT, MILK, BATA, DAWOOD, etc. In fact, these stocks are among the least traded stocks included in the sample. This implies that the serial dependence is affected by the trading activity of stocks and is likely to be more serious in inactive stocks.

A comparatively higher level of serial dependence in inactive stocks also explains the higher level of serial dependence observed in indices as these indices include many of, and are therefore heavily affected by, the inactive stocks. This is also mentioned by Laurance (1986).

Table 1: *Serial Correlation Coefficients by Indices and Securities for the Sample Period (Jan 89 - Dec 93)*

	LAG 1	LAG 2	LAG 3	LAG 4	LAG 5	LAG 7	LAG 10	LAG 13	LAG 17	LAG 20	LB(5)	LB(10)	LB(20)
General index	0,297 **	0,149 **	0,163 **	0,149 **	0,097 **	0,136 **	0,132 **	0,109 **	0,090 *	0,057	196,00 **	259,00 **	341,00 **
Sector indices													
1 TEXT	0,241 **	0,114 **	0,106 **	0,101 **	0,106 **	0,091 **	0,109 **	0,110 **	0,060	0,043	121,00 **	185,00 **	235,00 **
2 CHEM	0,347 **	0,218 **	0,169 **	0,146 **	0,070 **	0,028	0,066	0,116 **	0,043	0,032	259,00 **	277,00 **	331,00 **
3 SUGAR	0,162 **	0,202 **	0,155 **	0,150 **	0,135 **	0,091 **	0,046	0,025	0,027	-0,005	153,00 **	194,00 **	221,00 **
4 PAPER	0,193 **	0,115 **	0,078 *	0,015	-0,048	-0,024	0,049	0,073 *	-0,010	0,013	68,60 **	81,50 **	126,00 **
5 CEMENT	0,223 **	0,196 **	0,141 **	0,128 **	0,090 **	0,045	-0,005	0,021	0,081 *	0,018	155,00 **	161,00 **	193,00 **
6 FUEL	0,235 **	0,086 **	0,145 **	0,088 **	0,033	0,111 **	0,063	0,056	0,033	0,034	108,00 **	141,00 **	164,00 **
7 TRANS	0,086 **	0,060 *	-0,022	-0,021	0,023	0,055	-0,033	0,068 *	0,037	0,054	14,50 *	26,10 **	50,10 **
8 INSUR	0,168 **	0,094 **	0,083 **	0,043	0,111 **	0,039	0,088 **	0,042	0,099 **	0,065 *	67,80 **	81,80 **	122,00 **
Securities													
1 GRINDL	0,101 **	0,038	-0,020	-0,006	0,001	-0,031	0,031	0,061 *	0,032	0,005	14,20 *	19,50 *	34,20 *
2 LTVC	0,003	-0,015	-0,033	-0,011	-0,016	-0,033	0,016	-0,002	0,056	-0,061	1,73	9,86	23,30
3 NDLC	0,063 *	0,059 *	-0,018	-0,015	-0,048	-0,033	0,037	0,011	-0,039	0,029	12,00 *	19,20 *	24,10
4 PICIC	0,209 **	0,114 **	0,047	-0,006	0,011	0,011	0,033	-0,034	0,029	0,044	69,10 **	74,40 **	82,10 **
5 ADAMJEE	0,238 **	0,047	0,016	0,031	0,068 *	0,008	0,073 *	-0,011	0,014	-0,007	76,10 **	84,70 **	96,40 **
6 SHAHM	0,193 **	0,077 *	0,066 *	0,037	0,020	0,005	0,008	0,051	-0,022	-0,041	57,60 **	61,50 **	81,50 **
7 SHAKER	0,158 **	0,147 **	0,088 **	0,052	0,016	0,045	0,029	0,012	0,078 *	-0,024	67,10 **	75,80 **	94,60 **
8 PAKLA	0,212 **	0,085 **	-0,038	-0,094 **	-0,065 *	-0,057	-0,038	-0,023	0,111 **	-0,041	70,90 **	83,20 **	159,00 **
9 PAKT	0,090 **	0,040	0,017	0,015	-0,007	-0,033	0,017	-0,039	0,078 **	0,023	12,00 *	21,30 *	46,80 **
10 KESC	0,166 **	0,028	-0,086 **	-0,117 **	-0,020	0,041	0,026	0,020	0,057	0,027	58,20 **	65,00 **	81,30 **
11 NATR	0,274 **	0,080 *	0,012	0,006	-0,001	-0,005	0,072 *	0,001	0,042	0,040	95,70 **	104,00 **	114,00 **
12 PSO	0,119 **	0,077 **	0,093 **	0,042	0,046	-0,008	-0,043	0,069 *	0,066 *	0,030	38,10 **	44,50 **	90,30 **
13 SUIN	0,159 **	-0,015	-0,017	-0,036	0,013	0,018	0,045	0,057	-0,063 *	0,040	31,90 **	37,70 **	59,80 **
14 SUIS	0,258 **	0,102 **	-0,014	-0,018	-0,013	-0,003	-0,046	-0,048	0,017	-0,050	91,20 **	94,50 **	112,00 **
15 GENT	0,158 **	0,034	-0,046	0,042	0,021	-0,003	0,020	-0,023	0,053	-0,045	35,60 **	37,70 **	50,30 **
16 MILLT	0,207 **	0,109 **	-0,024	-0,060	-0,012	-0,007	0,022	-0,024	-0,022	-0,041	69,30 **	74,40 **	91,50 **
17 PAKSU	0,207 **	0,053	0,010	-0,020	-0,033	-0,021	0,050	0,034	-0,003	-0,001	55,20 **	62,30 **	74,40 **
18 PHILI	0,125 **	0,094 **	0,029	0,023	0,012	0,013	0,034	-0,010	0,002	0,003	30,20 **	34,30 **	62,50 **
19 PNSC	0,089 **	-0,024	-0,015	-0,013	0,002	0,024	-0,021	0,002	0,057	0,007	10,30	18,10	29,60
20 ABBOTT	0,199 **	0,224 **	0,218 **	0,128 **	0,149 **	0,063	0,079 *	0,070 *	0,013	0,017	207,00 **	266,00 **	305,00 **
21 DAWOOD	0,232 **	0,119 **	0,137 **	0,069 *	0,053	0,021	0,006	-0,000	-0,051	0,000	111,00 **	118,00 **	134,00 *
22 ENGRO	0,275 **	0,178 **	0,053	0,053	-0,036	-0,053	-0,023	-0,014	0,056	0,068 *	134,00 **	143,00 **	166,00 **
23 GLAXO	0,294 **	0,190 **	0,131 **	0,139 **	0,092 **	0,036	0,000	-0,000	0,009	-0,007	197,00 **	210,00 **	211,00 **
24 HOECHT	0,192 **	0,112 **	0,028	0,064 *	0,051	-0,015	0,054	0,065 *	-0,010	0,027	66,50 **	73,40 **	82,40 **
25 ICI	0,106 **	-0,025	0,040	0,040	-0,069 *	0,033	0,074 *	0,086 **	-0,009	0,051	23,10 **	34,90 **	68,50 **
26 RECKI	0,236 **	0,195 **	0,100 **	0,048	-0,002	0,000	-0,002	-0,076 *	-0,011	0,055	124,00 **	128,00 **	143,00 **
27 WELLC	0,208 **	0,117 **	0,071 *	0,058	-0,010	-0,034	-0,003	0,007	0,015	0,081 **	77,00 **	84,90 **	104,00 **
28 WYTH	0,293 **	0,231 **	0,158 **	0,098 **	0,130 **	0,026	0,014	0,024	0,052	0,081 *	224,00 **	241,00 **	262,00 **
29 PACK	0,200 **	0,165 **	0,051	0,094 **	0,013	-0,002	0,020	0,004	-0,045	0,065 *	92,20 **	99,90 **	113,00 **
30 BATA	0,205 **	0,107 **	0,108 **	0,077 *	0,084 **	0,059	0,038	0,033	0,056	0,045	91,70 **	105,00 **	120,00 **
31 BROOK	0,390 **	0,271 **	0,102 **	0,117 **	0,061	0,062	0,014	0,061	0,004	-0,023	297,00 **	317,00 **	331,00 **
32 LEVER	0,230 **	0,010	-0,038	0,025	-0,041	-0,020	0,033	0,001	-0,024	-0,001	66,30 **	74,20 **	89,60 **
33 MILK	0,341 **	0,339 **	0,251 **	0,197 **	0,148 **	0,086 *	-0,018	-0,025	-0,031	-0,072	416,00 **	457,00 **	473,00 **
34 RAFHAN	0,193 **	0,122 **	0,095 **	0,059	0,061	-0,022	0,003	0,045	-0,043	-0,013	80,30 **	86,40 **	97,70 **
35 SHEZ	0,161 **	0,061	0,051	0,023	0,010	-0,105 **	-0,003	-0,026	0,065 *	0,015	34,10 **	51,60 **	72,10 **
36 BALOCH	0,042	0,015	-0,080 **	-0,013	-0,008	-0,017	-0,022	-0,021	0,002	-0,017	10,20	18,30	20,60

Notes: 1 LB(k) is the Ljung Box Q statistics at lag k; 2. ** and * indicate significance level at 1% and 5% respectively.

4.2 Cross Correlation Analysis

Another factor that causes higher serial dependence in indices is cross correlations among stock returns. To examine the effects of cross correlations, four stocks, GRINDL, NDLC, PICIC, and ADAMJEE were taken. These stocks belong to the Insurance (INS) sector and do not seem to be highly serially correlated. However, the sector index (INS) shows a higher level of serial dependence. The cross correlations among these stocks are reported in Table 2.

Table 2 reports the Ljung-Box Q statistics for three hypotheses. The first hypothesis tests whether the correlations between the return of a stock and the lagged returns of other stocks are zero. Specifically, whether all the correlations up to lag 10 are zero. Similarly, the second hypothesis tests whether all the correlations between a series and up to 10 period lead of other series are zero. Finally, the third hypothesis tests the cross correlations between a series and the lagged and lead values of other series. The table shows significant cross correlations among stock returns. Although the insurance sector consists of about 30 stocks, these four stocks give some idea of the effects of cross correlations.

Table 2: *Cross Correlations among Stok Returns for the Sample Period (Jan 89 - Dec 93)*

Panel A: **Q-Values (Lags 1 to 10)**			
	GRINDL	NDLC	PICIC
NDLC	25,290**		
PICIC	12,240	18,220	
ADAMJEE	25,310**	43,540**	27,080**
Panel B: **Q-Values (Leads 1 to 10)**			
	GRINDL	NDLC	PICIC
NDLC	17,890		
PICIC	58,830**	22,280*	
ADAMJEE	25,290**	13,090	39,250**
Panel C: **Q-Values (Lead 10 to Lag 10)**			
	GRINDL	NDLC	PICIC
NDLC	74,270**		
PICIC	157,820**	52,670**	
ADAMJEE	81,720**	81,500**	88,660**

Note: ** and * indicate significance level at 1% and 5% respectively

It can be inferred from the above analysis that the cumulative effects of serial correlations due to the inclusion of inactive stocks and cross correlations among stock returns aggravate the serial dependence in sector indices.

4.3 Runs Analysis

An alternative test to examine the serial dependence is the Runs test. The test was performed for all the sample stocks and indices. The results are shown in Table 3. It can be seen that the absolute value of K is greater than 1.96 for all stocks and indices, except for LTVC, indicating the existence of serial dependence in the market. This confirms the earlier result that LTVC is the only stock in the sample with no serial dependence. Moreover, the expected number of runs are greater than the actual number of runs in all cases, implying negative values for k, and hence suggesting positive serial dependence. Thus the runs tests verify the results found earlier.

Table 3: *Runs Analysis by Indices and Securities (Jan 89 - Dec 93)*

	Actual Runs (R)	Expected Runs (M)	Standard Error (M)	K
General index	424	578	16,85	-9,09 **
Sector indices				
1 TEXT	451	583	16,96	-7,75 **
2 CHEM	384	575	16,73	-11,39 **
3 SUGAR	466	584	16,95	-6,93 **
4 PAPER	493	584	16,81	-5,36 **
5 CEMENT	499	590	16,79	-5,39 **
6 FUEL	469	580	16,93	-6,54 **
7 TRANS	558	626	16,34	-4,11 **
8 INSUR	484	581	16,96	-5,71 **
Securities				
1 GRINDL	619	694	16,01	-4,64 **
2 LTVC	616	629	14,91	-0,83
3 NDLC	672	764	15,99	-5,72 **
4 PICIC	625	758	15,96	-8,28 **
5 ADAMJEE	620	755	15,88	-8,46 **
6 SHAHM	612	780	16,10	-10,38 **
7 SHAKER	552	759	15,82	-13,06 **
8 PAKLA	546	683	15,14	-9,03 **

Continued next page

Table 3 *continued*

9 PAKT	637	776	16,07	-8,64 **
10 KESC	641	729	15,91	-5,47 **
11 NATR	594	751	15,93	-9,82 **
12 PSO	622	750	15,88	-8,05 **
13 SUIN	611	774	16,05	-10,11 **
14 SUIS	585	768	16,01	-11,42 **
15 GENT	611	769	16,01	-9,82 **
16 MILLT	591	769	16,01	-11,06 **
17 PAKSU	624	753	15,94	-8,05 **
18 PHILI	595	769	16,01	-10,84 **
19 PNSC	670	745	15,91	-4,69 **
20 ABBOTT	552	735	15,61	-11,70 **
21 DAWOOD	525	710	15,03	-12,26 **
22 ENGRO	583	777	16,06	-12,04 **
23 GLAXO	618	772	16,03	-9,55 **
24 HOECHT	615	772	16,03	-9,78 **
25 ICI	667	745	15,92	-4,87 **
26 RECKI	558	770	16,02	-13,21 **
27 WELLC	581	776	16,06	-12,12 **
28 WYETH	562	735	15,58	-11,07 **
29 PACK	640	775	16,05	-8,36 **
30 BATA	619	770	16,02	-9,43 **
31 BROOK	525	771	16,01	-15,37 **
32 LEVER	594	763	15,97	-10,57 **
33 MILK	519	685	14,69	-11,23 **
34 RAFHAN	617	766	15,95	-9,30 **
35 SHEZ	513	672	14,91	-10,61 **
36 BALOCH	672	767	16,00	-5,87 **

Note: K is the standardized variable, distributed normally as N(0,1)

4.4 Activity/Size of Stocks

It was noted earlier that the nature of serial dependence differs across the stocks. The next step was to examine whether these differences can be explained by the size and/or activity of these stocks. Two procedures were used for this purpose. First, the serial correlation coefficients were averaged for the five most active and the five least traded stocks and compared. This was repeated for the five large and five small stocks.

The comparison is shown in Table 4, that shows significant differences in correlation coefficients between active and inactive stocks, particularly at lower lags. The re-

sults suggest that the activity of a stock is an important factor in the presence of serial dependence and that the active stocks are less likely to exhibit serial dependence. On the other hand, the size of a stock does not appear to have any significant effect on serial dependence.

Table 4: *Average Absolute Coefficients by Activity and Size of Stocks*

	ACTIVITY		SIZE	
	Active 5	Inact 5	Large 5	Small 5
LAG 1	0.098	0.254	0.178	0.138
LAG 2	0.031	0.204	0.041	0.080
LAG 3	0.035	0.174	0.040	0.078
LAG 4	0.037	0.114	0.030	0.036
LAG 5	0.020	0.113	0.034	0.037
LAG 6	0.032	0.096	0.027	0.054
LAG 7	0.031	0.051	0.017	0.037
LAG 8	0.034	0.067	0.033	0.038
LAG 9	0.030	0.037	0.025	0.037
LAG 10	0.031	0.031	0.053	0.012
LAG 13	0.030	0.030	0.043	0.025
LAG 17	0.049	0.041	0.041	0.039
LAG 20	0.032	0.043	0.032	0.043
LB(5)	23.61	209.94	51.02	65.53
LB(10)	30.25	237.40	59.06	76.45
LB(20)	44.54	258.80	84.44	91.90

Note: LB(k) is the Ljung-Box Statistic at lag k

Second, rank correlations between the serial dependence and the activity of stocks and between the serial dependence and the size of stocks were computed. The individual stocks were ranked according to the magnitude of first order serial correlation coefficients. Then using the rankings based on trading volume and market capitalization, rank correlations were computed for activity and size of stocks and are reported in Table 5.

The table shows a significant negative rank correlation between serial dependen-

ce and activity, confirming the earlier result that the serial dependence is likely to be more serious in less active stocks. Similarly, an insignificant correlation between serial dependence and size of the stocks verifies that the size of a stock is not associated with the presence of serial dependence.

Table 5: *Rank Correlation Statistics by Activity and Size*

Case	Rank Cor	Se(r)	Z-value
Activity	- 0.5359	0.1690	- 3.17**
Size	0,2234	0.1690	1.32

Note: ** indicate significance level at 1%

4.5 Intertemporal Behavior

To examine whether serial dependence changed over time, serial correlations were computed for the three sub-samples. The results (not reported here due to lack of space) indicate significant changes in serial dependence over time in the case of sector indices. For individual stocks the situation seems to be roughly the same in all the periods. In the case of indices the serial dependence increased significantly in the second period. For example, in the case of General Market Index, the coefficients were significant up to lag 4 in the first period, but in the second period the number of significant coefficients increased up to lag 13. Similarly, the textile index had no signs of serial dependence in the first period but showed a higher level of serial dependence in the second period.

The situation improved, however, in the third period where the extent of serial dependence decreased and the number of significant coefficients reduced to lag 3 or 4. It appears that the serial dependence increased in the period immediately after the market was opened and then reduced after one year. This pattern is similar to the patterns of average returns and volatility found by Husain and Uppal (1998) and indicates the possibility of some links between volatility and serial dependence.

4.6 Comparison with other Markets

Finally it would be useful to compare the results of the Pakistani market with those of the other markets. Such a comparison is shown in Table 6. The table compares

the first order serial correlation coefficients found in various markets and provides information on the average as well as the number of positive and significant coefficients. The table also reports the number of stocks used in these studies. The terms in the parenthesis show the percentages of corresponding stocks in total stocks, e.g., in the study by Fama for the US market 22 of 30 stocks (i.e. 73%) had positive signs and 11 of 30 stocks (i.e. 37%) had significant coefficients.

Table 6: *Serial Correlation Coefficients Reported for Various Markets*

Study	Country/ies	No. of Stocks	Average Coeff.	Positive Terms	Coeff. > 2 Sd
Fama(1965)	USA	30	0,026	22(73)	11(37)
Solnik(1973)	France	65	-0,019	33(51)	41(63)
	Italy	30	-0,023	14(47)	9(30)
	UK	40	0,072	34(85)	21(53)
	Germany	35	0,078	28(80)	23(66)
	Nederland	24	0,031	17(71)	9(38)
	Belgium	17	-0,018	7(41)	5(29)
	Switzerland	17	0,012	11(65)	4(24)
	Sweden	6	0,056	3(50)	1(17)
Conrad & Juttner(1973)	Germany	54	-0,142	25(46)	39(72)
Jennergren & Korsvold(1975)	Norway	15	0,068	13(87)	8(53)
	Sweden	30	0,098	29(97)	26(87)
Laurance(1986)	Malaysia	16	0,039	13(81)	5(31)
	Singapore	24	0,057	17(71)	19(79)
Butler & Malaikah(1992)	Kuwait	36	0,053	25(69)	13(36)
	Saudi Arabia	35	-0,471	0(00)	35(100)
Aybar(1992)	Turkey	41	0,138	NA	38(93)
Present Study	Pakistan	36	0,190	36(100)	34(94)

Note: Terms in paranthesis are the percentages of corresponding stocks in total stocks e.g. 22/30 = 73%

It can be seen from Table 6, that Pakistani market has the highest magnitude of average coefficient after Saudi Arabia which has an unusually high magnitude. The significance of the coefficients varies across the markets. Although, a high proportion of significant coefficients are shown in emerging markets, Pakistan, Saudi Arabia, and Turkey,

some of the developed markets Sweden, Singapore, and Germany also show considerable level of significance. Regarding the signs, it seems that the equity markets, in general, exhibit positive coefficients indicating slow adjustment to new information.

5. Summary and Conclusion

The objective of the paper was to test the weak form hypothesis of market efficiency in the Pakistani equity market. Using daily closing prices of 36 individual stocks, 8 sector indices and the market index from January 1, 1989 to December 30, 1993 and applying serial correlation and runs analysis various hypotheses regarding market efficiency were tested .

The results suggest that the market, in general, exhibits strong serial dependence. The extent of serial dependence, however, differs between sector indices and individual stocks where the indices show a much higher serial dependence. Therefore, using index data to examine serial dependence may not be appropriate. Further, the factors responsible for serial dependence in stock returns appear to be infrequent trading and stock returns volatility.

A comparison of serial dependence over different sample periods shows that the serial dependence increased significantly when the market was opened, but decreased after one year of opening. This pattern is similar to the behavior of return and volatility found by Husain and Uppal (1998) and suggests a possible link between volatility and serial dependence. In fact, it is argued in the literature ,e.g., Errunza et. al (1994), that the extent of serial dependence is overestimated in the presence of volatility.

The analysis also indicates that the Pakistani market, like other emerging markets, adjusts slowly to new information. This points to the weaknesses of the market regarding the dissemination of the relevant information to potential investors suggesting that effective measures should be taken to develop systems which facilitate dissemination of pertinent information. Strict rules should be set and imposed to enforce timely and relevant information releases. Even if the information is available it is not effective until a thorough analysis of available information is done, so that the investors are advised on the basis of sound financial analysis rather than on informal tips or intuition. An effective measure may be the setting up of an equity market research center and data bases, where the pertinent information could be easily and quickly accessible to the public.

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Abstract

This paper tests the weak form efficiency hypothesis in the Pakistani equity market. Using daily closing prices of 36 stocks, 8 sector indices, and the market index from January 1, 1989 to December 30, 1993 and applying Serial correlation and Runs analysis, the paper does not find the market to be efficient. The market exhibits strong serial dependence and the factors responsible appear to be infrequent trading and stock returns volatility. The intertemporal behavior of serial dependence suggests that the serial dependence increased significantly when the market was opened to international investors but started to decrease after a year. The analysis indicates that the Pakistani market adjusts slowly to new information. This points to the weaknesses of the market regarding the dissemination of pertinent information to potential investors, suggesting that effective measures should be taken in this regard.