“Lead lag Relationship: Analysis of KSE”

Arsalan Siraj Mir¹, Atta-ur-Rahman²

Abstract

This research paper finds the lead lag relationship between the firms listed on the KSE-100 index. Lead lag relationship is analyzed between large and small capitalization portfolios. Moreover, up market and down market conditions are also explored for finding out the lead lag relationship in the KSE-100 index. Autoregressive Conditional Heteroskedasticity model is used for finding out the effect of symmetric and asymmetric betas on small cap portfolio returns. The results show that there is no lead lag relationship between small cap portfolios and large cap portfolios when the market is not divided into up and down markets. For the asymmetric beats, the analysis shows that there is lead lag relationship between small cap portfolio returns and lagged large cap portfolio returns in the up market. On the other hand, large cap portfolio returns lead small cap portfolio returns in the down market.

1. Introduction:

This research is based on finding out the lead lag relationship between companies listed on the KSE-100 index. Lead lag relationship between firms in this study is obtained by classifying the firms as large or small depending on their market capitalizations. A company with high market capitalization is regarded as a large firm and a company with low market capitalization is regarded as a small firm. Finding out the lead lag relation within an industry or on the stock exchange helps the investors and researchers in a number of ways. The general trend is that large firms usually lead small firms (Lo and MacKinlay, 1990; Chan, 1993; Chordia and Swaminathan, 2000). However, there is evidence in the literature that some markets have different trends with regards to lead lag relationship (McQueen, Pinegar and Thorley, 1996; Chui and Kwok, 1998). This study empirically tests the data of KSE-100 index in order to find out the lead lag relationship between large portfolios and small portfolios.

2. Literature Review:

This discussion commences by looking into studies conducted for finding the autocorrelation between large and small portfolios. The researchers from a number of perspectives have examined this topic. Some researchers have followed the route of testing lead lag relation between large and small portfolios, while others have analyzed the data based on the response of varied size portfolios in the event of diffusion of

¹ Institute Of Management Sciences Peshawar, Pakistan. Email: arsalan.siraj.mir@gmail.com
² PhD, Assistant Professor Institute Of Management Sciences Peshawar, Pakistan.

new information in the market. Large firms obtain information quickly as compared to the smaller firms due to the fact that the cost of acquiring new information for the large firms is lower as compared to the cost incurred by smaller firms (Ho and Michaely, 1988). A number of factors can be considered in the support of this finding, such as the credibility of the large firms and their market share as well.

The relationship between large stocks and small stocks exists according to a study conducted by Lo and MacKinlay (1990), in which they have argued that large firms lead small firms. Similarly, Lo and MacKinlay (1990) and Chan (1993) state that new information in the market affects large firms before the small firms. In addition to that, the quality of signal possessed by large companies is superior to small firms. Similarly, covariance between past and current returns of large firms is higher as compared to small firms.

By the application of Iterative Seemingly Unrelated (ITSUR) model, for analyzing cross correlation between the A type (meant for local investors) stocks and B type stocks (meant for foreign investors), the result is that B type stocks lead the A type stocks (Chui and Kwok, 1998). It is to be noted here that A-type stocks include stocks of large firms, while B type stocks contain stocks of small firms. The result of this study leads to an opposite view on the general consensus that large firms lead small firms. McQueen, Pinegar and Thorley (1996) also argue that small firms respond to bad news as quick as the larger firms. Response of larger firms has been verified to be quicker than the smaller firms in this study. One of the major studies in the field of lead lag relation between stock market index returns and those of a corresponding index option has been conducted by Fleming, Ostdiek and Whaley (1996) as they focused on index option market and S&P 100 cash market. The results showed that index options lag futures but lead cash market. This conclusion supported the hypothesis, which stated that the induction of lead and lag is achieved due to relative costs of trading in different markets.

Chordia and Swaminathan (2000) tested size effect through the analysis of autocorrelation between stocks of low volume and those of high volume show that returns of high volume stocks can be used for predicting the returns of low volume stocks. VAR model was used for analysis in the aforementioned study. The reason for high volume stocks' ability to predict the returns of low volume stocks is that returns of high volume stocks show quicker response to new information in the market. It has also been confirmed by Kanas and Kouretas (2001) that co-integration exists between small portfolios and large portfolios in the London Stock Exchange. The study also showed that large portfolios lead small portfolios but there is no bilateral relation between the two in this process. The cross correlation investigation of the Chilean stock exchange (Marshall and Walker, 2002) confirms that the effect of good as well as

bad news is much more profound on large portfolios as compared to small portfolios.

Altay and Diskussionsbeiträge (2003) have tested cross autocorrelation in the Istanbul and German Stock Exchanges by using ITSUR model for a period of 10 years i.e. 1993 to 2002. In case of German Stock Exchange, the lead behavior of large stocks was confirmed for the entire two periods. On the other hand, Istanbul Stock Exchange exhibited no cross autocorrelation in the second period. The reason for this deviation can be attributed to the financial crisis of 2001 in Turkey. The large and small portfolios of the European countries, when analyzed using Granger causality (Granger, 2001) and cross autocorrelation for a period of 10 years i.e. 1990 to 1999, show that large portfolios lead small portfolios (Ratner, Meric and Meric 2004; Wang and Pearson, 2006). Thus, it can be safely assumed that, in the presence of normal market conditions, the trend would be that large firm would lead small firms due to information being diffused quickly by the large firms.

In his research study, Wan (2006) applied Generalized Auto-Regressive Heteroskedasticity (GARCH) on the Chinese Stock Exchange. He conducted the study for finding cross autocorrelation between A-type portfolios and B-type portfolios. The results show that A-type portfolios lead B-type portfolios. These results, however, were contradictory to the findings of an earlier study conducted on the same market by Chui ve Kwok (1998). A recent study conducted by Kayali and Akarim (2011) for a period of 3 years i.e. 2006 to 2009 on the Turkish Stock Exchange show similar results to the previous studies that large portfolios lead small portfolios. There have been a number of papers based on the analysis of participating portfolio returns of the industry for the purpose of predicting movements in the stock market. Thenmozhi (2002) analyzed the U.S. stock market which consisted of two parts. The first part was meant of analyzing the market from the year 1946 to 2002 i.e. 57 years. The total sample consisted of 34 industries. The analysis confirmed that out of 34 industries, prediction was prevalent among 14 industries but it was limited for up to a month. The industries, which could predict market movement for a period of one month included retail, services, real estate, financial, metal and petroleum. There were still other industries, which could extend the period of prediction to 2 months.

2.1 Efficient Market Theory:

An efficient market is considered to be that market, where all the information is readily available and utilized for ensuring that the spot, future and securities market price moves simultaneously with no delay whatsoever. This perfect scenario is hampered by the presence of microstructure in the capital market, transaction costs and so on (Debushish and Mishra, 2008). This means that the absence of friction in the market would ensure that actual information is reflected in the price of securities as

well as the derivatives that are offered in the market. Similarly, arbitrage opportunities would arise without incurring costs. But this is not the case and a number of frictions assist in the lead or lag of prices in the same market.

Debushish and Mishra (2008) conducted a study on the Indian market for the examination of lead lag relation between options and futures contracts and NSE NIFTY index. The results indicated that derivatives market of the NSE NIFTY index lead the stock index which was underlying. Similarly, there was a significant difference in the call and put prices of the indices with regards to their reaction towards information. The mentioned difference was in comparison to the reaction of futures and cash markets. The study also stressed on the importance of expectations by the investors, which is also a key factor in lead lag relation.

There have been a number of researches, which have argued that the lead lag relation is best exhibited within the same industry. The intra-industry trend, according to Hou (2007), is that returns of large firms lead the returns of small firms. He argued that the main cause of this trend is the difference in the adaptability of the firms to negative information. Similarly, the aforementioned lead lag effect is also exhibited in the news of earnings announcement. As mentioned earlier, ideal scenario is based on the presence of a frictionless market. But in reality, a number of frictions lead to the slow adjustment of stock prices to new information. Hou (2007) also find that once effect of large firms leading small firms within an industry is accounted for, the lead lag relation cannot be found across industries.

The patterns of lead and lag across stocks can also be caused by difference in levels of time variation for forecasted returns (Hameed, 1997). An argument regarding the above statement is that cross autocorrelations, which are asymmetric, could be explained much better by the highly contemporaneous correlation across portfolios and their autocorrelations (Kewei Hou, 2002). Lo and Mackinlay (1990) have attributed the effect of lead and lag to common information diffusing slowly from large to small firms within an industry.

It has been argued that lead lag effect between firms of high volume and those of low volume is due to the slow adjustment of low volume firms to the common information (Chordia and Swaminathan, 2000). These findings have been further proved by Hou (2007), when he concluded in his study that intra industry lead lag effect is caused by slow diffusion of common information. During this diffusion, large firms respond comparatively quicker and effectively. This trait leads to lead lag relation within the industry.

Mech (1993) has shown that prices of stocks respond to information more quickly

in the situation when change in price is large in relation to bid ask spread. Similarly, Chen (1993) presented a model in which he proved that asymmetric auto correlation arises due to cross sectional difference in signal quality. His model was structured on the basis of incomplete information. Peng (2002) constructed a model, which converted the incomplete information into a constraint of information capacity. This constraint, when faced by the investor, leads to a delay in the process of price adjustment.

Large firms as opposed to small firms carry out the price adjustment of stocks swiftly. The reason for this feature is that size of the firm correlates highly with variables like trading volume, institutional ownership and the amount of analysts taking interest in the operations of the firm (Chordia and Swaminathan, 2000). The method by which prices are adjusted to accommodate the information has been the main cause of concern in modern finance literature. As mentioned before, a frictionless market allows rapid diffusion of new information into the industry. The first study, which showed the existence of friction in the market, was that of Lo and Mackinlay (1990b). Such frictions impede the proper flow of information into the market prices. They showed that correlation between current returns of small firms and lagged returns of large firms is greater as compared to the correlation between lagged returns of small firms and current returns of large firms. There have been a number of studies, which presented their own explanation for this phenomenon.

One type of explanation is that lead and lag is a result of trading, which is non synchronous. The basic idea behind this explanation is that information, which has already shown its effect on prices of large firms' stocks, is reflected in the prices of small firms' stocks once they are open to trade. The trade of small firm stocks would take place with a lag due to the effect of thin trading. Another explanation is that cross autocorrelation is simply restated contemporaneous correlation and portfolio autocorrelation (Hameed, 1997). The third explanation is that risk premium, which is time varying, lead to the prediction of returns on the stocks of small firms (Conrad and Kaul, 1988).

The above three explanations have been dismissed by Chordia and Swaminathan (2000) by arguing that such explanations have not accounted for the lead and lag phenomena. They further stated that such explanations only show support for speed of adjustment hypothesis. This hypothesis states that lead and lag is caused by difference in speeds of stock adjustment to shocks in the economy through new information. Some stocks have the ability to adjust faster than others and hence lead lag effect occurs. If that is the case, then there can be two cases. Either lead-lag is caused by the swift adjustment of large firms' stocks or due to slow adjustment of small firms' stocks. The low trading costs of large stocks suggest that information is first reflected

in larger stocks. But Mech (1993) has stated that the high costs associated with small stocks are the cause of lead-lag effect.

In the recent past, it has been suggested that liquidity is a big factor in relation to efficiency of the market. Hou and Moskowitz (2005) also argue that liquidity is closely related to the speed with which information is incorporated into the financial market. This study has focused on own stock or own sector linkages between liquidity measures and market efficiency. Chordia, Sarkar and Subrahmanyam (2007), on the other hand, have attempted to understand the causes of patterns in the lead-lag effect through the exploitation of dynamic relation between returns, volatility and liquidity as shown by Chordia, Roll and Subrahmanyam (2001).

The own asset liquidity cannot explain cross sectional returns predictability (Hou and Moskowitz, 2005). It has also been suggested by Chordia, Sarkar and Subrahmanyam (2007) that liquidity should be regarded as a major factor in the explanation of inefficiency in the market. In addition to that, liquidity spillover among different classes of assets should be included in the explanation of inefficiency.

2.2 Karachi Stock Exchange:

Scholar (2010) have carried out a research on KSE in order to find out the lead lag relation, which exists between portfolios of large capitalization and those of small capitalization. Our research is partly based on this study as it deals with companies traded on KSE and has classified firm size on the basis of market capitalization. The aforementioned study has conducted observations on monthly basis and the returns of small and large cap firms have been monitored. Initially, companies, which were ranked on the basis of average weighted market capitalization, have been selected in this study. In addition to that, the researchers also selected five small and large cap portfolios having the lowest and highest market capitalization in on the KSE respectively. The data period is ten years i.e. from the beginning of 2000 to the end of 2009. This period was the most unpredictable in KSE history as it went through a number of shocks and breakthroughs.

The analysis of data in the study conducted by Scholar (2010) shows negative correlation between all the selected autocorrelation orders. The first order autocorrelation showed the existence of significant lead lag relationship between large and small cap portfolios. The second order autocorrelation showed a similar statistical significance for both large and small portfolios. The third order autocorrelation shows significance only for large cap portfolios. This is due to the fact that small portfolios adjust its prices quickly to new information. Further results of our analysis would be compared with this study and others of similar nature in order to report on any

similarities or differences that might arise.

3. Research Methodology:

The research paper is based on quantitative technique. Data is gathered for firms listed on the KSE100 and is then divided into two groups i.e. small firms and large firms based on their market capitalization. Information diffusion for up market as well as down market is also tested during the analysis. Statistical analyses are conducted entirely through Gretl.

3.1 Sampling technique and data collection:

Daily share prices data is collected from July 2003 to October 2010, for each year kse100 listed companies were observed, in the available period common stocks on kse100 were selected according to the availability for maximum time period. In the end 100 stocks were selected for time period July 2005 to October 2010 i.e. 1390 observations for stock ($n=1,2,3...100$).

Companies have been sorted through market capitalization value for finding small market cap and large market cap companies. Returns have been calculated for companies and market. All the stocks are sorted according to market capitalization and then divided into three groups small medium and large. Small and large group consists of 40 stocks. Portfolios are formed and then analyzed.

The variables are analyzed through Auto-Regressive Conditional Heteroskedasticity (ARCH) model to find out lead-lag between small and large cap portfolio. The first equation analyzes small cap portfolio with large cap portfolio and lagged large cap portfolio. The second equation includes up and down market for large cap portfolio along with up and down market for lagged large cap portfolio as the independent variables.

3.2 Variables:

The variables used in analyses are the following.

- Returns of small market capitalization portfolio ($r_{s,t}$)
- Returns of large market capitalization portfolio ($r_{l,t}$)

The KSE-100 index companies were divided into small and large portfolios on the basis of their market capitalization for each year. In order to specify up and down market effect in the data set, dummy variables were introduced. The down market effect was cancelled while estimating up market returns. Similarly, dummy variable

was used to extract down market portfolio from the data.

3.3 Hypotheses:

Null hypothesis

H_o^1 : Large cap firms do not lead small cap firms.

H_o^2 : $\beta_0^{UP} = \beta_0^{down}$

H_o^3 : $\beta_1^{UP} = \beta_1^{down}$

4. Statistical Analysis:

KSE stocks analyses results are summarized below. Companies with small market capitalization portfolio have been analyzed with large market capitalization portfolio using the ARCH model indifferent scenarios. Table 1 shows the Summary statistics of the variables i.e. small and large portfolio as well as large portfolio in up and down market.

The summary statistics in the above table shows the mean and median values. Maximum return in the up market was 3.792 while the maximum return in down market was 0. On the other hand, minimum returns in up and down markets were

Summary statistics				
	Small portfolio	Large portfolio	Large up	Large down
Mean	0.0010556	0.0035378	0.0075134	-0.0039756
Median	0	0.00059394	0.00059394	0
Minimum	-0.11356	-0.045949	0	-0.045949
Maximum	0.064932	3.792	3.792	0
Standard deviation	0.012629	0.10273	0.10215	0.007778
C.V.	11.964	29.039	13.595	1.9564
Skewness	-0.086647	36.274	36.789	-2.4795
Ex. kurtosis	7.5722	1335.1	1360.4	6.0868

0 and -0.045949 respectively.

Symmetric Beta:

In Table Panel A shows results using ARCH model (Autoregressive Conditional Heteroskedasticity) for finding the cross-autocorrelation which was discovered by Lo

and MacKinlay (1990a) using the following model.

$$\begin{aligned} r_{s,t} &= \alpha + \beta_0 r_{l,t} + \beta_1 r_{l,t-1} + \varepsilon_t \\ \varepsilon_t &\sim N(0, h_t), \quad h_t = \gamma_0 + \gamma_1 \varepsilon_{t-1}^2 \end{aligned} \quad (1)$$

Using the ARCH model, $(r_{s,t})$ Returns of small cap stock portfolio are regressed with $(r_{l,t})$ return of large cap stock portfolio and lagged $(r_{l,t-1})$ large stock portfolio.

Results of the Panel A indicate that the coefficient of large cap portfolio is 0.00398044 while the coefficient of large cap lagged portfolio is -0.000609038. Their

Panel A: Symmetric beta				
α	β_0	β_1	γ_0	γ_1
0.0010633	0.00398044	-0.000609038	0.0001192	0.305783
0.0006 ***	0.1676	0.8514	5.64e-75 ***	5.69e-07 ***

p-values are 0.1676 and 0.8514 respectively which are greater than 0.05. The value of coefficient γ_1 is statistically significant, which shows that future volatilities depend on current volatilities. The extent to which future volatilities are affected by current volatilities is 30% (0.305783). Thus, there is no evidence of lead lag relationship between the small and large cap portfolios of KSE-100 index from these results.

Asymmetric Beta:

Rozeff and Kinney (1976) and Keim (1983) specification is used for finding the consequence of separate up and down market and their lagged betas. Model used on Panel B is as follows.

$$\begin{aligned} r_{s,t} &= \alpha + \beta_0 r_{l,t} + \beta_1 r_{l,t-1} + UP(\alpha^{UP} + \beta_0^{UP} r_{l,t} + \beta_1^{UP} r_{l,t-1}) \\ &\quad + down(\alpha^{down} + \beta_0^{down} r_{l,t} + \beta_1^{down} r_{l,t-1}) + \varepsilon_t \\ \varepsilon_t &\sim N(0, h_t), \quad h_t = \gamma_0 + Up \gamma_0^{UP} + down \gamma_0^{down} + \gamma_1 \varepsilon_{t-1}^2 \end{aligned} \quad (2)$$

In above equation 2 (β_0^{UP} and β_0^{down}) are coefficient of large cap stock portfolio in up and down market respectively and lagged large cap portfolio returns coefficient are β_1^{UP} and β_1^{down} in up and down market respectively.

The second analysis is carried out to find out lead lag relationship in up and down market between large and small cap portfolios. The up and down market portfolios are created for the large cap portfolio and lagged large cap portfolios. Results of the

analysis show the existence of lead lag relationship between small and large cap portfolios in down market with a p-value of 1.82e-36. On the other hand, the analysis for lead lag relationship between small cap portfolios and lagged large cap portfolios

Panel B: Asymmetric beta						
α	β_0^{UP}	β_0^{down}	β_1^{UP}	β_1^{down}	γ_0	γ_1
0.0044296	0.00124737	0.00777557	0.00115873	1.49E-05	0.000107178	0.295442
5.16e-22 ***	0.6463	1.82e-36 ***	0.0692 *	0.9805	8.44e-80 ***	1.80e-07 ***

show the presence of lead lag relationship in up market with a p-value of 0.0692. The effect of current volatilities on future volatilities (γ_1) is also significant having a value of 0.295442. Therefore, it can be said that small cap portfolio returns depend on returns of large cap portfolios in down market. However, lead lag relationship exists between small cap portfolios and lagged large cap portfolios in up market.

Panel C shows calculated values of t-statistics for hypothesis. The calculated values were greater than tabulated values, which mean that null hypothesis in both the cases were rejected. For $\beta_1^{UP} = \beta_1^{down}$, null hypothesis is rejected at 10% significance level.

5. Conclusion:

Panel C: Test Statistics
$\beta_1^{UP} = \beta_1^{down}$
t-statistics = 19.05753
$\beta_1^{UP} = \beta_1^{down}$
t-statistics = 1.7395

This research signifies that lead lag relationship exists between small and large firms on the KSE-100 index. However, under normal conditions when market is not distinguished as up or down, there is no evidence of lead lag relationship. This can be seen from the results of the first analysis. When the large cap portfolio is and lagged large cap portfolio is further divided on the basis of market conditions (up and down), the results become quite interesting. It can be observed from the findings in this study that large cap portfolios lead small cap portfolios in down market. The reason for this trend is that when the market is down, smaller firms retreat slightly in terms of their operations in order to reduce the losses. Large firms, on the other hand, try to make the most out of the adverse conditions as they have the resources to compete in such situations.

On the other hand, small firms' returns are not reliant on the current returns of large firms in up market. This is because when the market is improving, small firms tend to take more risks, as they are aware of the rewards an increase in trading volume would provide. The results of this study also show that returns of small firms rely on the lagged returns of large firms in up market. Therefore, it can be concluded in the end that lead lag relationship exists between small and large portfolios on the KSE-100 index. However, large portfolio leads small portfolio in down market while lagged large portfolio leads small portfolio in down market.

The results of this study are consistent with the researches of Lo and MacKinlay (1990), Fleming et al. (1996), Kanas and Kouretas (2001), Kewei Hou (2002), Ratner et al. (2004), and Kayali and Akarim (2011). These studies have verified the trend of large firms leading small firms and industry returns leading market returns.

It can be concluded in the end that the general trend for lead lag relationship, barring any market anomaly, remains the same throughout different market around the world i.e. large firms lead small firms but the conditions for such relationship may vary. This is because our results show that in up market-lagged returns of large firms lead small firms. On the other hand, in down market, current returns of large firms lead small firms.

The results of this study shows somewhat similar trend in the lead lag relation as observed by previous researches, which were based on different markets. This study should be considered as a step towards elaborating the lead lag relation in the KSE-100 index and further research would be required in order to verify and confirm these results. The reason is that once tested using all the available statistical tools, it can be safely concluded that such a trend exists. Similarly, future researches in this field can opt for another indicator apart from market capitalization as the basis for classifying firms as large and small.

Market conditions change the pattern, which is followed by stock returns. Therefore, further study is essential in determining the general trend as the data period selected in this study might reflect a stagnant market, where changes have been either absent or few and far between. Once a considerable literature exists, investors and researchers would easily make up their minds regarding the lead lag relation that exists in the KSE-100 index. This research should be considered as the initiation of further researches in the future regarding the Pakistani market due to the absence of researches in this field. The study conducted on the KSE-100 index prior to this research has been that of Scholar (2010). For a market that faces considerable shifts in terms of returns, further research is the need of the hour.

References:

- Altay, E., & Diskussionsbeiträge, B. (2003). Cross autocorrelation between small and large cap portfolios in the German and Turkish stock markets. Univ., Wirtschaftswiss. Fak..
- Brooks, C. (2008). Introductory econometrics for finance. Cambridge university press.
- Chan, K. (1993). Imperfect Information and Cross-Autocorrelation among Stock Prices. *The Journal of Finance*, 48(4), 1211-1230.
- Chang, E. C., McQueen, G. R., & Pinegar, J. M. (1999). Cross-autocorrelation in Asian stock markets. *Pacific-Basin Finance Journal*, 7(5), 471-493.
- Chordia, T., & Swaminathan, B. (2000). Trading volume and cross-autocorrelations in stock returns. *The Journal of Finance*, 55(2), 913-935.
- Chui, A. C. W., & Kwok, C. (1998). Cross-autocorrelation between A shares and B shares in the Chinese stock market. *Journal of Financial Research*.
- Dickey, D. A., & Fuller, W. A. (1981). Likelihood ratio statistics for autoregressive time series with a unit root. *Econometrica: Journal of the Econometric Society*, 1057-1072.
- Fleming, J., Ostdiek, B., & Whaley, R. E. (1996). Trading costs and the relative rates of price discovery in stock, futures, and option markets. *Journal of Futures Markets*, 16(4), 353-387.
- Granger, C. W. J. (2001). Investigating causal relations by econometric models and cross-spectral methods. *ECONOMETRIC SOCIETY MONOGRAPHS*, 33, 31-47.
- Ho, T. S., & Michaely, R. (1988). Information quality and market efficiency. *Journal of Financial and Quantitative Analysis*, 23(01), 53-70.
- Kanas, A., & Kouretas, G. P. (2001). A cointegration approach to the lead-lag effect among size-sorted equity portfolios (No. 0101).
- Lo, A. W., & Craig MacKinlay, A. (1990). An econometric analysis of nonsynchronous trading. *Journal of Econometrics*, 45(1), 181-211.
- Lo, A. W., & MacKinlay, A. C. (1990). When are contrarian profits due to stock market overreaction?. *Review of Financial studies*, 3(2), 175-205.
- Marshall, P., & Walker, E. (2002). Asymmetric reaction to information and serial dependence of short-run returns. *Journal of Applied Economics*, 5(2), 273-292.
- McQueen, G., Pinegar, M., & Thorley, S. (1996). Delayed reaction to good news and the cross-autocorrelation of portfolio returns. *The Journal of Finance*, 51(3), 889-919.
- Ratner, M., Meric, G., & Meric, I. (2004). The Cross-Autocorrelation Of Size-Based Portfolio Returns In Europe. *Studies In Economics And Finance*, 22(1), 42-60.

- Hameed, A. (1997). Time-varying factors and cross-autocorrelations in short-horizon stock returns. *Journal of Financial Research*, 20(4), 435-58.
- Richardson, T., & Peterson, D. (1998). The cross-autocorrelation of size-based portfolio returns is not an artifact of portfolio autocorrelation. *Journal of Financial Research*.
- Thenmozhi, M. (2002). Futures trading, information and spot price volatility of NSE-50 index futures contract. NSE Research Paper, NSE India.
- Wang, D., & Pearson, A. (2006). Cross-Autocorrelation of Dual-Listed Stock Portfolio Returns: Evidence From the Chinese Stock Market (No. 182). Society for Computational Economics.
- Scholar, M. S. (2010). Testing Lead-Lag Relationship Between Small and Large Capitalization Portfolio-Evidence from Karachi Stock Exchange (KSE). *World Applied Sciences Journal*, 10(5), 590-596.