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# The Random Walk Model in the Karachi Stock Market: An Empirical Investigation

Khalid Mustafa[1], Roohi Ahmed[1]*

1. Department of Economics University of Karachi, Karachi Pakistan
*E-mail: roohiazeem@yahoo.com

**Abstract**
The study empirically investigates the weak form efficiency test in Karachi Stock Exchange. Augmented Dickey Fuller test and variance ratio test are used to investigate the weak form efficiency. The data used in this study is daily covered from January, 1995 to December 2011. Twenty-one companies are selected out of 659 companies listed with Karachi stock exchange. The methodology is to select these 21 companies is number of days trading. In order to avoid the possible bias Lo and MacKinlay, (1988) technique for a longer time period is used. Those companies are selected whose trading days are at least 3500 days during the study period. The result of ADF test for stationarity shows that the existence of random walk in KSE-100 index and all selected firms. However, the existence of random walk components in stock prices does not necessary implies that stock returns are unpredictable. The result of ADF test on the KSE-100 index and selected firms stock returns does not tell whether the short-term fluctuations dominate the stochastic trend components. With consideration of these aspects we apply variance ratio test. The results indicate that, it might reject the null hypothesis of random walk for all holding periods of KSE-100 index and all selected firms on the basis of variance ratio test which is statistically significant at 5 percent level. The weak for efficiency is prevailed in both reform period only.
**Key Words**: Efficiency, Stock market, Random walk

**The Random Walk Model in the Pakistani Equity Market: An Investigation**

## 1. Introduction

The Random Walk hypothesis advocate the theme that the stock price changes are random and past price changes were meaningless to forecast future price changes. This provides evidence in support of the weak from efficient market hypothesis. However, the behavior of price also depends on the nature of the market. In the developed market, it is observed that the market is considering a low degree of serial correlation (Working, (1934); Kendall, (1943), (1953); Cootner, (1962); Osborne, (1962); Fama, (1965)). In the less developed markets, the results about random walk model are controversial. These controversial studies can be classified into two groups. One group findings support the random walk model in developing countries, Branes, (1986), (on the Kuala Lumpur Stock Exchange); Chan, Gup and Pan, (1992), ( on major Asian markets) Dickinson and Muragu, (1994) (on the Nairobi Stock Exchange) and Ojah and Karemera (1999), (on the four Latin American countries market), Lean and Smith (2007), (on eight Asian countries), Padhan (2011) (on Indian stock market), and Hasan (2004) (on Dhaka stock market). On the other hand, the second group, who believes that the market of developing countries do not follow the random walk model (Cheung, Wong and Ho, 1993), Claessens, Gupta and Glen (1995), Harvey (1994) Kababa (1998) Roux and Gilberson (1978), Poshakwale S. (1996) and Chaudhuri and Wu (2003).

In the less developed countries the stock markets are emergent. It is generally believed that the emerging markets are less efficient than the developed market. The feature of the emerging market is shallow market with high turnover. The characteristic of emerging market is the growth potential and rapid growth of size of the market. However, the participants in emerging markets are not well informed and their behavior is irrational as compare to well develop countries markets. The main reasons of slow progress in emerging financial markets are lack of financial development especially in capital markets. The market imperfection such as transaction costs, lack of timely information, cost of acquiring new information and greater uncertainty about the future (Taylor, 1956; Goldsmith, 1971; Mason, 1972; Wai and Patrick, 1973) are the main causes of slow progress in emergent market. Moreover the speculations are common in emerging markets that provide the rooms to large investors to speculate the market. This ability of investors, on a given set of information, lies behind the notion of stock market efficiency. The lower is the market efficiency, the greater the predictability of stock price changes. In addition, there is insufficient data in a convenient form, structural profile, inadequate regulations, lack of supervision and administrative loose in the

 

implication of existing rules in emerging markets. As well companies information are released and circulated before the annual report is officially available, the annual reports of some of the listed companies are mistrusted and is often result of rumors circulation in the market about the companies. The market moved over a period of time to become a speculation market and then a gamble market. It indicates that there is a trend of market movement and most of the investors in the market become speculators. Moreover, share price indices data are available and reliable to test the weak form efficiency of the market.

Karachi stock exchange (KSE) has been termed as one of the best performing emerging market during 1990. However, like many other emerging markets KSE is considered as shallow market[1], plays limited role to raise the funds[2] and a fairly volatile[3] market. The market has experienced the booms and bursts of comparatively shorter time duration. The reason may be poor dissemination of information, weak institutional supports and lack of compliances of regulating authority requirement. Moreover, due to high volatility and perceived speculative nature the incidence of insider trading is commonly expected at KSE. In addition, preferential treatment is given to members of stock markets for their role as market makers[4]; settlement risk[5]. From regulatory side, loose enforcement of rules and regulation[6] and foreign investors were not allowed to invest in KSE without prior approval of the government. Moreover, restriction on outflow and inflow of foreign exchange movements[7]; liquidity constraints, narrow trading base and limited use of technology[8] are constrained to develop the market. As a result information played limited role on stock market. Moreover, KSE was unable to provide long term capital needs of the economy.

Not much research is observed about the behavior of stock prices in Karachi stock market. Khilji (1993, 1994), Uppal (1994); Ahemd (1995), Hussain (1997), Ali and Mustafa (2001), Hameed and Ashraf (2006) and Ali, Rehman, Yilmaz, Khan, and Afzal (2010) examined the random walk model in Pakistan stock market. Khilji (1993) studied about the behavior of Pakistan stock returns and found that the distribution of stock returns to be non-normal, generally positive skewed leplkertic and positive mean. Using an error correcting, first order auto-regressive model, and employing the Kalman Filter test, he determined the time-varying behavior of monthly-expected returns and found expected returns to be constant and equal to long term expected monthly return. However, this is a amazing findings in the context of a developing economy and needs further investigation by using weekly or daily data as he suggested. Khilji (1994) examined the non-linearity dependence of stock returns in Pakistani context. He used weekly indices and applies determined strong nonlinear dependence six of the eleven indices. He claimed that this nonlinear dependence could result from a nonlinear deterministic system or a nonlinear stochastic system. In order to distinguish between the two, the author suggested the use of nonlinear stochastic models like GARCH to estimate the returns. Hussain (1997) investigated the validity of random walk model in the Pakistani equity market using the data from January 1989 to December 1993. He tested the serial correlation and run test. He found the presence of strong serial dependence in stock returns and suggested that the random walk model is not appropriate to describe stock returns

[1] The market capitalization to GDP ratio (31%) is less than turns over to GDP ratio (322%) in 2006. For developed market the market capitalization ratio to GDP is large and turnover is small. It implies that the size of the market is less than the size of the economy in Pakistan. Pakistan stock market in contrast to developed market like, as US capital where market capitalization to GDP ratio is 92 percent turnover is 65 percent.

[2]. In 2006 seven new companies were listed in KSE which raised Rs. 13.59 billion.

[3] During 2006, standard deviation of KSE-100 was 666.65

[4] Members are not care the margin requirements in their mutual trade as a result a considerable part of trade lies between member themselves. It does not necessarily represent the true small investors. Moreover, members involve in speculative trade between themselves and take command on stock positions

[5] At that time it took time seven to fourteen days for settlements of shares and transfers the registration of share from seller to buyers. As a result *badla* financing and other informal trade begin which ultimately increase the uncertainty in stock market

[6] This rises the problems of insider trading through unchecked marginal requirements. These marginal requirements are neither regulated nor rigorously enforced. As a result the trade is stock market takes place with too much leverage, which can easily force a trader into bankruptcy if his expectations about the future prices are not materialized

[7] This policy kept the foreign investors away from Pakistani stock markets.

[8] These constraints limited the number of listed companies and their market capitalization.

 

behavior in Pakistani equity market. Moreover, the researchers (Nishat, 1999; Nishat, 2000) have identified the change in behaviour of the stock prices and shift in pattern of observed anomalies after financial reforms of 1990s. These financial reforms provided depth and breadth in Karachi stock market and more competitive environment for investors in Pakistan, (Nishat, 2001). Hameed and Ashraf (2006) investigate the volatility of stock returns and weak-form efficiency for the Pakistani stock market. They used daily closing prices from December 1998 to March 2006 and pointed out that returns exhibit persistence and volatility clustering. Moreover, weak-form efficiency hypothesis is rejected as it is found that past information helps in predicting future prices. Mahmood (2007) found evidence of random walk in KSE and rejected the day and month effect while testing the monthly and daily index data. Whereas Haroon (2005) rejected the weak form efficiency in KSE and found evidence of Monday or week day effect. Strong serial correlation indicated the non-randomness and violation of EMH. Bashir, Ilyas, and Furrukh (2011) study based on daily closing stock prices for individual firm during June, 1997 to April 2009 and used banking sector firms listed on Karachi Stock Exchange. They used Cointegration and VAR technique and found the absence of of weak form Efficient Market Hypothesis in banking sector. Moreover the prices exhibit predictable and exploitable patterns concluding inefficiency of banking sector for KSE.

Since 1998 the Karachi stock market has taken many measures to protect investor's interest from excessive volatility in prices. These are introduction of Karachi Automated Transaction systems (KATS) for up grad test to handle excessive trading volume; Central Depository System (CDS) and redesign this system into several Virtual Local Area Networks (VLAN) termed as inter-VLAN communication which help to deal more than one million per day; and National Clearing System to handle clearing and settlement of three exchanges of the country under one roof. These measures have eliminated the chances of forgery frauds, delay in transfer and thus reduce the volatility in stock prices. In addition to that, the exchange provides information on real time basis to the investors through the Internet. Now investors all over the world can access and down load latest trading information from the web site. Security and Exchange Commission of Pakistan (SECP) provide guidelines to reinforce good corporate governance whose aim is enhancing investor confidence by increasing transparency in the business practices of listed companies. In order to minimize the organizational weakness and to improve the financial soundness government privatized the financial and non-financial institution. They generated the funds from stock markets that ultimately improved the performance of stock market. Further, these information are also linked and influenced by political and economic information and investors could relate it towards the trading activity of the market. Due to such measurement, it will interest to study the random walk before and after reforms. The objective of the study is to investigate the validity of random walk hypothesis for Karachi stock market. The study also distinguishes the test of the existence of random walk hypothesis during non-reform and reform period.

The rest of the study is as follows. The second section presents the econometric methodology followed by data description in section three. The results are discussed in section four. The summary and concluding remarks are given section five.

## 2. Econometric Methodology

Stock market play a role like a fair game model, in which there is no difference between actual and expected return on stocks. To precede the fair game model, first calculate the return of stock prices i.e.

$$R_t = LnP_t - LnP_{t-1} \qquad (1)$$

Where $R_t$ = Return on share prices

$P_t$ = Stock prices

However, some issues are arises with respect to efficient market hypothesis. These are that the some part of the returns is predictable. This aspect is discussed by Sharp (1983). According to Sharp (1983) the return of the asset has two components i.e. last period equilibrium return and unexpected components of the returns.

$$R_t = E_{t-1}\left(R_t^e\right) + U_{t-1} \qquad (2)$$

 

Where $R_t$ =Expected return

$E_{t-1}$ = the conditional expectations operator with the conditions sets consisting of information up and including period $t-1$.

$U_{t-1}$ = unexpected return or stochastic term or predication on stock prices in period t-1.

However,

$$E_{t-1}\left(R_t^e\right) = E\left(R_t^e / V_{t-1}\right) \qquad (3)$$

Where $V_{t-1}$ is the available information in $t-1$ period.

But the component of unexpected returns also depends on set of information i.e. $E\left(U_t / V_{t-1}\right)$. Thus equation (2) becomes

$$R_t = E_{t-1}\left(R_t^e\right) + E\left(U_t / V_{t-1}\right) \qquad (4)$$

If the market is informationally efficient than

$$E\left(U_t / V_{t-1}\right) = 0 \qquad (5)$$

If $V_{t-1}$ contains only past returns then equation (5) becomes as

$$E\left(U_t / V_{t-1}\right) = E\left(U_t / R_{t-1}, R_{t-2}, \_\_\_\_ R_{t-n}\right) \qquad (6)$$

The equation (6) represent the market is weakly efficient. In a fair game model in which there is no difference between the actual return on the game and expected return before the game. Stock market is like a fair game model, in which there is no difference between actual and expected return on stocks. Mathematically fair game model can be written as

$$R_{i,t+1} = E\left(R_{i,t+i} / V_i\right) + U_{i,t+1} \qquad (7)$$

Where $R_{i,t+1}$: Actual returns on stocks i in period $t+1$, $R_{t,t+1} / V_t$ Expected returns on stock i, in period $t+1$, if the set of information is available. $U_{i,t+1}$ stochastic term or prediction error on stocks in period $t+1$.

If the stock market is fair game then $U_{i,t+1}$ is the nonsystematic error. A nonsystematic error has three statistical properties i.e, (a) consistency (b) independence and (c) efficiency.

The prediction error will be consistent if the expected returns given the available set of information are unbiased estimator of actual returns.

 

$$U_{i,t+1} = R_{i,t+1} - E\left(R_{i,t+1}/V_t\right)$$

$$E\left(U_{i,t+1}/V_{i,t+1}\right) = \frac{E\left[\left(R_{i,t+1}\right) - E\left(R_{i,t+1}/V_t\right)\right]}{V_t}$$

$$E\left(U_{i,t+1}/V_{i,t+1}\right) = E\left[R_{i,t+1}/V_t\right] - E\left[R_{i,t+1}/V_t\right]$$

$$E\left(U_{i,t+1}/V_{i,t+1}\right) = 0 \qquad (8)$$

It means, if the observations are large, the prediction error will be zero, this implies that actual return is equal to the expected return on the basis of given information.

The prediction error will be independent if it is uncorrelated with expected return

$$E\left(U_{i,t+1}/V_{i,t+1}\right) = E\left[\left(U_{i,t+1}\right) - \left(R_{i,t+1}/V_{it}\right)\right]$$

$$E\left(U_{i,t+1}/V_{i,t+1}\right) = E\left(U_{,,t+1}/V_t\right)E\left[R_{i,t+1}/V_t\right]$$

$$E\left(U_{i,t+1}/V_{i,t+1}\right) = 0 \qquad (9)$$

The prediction error will be efficient if it is serially uncorrelated.

$$E\left[U_{i,t+1}, U_{j,t}\right]/V_t = 0 \qquad (10)$$

$$E\left[U_{i,t+1}, U_{i,t}\right]/V_t = 0 \qquad (11)$$

$$E\left[U_{i,1}, U_{i,t}\right]/V_t = 0 \qquad .(12)$$

If equation (8) to (12) holds, it means that our model is fair game model. The stock prices always equal their fair or fundamental values. Any change in fundamental values will be reflected immediately in market prices. However fundamental prices would be changed due to new information. If there were no new information, then fundamental value would not changed. So, the best estimate of return on stocks tomorrow is the return on stocks today. This is because, even though tomorrow's return will almost certainly differ from today it differs in a way that is completely unpredictable and hence the best estimates are today's return. So, if efficient market hypothesis is true then

$$E\left[R_{i,t+1}/V_t\right] = R_{i,t}$$

$$R_{i,t+1} = R_{i,t} + U_{i,t+1} \qquad (13)$$

The above equations show the random walk model. It implies that the yield on stock tomorrow is equal to the yield on stock today plus an amount that depends on new information generated between today and tomorrow, which is unpredictable, given today's information set "V" which shows the information set conditions expectation.

 

To examine the Random walk model we used Lo and Mackinlay (1988) variance ratio test. This test is derived from the assumption of linear relations in observations interval regarding the variance increments. If a time series follows a random walk process, the variance of kth difference variable is k time as large as that of the first difference variable. For time series characterized by random walk, one kth of the variance of $P_t - P_{t-1}$ is expected to be same as the variance of $P_t - P_{t-k}$ or

$$Var(k) = \frac{\sigma_k^2}{k\sigma_1^2} \qquad (14)$$

Where $\sigma_k^2$ is the unbiased estimator or one kth of the variance of $LnP_t - LnP_{t-k}$ and $\sigma_1^2$ is the unbiased estimator of the variance $LnP_t - LnP_{t-1}$. These estimators can be calculated as following

$$\sigma_k^2 = \frac{1}{k(T-k+1)\left(1-\frac{k}{T}\right)}\sum_{t=k}^{T}\left(P_t - P_{t-k} - k\mu\right)^2$$

$$\sigma_1^2 = \frac{1}{T-1}\sum_{t=k}^{T}\left(P_t - P_{t-k} - k\mu\right)^2$$

T is the sample size and $\mu = \frac{1}{T}\left(P_T - P_0\right)$. With the assumption of homoscedasticity, the asymptotic variance of Variance Ratio statistic is shown as

$$\phi(k) = \frac{2(2k-1)(k-1)}{3kT} \qquad (15)$$

The VR statistics (Lo Mackinlay, 1988) asymptotically approaches

$$Z(k) = \frac{VR(k)-1}{\left(\phi(k)\right)^{1/2}} \rightarrow N(0,1) \qquad (16)$$

Where $\rightarrow$ denotes that the distributional equivalence is asymptotic. However, most of the studies argued that variance returns are conditionally hetroscrdastic with respect to time (Hamo, Masulis and Ng (1990); Theodossiou and Lee, (1993); Koutmos, Negakis and Theodossiou (1993), Koutmos, Theodossiou and Lee, (1994)). As a result there may not exist a linear relation over observation intervals. To overcome this problem Lo and Mackinlay (1988) derive the hetroscedasticity consistent variance estimators $\phi^*(k)$.

$$\phi^*(k) = \sum_{j=1}^{k-1}\left[\frac{2(k-j)}{k}\right]\hat{\delta}(j) \qquad (17)$$

in which

$$\hat{\delta}(j) = \frac{\sum_{r=j+1}^{T}\left(P_t - P_{t-1} - \hat{\mu}\right)^2\left(P_{t-j} - P_{t-j-1} - \hat{\mu}\right)^2}{\left[\sum_{r=j+1}^{T}\left(P_t - P_{t-1} - \hat{\mu}\right)^2\right]^2} \qquad (18)$$

 

Thus, the variance ratio test statistic can be standardized asymptotically to a standard normal variable or

$$Z^*(k) = \frac{VR(k)-1}{\left(\phi^*(k)\right)^{1/2}} \rightarrow N(0,1) \qquad (19)$$

**3. Data**

The data used in this study is daily covered from January, 1995 to December 2011. The data for KSE-100 index and individual firms are taken form Karachi Stock Exchange data stream. The total observations during sample period are 4035. Twenty-one out of 659 firms are selected. The methodology is to select these 21 firms is number of days trading. In order to avoid the possible biasness (Lo and MacKinlay, 1988) a longer time period is used. Those companies are selected whose trading days are at least 2000 days. Moreover, the time period from January 1995 to December 2000 has taken before reforms and the time period from January 2001 to December 2011.

**4. Discussion of Empirical Findings**

Variance ratio test is used to investigate random walk in return series. First ADF is used for this purpose and then variance ratio test is applied. Table 1 shows the same for full sample size, non-reforms period, and reforms period. The result shows that the null hypothesis cannot be rejected, that is after taking the first differences on the stock price indices. It appears that there exists some evidence of random walk in KSE-100 index and all the selected firms because the values of return series at the first lag are more than the critical values during periods. However, the existence of random walk components in stock prices does not necessarily imply that stock returns are unpredictable. If a white noise process characterises stock returns, the corresponding price indices are said to follow the random walk. From this case the stock returns considered being unpredictable. On the other hand, if stock returns do not follow white noise, or they are integrated into order one or I(1), there exist some predictable components. The purpose of variance ratio approach is to detect dependency of stock return series while ADF approach is formulated to examine only the existence of stochastic trend components. In this perspective, the result from applying the ADF test on the KSE-100 index and selected firms stock returns does not tell whether the short-term fluctuations dominate the stochastic trend components. With consideration of this aspect variance ratio test is applied with homoscedastic term denoted by Z(k) and hetroscedastic term denoted by Z*(k) on the KSE-100 index and selected firms stock returns. Table 2 to 4 show the same for all periods.

The random walk null hypothesis is that the variance ratio is equal to one. If it is not equal to one, then the stock prices are mean reverting. The magnitude of variance ratio test increases with increases in lags in KSE-100 index, and with all selected firms. However, homoscedasticity $Z(k)$ and hetroscedasticity $Z^*(k)$ show no evidence of random walk pattern with the increase in lags value.

The variance ratio for KSE-100 index is less than unity, which indicates that there is negative auto-correlation of daily stock returns. More than one variance found in 17 out of 21 firms (80 percent). This implies that these firms have a positive serial correlation of daily stock returns. Positive autocorrelation in stock returns implies a slow adjustment of stock prices to new information (both insider and outsider). The variance ratio 4 out of 21 (20 percent) is less than one. It indicates that the presence of autocorrelation in stock returns in these firms.

The hetroscedasticity test statistics $Z(k)$ rejected random walk hypothesis for all selected firms and KSE-100 index series at any common level of significance. It implies that the future movements of these stock can be predicted by using past price movements of these stock. According to Leroy (1973) and Locus (1978) the existence of autocorrelation in financial market does not necessarily imply any market inefficiency. It can be concluded that null hypothesis is rejected on the basis of Z(k) (a) for KSE-100, ACBL, BOP, FFBL, HUBCO, and PSO for all holding lags; (b) for DSFL for 4 to 16 lags period; (c) for FABL for 4 to 32 holding periods; (d) ICI 4 to 12 holding periods; (e) for JPGL 4 holding period; (f) for POL for 4 lags to 28 lags periods; (g) for SNGC 16 to 40 lag periods and (h) for AICL, DGK, KESC, MCB, PGF, PTCL SEPCO, and SSGC no lags period. Moreover, it cannot reject the hypothesis for any holding period in DSF. The values of Z(k) and Z*(k) are statistically significant at 5 percent. The variance ratio test in return series in most of the selected firms including KSE-100 index is less than one (13 out of 22). It shows the negative serial correlation. It has two implications; (a) the infrequent trading of small capitalization stock seems to be major cause of negative serial correlation; (b) it gives rise to mean reversion.

 

During the non-reforms period the result is the same as was observed during full sample period. However, significant change is found during reforms period. KSE-100 index and most of the selected firms follow the random walk because the value of $Z(k)$, in most cases are less than ±1.96 which indicates that the series follows random walk.

## 5. Summary and Concluding Remarks

The study empirically investigates the weak form efficiency test in Karachi Stock Exchange. Augmented Dickey Fuller test and variance ratio test are used to investigate the weak form efficiency. The data used in this study is daily covered from January, 1995 to December 2011. Twenty-one companies are selected out of 659 companies on the basis of number of days trading. In order to avoid the possible biasness Lo and MacKinlay, (1988) technique for a longer time period is used. The result of ADF shows that the existence of random walk in KSE-100 index and all selected firms. However, the existence of random walk components in stock prices does not necessary implies that stock returns are unpredictable. The result of ADF test on the KSE-100 index and selected firms stock returns does not tell whether the short-term fluctuations dominate the stochastic trend components. With consideration of this aspect it is applied variance ratio test. The results indicate that there is no evidence of random walk for all holding periods of KSE-100 index and all selected firms on the basis of Z(k) and Z*(k) basis. The values of Z(k) and Z*(k) are statistically significant at 5 percent or the values of these statistics are more than 1.96. However, significant change is found during reforms period. KSE-100 index and most of the selected firms follow the random walk because the values of $Z(k)$, in most cases are less than ±1.96 which indicates that the series follows random walk.

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**Table 1 Dicky Fuller Test**

| | Full Sample period | | Non-Reforms | | Reforms | |
|---|---|---|---|---|---|---|
| | Level | 1st diff | Level | 1st diff | Level | 1st diff |
| KSE | 1.759 | -33.794 | -2.57 | -14.835 | 0.631 | -12.526 |
| ACBL | -3.871 | -30.523 | -2.372 | -13.906 | -2.193 | -20.636 |
| AICL | -0.552 | -32.681 | -4.037 | -23.31 | 1.896 | -23.36 |
| BOP | -1.617 | -30.06 | -3.837 | -22.58 | 1.367 | -21.561 |
| DGK | -1.526 | -28.917 | -4.608 | -21.693 | -1.526 | -18.412 |
| DSFL | -4.265 | -30.809 | -3.288 | -23.903 | -2.302 | -21.59 |
| Engro | -3.549 | -31.193 | -2.713 | -23.673 | -1.456 | -20.565 |
| FABL | -0.865 | -32.792 | -1.509 | -26.813 | -0.894 | -21.105 |
| FFC | -1.454 | -34.14 | -2.333 | -23.681 | -0.285 | -24.798 |
| FFBL | -1.483 | -32.211 | -1.414 | -27.015 | -1.487 | -17.483 |
| HUB | -1.872 | -32.586 | -1.404 | -24.709 | -1.392 | -21.98 |
| ICI | -4.434 | -32.143 | -3.939 | -24.996 | -0.819 | -21.716 |
| JPGL | -2.794 | -33.232 | -2.052 | -25.053 | -2.248 | -19.437 |
| KESC | -2.246 | -33.429 | -1.881 | -25.813 | -2.583 | -24.435 |
| MCB | -3.397 | -34.101 | -3.702 | -26.987 | -1.074 | -20.484 |
| PGF | -2.031 | -31.918 | -1.590 | -23.995 | -1.254 | -21.283 |
| POL | -1.919 | -22.175 | -1.640 | -12.337 | -1.87 | -18.476 |
| PSO | -2.464 | -31.363 | -1.847 | -23.208 | -1.085 | -23.822 |
| PTCL | -2.655 | -33.84 | -3.166 | -25.874 | -0.251 | -23.089 |
| SEPCO | -4.438 | -32.336 | -3.334 | -25.284 | -1.389 | -20.576 |
| SNGC | -0.678 | -33.336 | -1.621 | -26.023 | 0.050 | -20.952 |
| SSGC | -4.222 | -33.591 | -3.762 | -26.108 | -0.910 | -21.041 |
| Critical Values | | | | | | |
| 1% | -3.4364 | | -3.4382 | | -3.4405 | |
| 5% | -2.8634 | | -2.8642 | | -2.8652 | |
| 10% | -2.5678 | | -2.5682 | | -2.5687 | |

 

**Table 2 Variance Ratio Test (Full sample)**

| | | Lag4 | Lag8 | Lag12 | Lag16 | Lag20 | Lag24 | Lag28 | Lag32 | Lag36 | Lag40 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| KSE | Coeff | 1.125 | 1.229 | 1.345 | 1.411 | 1.464 | 1.471 | 1.465 | 1.455 | 1.459 | 1.457 |
| | Z(k) | 3.215 | 3.725 | 4.428 | 4.493 | 4.492 | 4.136 | 3.763 | 3.432 | 3.256 | 3.068 |
| | Z*(k) | 28.02 | 14.01 | 9.341 | 7.006 | 5.604 | 4.67 | 4.003 | 3.525 | 3.114 | 2.802 |
| ACB L | Coeff | 1.248 | 1.285 | 1.332 | 1.383 | 1.417 | 1.428 | 1.449 | 1.453 | 1.45 | 1.443 |
| | Z(k) | 6.131 | 4.456 | 4.096 | 4.024 | 3.881 | 3.612 | 3.492 | 3.285 | 3.068 | 2.859 |
| | Z*(k) | 8.902 | 4.451 | 2.967 | 2.225 | 1.78 | 1.484 | 1.272 | 1.12 | 0.989 | 0.89 |
| AICL | Coeff | 0.983 | 1.022 | 1.07 | 1.086 | 1.087 | 1.074 | 1.051 | 1.045 | 1.04 | 1.044 |
| | Z(k) | -0.428 | 0.351 | 0.88 | 0.921 | 0.825 | 0.637 | 0.404 | 0.333 | 0.278 | 0.29 |
| | Z*(k) | 4.938 | 2.469 | 1.646 | 1.234 | 0.988 | 0.823 | 0.705 | 0.621 | 0.549 | 0.494 |
| BOP | Coeff | 1.203 | 1.327 | 1.395 | 1.409 | 1.416 | 1.406 | 1.413 | 1.427 | 1.433 | 1.431 |
| | Z(k) | 5.001 | 5.095 | 4.856 | 4.282 | 3.858 | 3.415 | 3.201 | 3.085 | 2.942 | 2.772 |
| | Z*(k) | 4.304 | 2.152 | 1.435 | 1.076 | 0.861 | 0.717 | 0.615 | 0.541 | 0.478 | 0.43 |
| DGK | Coeff | 1.003 | 1.043 | 1.07 | 1.057 | 1.048 | 1.013 | 1.004 | 1.012 | 1.014 | 1.023 |
| | Z(k) | 0.073 | 0.661 | 0.849 | 0.589 | 0.439 | 0.108 | 0.031 | 0.086 | 0.094 | 0.146 |
| | Z*(k) | 3.166 | 1.583 | 1.055 | 0.791 | 0.633 | 0.528 | 0.452 | 0.398 | 0.352 | 0.317 |
| DSFL | Coeff | 1.112 | 1.203 | 1.214 | 1.195 | 1.172 | 1.138 | 1.092 | 1.062 | 1.038 | 1.017 |
| | Z(k) | 2.883 | 3.305 | 2.749 | 2.133 | 1.667 | 1.213 | 0.745 | 0.468 | 0.27 | 0.114 |
| | Z*(k) | 5.386 | 2.693 | 1.795 | 1.347 | 1.077 | 0.898 | 0.769 | 0.678 | 0.599 | 0.539 |
| Engro | Coeff | 1.123 | 1.105 | 1.147 | 1.173 | 1.175 | 1.148 | 1.134 | 1.108 | 1.085 | 1.069 |
| | Z(k) | 3.047 | 1.645 | 1.817 | 1.822 | 1.632 | 1.252 | 1.044 | 0.785 | 0.581 | 0.446 |
| | Z*(k) | 2.246 | 1.123 | 0.749 | 0.561 | 0.449 | 0.374 | 0.321 | 0.283 | 0.25 | 0.225 |
| FABL | Coeff | 0.771 | 0.748 | 0.727 | 0.715 | 0.701 | 0.692 | 0.689 | 0.695 | 0.698 | 0.698 |
| | Z(k) | -5.407 | -3.763 | -3.216 | -2.86 | -2.657 | -2.483 | -2.31 | -2.112 | -1.966 | -1.862 |
| | Z*(k) | 3.445 | 1.722 | 1.148 | 0.861 | 0.689 | 0.574 | 0.492 | 0.433 | 0.383 | 0.344 |
| FFC | Coeff | 1.007 | 1.009 | 1.063 | 1.098 | 1.124 | 1.111 | 1.094 | 1.072 | 1.045 | 1.01 |
| | Z(k) | 0.176 | 0.143 | 0.789 | 1.045 | 1.171 | 0.951 | 0.742 | 0.53 | 0.311 | 0.066 |
| | Z*(k) | 8.502 | 4.251 | 2.834 | 2.126 | 1.7 | 1.417 | 1.215 | 1.07 | 0.945 | 0.85 |
| FFBL | Coeff | 0.736 | 0.704 | 0.702 | 0.676 | 0.648 | 0.628 | 0.617 | 0.607 | 0.597 | 0.589 |
| | Z(k) | -5.523 | -3.917 | -3.111 | -2.881 | -2.772 | -2.657 | -2.521 | -2.412 | -2.325 | -2.245 |
| | Z*(k) | 2.7 | 1.35 | 0.9 | 0.675 | 0.54 | 0.45 | 0.386 | 0.34 | 0.3 | 0.27 |
| HUB | Coeff | 1.131 | 1.196 | 1.317 | 1.367 | 1.424 | 1.416 | 1.411 | 1.399 | 1.394 | 1.389 |
| | Z(k) | 3.349 | 3.169 | 4.044 | 3.987 | 4.08 | 3.63 | 3.305 | 2.991 | 2.778 | 2.596 |
| | Z*(k) | 5.232 | 2.616 | 1.744 | 1.308 | 1.046 | 0.872 | 0.747 | 0.658 | 0.581 | 0.523 |
| ICI | Coeff | 1.09 | 1.163 | 1.168 | 1.156 | 1.142 | 1.112 | 1.079 | 1.057 | 1.04 | 1.019 |
| | Z(k) | 2.306 | 2.642 | 2.148 | 1.699 | 1.37 | 0.98 | 0.637 | 0.428 | 0.283 | 0.127 |
| | Z*(k) | 5.702 | 2.851 | 1.901 | 1.425 | 1.14 | 0.95 | 0.815 | 0.717 | 0.634 | 0.57 |
| JPGL | Coeff | 0.886 | 0.908 | 0.904 | 0.872 | 0.854 | 0.837 | 0.816 | 0.797 | 0.777 | 0.753 |
| | Z(k) | -2.696 | -1.376 | -1.133 | -1.286 | -1.3 | -1.316 | -1.369 | -1.408 | -1.454 | -1.525 |
| | Z*(k) | 1.462 | 0.731 | 0.487 | 0.366 | 0.292 | 0.244 | 0.209 | 0.184 | 0.162 | 0.146 |
| KESC | Coeff | 1.015 | 1.082 | 1.134 | 1.115 | 1.099 | 1.083 | 1.058 | 1.028 | 0.998 | 0.97 |
| | Z(k) | 0.386 | 1.333 | 1.719 | 1.257 | 0.958 | 0.729 | 0.469 | 0.211 | -0.014 | -0.201 |
| | Z*(k) | 28.02 | 14.01 | 9.341 | 7.006 | 5.604 | 4.67 | 4.003 | 3.525 | 3.114 | 2.802 |
| MCB | Coeff | 0.963 | 0.93 | 0.94 | 0.921 | 0.907 | 0.877 | 0.849 | 0.822 | 0.803 | 0.783 |
| | Z(k) | -0.942 | -1.127 | -0.762 | -0.855 | -0.891 | -1.069 | -1.21 | -1.329 | -1.383 | -1.442 |
| | Z*(k) | 8.902 | 4.451 | 2.967 | 2.225 | 1.78 | 1.484 | 1.272 | 1.12 | 0.989 | 0.89 |

 

**Table 2 (cont…)**
**Variance Ratio Test (Full Sample)**

| | | Lag4 | Lag8 | Lag12 | Lag16 | Lag20 | Lag24 | Lag28 | Lag32 | Lag36 | Lag40 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PGF | Coeff | 0.962 | 1.016 | 1.061 | 1.071 | 1.084 | 1.082 | 1.082 | 1.078 | 1.06 | 1.041 |
| | Z(k) | -0.935 | 0.249 | 0.749 | 0.743 | 0.778 | 0.689 | 0.635 | 0.563 | 0.407 | 0.264 |
| | Z*(k) | 4.938 | 2.469 | 1.646 | 1.234 | 0.988 | 0.823 | 0.705 | 0.621 | 0.549 | 0.494 |
| POL | Coeff | 1.146 | 1.211 | 1.311 | 1.358 | 1.402 | 1.411 | 1.344 | 1.272 | 1.194 | 1.119 |
| | Z(k) | 2.699 | 2.467 | 2.869 | 2.813 | 2.797 | 2.594 | 2.001 | 1.475 | 0.989 | 0.574 |
| | Z*(k) | 4.304 | 2.152 | 1.435 | 1.076 | 0.861 | 0.717 | 0.615 | 0.541 | 0.478 | 0.43 |
| PSO | Coeff | 1.227 | 1.379 | 1.477 | 1.54 | 1.577 | 1.585 | 1.589 | 1.589 | 1.579 | 1.571 |
| | Z(k) | 5.725 | 6.045 | 6.003 | 5.788 | 5.478 | 5.037 | 4.673 | 4.357 | 4.027 | 3.759 |
| | Z*(k) | 3.166 | 1.583 | 1.055 | 0.791 | 0.633 | 0.528 | 0.452 | 0.398 | 0.352 | 0.317 |
| PTCL | Coeff | 1.036 | 1 | 1.008 | 1.001 | 1.004 | 0.977 | 0.938 | 0.906 | 0.885 | 0.863 |
| | Z(k) | 0.922 | 0 | 0.102 | 0.011 | 0.039 | -0.201 | -0.5 | -0.706 | -0.812 | -0.916 |
| | Z*(k) | 5.386 | 2.693 | 1.795 | 1.347 | 1.077 | 0.898 | 0.769 | 0.678 | 0.599 | 0.539 |
| SEPCO | Coeff | 0.922 | 0.939 | 0.991 | 1.011 | 1.055 | 1.081 | 1.101 | 1.121 | 1.137 | 1.156 |
| | Z(k) | -1.888 | -0.934 | -0.109 | 0.113 | 0.501 | 0.669 | 0.769 | 0.859 | 0.914 | 0.986 |
| | Z*(k) | 2.246 | 1.123 | 0.749 | 0.561 | 0.449 | 0.374 | 0.321 | 0.283 | 0.25 | 0.225 |
| SNGC | Coeff | 1.037 | 1.106 | 1.153 | 1.192 | 1.231 | 1.239 | 1.23 | 1.209 | 1.192 | 1.178 |
| | Z(k) | 0.946 | 1.714 | 1.952 | 2.087 | 2.224 | 2.087 | 1.851 | 1.568 | 1.354 | 1.188 |
| | Z*(k) | 3.445 | 1.722 | 1.148 | 0.861 | 0.689 | 0.574 | 0.492 | 0.433 | 0.383 | 0.344 |
| SSGC | Coeff | 0.969 | 1.01 | 1.05 | 1.06 | 1.081 | 1.065 | 1.038 | 1.017 | 0.999 | 0.986 |
| | Z(k) | -0.783 | 0.16 | 0.63 | 0.644 | 0.77 | 0.56 | 0.302 | 0.126 | -0.007 | -0.092 |
| | Z*(k) | 8.502 | 4.251 | 2.834 | 2.126 | 1.7 | 1.417 | 1.215 | 1.07 | 0.945 | 0.85 |

 

**Table 3 Variance Ratio Test (Non-Reforms)**

| | | Lag4 | Lag8 | Lag12 | Lag16 | Lag20 | Lag24 | Lag28 | Lag32 | Lag36 | Lag40 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| KSE | Coeff | 1.241 | 1.36 | 1.466 | 1.517 | 1.565 | 1.562 | 1.55 | 1.529 | 1.528 | 1.515 |
| | Z(k) | 4.854 | 4.586 | 4.684 | 4.426 | 4.284 | 3.865 | 3.486 | 3.125 | 2.933 | 2.708 |
| | Z*(k) | 15.07 | 7.535 | 5.023 | 3.767 | 3.014 | 2.512 | 2.153 | 1.884 | 1.674 | 1.507 |
| ACB L | Coeff | 1.231 | 1.247 | 1.288 | 1.35 | 1.406 | 1.426 | 1.46 | 1.459 | 1.453 | 1.446 |
| | Z(k) | 4.39 | 2.969 | 2.731 | 2.827 | 2.904 | 2.764 | 2.75 | 2.558 | 2.374 | 2.213 |
| | Z*(k) | 3.937 | 1.968 | 1.312 | 0.984 | 0.787 | 0.656 | 0.562 | 0.492 | 0.437 | 0.394 |
| AICL | Coeff | 1.001 | 1.045 | 1.086 | 1.095 | 1.081 | 1.052 | 1.011 | 0.995 | 0.979 | 0.968 |
| | Z(k) | 0.019 | 0.551 | 0.832 | 0.782 | 0.591 | 0.344 | 0.067 | -0.028 | -0.112 | -0.162 |
| | Z*(k) | 2.643 | 1.322 | 0.881 | 0.661 | 0.529 | 0.441 | 0.378 | 0.33 | 0.294 | 0.264 |
| BOP | Coeff | 1.226 | 1.354 | 1.408 | 1.424 | 1.441 | 1.446 | 1.472 | 1.501 | 1.51 | 1.503 |
| | Z(k) | 4.33 | 4.29 | 3.901 | 3.453 | 3.181 | 2.918 | 2.845 | 2.816 | 2.695 | 2.516 |
| | Z*(k) | 2.051 | 1.026 | 0.684 | 0.513 | 0.41 | 0.342 | 0.293 | 0.256 | 0.228 | 0.205 |
| DGK | Coeff | 0.978 | 0.991 | 0.994 | 0.976 | 0.962 | 0.914 | 0.891 | 0.882 | 0.858 | 0.845 |
| | Z(k) | -0.411 | -0.106 | -0.056 | -0.19 | -0.267 | -0.548 | -0.64 | -0.646 | -0.731 | -0.755 |
| | Z*(k) | 1.793 | 0.897 | 0.598 | 0.448 | 0.359 | 0.299 | 0.256 | 0.224 | 0.199 | 0.179 |
| DSFL | Coeff | 1.14 | 1.246 | 1.239 | 1.229 | 1.218 | 1.193 | 1.149 | 1.114 | 1.08 | 1.047 |
| | Z(k) | 2.812 | 3.125 | 2.395 | 1.955 | 1.648 | 1.323 | 0.942 | 0.672 | 0.443 | 0.246 |
| | Z*(k) | 2.278 | 1.139 | 0.759 | 0.569 | 0.456 | 0.38 | 0.325 | 0.285 | 0.253 | 0.228 |
| Engro | Coeff | 1.142 | 1.158 | 1.193 | 1.202 | 1.2 | 1.168 | 1.152 | 1.124 | 1.096 | 1.073 |
| | Z(k) | 2.674 | 1.882 | 1.814 | 1.617 | 1.418 | 1.08 | 0.901 | 0.685 | 0.499 | 0.359 |
| | Z*(k) | 3.64 | 1.82 | 1.213 | 0.91 | 0.728 | 0.607 | 0.52 | 0.455 | 0.404 | 0.364 |
| FABL | Coeff | 0.674 | 0.614 | 0.582 | 0.572 | 0.555 | 0.546 | 0.538 | 0.538 | 0.535 | 0.525 |
| | Z(k) | -5.66 | -4.238 | -3.621 | -3.158 | -2.908 | -2.691 | -2.524 | -2.353 | -2.226 | -2.153 |
| | Z*(k) | 1.263 | 0.631 | 0.421 | 0.316 | 0.253 | 0.21 | 0.18 | 0.158 | 0.14 | 0.126 |
| FFC | Coeff | 1.031 | 1.051 | 1.103 | 1.134 | 1.165 | 1.14 | 1.111 | 1.078 | 1.037 | 0.987 |
| | Z(k) | 0.544 | 0.566 | 0.902 | 1 | 1.091 | 0.839 | 0.613 | 0.402 | 0.179 | -0.06 |
| | Z*(k) | 4.245 | 2.122 | 1.415 | 1.061 | 0.849 | 0.707 | 0.606 | 0.531 | 0.472 | 0.424 |
| FFBL | Coeff | 0.688 | 0.642 | 0.612 | 0.586 | 0.561 | 0.548 | 0.54 | 0.53 | 0.516 | 0.497 |
| | Z(k) | -5.478 | -3.975 | -3.4 | -3.09 | -2.902 | -2.709 | -2.541 | -2.42 | -2.344 | -2.306 |
| | Z*(k) | 0.614 | 0.307 | 0.205 | 0.153 | 0.123 | 0.102 | 0.088 | 0.077 | 0.068 | 0.061 |
| HUB | Coeff | 1.143 | 1.187 | 1.286 | 1.328 | 1.395 | 1.396 | 1.408 | 1.407 | 1.416 | 1.427 |
| | Z(k) | 2.838 | 2.348 | 2.833 | 2.767 | 2.951 | 2.684 | 2.548 | 2.369 | 2.277 | 2.213 |
| | Z*(k) | 2.216 | 1.108 | 0.739 | 0.554 | 0.443 | 0.369 | 0.317 | 0.277 | 0.246 | 0.222 |
| ICI | Coeff | 1.046 | 1.108 | 1.076 | 1.038 | 1.003 | 0.951 | 0.904 | 0.881 | 0.868 | 0.845 |
| | Z(k) | 0.922 | 1.369 | 0.76 | 0.324 | 0.023 | -0.335 | -0.605 | -0.7 | -0.73 | -0.811 |
| | Z*(k) | 2.251 | 1.125 | 0.75 | 0.563 | 0.45 | 0.375 | 0.322 | 0.281 | 0.25 | 0.225 |
| JPGL | Coeff | 0.834 | 0.849 | 0.829 | 0.787 | 0.761 | 0.733 | 0.712 | 0.7 | 0.685 | 0.661 |
| | Z(k) | -2.897 | -1.667 | -1.489 | -1.58 | -1.57 | -1.591 | -1.581 | -1.536 | -1.516 | -1.545 |
| | Z*(k) | 0.389 | 0.195 | 0.13 | 0.097 | 0.078 | 0.065 | 0.056 | 0.049 | 0.043 | 0.039 |
| KESC | Coeff | 1.09 | 1.198 | 1.26 | 1.238 | 1.206 | 1.182 | 1.151 | 1.11 | 1.068 | 1.026 |
| | Z(k) | 1.804 | 2.51 | 2.6 | 2.027 | 1.554 | 1.245 | 0.952 | 0.647 | 0.376 | 0.136 |
| | Z*(k) | 1.013 | 0.507 | 0.338 | 0.253 | 0.203 | 0.169 | 0.145 | 0.127 | 0.113 | 0.101 |
| MCB | Coeff | 0.929 | 0.883 | 0.901 | 0.886 | 0.875 | 0.852 | 0.835 | 0.817 | 0.807 | 0.786 |
| | Z(k) | -1.4 | -1.459 | -0.974 | -0.955 | -0.928 | -0.996 | -1.024 | -1.058 | -1.05 | -1.102 |
| | Z*(k) | 36.21 | 18.10 | 12.07 | 9.054 | 7.243 | 6.036 | 5.174 | 4.527 | 4.024 | 3.621 |

 

**Table 3 (cont…)**
**Variance Ratio Test (Before Reforms)**

| | | Lag4 | Lag8 | Lag12 | Lag16 | Lag20 | Lag24 | Lag28 | Lag32 | Lag36 | Lag40 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PGF | Coeff | 1.241 | 0.978 | 0.992 | 0.991 | 0.996 | 0.988 | 0.984 | 0.978 | 0.963 | 0.945 |
| | Z(k) | -0.935 | 0.249 | 0.749 | 0.743 | 0.778 | 0.689 | 0.635 | 0.563 | 0.407 | 0.264 |
| | Z*(k) | 2.591 | 1.296 | 0.864 | 0.648 | 0.518 | 0.432 | 0.37 | 0.324 | 0.288 | 0.259 |
| POL | Coeff | 1.077 | 1.165 | 1.297 | 1.372 | 1.444 | 1.454 | 1.379 | 1.297 | 1.201 | 1.101 |
| | Z(k) | 0.782 | 1.06 | 1.505 | 1.606 | 1.697 | 1.574 | 1.211 | 0.885 | 0.563 | 0.268 |
| | Z*(k) | 6.398 | 3.199 | 2.133 | 1.6 | 1.28 | 1.066 | 0.914 | 0.8 | 0.711 | 0.64 |
| PSO | Coeff | 1.309 | 1.487 | 1.593 | 1.674 | 1.731 | 1.749 | 1.759 | 1.762 | 1.749 | 1.735 |
| | Z(k) | 5.996 | 5.977 | 5.742 | 5.559 | 5.34 | 4.962 | 4.634 | 4.337 | 4.008 | 3.724 |
| | Z*(k) | 6.686 | 3.343 | 2.229 | 1.671 | 1.337 | 1.114 | 0.955 | 0.836 | 0.743 | 0.669 |
| PTCL | Coeff | 1.054 | 1.02 | 1.012 | 0.99 | 0.991 | 0.962 | 0.923 | 0.888 | 0.863 | 0.834 |
| | Z(k) | 1.075 | 0.252 | 0.119 | -0.085 | -0.067 | -0.258 | -0.482 | -0.654 | -0.752 | -0.862 |
| | Z*(k) | 2.305 | 1.152 | 0.768 | 0.576 | 0.461 | 0.384 | 0.329 | 0.288 | 0.256 | 0.23 |
| SEPCO | Coeff | 0.902 | 0.914 | 0.966 | 0.992 | 1.046 | 1.073 | 1.099 | 1.125 | 1.147 | 1.178 |
| | Z(k) | -1.856 | -1.03 | -0.321 | -0.064 | 0.328 | 0.472 | 0.59 | 0.695 | 0.768 | 0.88 |
| | Z*(k) | 1.489 | 0.745 | 0.496 | 0.372 | 0.298 | 0.248 | 0.213 | 0.186 | 0.165 | 0.149 |
| SNGC | Coeff | 1.046 | 1.112 | 1.143 | 1.183 | 1.227 | 1.247 | 1.251 | 1.243 | 1.237 | 1.224 |
| | Z(k) | 0.922 | 1.42 | 1.431 | 1.559 | 1.713 | 1.691 | 1.583 | 1.429 | 1.31 | 1.173 |
| | Z*(k) | 2.068 | 1.034 | 0.689 | 0.517 | 0.414 | 0.345 | 0.295 | 0.259 | 0.23 | 0.207 |
| SSGC | Coeff | 0.926 | 0.956 | 0.986 | 0.999 | 1.006 | 0.974 | 0.936 | 0.916 | 0.903 | 0.89 |
| | Z(k) | -1.44 | -0.542 | -0.136 | -0.008 | 0.044 | -0.173 | -0.392 | -0.48 | -0.521 | -0.559 |
| | Z*(k) | 1.785 | 0.892 | 0.595 | 0.446 | 0.357 | 0.297 | 0.255 | 0.223 | 0.198 | 0.178 |

 

**Table 4 Variance Ratio Test (Reforms)**

| | | Lag4 | Lag8 | Lag12 | Lag16 | Lag20 | Lag24 | Lag28 | Lag32 | Lag36 | Lag40 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| KSE | Coeff | 0.959 | 1.035 | 1.169 | 1.266 | 1.349 | 1.452 | 1.498 | 1.532 | 1.558 | 1.558 |
| | Z(k) | -0.088 | 0.498 | 1.869 | 2.493 | 2.897 | 3.055 | 3.127 | 3.201 | 3.218 | 3.188 |
| | Z*(k) | -0.028 | 0.025 | 0.110 | 0.180 | 0.240 | 0.287 | 0.312 | 0.352 | 0.374 | 0.392 |
| ACB L | Coeff | 1.277 | 1.414 | 1.418 | 1.520 | 1.600 | 1.672 | 1.786 | 1.834 | 1.813 | 1.796 |
| | Z(k) | 5.920 | 5.586 | 4.448 | 4.706 | 4.802 | 4.872 | 5.223 | 5.174 | 4.735 | 4.382 |
| | Z*(k) | 1.752 | 1.791 | 1.511 | 1.820 | 1.872 | 1.907 | 2.056 | 2.036 | 1.862 | 1.735 |
| AICL | Coeff | 0.845 | 0.781 | 0.785 | 0.791 | 0.816 | 0.816 | 0.866 | 0.878 | 0.871 | 0.874 |
| | Z(k) | -3.280 | -2.94 | -2.273 | -1.862 | -1.461 | -1.185 | -0.886 | -0.752 | -0.754 | -0.693 |
| | Z*(k) | -2.34 | -2.071 | -1.552 | -1.142 | 0.892 | -0.723 | -0.542 | -0.462 | -0.463 | -0.423 |
| BOP | Coeff | 1.234 | 1.385 | 1.418 | 1.411 | 1.389 | 1.372 | 1.382 | 1.408 | 1.397 | 1.395 |
| | Z(k) | 5.012 | 5.191 | 4.444 | 3.752 | 3.111 | 2.696 | 2.547 | 2.534 | 2.315 | 2.179 |
| | Z*(k) | 2.056 | 2.200 | 1.813 | 1.621 | 1.350 | 1.177 | 1.113 | 1.115 | 1.016 | 0.965 |
| DGK | Coeff | 0.988 | 1.036 | 1.031 | 0.990 | 0.963 | 0.967 | 0.996 | 1.033 | 1.066 | 1.105 |
| | Z(k) | 2.882 | 3.902 | 3.364 | -3.021 | -2.562 | 2.023 | 1.527 | 1.199 | 0.823 | 0.427 |
| | Z*(k) | -0.122 | 0.253 | 0.174 | -0.042 | -0.153 | -0.127 | -0.011 | 0.111 | 0.213 | 0.312 |
| DSFL | Coeff | 1.135 | 1.289 | 1.316 | 1.334 | 1.321 | 1.279 | 1.229 | 1.193 | 1.142 | 1.077 |
| | Z(k) | 0.230 | 0.482 | 0.331 | -0.081 | -0.293 | -0.235 | -0.023 | -0.209 | 0.387 | 0.579 |
| | Z*(k) | 1.578 | 2.214 | 1.923 | 1.744 | 1.482 | 1.178 | 0.896 | 0.702 | 0.482 | 0.253 |
| Engro | Coeff | 1.071 | 0.989 | 1.021 | 1.052 | 1.061 | 1.061 | 1.068 | 1.069 | 1.062 | 1.074 |
| | Z(k) | 1.532 | -0.14 | 0.223 | 0.471 | 0.487 | 0.443 | 0.456 | 0.432 | 0.367 | 0.291 |
| | Z*(k) | 1.005 | -0.091 | 0.152 | 0.321 | 0.331 | 0.306 | 0.315 | 0.302 | 0.256 | 0.295 |
| FABL | Coeff | 0.999 | 1.050 | 1.039 | 0.990 | 0.955 | 0.925 | 0.915 | 0.909 | 0.902 | 0.898 |
| | Z(k) | -1.419 | -1.961 | -1.843 | -2.052 | -2.043 | -1.991 | -1.636 | -1.523 | -1.455 | -1.414 |
| | Z*(k) | -0.003 | 0.721 | 0.452 | -0.082 | -0.382 | -0.581 | -0.608 | -0.603 | -0.615 | -0.613 |
| FFC | Coeff | 0.933 | 0.853 | 0.824 | 0.771 | 0.742 | 0.733 | 0.752 | 0.752 | 0.748 | 0.741 |
| | Z(k) | -0.003 | 0.680 | 1.345 | -0.087 | -0.35 | -0.542 | -0.562 | -0.557 | -0.568 | -0.558 |
| | Z*(k) | -1.000 | -1.432 | -1.362 | -1.532 | -1.521 | -1.435 | -1.233 | -1.146 | -1.105 | -1.074 |
| FFBL | Coeff | 0.963 | 0.981 | 1.058 | 1.143 | 1.185 | 1.203 | 1.230 | 1.227 | 1.221 | 1.206 |
| | Z(k) | -0.649 | -0.21 | 0.524 | 1.095 | 1.256 | 1.240 | 1.299 | 1.183 | 1.083 | 0.956 |
| | Z*(k) | -0.410 | -0.142 | 0.352 | 0.746 | 0.856 | 0.856 | 0.893 | 0.821 | 0.753 | 0.669 |
| HUB | Coeff | 1.028 | 1.069 | 1.203 | 1.263 | 1.340 | 1.393 | 1.501 | 1.619 | 1.731 | 1.829 |
| | Z(k) | 0.614 | 0.943 | 2.163 | 2.378 | 2.724 | 2.848 | 3.337 | 3.848 | 4.260 | 4.529 |
| | Z*(k) | 0.396 | 0.623 | 1.452 | 1.602 | 1.843 | 1.948 | 2.287 | 2.635 | 2.923 | 3.112 |
| ICI | Coeff | 0.924 | 0.955 | 1.016 | 1.092 | 1.158 | 1.209 | 1.213 | 1.201 | 1.181 | 1.153 |
| | Z(k) | -1.593 | -0.593 | 0.126 | 0.826 | 1.263 | 1.507 | 1.411 | 1.241 | 1.049 | 0.840 |
| | Z*(k) | -1.132 | -0.432 | 0.132 | 0.564 | 0.897 | 11.13 | 1.063 | 0.945 | 0.796 | 0.643 |
| JPGL | Coeff | 1.024 | 1.068 | 1.045 | 0.996 | 0.966 | 0.965 | 0.958 | 0.934 | 0.901 | 0.868 |
| | Z(k) | 0.516 | 0.923 | 0.487 | -0.037 | -0.026 | -0.250 | -0.279 | -0.409 | -0.575 | -0.726 |
| | Z*(k) | 0.333 | 0.612 | 0.032 | -0.024 | 0.180 | -0.175 | -0.153 | -0.286 | -0.396 | -0.502 |
| KESC | Coeff | 0.975 | 1.009 | 1.026 | 0.985 | 0.938 | 0.960 | 1.015 | 1.032 | 1.031 | 1.022 |
| | Z(k) | -0.523 | 0.131 | 0.274 | -0.123 | -0.495 | -0.281 | 0.101 | 0.205 | 0.181 | 0.124 |
| | Z*(k) | -0.276 | 0.677 | 0.153 | -0.072 | -0.273 | -0.162 | 0.056 | 0.115 | 0.102 | 0.072 |
| MCB | Coeff | 1.070 | 1.084 | 1.098 | 1.051 | 1.031 | 1.017 | 0.999 | 0.975 | 0.938 | 0.899 |
| | Z(k) | 1.502 | 1.132 | 3.312 | 0.462 | 0.256 | 0.125 | -0.005 | -0.142 | -0.352 | -0.555 |
| | Z*(k) | 0.968 | 0.756 | 0.705 | 0.312 | 0.174 | 0.086 | -0.003 | -0.103 | -0.245 | -0.353 |

 

**Table 4 (cont…)**
**Variance Ratio (After Reforms)**

| | | Lag4 | Lag8 | Lag12 | Lag16 | Lag20 | Lag24 | Lag28 | Lag32 | Lag36 | Lag40 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PGF | Coeff | 1.023 | 0.996 | 1.022 | 1.040 | 1.076 | 1.098 | 1.113 | 1.178 | 1.188 | 1.179 |
| | Z(k) | 0.465 | -0.048 | 0.242 | 0.363 | 0.605 | 0.697 | 0.809 | 1.104 | 1.093 | 0.987 |
| | Z*(k) | 0.208 | -0.022 | 0.113 | 0.174 | 0.282 | 0.331 | 0.412 | 0.532 | 0.521 | 0.473 |
| POL | Coeff | 0.961 | 0.995 | 1.097 | 1.849 | 1.247 | 1.286 | 1.279 | 1.236 | 1.179 | 1.124 |
| | Z(k) | -0.707 | -0.056 | 0.899 | 1.432 | 1.070 | 1.780 | 1.591 | 1.254 | 0.893 | 0.581 |
| | Z*(k) | -0.235 | -0.019 | 0.890 | 0.502 | 0.603 | 0.632 | 0.561 | 0.451 | 0.321 | 0.210 |
| PSO | Coeff | 0.939 | 0.952 | 0.986 | 1.008 | 1.029 | 1.082 | 1.438 | 1.206 | 1.247 | 1.286 |
| | Z(k) | -1.293 | -0.632 | -0.462 | 0.085 | 0.236 | 0.592 | 0.921 | 1.253 | 1.441 | 1.583 |
| | Z*(k) | -0.893 | 0.614 | -0.103 | 0.052 | 0.163 | 0.424 | 0.652 | 0.891 | 1.032 | 1.132 |
| PTCL | Coeff | 0.976 | 0.950 | 0.976 | 1.004 | 1.025 | 1.044 | 1.053 | 1.056 | 1.061 | 1.050 |
| | Z(k) | -0.492 | -0.662 | -0.784 | 0.039 | 0.205 | 0.321 | 0.357 | 0.351 | 0.320 | 0.278 |
| | Z*(k) | -0.350 | -0.492 | -1.841 | 0.029 | 1.492 | 0.245 | 0.261 | 0.262 | 0.271 | 0.213 |
| SEPCO | Coeff | 0.058 | 0.056 | 0.057 | 0.055 | 0.055 | 0.055 | 0.056 | 0.056 | 0.056 | 0.058 |
| | Z(k) | -20.09 | -12.71 | -10.01 | -8.532 | -2.527 | -6.83 | -6.284 | -3.854 | -5.491 | -5.187 |
| | Z*(k) | -15.17 | -99.91 | -7.952 | -6.806 | -6.042 | -5.491 | -5.065 | -4.742 | -4.442 | -4.213 |
| SNGC | Coeff | 0.880 | 0.911 | 0.901 | 0.926 | 0.968 | 0.986 | 1.012 | 1.032 | 1.043 | 1.054 |
| | Z(k) | -2.526 | -1.181 | -1.045 | -0.652 | -0.253 | -0.099 | 0.079 | 0.208 | 0.253 | 0.297 |
| | Z*(k) | -0.642 | -0.32 | -0.29 | -0.189 | -0.072 | -0.023 | 0.023 | 0.051 | 0.071 | 0.082 |
| SSGC | Coeff | 1.053 | 1.088 | 1.098 | 1.070 | 1.097 | 1.113 | 1.142 | 1.157 | 1.154 | 1.153 |
| | Z(k) | 1.139 | 1.152 | 3.325 | 0.632 | 0.774 | 0.820 | 0.852 | 0.977 | 0.902 | 0.845 |
| | Z*(k) | 0.657 | 0.712 | 0.632 | 0.389 | 0.471 | 0.503 | 0.586 | 0.620 | 0.552 | 0.524 |