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Stock Prices and Exchange Rate Nexus in Pakistan: An Empirical Investigation Using MGARCH-DCC Model

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Abstract

The study examines stock prices (LOGKSE) and exchange rate (LOGPK)-Pakistani Rupee vis-à-vis US Dollar- interactions in Pakistan. This study employs a multivariate VAR-GARCH model using monthly data from January 2012 to October 2020. The results of the Johansen cointegration test show that there is no relationship between Foreign Exchange Market and Stock Market in the long run. In the short-run, stock exchange returns are affected slightly negatively by the changes in the foreign exchange market, but the foreign exchange market does not seem to be affected by the ups and downs of the stock exchange. The VAR model and Granger Causality show that both markets are strongly influenced by their own lagged values rather than by the lagged values of one another and show weak or no correlation between the two markets. Volatility persistence is observed in both the stock and foreign exchange markets, implying that shocks and past period volatility are major drivers of future volatility in both markets. Thus greater uncertainties today will induce panic and consequently generate higher volatility in the future period. This phenomenon has been observed many times on Pakistan Stock Exchange especially. The results have important implications for local international investors in portfolio diversification decisions and risk hedging strategies.

Keywords: Financial Economics, Emerging Markets, VAR-GARCH, Johansen Cointegration, Granger Causality

JEL Classification Code: C01, C02, C58, D53, F31

1. Introduction

Since the start of the new century, The Pakistani Rupee has been continually depreciating against the US Dollar (USD). Initially, this depreciation has been slight, but from 2009 the depreciation has been quite high, and in the last six years (2015–2021), the depreciation of the Rupee against the US Dollar has been staggering. Pakistan, at the moment, seems to be in a currency crisis (Figure 1).

The sharp depreciation of the currency is not just one of the problems that Pakistan is facing, but it is hounded now with problems as serious as stagflation, high interest, and unemployment rates. The country's worsening macroeconomic position has led to Moody's downgrading Pakistan's debt rating to "negative," which signals the country's high external vulnerability, weak debt affordability, and very low global competitiveness. Pakistan Stock Exchange is also declining steadily and was dubbed the worst-performing equity market in 2019. The fascinating fact is that PSX qualified for the popular MSCI Emerging Markets Index in May 2017. Despite feverish efforts by successive governments and the Securities and Exchange Commission of Pakistan to bring more stability to Capital Markets, the situation remains either the same or deteriorates further.

Research has indicated that an efficient stock market, as well as a favorable foreign exchange market, is vital for any economy to prosper. A stable and well-organized stock market provides an alternative financing avenue for banks. The stock market has, in no way, substituted the banking system (Beck & Levine, 2004; Ehigiamusoe & Lean, 2017; Nyasha & Odhiambo, 2017). Similarly, the exchange rate affects the economy in multiple ways. An unfavorable exchange rate lowers economic growth and widens the trade deficit by affecting the competitiveness of exports. Siddiqui and Erum (2016) showed that volatility of the

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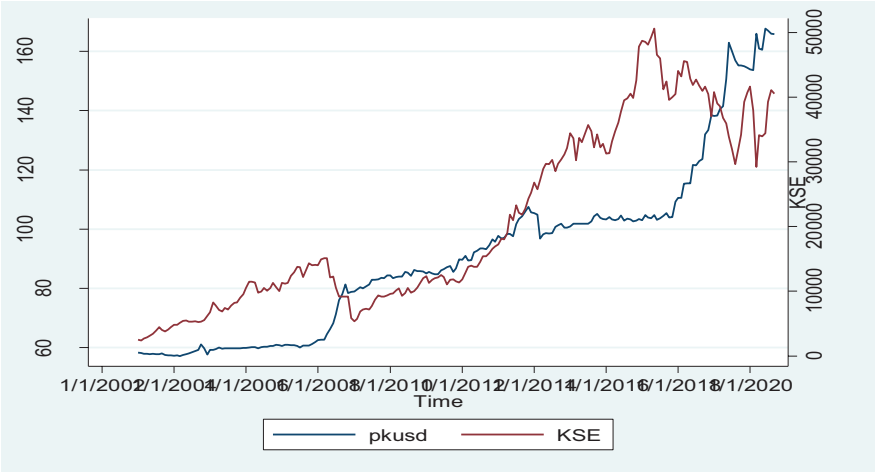

Figure 1: Historical KSE-100 Index and PK/US Dollar Rates

exchange rate had negative and significant effects on both Pakistani exports and imports. An unfavorable exchange rate leads to a decline in both savings and investments which decreases productivity (Ghura & Grennes, 1993). Constant depreciation of the exchange rate creates credit shortages and reduces business activities (Ngwube & Ogbuagu, 2014). This scenario also bodes ill for imports too as expectations of future currency devaluation trigger capital flight hence reducing reserves available for imports. Imports decline with economic activity slowing down eventually.

In the current scenario, it is imperative to understand Pakistan's financial markets and Exchange market links. This study has adopted the VAR-GARCH (1, 1) model along with Johansen Cointegration and Granger causality to account for the ARCH effect present in most of the financial time series data and detect the volatility response of the variables of interest. This model has not been previously used in Pakistan to study the exchange rate-stock market relationship. Section 2 gives the historical overview of Exchange Rate regimes and stock market development in Pakistan. The literature and method review for the study are presented in Sections 3 and 4, respectively, while Section 5 presents and discusses the empirical results. Hence, Section 6 presents the policy recommendation and conclusion.

2. History of Stock Market Development in Pakistan and Exchange Rate Regimes

2.1. Exchange Rate Regimes in Pakistan: 1947 till Now

Pakistan, an emerging country, followed a fixed exchange rate regime from August 1947 to December 1981. Pak Rupee (PKR) remained pegged to pound sterling (GBP) till the failure of the Bretton Woods System of Fixed Exchange Rates in 1971. Then Pakistan delinked PKR from GBP and pegged it with USD. The fixed exchange rate regime helped in two deliberate nominal appreciations of PKR against GBP. In 1982 Pakistan adopted a managed floating regime. From January 1982 to June 1998, PKR depreciated, on average, by 0.75% per month. In 1998, after nuclear tests (which resulted in the weakening of the currency, very low reserves, and freezing of resident foreign currency accounts) temporary dual exchange rate system was adopted in the country. This dual system consisted of an official exchange rate fixed at PKR 46/USD and a floating rate determined through the demand and supply of foreign exchange in the interbank market. In May 1999 SBP established a market-based floating exchange rate regime after abolishing the dual rate. This system is still running in Pakistan. Soon after the introduction of the regime, an unofficial cap/ceiling was imposed by the SBP through the selling/intervention of reserves at the cap level. This new regime of the market-based floating exchange rate has performed worse than both the earlier fixed and managed floating regimes. State bank of Pakistan (SBP) has consistently intervened to reduce the volatility of the exchange rate changes, which further increased its volatility (depreciating domestic currency led to a widening trade deficit and eroding reserves which wreaked further havoc on the exchange rate stability).

2.2. Stock Market (KSE-100 Index) Review: 1947 till now

Karachi Stock Exchange (Guarantee) Limited (KSE) was incorporated on March 10, 1949, with five companies, initially listed and a total paid-up capital of 37 million rupees. The first index introduced in KSE was based on fifty companies and was called KSE 50 index. In 1970 a second

stock exchange was established in Lahore and Islamabad Stock Exchange; the third one was established in Islamabad in 1989. All three exchanges had separate management, trading interfaces, indexes, and listing criteria and had no mutual links to each other. These separate structures inherently created a conflict of interest and threatened to jeopardize the investors' interests. Therefore, the Stock Exchanges (Corporatization, Demutualization & Integration) Act 2012 (known as "Demutualization Act") resulted in a merger of these exchanges and the establishment of only one exchange called Pakistan Stock Exchange Limited (PSX) which started its operations on January 11, 2016.

KSE-100 index (chosen to represent KSE initially and now PSX) with a base of 1,000 points, started in November 1991. On October 21st, 2020, the index stood at 40,956 points. Almost every index in the world routinely moves between bullish (increase) and bearish (decrease) trends, but for KSE-100 Index such trends have been more frequent and very intense. Looking at Fig. 1, the major portion of the bullish trend for the KSE-100 Index has been witnessed after the crash of 2008. Initially, a bullish trend started in 2003 and continued till the mighty fall of 2008. The main reasons behind the bullish trend from 2003 to 2008 were US aid and ease of economic sanctions, but overall, all the economic indicators also showed a persistent increase. The most disastrous year (2008) in the history of financial markets in Pakistan dawned with an index of 13,666, which climaxed at 15,654 by April 20th, 2008. Then the stock market came crashing down by 55% (lost 5,600 points), resulting in enforcement of the floor fixed at 9,144 in August, lifting of which in December (after 108 days) resulted in another crash with the index hurtling down further. Later on, the KSE-100 index experienced recovery and reached 32,812 points at the end of 2015 despite the imposition of capital gains tax in July 2010. The key reasons behind this increase were Chinese investments in major sectors, especially power generations, and an increase in foreign remittances. In January 2016, the three stock exchanges in Pakistan (Karachi Stock Exchange, Lahore Stock Exchange, and Islamabad Stock Exchange) were merged to establish a single stock exchange named the Pakistan Stock Exchange (PSX). As a result of this merger KSE 100 Index rose once again. In 2017 Pakistan qualified for the popular MSCI Emerging Markets Index in May 2017, and the KSE-100 index reached an all-time high of 53127.24.

3. Literature Review

As indicated by Portfolio Balance Approach, the growth of the stock exchange increases the capital inflows by increasing the interest of foreign investors. The demand for the domestic currency increases and it gets appreciated. In contrast to this, when the stock market declines, it not only loses the interest of the foreign investors but also reduces the wealth of local investors. Hence, the demand for the local currency decreases, and the worth of the currency depreciates (an increase in the exchange rate) in response to foreign currency. So, the Portfolio Balance Approach concludes the negative relationship between the foreign exchange rate and the stock exchange. The flow-oriented model suggests that a causal relationship runs from the exchange rate to the stock prices due to its effect on input and output prices. Branson (1983) and Frankel (1983) developed the stock-oriented model and concluded that growth in the stock market results in appreciation of the local currency. So, the three models suggested a causal link between foreign exchange rate and stock market growth. Who influenced who was further researched?

Adler and Dumas (1984) stated that US Corporations, even those with no foreign operations/foreign currency assets/liabilities/transactions, were still exposed to foreign currency risks as every country is linked to other countries through exports/imports. In contrast to advanced countries, firms in emerging economies are more prone to currency risk. These firms are usually price-takers in international trade and cannot pass through the changes in exchange rates to foreign buyers. Ma and Kao (2008) found that the nature of the relationship (positive or negative) between foreign exchange rate and stock exchange return is dependent on whether the country is an export dominant country or a dominant import country. The empirical literature that has examined the stock prices-exchange rate relationship has come up with conflicting results. Some studies have found a significant positive relationship between stock prices and exchange rates (for instance, Aggarwal (1981), Smith (1992), Granger et al. (2000), Phylaktis and Ravazzolo (2005), Muller and Verschoor (2009), Tian and Ma (2010), and Diamandis and Drakos (2011) while others have reported a significant negative relationship between the two. On the other hand, some studies have found very weak or no association between stock prices and exchange rates (for instance, Franck and Young (1972), Bartov and Bodnar (1994), Suriani et al. (2015), Bhattacharya and Mukherjee (2003), Gulati and Kokhani (2012), Gulati and Higgins (2003), Jorion (1990), and Ong and Izan (1999).

The empirical evidence regarding the direction of causality between stock prices and exchange rates is also inconclusive. Oskooee & Shrabian (1992) concluded bidirectional causality between stock prices measured by S&P 500 index and the effective exchange rate in the short run. The cointegration analysis revealed no long-run relationship between the two variables. Koutoulas and Kryzanowski (1996) found significant evidence that exchange rate volatility leads to stock market volatility in Canada. Kearney (1988) had similar results for Ireland. Smith (1992) demonstrated that stock returns led exchange rates in Germany. Thang (2009) found that the exchange rate had a negative impact on the Malaysian stock market index in the long run as well as the short run. Kyereboah-Coleman and Agyire-Tettey (2008) showed that the exchange rate

had a negative impact on the stock market index in Ghana. Mukherjee and Naka (1995) showed that the exchange rate had a positive impact on stock prices in Japan. El-Masry et al. (2007) found that the appreciation of the exchange rate had a positive impact on the United Kingdom non-financial firms' stocks return. Aydemir and Demirhan (2009) found that there was a bi-directional relationship between exchange rates and all the stock market indices in Turkey. Hatemi and Irandoust (2002) examined the possible causal relationship between exchange rates and stock prices in Sweden. They use monthly nominal effective exchange rates and stock prices over the period 1993–98. They find that Granger causality is unidirectional from stock prices to effective exchange rates. Kumar (2010) found that the results of both the causality tests reveal evidence of a bi-directional relationship between the stock index and exchange rates in India.

Bagh et al. (2017) found a positive and statistically significant relationship between Exchange Rate Volatility on the Stock Index of Pakistan using twelve years of monthly data from 2003 to 2015. Yaqoob and Bibi (2021) also found that the correlation Real Effective Exchange Rate with the PSX exhibited a positive sign. Khan and Ali (2015) concluded a bidirectional relationship between the exchange rate volatility and the variability of stock market prices in Pakistan using monthly data from January 1992 to February 2013. Ali et al. (2010) found a causal relationship between the exchange rate and the Pakistan stock exchange using Granger Causality. Suriani et al. (2015) and Sohail and Hussain (2019) found no relationship existed between exchange rate and stock price.

4. Methodology

In this paper, the objective is to provide additional evidence on the short-run and long-run dynamics between exchange rate and stock price in Pakistan. This study contributes to the literature in two distinct aspects. First, the paper empirically explores the short-term and long-run dynamic relationships between price behaviors of stock price and exchange rate in Pakistan. A better understanding of the short-term movements of these two markets enables financial managers to make more informed investment and financing decisions. Secondly, a range of techniques has been utilized to establish and corroborate results. The techniques used include Granger Causality, vector autoregression, Johansen Cointegration, and multivariate generalized autoregressive conditional Heteroskedasticity (MGARCH) models.

4.1. MGARCH-DCC

The model that has been used in this study is the DCC MGARCH (1, 1) model, which was initially proposed by Engle (2002). The notations used are the ones suggested by StataCorp. Thus, asset returns are defined in the following manner:

$$\boldsymbol{r}_t = \boldsymbol{C}\boldsymbol{x}_t + \sqrt{\boldsymbol{h}_t}\boldsymbol{v}_t \tag{1}$$

where $\boldsymbol{C}$ is a vector of ones and $\sqrt{\boldsymbol{h}_t}$ is the Cholesky factor of a matrix of time-varying conditional covariances. This matrix of time-varying conditional covariances in the following manner:

$$\boldsymbol{h}_t = \sqrt{\boldsymbol{D}_t}\boldsymbol{R}_t\sqrt{\boldsymbol{D}_t} \tag{2}$$

where $\boldsymbol{R}_t$ is a time-varying matrix of quasicorrelations, hence the "dynamic conditional correlation" terminology.

$$\boldsymbol{R}_t = (\boldsymbol{Q}_t)^{-1/2}\boldsymbol{Q}_{tdiag}(\boldsymbol{Q}_t)^{-1/2} \tag{3}$$

where, $\boldsymbol{Q}_t = (1 - \lambda_1 - \lambda_2)\boldsymbol{R} + \lambda_1\tilde{\boldsymbol{\epsilon}}_t - 1\tilde{\boldsymbol{\epsilon}}_{t-1}' + \lambda_2\boldsymbol{Q}_{t-1}$

Moreover, λ_1 and λ_2 are estimated parameters that govern the behavior of the conditional quasicorrelations, such that: $0 \leq \lambda_1 + \lambda_2 < 1$, $0 \leq \lambda_1$, $0 \leq \lambda_2$.

Furthermore, $\tilde{\boldsymbol{\epsilon}}_t$ is a $m \times 1$ vector of standardized residual, and $\boldsymbol{R}$ is the $'$ weighted average of the unconditional covariance matrix of the standardized residuals, $\tilde{\boldsymbol{\epsilon}}_t$, and the unconditional mean of $\boldsymbol{Q}_t'$ (StataCorp, 2018b, p. 5). Additionally, $\boldsymbol{D}_t$ is a diagonal matrix of conditional variances, defined in accordance with the univariate GARCH (1, 1) model.

4.2. Unit Root Test

Various parametric and non-parametric tests have been developed to investigate whether a series is stationary or contains a unit root. Thus, this study adopted Augmented Dickey-Fuller (ADF) and Phillip-Perron, and KPSS to identify if the series used contains unit-roots.

4.3. Johansen Cointegration Test

The Engle and Granger (1987) and Johansen cointegration by Johansen (1990, 1992) was employed to determine the number of cointegrating vectors. Johansen proposed a maximum likelihood estimation procedure, which allows simultaneous estimation of the system involving two or more variables to circumvent the problems associated with the traditional regression methods. Further, this method is independent of the choice of endogenous variable, and it allows estimation and test in the presence of more than one cointegrating vector in the multivariate system. In general, Johansen co-integration test is given by

$$Y_t = A_1 Y_{t-1} + \ldots + A_p Y_{t-p} + BX_t + \varepsilon_t \tag{4}$$

where Y_t is a vector of non-stationary $I(1)$ variables; X_t is a vector of deterministic variables and ε_t is a vector of innovations.

4.4. VAR model

A VAR (2) model has been used in this study. It has the following form.

$$Y_t = \beta_1 Y_{t-1} + \beta_2 Y_{t-2} + \varepsilon_t \quad (5)$$

5. Empirical Results

In this study, daily data for the stock market and exchange rates have been collected. The sample period of the study covers the time period January 2012 through to October 2020 with 2257 observations. KSE 100 Index is chosen to represent the Pakistani Stock market. Additionally, the local currency (Pakistani Rupee) against the US Dollar has been taken as the exchange rate. Data for the stock exchange market and currency exchange market Yahoo Finance and STATA 14 have been used for analysis. The return series have been generated as follows:

$$R_t = 100 \times \text{Log}\,(X_t/X_{t-1}) * 100$$

Table 1 presents the descriptive statistics for the KSE 100 and exchange rate return series.

According to the results in Table 1, the mean of both return series is positive and close to zero. Pakistan stock exchange is more volatile than the foreign exchange market, as evident from the standard deviation. The stock market is negative, while the foreign exchange market is positively skewed. Both markets have kurtosis greater than 3, making their return series leptokurtic. Box Pierce LM test confirms the presence of autocorrelation in the residuals of all the series.

Augmented Dickey-Fuller (ADF), Phillips-Perron (PP), and the Kwiatkowski, Phillips, Schmidt, and Shin (KPSS) tests confirm that all the series are stationary around levels (Table 2). An optimal lag length is selected by looking at various information criteria, and the results are presented in Table 3.

The FPE, Akaike Information Criterion, Hannan Quinn Information Criterion disagree with Schwarz Bayesian

Table 1: Descriptive Statistics

	Pakistan	
	S_t (Stock Return Series)	**$Exch_t$ (Foreign Exchange Return Series)**
Mean	0.0243829	0.0122122
Max	2.034214	3.348264
Min	–3.084546	–2.57021
Std.Deviation	0.4414325	0.3762661
Skewness	–0.6156883	0.3612572
Kurtosis	8.352964	9.050733
Box-Pierce LM Test	376.1154**	52.9763**

Note: **Significant at 5% level.

Table 3: Lag Length Selection

Lag	FPE	AIC	HQIC	SBIC
0	0.016587	1.57664	1.58384	1.5949
1	0.013373	1.36124	1.38283	1.41603*
2	0.013002*	1.33312*	1.36911*	1.42444
3	0.013097	1.34039	1.39078	1.46824
4	0.013242	1.35135	1.41614	1.51572

Table 2: Unit Root Test Results

Variables	ADF Statistics			PP Statistics			KPSS Statistics		
	Level	Critical Values		Level	Critical Values		Level	Critical Values	
S_t	–41.677	1%	–3.430	–41.597	1%	–3.430	0.0463 (at Lag 8)	1%	0.216
		5%	–2.860		5%	–2.860		2.5%	0.176
		10%	–2.570		10%	–2.570		5%	0.146
								10%	0.119
$Exch_t$	–69.504	1%	–3.430	–73.687	1%	–3.430	0.0918 (at Lag 8)	1%	0.216
		5%	–2.860		5%	–2.860		2.5%	0.176
		10%	–2.570		10%	–2.570		5%	0.146
								10%	0.119

Table 4: Johansen Cointegration Test Results

	Johansen Cointegration Tests Results			
H0	**Eigen Value**	**5% Critical Value (Eigen Value)**	**Trace Statistic**	**5% Critical Value (Trace Statistic)**
r = 0			2417.8525	15.41
r = 1	1614.8786	14.07	802.9739	3.76
r = 2	802.9739	3.76		

Note: *r* denotes the number of cointegrating vectors. Eigen and trace are Johansen test statistics for testing cointegration.

Information differ on the selection of lags. Preferring FPE, AIC, and HQIC over SBIC, two lags are selected, and VAR is estimated using two lags.

5.1. Long-Run Relationship Between Stock Market and Foreign Exchange Market

Johansen integration test was used to study the relationship between the two financial markets. Two statistical tests were used in Johansen cointegration tests: trace and the maximal Eigenvalue test. The first row in the table tests the hypothesis of no cointegrating relation, and the second-row tests the hypothesis of one cointegrating equation, etc., against the alternative of the full rank of cointegration. The result is presented in Table 4:

Both trace and maximum Eigen Value test results indicate no cointegrating equations and hence no long-run relationship between Foreign Exchange Market and Stock Market. As no long-run relationship is established, then the next short-run relationship between these two variables is estimated.

5.2. Short-Run Relationship Between Stock Market and Foreign Exchange Market

Table 5 indicates that stock exchange returns are affected negatively (albeit slightly) by the changes in the foreign exchange market, but the foreign exchange market does not seem to be affected by the ups and downs of the stock exchange. Both the markets are strongly affected by their own lagged values, especially the first lag in the Stock market and both lags in the case of the foreign exchange market, which came out to be significant.

In addition, the Granger Causality test was also performed, and the results indicated that no variable granger caused other. The diagnostics of the VAR (2) model were also performed. It included a stability test (the model was found to be stable as all the eigenvalues fell inside the unit circle.), an auto-correlation test (confirming no correlation), and a normality test (the errors were also found to be normally distributed).

Table 5: VAR (2)

S_t	Coeff	*P > Z*
S_t		
L1	0.1693987	0.000
L2	0.0266428	0.255
$Exch_t$		
L1	–0.0150494	0.641
L2	–0.0193507	0.539
$Exch_t$		
S_t		
L1	0.0354617	0.083
L2	–0.0042204	0.824
$Exch_t$		
L1	–0.4544049	0.000
L2	–0.1680265	0.000

5.3. VAR (1)-GARCH (1, 1)

The study also uses the multivariate VAR (1)-GARCH (1, 1) in the DCC model to study the dynamic mean spillover and volatility transmissions between stock and Foreign Exchange Market. The estimated results for VAR (1)-GARCH (1, 1) are displayed in Table 6.

Table 6 presents the results of the interactions between stock returns and changes in Exchange Rate. For the mgarch model, the maximization was carried out under the Gaussian distribution assumption, and the wald test came out to be highly significant, indicating that our model described the time structure of the data in a satisfactory way.

Parameters for the mean equation and univariate volatilities are provided for each time series, as well as correlations between the two series. The mean equation of LOGKSE, where the lagged coefficient LOGPK is not statistically significant, and the mean equation of LOGKSE,

Table 6: VAR (1)—GARCH (1, 1)

		Coefficient	*P* > |*z*|
LOGKSE		0.093015	0.000
	LOGKSE L1		
	LOGPK LI	–0.0091406	0.708
	Cons	0.0442981	0.000
ARCH_LOGKSE			
	ARCH L1	0.1618997	0.000
	GARCH L1	0.9335955	0.000
	Cons	–0.0190756	0.543
LOGPK			
	LOGKSE L1	0.0072843	0.679
	LOGPK LI	–0.4193483	0.000
	Cons	0.0436718	0.000
ARCH_LOGPK			
	ARCH L1	0.1035099	0.000
	GARCH L1	1.265649	0.000
	Cons	–0.0397413	0.188
corr (LOGKSE, LOGPK)		0.033942	0.166
Adjustment			
	lambda1	0.0574074	0.064
	Lambda2	0.0035023	0.933

where the lagged coefficient LOGPK is not statistically significant, are the two exceptions. Thus the results indicate that the two series are strongly affected by their own lagged values but are not affected by the lagged value of the other series. The correlation has come out to be 0.034 which indicates little or no association between the two markets. Two parameters Lambda1 and lambda2 have values 0.06 and 0.003 which indicates that the evolution of the conditional covariances depends less on their past values than on lagged residuals' innovations.

Meanwhile, the result from the variance equation indicates that there is volatility persistence in both the stock market and foreign exchange market with significant ARCH terms and GARCH terms. This implies that shocks and past period volatility are major drivers of volatility in both markets. Thus greater uncertainties today will induce panic and consequently generate higher volatility in the future period.

The findings of this study are consistent with the results of Suriani et al. (2015) and Hussain et al. (2019) that the two markets are independent of one another but contradict the works of Bagh et al. (2017) and Khan and Ali (2015). They found a significant relationship between the two.

6. Conclusion

This study was undertaken to study the nature and dynamics of the relationship between the Stock Market and the Foreign Exchange Market of Pakistan. Daily data for the stock market and exchange rates from January 2012 through to October 2020 with 2257 observations was used for analysis. The results showed that both the markets were leptokurtic; the stock market was negative while the foreign exchange market was positively skewed. Both trace and maximum Eigen Value tests indicated no cointegration between Foreign Exchange Market and Stock Market. At the same time, in the short-run VAR model and Granger Causality also ruled out any causality between the two. This essentially means that the two markets do not affect each other. Finally, in VAR (1)-GARCH (1, 1), the mean equation of LOGKSE lagged coefficient LOGPK was not statistically significant, and in the mean equation of LOGKSE, the lagged coefficient LOGKSE was not statistically significant. The two series were strongly affected by their own lagged values but not affected by the lagged value of the other series. The correlation was 0.034, which indicated little or no association between the two markets. The results from the variance equation indicated volatility persistence in both the stock market and foreign exchange market with significant ARCH terms and GARCH terms. This implies that shocks and past period volatility are major drivers of volatility in both markets. Thus greater uncertainties today will induce panic and consequently generate higher volatility in the future period.

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