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Asymmetric Volatility Spillover between Macroeconomic Variables and Pakistan Stock Exchange

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ABSTRACT

The present research focused on the association of macroeconomic variables uncertainty with the volatility of stock market in Pakistan. The research explored uncertainties in macroeconomic series by common version of EGARCH and GARCH variances were used as proxies of volatilities. Furthermore, the series were incorporated into mean and variance equations to model spillover effect between stock market and indicators of macroeconomy. The association was additionally checked through VECM and Wald test methods. The investigation used monthly observations from January 2001 to December 2020. Findings revealed a significant causality amid macroeconomic volatility and stock exchange volatility. The outcomes also reconciled with Banumathy and Azhagaiah (2015); Wang (2011). A bilateral causal relationship was found between volatilities of gold prices and manufacturing output with stock market, whereas uni-directional causality was from exchange rate, inflation and oil prices toward stock market.

1. Introduction

Stock markets provide an opportunity for countries to accumulate resources within and outside the country. The marketplace offers a medium to move assets from businessmen across the world in different economies. Measurements of financial market volatility facilitate forecasters to forecast the course of expansion of financial markets. (He et al., 2020) argued that the decline of the stock market always leads to financial adversity and to collapse economic system. Analysis concerning the association of stock return volatility has got much importance in current eras. Stock market's growth relies on strength of financial structure, macroeconomic indicators and external markets (Hussain et al., 2020; Ali et al., 2021).

Officer (1973) was a pioneer who related stock price volatility and economic indicators with each other and found a huge volatility for great depression of 1930. Chaudhry (2020) found causal uncertainty impact in stock market returns. Controlling for contemporary shifts in first moment indicated a significant obstacle to classifying causal impacts of uncertainty in numerous applications (Alfaro et al., 2018;Baker, et al., 2020; Barrero et al., 2017; Ali, Mouneer & Qasim, 2022). Empirical text on the association of stock markets with

macroeconomics has divided in two broad classes. The first class gave concentration on the association among macroeconomic indicators and indices running in stock markets. In spite applying various econometric techniques, they found that just macroeconomic factors influence stock markets. Principally, variables like interest rate, inflation, money supply, exchange rates and industrial production were recognized noteworthy factors to determine performance in stock markets.

Mala and Reddy (2007) calculated instability at share market of Fiji and established significant effect of interest rates on unpredictability of stock markets. Adam and Tweneboah (2008) found a positive association amid stock return and inflation and argued that shareholders should be compensated for inflationary power. Wang (2011) found bidirectional relationships between inflation volatility and stock market in China. Demir (2019) developed significant association of macroeconomic instability through stock prices volatility.

1.1. Pakistan Stock Exchange (PSX)

The PSX Limited came into being in Jan 2016 as the Government of Pakistan made decision and merged the three exchange markets into a single combine market. PSX became a component of the Morgan Stanley Capital International (MSCI) Emerging Markets Index in Mar 2018. The Financial Times Stock Exchange categorized PSX as market of Secondary Emerging country.

1.2. Research Question

How do macroeconomic indicators, such as inflation, industrial production, money supply, gold prices, oil prices and exchange rates contribute to the volatility of stock markets, and what are the implications of this relationship on the overall economic stability of a country?

1.3. Significance of the Study

Volatility in stock markets during last decade increased the discussion on stock prices actions in developed countries in common and especially for developing country like Pakistan. Pakistan is trying to build up pecuniary sector by improving its capital markets. This study will benefit policy makers, because the study will enlighten the role of macro-economic variables on stock market volatility. Investors will be capable to prepare strategies to diminish their vulnerability with portfolio diversification, hedging and risk management.

The Pakistani market has started to wide rapidly and reactive to problems like changes in financial movements, macroeconomic variables and political atmosphere. Either these relations as well hold in Pakistan, consequently study of relationships between stock markets or macroeconomics was a fundamental subject in current research.

2. Literature Review

Literature review was useful to understand the studies initiated in earlier times concerning volatility of stock markets inside Pakistan and diverse characteristics worldwide and at national level. Examination of determinants of stock market give support about different forces linked with stock return. Many authors used various types of data and evaluation method for dissimilar stock marketplaces. Detail on the investigation at national and global level is provided in this study

Omar, Hussain, Bhatti, and Altaf (2013) checked random walk actions in KSE. Daily, weekly and monthly stock prices from 1998 to 2012 were tested using descriptive statistics, VAR analysis and unit root analysis. Outcomes of all tests indicated that KSE didn't followed random walk trend and therefore was not weak form efficient. Shamshir and Mustafa (2014) investigated the effect of day of week and volatility for 2009-2013 using indices in KSE. Objective was to evaluate the reliability of all indices functioning at KSE. By OLS and autoregressive system the research showed effect of Tuesday and Thursday in cases of KSE all-share and KSE-100 respectively and no effect in KSE 30 and KMI 30 indices. The GARCH (1,1) revealed huge volatility in KSE 100 index, relatively less frequent shocks in

KSE all share as well as KSE 30 index.

Xiong and Han (2015) used granger causality-MSV (stochastic volatility models) to examine the spillover effect concerning the foreign exchange market with stock market. The investigational results showed that there was a negative association of dynamic spillovers between the markets. There were effects of asymmetric volatility spillover among two markets. Dedi and Yavas (2016) scrutinized linkage of equity market return with volatility spillover in the subsequent countries: UK, Germany, Turkey and Russia. MARMA, GARCH, GARCH-M, and EGARCH methodologies were of use to daily data from 31 Mar 2011 to 11 Mar 2016. The outcomes of study showed the significant movements of returns between the sample countries. All other markets excluding UK and Turkey, experienced volatility spillover from other countries. Finally, due to risk and return trade-off, research work analyzed the outcome of market volatility and recognized that only the UK market volatility had an optimistic result on future returns.

Ewing and Malik (2016) analyzed the transmission of restricted stock price volatility across the US, Canada, and Mexican markets. There was substantial concentration in either stock market instability is conventional and degree by which cross market associations exists. Through daily data for the episode 6-2-92 to 10-28-99 research provided observed confirmation on the degree by which cross market relations existed in pre and post-NAFTA phases. Bhunia and Yaman (2017) examined there causal linkage connecting US and some capital markets from Asia. Lying on stocks values for model of different Asian markets, they found positive link with US market in the majority cases, excluding Vietnam. Outcomes indicated significant long and short-term causality from both sides amid US and Asian markets. These result illustrate that, as both markets sets were integrated, so there were still helpful prospects for global investors to vary their portfolio in US and Asian markets.

A study by (Ruhani et al., 2018; Ali, 2021) discussed importance for estimation of stock price performance and explained its importance for numerous reasons along with for diverse stakeholders in financial market. The increasing associations of national markets in commodity, currency and stock with commodity and stock with world international markets and the survival of common players have specified new characteristics to stock price behavior, mean that its fast transmissibility across different markets. This study reviewed the presented literature of different theories making explanation of stock index behavior. To assess the literature, the research presented the theories in two wide eras. First era was the pre-modern era in monetary theory and second was the theories in contemporary financial economics through technical development.

He et al., (2020) studied the asymmetric effect of significant economic uncertainty (EU) on the S&P500 index using monthly data from 2000 to 2019. Study found that volatility of S&P500 index was recipient of spillovers from important EU indices. Time varying spillover showed that bad volatility reacted more powerfully to shocks in EU succeeding the crisis and trade negotiation.

Summarized findings across the studies reveal diverse insights into stock market behavior. The Karachi Stock Exchange (KSE) was found not to follow a random walk trend, indicating inefficiency. Specific impacts on certain days and significant volatility were identified in the KSE 100 index. Negative associations and asymmetric volatility spillover were observed between foreign exchange and stock markets. Significant movements of returns and volatility spillover were noted among the UK, Germany, Turkey, and Russia. Evidence of cross-market associations in stock price volatility was provided across the US, Canada, and Mexican markets. Positive linkages were discovered between the US and Asian capital markets, with the importance of estimating stock price performance emphasized. Volatility spillovers from significant EU indices to the S&P500 index were highlighted during periods of economic

uncertainty.

2.1. Research Gap

Potential research gap exists in the comprehensive evaluation of the impacts of inflation, industrial production, money supply, gold prices, oil prices, and exchange rates on stock market volatility. While existing literature has explored the association between macroeconomic indicators and stock market performance, there is a need for a more integrated and diversified analysis that considers the coinciding impacts of multiple factors. Additionally, the dynamic nature of financial markets requires a thorough investigation into how these variables interact over different economic conditions. This study contributes by augmenting all potential factors that are likely to be causing volatility in the stock market of Pakistan.

3. Research Methodology

The exact econometric methods and appropriate data handling are considered as the basis of any study work. This part gives detail about methodological framework, data compilation, sample choice and creation of variables from available data sets.

3.1. White Noise

One of the fundamental steps while modeling stochastic procedures is white noise

$$E(\varepsilon_t) = 0$$

$$E(\varepsilon_t \varepsilon_s) = \begin{cases} \sigma^2 \; for t=s \\ 0 \; for t \neq s \end{cases} \quad (1)$$

3.2. Autoregressive Process

First, consider AR (1) process

$$Y_t = \alpha_0 + \beta_1 Y_{t-1} + \varepsilon_t \quad (2)$$

Here, α_0 and β_1 are some real constants; "t" is white noise procedure describe in equation. This process can as well be generalized to an AR (p) from.

$$Y_t = \alpha_0 + \sum_{j=1}^{p} \beta_j Y_{t-j} + \varepsilon_t \quad (3)$$

3.3. Moving Average Process

A moving average procedure of single order MA (1) is as below

$$Y_t = \alpha_0 + \alpha_1 \varepsilon_{t-1} + \varepsilon_t \quad (4)$$

Where, α_0 and α_1 may be some real constants and ε_t is white noise term. The general form of MA (q) is given below

$$Y_t = \alpha_0 + \sum_{j=1}^{q} \alpha_j \varepsilon_{t-j} + \varepsilon_t \quad (5)$$

One limitation of simple GARCH family framework is to require symmetric response of instability to negative as well as positive shocks**.** Residuals are squared in GARCH models and provide identical results for bad or good information. On the other hand asymmetric GARCH representation suggests that shocking news have diverse influence on volatility in comparison to good news**.**

3.4. EGARCH Model

Nelson (1991) designed EGARCH form. This form is advanced than GARCH as it disregards the non-negative restriction and does not require any limitation to parameters. EGARCH as well explores impact of bad news which is important in monetary markets.

$$\pi_t = \pi_0 + \sum_{i=1}^{n} \pi_i X_{t-i} + \varepsilon_t \quad (6)$$

$$\varepsilon_t / \Omega_t \approx \text{iidN}(0, h_t)$$

$$\log h_t = \gamma + \sum_{j=1}^{q} \alpha_j \left| \frac{\varepsilon_{t-j}}{\sqrt{h_{t-j}}} \right| + \sum_{j=1}^{q} \beta_j \frac{\varepsilon_{t-j}}{\sqrt{h_{t-j}}} + \sum_{i=1}^{p} \delta_i \log(h_{t-i}) \quad (7)$$

In equation 7 γ,α,β ,and δ are parameters. Left side of equation is in logarithmic form to order the leverage effect exponential. The pattern is symmetric if: $\beta_1 = \beta_2 = \ldots = 0$

Now $\beta_j \prec 0$ represents extra collision of pessimistic news than optimistic. This study employed EGARCH because this better detains asymmetric affect.

3.5. Cointegration Analysis

Cointegration explains to essential theory that the variables integrated in study expose a long run affiliation. Study for integrating order is same like the examining unit roots in series. The two recognized approaches are commonly used to check the cointegration between the series in a model. These are ADF residual base test projected by R. F. Engle and Granger (1987) and Johansen's approach (S Johansen & Juselius, 1990). Johansen's method that allowed examination all the probable co-integrating relationships was used.

The existence of a single vector was checked through two likelihood ratio tests. These tests statistics were Trace test and maximal-Eigen values. The null hypothesis was about r co-integrating vectors beside the alternative about more than r can be examined under the trace test and explained as:

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^{p} \ln(1 - \lambda_i) \quad (9)$$

The r co-integrating equations might be experienced in the null hypothesis in contrast to the alternative about r+1 from maximal-Eigen values test and described as:

$$\lambda_{\max}(r, r+1) = -T \ln(1 - \lambda_{t+1}) \quad (10)$$

The critical values of both tests were derived through Monte Carlo simulations along with tabulated from Søren Johansen (1988);(Osterwald-Lenum, 1992). J. R. Harris (1995) said that for cointegration trace test provide more robustness between these two LR tests. In present study for estimating the relationship, the adjusted likelihood ratio (LR) statistics Sims (1980) were utilized to determine the VAR order i.e k. The lag length was determined by the AIC and SBC criteria.

3.6. Causality Tests

The causality test can be conducted in two ways; it depends on the outcomes of linkage. If short-run relation existed, the Granger tests may be apply under the VAR Model whereas if there exist long-run association, the causality tests might be under the VECM. The typical Granger test is appropriate for analyzing the relationship if no cointegration exists amid variables. The VECM must be functional for co-integrated variables.

3.7. Data Description

Investigator has utilized secondary data to examine the volatility in the sample markets. The macroeconomic indicators used in this study are gold prices (GP), manufacturing production (MP), oil prices (COP), exchange rate (RER), money supply (RMS) and inflation (INFL). The study used monthly observations for the time 2001:01-2021:12. Monthly observations are choosing to investigate high frequency data to capture volatility by employing ARCH/ GARCH family models. The researcher has collected statistics on macroeconomic indicators from diverse sources like business recorder, statistical bulletin of SBP and International

Financial Statistics.

4. Results and Discussions

According to Fisher's proposition market rate of interest incorporated the predictable inflation and anticipated real interest rate (Fisher, 1930). The association of exchange rate and stock prices is based on a simple economic theory. If the home currency decreases its value beside foreign currency, export prices products decline and thus, the level of a country's export will raise and depreciation of home currency has a harmful association with return. This study attempts to model the macroeconomic uncertainty by applying non-linear GARCH framework. Macroeconomic variables are firstly checked for descriptive values and shown in table 1.

Skewness determines the asymmetric distribution and its value different from unity means asymmetric distribution otherwise normal distribution. The value of skewness for all series is different from zero. Kurtosis and high Jarque-Bera statistics prove considerably deviation from normality. Hence, the values of skewness, kurtosis and Jarque-Bera prove abnormal distribution.

This means that there is a need to apply ARCH GARCH family models to handle the abnormality and modeling the conditional variance. Macroeconomic indicators are further checked for time series properties to avoid the possibility of spurious outcomes. It is better to investigate macroeconomic series for stationary properties. There are diverse techniques to check the characteristics of time series statistics. ADF, PP and KPSS tests give valid results and intensely used by in the literature.

Table 1: Descriptive Results for Macroeconomic Indicators

	KSESR	GP	MP	COP	RER	RMS	INFL
Mean	0.02	81230.82	108.92	5377.86	100.55	37323.85	149.01
Median	0.02	76847.66	112.90	4842.30	97.01	32035.46	159.65
Maximum	6.96	166668.2	173.95	11470.97	127.44	67660.71	256.22
Minimum	-6.88	15637.66	49.14	1127.20	51.88	18216.89	79.39
Std. Dev.	0.98	51026.61	24.49	3020.71	12.98	13430.73	49.74
Skewness	0.04	0.04	-0.50	0.40	-0.23	0.65	-0.01
Kurtosis	48.24	1.36	2.99	1.97	5.43	2.25	1.57
Jarque-Bera	17312.43	22.62	8.68	14.42	52.24	19.31	17.17
Probability	0.000	0.000	0.013	0.000	0.000	0.000	0.000

Source: Authors calculations

Null hypotheses of both ADF and PP are about non-stationary series and alternative hypotheses about stationary variables. The macroeconomic variables in current research have shown trend over time. The series are first checked for intercept and trends before applying unit root tests.

The tests are performed in level and first differencing at trend with intercept. The study starts from ADF test that proves all the six variables are stationary at first difference. After that PP

test also verified the ADF results. At the end researcher applied KPSS test which also confirm presence of unit root at level while stationary after first difference.

The results from testing in Table 2 reveal that the entire indicators are stationary at first difference. This means that macroeconomic data is trended as usual and instead of OLS method some different procedure might be used. Next the research work has employed EGARCH procedure to model the uncertainty in macroeconomic data. The study has make use of this model because EGARCH provides better results as compared to simple ARCH/GARCH models.

The model is used to check the asymmetries along with TARCH. Results are reported in tables below for the every macroeconomic variable. Different sets of models are fitted for every series and lag length by minimizing SC and AIC. The models are also checked for, autocorrelation, F statistic etc.

The uncertainty in each variable is modeled using asymmetric GARCH. These models are used to capture asymmetric effect on conditional variance equation. Firstly a separate mean equation is estimated for every macroeconomic series. The mean equation is estimated using ARMA and simple least square method. After that a variance equation is estimated for every series separately.

Table 2: Results of Unit Root Test

Regressors	**ADF Test Statistics**		**PP Test Statistics**		**KPSS test statistics**	
	level	**1st diff**	**level**	**1st diff**	**level**	**1st diff**
INF	-2.50	-12.13*	-3.28	-16.31*	0.21	0.09*
GP	-1.29	-11.88*	-1.16	-11.84*	0.23	0.18*
MP	-1.51	-5.31*	-2.86	-16.62	0.31	0.04*
OP	-2.17	-9.01*	-1.81	-8.76*	0.26	0.05*
RER	-3.03	-11.14*	-3.66	-18.42*	0.22	0.07*
RMS	-1.79	-14.32*	-1.58	-15.35*	0.32	0.08*

Note. *implies1% significance level

This step is performed to model the uncertainties in different macroeconomic series. Again the information criteria used here are SC and AIC. The Table 3 fully described the application of EGARCH family on selected macroeconomic variables to model the conditional variances. The optimal lags in variance and mean equation are chosen through minimal values of mentioned information criteria. The results in the table show the effect of past volatility, volatility magnitude, long term effects and asymmetric effects. The last column indicates probability values for rejection or accepting null or alternative hypotheses.

Prior to performing test, the test requires verifying the best possible lags for selected sample. This applies to the Johansen cointegration as well as VECM and causality examination. Again the criteria employed here are the AIC, the SC and HQC and minimum lags length entail a superior model.

Table 3: VAR Lag Order Selection Criteria

Endogenous variables: HTKSESR HTBSESNSR HTSSECSR HTHISSR HTN225SR HTGSPCSR

Lag	**LogL**	**LR**	**FPE**	**AIC**	**SC**	**HQC**
1	-14303.30	NA	2.00e+56	149.50	150.33*	149.83
2	-14185.92	217.63	9.83e+55	148.79	150.45	149.46*
3	-14122.78	112.45	8.52e+55	148.64	151.13	149.65

4	-14073.34	84.46	8.55e+55	148.63	151.96	149.98
5	-14022.71	82.80	8.53e+55	148.62	152.77	150.30
6	-13961.98	94.89	7.71e+55	148.49	153.48	150.52
7	-13907.91	80.54	7.54e+55	148.44	154.26	150.80
8	-13754.38	217.49*	2.65e+55*	147.35*	154.01	150.05

Note. * specifies lags selected through the criterion

Ivanov and Kilian (2001) disputed SC and HQ gave superior results for high frequency models while AIC ought to be exercised in models across a shorter time. The results of all three mentioned criteria are reported in Table 3.

AIC selected eight lags, SC preferred one lag and from HQC two lags. The study pursued R. Harris and Sollis (2003) and chosen SBC lag length (i.e. one). Johansen procedure is a typical method of formative long-run relations in time series in a VECM. Macroeconomic variables in current sample turned into stationary by taking first difference.

Table 4: Johansen Cointegration Results

Hypothesized No. of CE(s)	**Eigen values**	**Trace Statistic**	**Critical Values**	**Probability**
$r \leq 0$ *	0.47	354.80	125.61	0.000
$r \leq 1$ *	0.37	231.42	95.75	0.000
$r \leq 2$ *	0.31	140.49	69.81	0.000
$r \leq 3$ *	0.19	71.36	47.85	0.000
$r \leq 4$ *	0.10	29.87	29.79	0.048
$r \leq 5$	0.03	9.28	15.49	0.339
$r \leq 6$	0.01	3.12	3.84	0.077
Hypothesized No. of CE(s)	**Eigen values**	**Max-Eigen Statistic**	**Critical Values**	**Probability**
$r \leq 0$ *	0.47	123.38	46.23	0.000
$r \leq 1$ *	0.37	90.93	40.07	0.000
$r \leq 2$ *	0.31	69.12	33.87	0.000
$r \leq 3$ *	0.19	41.48	27.58	0.000
$r \leq 4$	0.10	20.59	21.13	0.059
$r \leq 5$	0.03	6.16	14.26	0.592
$r \leq 6$	0.01	3.12	3.84	0.077

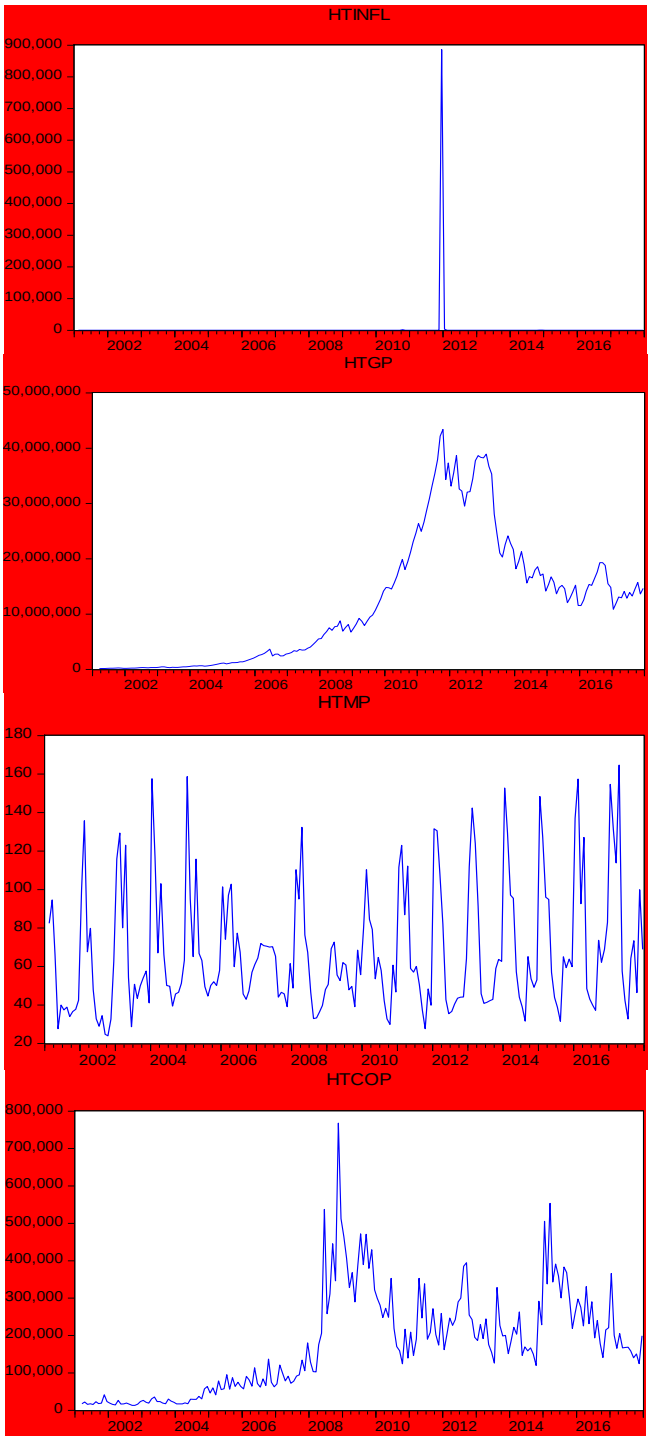
Note. *Shows 1% significance level

The cointegration analyses are presented in Table 4, which procedures two likelihood ratios; the trace statistics along with maximum Eigen values. The former exceed their critical value with five cointegrating equations. The maximum Eigen value statistics exceeded their critical value with four cointegrating equations at five percent significance level. since the Trace statistic has more robustness than the Maximal Eigen values (Cheung & Lai, 1993), consequently, analysis used five cointegrating equations to build the long run associations with the variables.

The short run causal relation is tested with Wald test. The Wald test calculates statistics base on unrestricted regression. This statistic measures closeness to the unrestricted estimation

came to persuade the limitations below the null hypothesis and if the limits are true, next the unrestricted estimations must come close to assure the restrictions.

Table 5 indicates that prospects of the Wald test values are lower than .05 in some cases like manufacturing production, gold prices and PSX volatility for both directions. This means bidirectional causal relation between PSX and gold prices, PSX and MP simultaneously. However, there did not hold causality between MP and GP. There prevail unidirectional linkages from volatilities of inflation, real exchange rate and real money supply to PSX volatility.



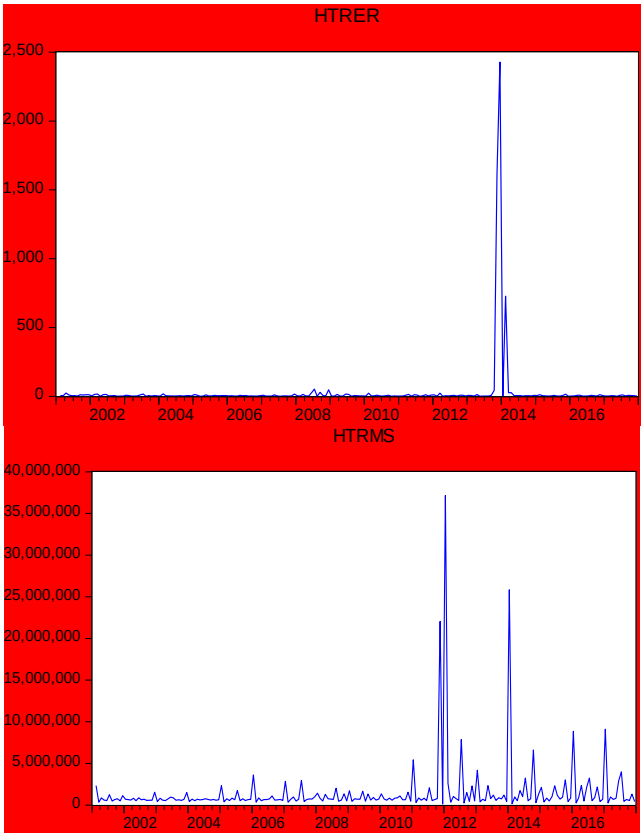


Figure 1: Variances Series of Macroeconomic Variables

Table 5: Wald Test Results

Dep. variable D(HTRER)	**D(HTKSESR) D(HTRMS)**	**D(HTINF)**	**D(HTGP)**	**D(HTMP)**	**D(HTOP)**
Excluded Chi-sq(Prob.)	Chi-sq(Prob.) Chi-sq(Prob.)	Chi-sq(Prob.)	Chi-sq(Prob.)	Chi-sq(Prob.)	Chi-sq(Prob.)
D(HTKSESR) 10.86(0.14)	2.05(0.95)	2.27(0.94)	21.94(0.02)*	28.71(0.00)*	1.85(0.96)
D(HTINF) 15.70(0.02)*	82.41(0.00)* 29.11(0.00)*		6.86(0.44)	55.51(0.00)*	15.81(0.02)*
D(HTGP) 35.01(0.00)*	16.15(0.02)* 23.94(0.00)*	26.25(0. 00)*		9.40(0.22)	9.41(0.22)
D(HTMP) 5.11(0.64)	45.07(0.00)* 1.12(0.99)	8.57(0.28)	4.43(0.72)		11.80(0.10)
D(HTOP) 8.43 (0.29)	6.64(0.46) 22.07(0.00)*	6.29(0.5)	8.92(0.25)	2.41(0.93)	
D(HTRER) 15.97(0.02)*	33.06(0.00)* 72.69(0.00)*	112.58(0.00)*	12.08(0.09)**	59.59(0.00)*	8.41(0.29)
D(HTRMS) 12.68(0.08)**	190.42(0.00)*	49.18(0.00)*	11.31(0.12)	51.85(0.00)*	
All 81.49(0.00)*	329.06 (0.00)* 233.74(0.00)*	246.92(0.00)*	103.6(0.00)*	122.2(0.00)*	43.85(0.39)

Note. *, ** Shows 1% and 5% significance level respectively.

Mostly the relationships are significant at one percent level. Generally the results are significant for causal linkage of macroeconomic variables uncertainties to volatility in PSX and are reconciled with the study of Bhunia and Yaman (2017). The results of causality test are also described in terms of flow chart in Figure 2. The chart is drawn to make the results easily understandable. The direction of arrows shows direction of causality from one to another. Findings revealed a significant causality amid macroeconomic volatility and stock exchange volatility. The outcomes also reconciled with Banumathy and Azhagaiah (2015); Wang (2011).

There are bidirectional arrows between HTPSX and HTMP, HTPSX and HTGP. Unidirectional arrows are from HTINFL, HTRER, and HTRMS towards HTPSX. HT represents volatility in variables.

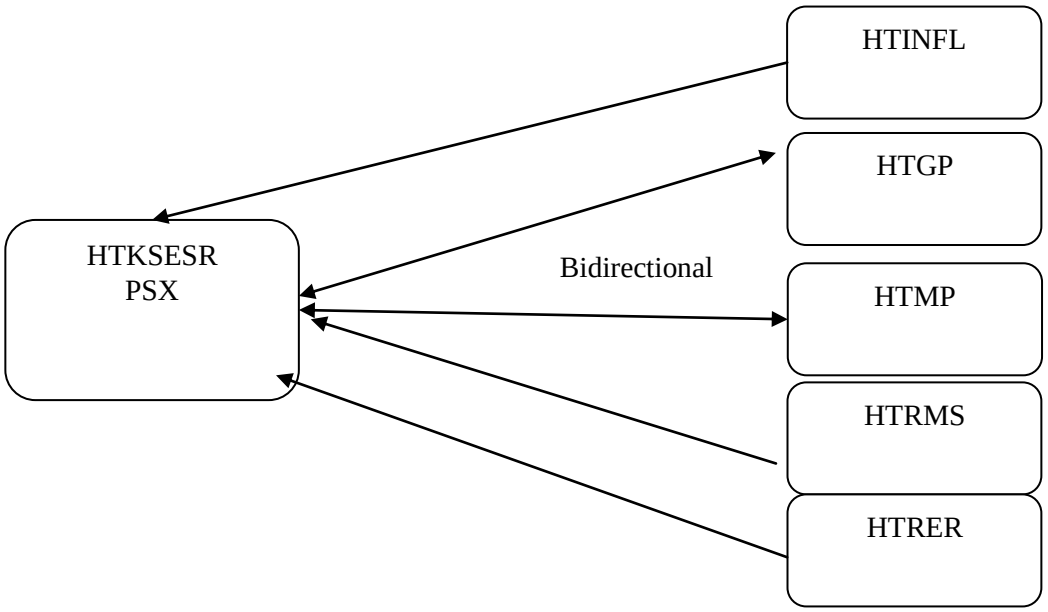


Figure 2: Directions of Causality

In broader terms, these findings have important implications for investors and policymakers. The sensitivity of the stock market to macroeconomic uncertainties underscores the need for vigilant monitoring and assessment of economic conditions. Investors may benefit from considering diversification strategies that account for the two-sided causal association between gold prices, manufacturing output, and stock returns. Policymakers, on the other hand, should be mindful of the uni-directional relationships identified, recognizing the impact of oil prices, exchange rates, and inflation on stock market dynamics. Moreover, the study's observation that Pakistan's stock market is still in a developmental phase with a comparatively weak financial structure suggests potential challenges and opportunities for policy interventions aimed at strengthening the financial infrastructure and fostering the growth and stability of the stock market in the country.

5. Conclusion and Policy Implications

Current study examined affiliation between volatility of PSX and of some macroeconomic variables as inflation, industrial output, supply of money, gold prices and rate of currency exchange. This task was completed in two steps, first involved the evaluation of volatility for all variables using AR (k) EGARCH (p, q). Next step explored causal linkage linking the volatility of stock prices with macroeconomic variables by using Johansen test in a VECM framework and Wald tests.

The empirical results suggested significant causal linkages between macroeconomic uncertainty and stock market volatility. There prevailed two-sided causal association between

volatilities of gold price and stock return, manufacturing output with stock returns. Further uni-directional relationship was found from oil prices, exchange rate and inflation to the direction of stock market. Pakistan's stock market is still at the level of a developing market; moreover its financial structure is comparatively weak. It is essential for the Pakistani government to progress the stock market efficiency and improving the financial structure in future. This investigate provides necessary suggestions for investors and policy makers. Study projected that suitable monetary actions must be taken by financial authorities. The higher instability or risk can be controlled by stabilizing the exchange rates. The manufacturing production sector can play significant positive role in expansion of the capital markets in Pakistan. Thus, it is suggested that authorities should devise such policies as to support stock prices by making improvements in the manufacturing sector.

Financial administrators and policy makers must input these macroeconomic aspects and keep an attentive eye while formulating and applying financial stability policies.

6. Scope for Further Research

Present endeavor discussed a number of promising research ideas which may be useful to conduct further research. It is suggested that further research in this area can be extended to explore global economic implications of severe uneven occurrences like COVID-19 across the globe. Another avenue for further research may be to study the repercussions of Russia Ukraine trouble on global stock markets.

References

Aliyu, S. U. R. (2012). Does inflation have an impact on stock returns and volatility? Evidence from Nigeria and Ghana. *Applied Financial Economics*, *22*(6), 427-435.

Ali, H., Liaquat, M., Safdar, N., & ur Rahman, S. (2021). Economic Growth, Inflation and Monetary Policy in Pakistan: Preliminary Empirical Estimates. *Review of Applied Management and Social Sciences*, *4*(2), 321-333.

Ali, H., Ali, M. Z., Nosheen, F., & Din, A. S. U. (2021). Unemployment and Monetary Policy Dynamics in Pakistan: Evidence from Cointegration Analysis. *Pakistan Journal of Humanities and Social Sciences*, *9*(1), 01-09.

Ali, H., Mouneer, S., & Qasim, B., T. (2022). Asymmetrical Impact of Foreign Direct Investment, Commodity Production and Inflation on GDP Growth Rate of Pakistan. *Journal of Economics and Management Sciences, 3(1),* 72-90.

Andrikopoulos, A., Angelidis, T., & Skintzi, V. (2014). Illiquidity, return and risk in G7 stock markets: interdependencies and spillovers. *International Review of Financial Analysis, 35*, 118-127.

Alfaro, I., Bloom, N., & Lin, X.(2018). The finance uncertainty multiplier. National Bureau of Economic Research w.24571

Baker, S. R., Bloom, N., & Terry, S. J.(2020). Using Disasters to Estimate the Impact of Uncertainty. National Bureau of Economic Research.w.27167

Barrero, J. M., Bloom, N., & Wright, I. (2017). Short and long run uncertainty. National Bureau of Economic Research w.23676.

Banumathy, K., & Azhagaiah, R. (2015). Modelling Stock Market Volatility: Evidence from India. Managing Global Transitions: *International Research Journal, 13*(1),27-41.

Bhunia, A., & Yaman, D. (2017). Is There a Causal Relationship Between Financial Markets in Asia and the US? *The Lahore Journal of Economics, 22*(1), 71.

Bollerslev, T. (1986). Generalized autoregressive conditional heteroskedasticity. *Journal of Econometrics, 31*(3), 307-327. doi: https://doi.org/10.1016/0304-4076(86)90063-1

Bollerslev, T., Engle, R. F., & Nelson, D. B. (1994). ARCH models. Handbook of econometrics, 4, 2959-3038.

Box, G. E., Jenkins, G. M., & Reinsel, G. (1970). Time series analysis: forecasting and control Holden-day San Francisco. BoxTime Series Analysis: Forecasting and Control Holden Day1970.

Brooks, C. (2019). Introductory econometrics for finance: Cambridge university press.

Chaudhry, A. (2020). The causal impact of macroeconomic uncertainity on expected returns. New York Times, 1-45

Davidson, J. E., Hendry, D. F., Srba, F., & Yeo, S. (1978). Econometric modelling of the aggregate time-series relationship between consumers' expenditure and income in the United Kingdom. *The Economic Journal, 88*(352), 661-692.

Demir, C. (2019). Macroeconomic Determinants of Stock Market Fluctuations: The Case of BIST-100. *Economies, 7*(8), 1-14.

Dickey, D. A., & Fuller, W. A. (1979). Distribution of the estimators for autoregressive time series with a unit root. *Journal of the American statistical association, 74*(366a), 427-431.

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.

Engle, R. (1995). ARCH: selected readings: Oxford University Press.

Engle, R., Ito, T., & Lin, W.-L. (1990). Meteor Showers or Heat Waves? Heteroskedastic Intra-daily Volatility in the Foreign Exchange Market. Econometrica, 58(3), 525-542.

Engle, R. F. (1982). Autoregressive conditional heteroscedasticity with estimates of the variance of United Kingdom inflation. Econometrica: *Journal of the Econometric Society,* 987-1007.

Engle, R. F., & Granger, C. W. (1987). Co-integration and error correction: representation, estimation, and testing. Econometrica: *Journal of the Econometric Society,* 251-276.

Engle, R. F., & Susmel, R. (1993). Common volatility in international equity markets. *Journal of Business & Economic Statistics, 11*(2), 167-176.

Ewing, B. T., & Malik, F. (2016). Volatility spillovers between oil prices and the stock market under structural breaks. *Global Finance Journal, 29*, 12-23.

He, F., Wand, Z., & Yin, L. (2020). Asymmetric volatility spillovers between international economic policy uncertainty and the U.S. stock market. *The North American Journal of Economics and Finance,* 51, 169-188.

Hussain, M., Awan, R. U., & Hassan, H., (2020). Eurozone Crisis and Asymmetric Volatility Spillover between the Stock Markets of Selected Emerging Asian and Developed Economies. *Global Social Sciences Review, 5*(1), 399-409.

Johansen, S., & Juselius, K. (1990). Maximum likelihood estimation and inference on cointegration—with appucations to the demand for money. *Oxford Bulletin of Economics and Statistics, 52*(2), 169-210.

Kearney, C., & Daly, K. (1998). The causes of stock market volatility in Australia. *Applied Financial Economics, 8*(6), 597-605.

Kwiatkowski, D., Phillips, P. C., Schmidt, P., & Shin, Y. (1992). Testing the null hypothesis of stationarity against the alternative of a unit root. *Journal of Econometrics, 54*(1-3), 159-178.

Liljeblom, E., & Stenius, M. (1997). Macroeconomic volatility and stock market volatility: empirical evidence on Finnish data. *Applied Financial Economics, 7(*4), 419-426.

Mala, R., & Reddy, M. (2007). Measuring stock market volatility in an emerging economy. *International Research Journal of Finance and Economics, 8*(5), 53-71.

Nelson, D. B. (1991). Conditional Heteroskedasticity in Asset Returns: A New Approach. Econometrica, 59(2), 347-370. doi: 10.2307/2938260

Officer, R. R. (1973). The variability of the market factor of the New York Stock Exchange. *The Journal of Business, 46*(3), 434-453.

Omar, M., Hussain, H., Bhatti, G. A., & Altaf, M. (2013). Testing of random walks in Karachi stock exchange. *Finance Management, 54,* 12293-12299.

Pesaran, M. H., & Shin, Y. (1998). An autoregressive distributed-lag modelling approach to cointegration analysis. *Econometric Society Monographs, 31,* 371-413.

Phillips, P. C., & Perron, P. (1988). Testing for a unit root in time series regression. *Biometrika, 75*(2), 335-346.

Saryal, F. S. (2007). Does inflation have an impact on conditional stock market volatility?: Evidence from Turkey and Canada. *International Research Journal of Finance and Economics, 11,* 123-133.

Schmidt, P., & Phillips, P. C. (1992). LM tests for a unit root in the presence of deterministic trends. *Oxford Bulletin of Economics and Statistics, 54*(3), 257-287.

Wang, X. (2010). The relationship between stock market volatility and macroeconomic volatility: Evidence from China. *International Research Journal of Finance and Economics,* 5, 149-160.