Regime Shift Behavior and Interconnectedness of Stock Market Volatility and Exchange Rate Movements: Empirical Evidence from Emerging and Developed Economies

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ABSTRACT

Purpose: The purpose of this study is to examine the regime shift behavior and interconnectedness between stock market volatility and exchange rate in a pre and post COVID context.

Design/Methodology/Approach: For this purpose Pakistan India and China has been taken as emerging economies and USA UK and Japan as developed economies. Daily data of exchange rates and stock market indices have been used from Jan,1 2011 to Apr 30, 2021. Markov regime switching model, GARCH model and Granger causality test has been used.

Findings: The outcomes of this study empirically confirmed that the Markov regime switching model is flexible model because it captures regime shifts in the mean and variance equation of all sample economies. Moreover, the sum of GARCH (1,1) indicates that volatility shocks are persistent except India. Study also concluded that exchange rate volatility has significant positive impact on stock market of Pakistan, USA and Japan in a pre COVID context.

Implications/Originality/Value: A post COVID context has significant impact on the stock market of India, U.S.A. and U.K. Granger causality results indicates unidirectional relationship for Pakistan, China and USA. Whereas for Japan bi-directional relationship is found but for India and UK no directional causality exist.

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Introduction

Volatility is a statistical indicator of ups and down in a price of a particular security or stock market indices. Greater the uncertainties in stock prices the higher the risk. Volatility is usually calculated as the standard deviation or variation of returns from a single stock or security market index. Volatility is also synonymous with significant shifts in all directions in the securities markets. If the stock price, for instance, increases and decreases by more than one percent over the long term, it is considered a volatile market (Yadav, 2017). The stock market activities substantially impact both the national economy and investors’ daily lives. Changes in the financial market are expected to affect exchange rates Rajkovic et al., (2020). The decline in share price is more likely to lead to the prevalent economic collapse. Term volatility can be interpreted as the difference in stock prices that may change over time. In stock return, the deviation in portfolio values differs over some time. The ups and downs in the exchange rate are characterized as risk, linked towards unpredictable swap rate fluctuations. Swap rate refers to the concerning of currency of one country to another. In a somewhat different view, it can be viewed as a price Bagh et al., (2017). In past studies, several researchers identified the relationship between stock market volatility and exchange rate movements. The exchange rate can be described as the currency swap rate between two countries (Abbas, 2010; Bagh et al., 2017; Saeed, et. Al., 2020).

Kumar (2013) claims that understanding the dynamic connection between stock prices and exchange rates is critical because this link may affect policymakers’ monetary and fiscal policy choices. The study of associations is widely acknowledged as a simple way to understand how information is transferred from stock markets to foreign currency markets and vice versa Mozumder et al., (2015). Existing literature identifies two ways of linking trade and stock values. The first is the market canal for commodities, which shows that exchange rate fluctuations affect foreign company’s competition and income and stock values. Depreciation of local currency reduces export product prices, leading to a rise in international demand and revenue.

On the other hand, as domestic currency is appreciated, the selling company’s external market reduces such that the company’s earnings will fall and its stock price decreases. While on the other hand, its reverse impact is true for importers. Moreover, the exchange rate fluctuations influence the value of a firm’s outstanding and foreign currency payable receivables (Dornbusch and Fischer, 1980; Cakan and Ejara, 2013). According to this argument, exchange rate volatility affects stock prices depending on both the weight and the extent of trade imbalances within a region Pan et al., (2007). This situation assumes the causal influence on the stock market of swap rate.

A second link is an asset market or fund balance approach that indicates that stock price movements will influence exchange rate changes. Currency exchange rates are determined on the basis of the portfolio balance strategy via the market mechanism. An anticipated rise in market prices resulting from hopes of economic growth will draw international money, which is why the demand for the country’s currency rises and vice versa. As a result, higher stock values are linked to local currency appreciation. On the other hand, stock price fluctuations can pressure exchange rates because investment prosperity and demand for the currency rely on stock market success (Gavin, 1989). As in the financial crisis, for example, a sudden disturbance in demand for assets will result from investors’ herding conduct or a lack of confidence in economic and political stability, such as 1998 Russian government bond default, or the 2001 Turkish currency crisis, which shows that stock prices movement cause exchange rate fluctuations (Yasir Saeed et al., 2018).

This study covers the gap of present regime shifts prevailing in the emerging and developed economies. The study is essential in this era because the changing dynamics of world trade during the COVID-19
pandemic have shifted the demand and supply forces across the economies. The stock returns and exchange rate have been exploited. This study contributes to testing the regime shift behavior and interrelatedness among ups and downs of the stock market and exchange rate, causal linkage, and impact of the stock market on the exchange rate in emerging and developed economies. This study is intended to seek the following objectives. Firstly to investigate the regime shift behaviour in stock returns of emerging and developed economies to capture the interrelatedness of exchange rate and stock return. Secondly, to examine the causal linkage between the stock market and the exchange rate of emerging and developed economies. Thirdly to determine the impact of stock market return on the exchange rate of emerging and developed economies. Lastly to provide directions and policy guidelines for the literature, investors, stock market brokers, and currency dealers in developing and emerging economies.

The remainder of the paper is laid out as follows. The prior literature on the relationship between exchange rates and stock markets is presented in Section 2. The Markov-switching regression, GARCH model, and data are discussed in Section 3. Section 4 contains a discussion of the empirical findings. The significant results are summarized in Section 5.

Literature Review
Liang et al. (2013) investigated the connection between currency exchange rates and stock markets in Indonesia, Malaysia, the Philippines, Singapore, and Thailand using 2008 to 2011. They utilized panel Granger causality and panel DOLS techniques. They used stock indexes as dependent variables and the foreign exchange swap rate as an independent variable. They found evidence supporting portfolio balancing theory.

Mustaq and Shah (2014) directed an experimental study on connection amid swap rate also equity index in Pakistan. Investigation stretches across the period of ten years, from 1997 to 2013. They used the Granger causality test to inspect the relationship. The results show that rates of swap and equity prices are connected in the long run, and this supports the long-term connections of the variables. The link between swap rates also the market of equity index is bidirectional. As a result, information travels in both directions, and because of this, bidirectional causality exists.

Caporale et al. (2014) inspected the interrelationships amid equity return and swap rate return variations during the 2008 financial crisis to better understand the processes through which exchange rate and stock return changes are linked. To build country-specific UEDCC-GARCH models, applied. They used daily data from 2003 to 2011. The study’s findings confirmed that the forex market influences the US and the UK stock market, while the stock market influences Canada’s forex market. This was true across Europe and Switzerland as well. In this instance, the co-integration test showed that Japan and the Euro area were no longer synchronized when the financial crisis began.

Ejaz et al. (2016) investigated the correlation path amid the rate of swap as well as equity market price ups and downs spillovers in India. From January 1992 to February 2013, monthly time series data of Bombay Stock Exchange rates (BSE-100 Index) and India’s exchange rate (Rupee against US Dollar) were used. The Phillips Person (PP) unit root test was used to ensure stationery. To calculate the variance, the GARCH model was applied to each vector. Granger causality analysis is performed on the sequence of each attribute. The Granger causality test reveals a bidirectional association between ups and downs in India’s swap rate and equity market price.

Ahmed (2019) examined the occurrence of excess possessions of swap rate fluctuation on stock prices over two altered reality-based regimes (soft peg period secondly free float one). He used the ARLD (autoregressive distributed lag modelling framework) model to find short and long-run asymmetries. In the soft peg regime period, stock returns are significantly affected by positive or negative EGP/USD exchange rate fluctuations. In the free-float period, long-term asymmetric exists while the short-term
asymmetric disappears. It was confirmed that currency devaluation had a substantial effect on stock returns compared to currency appreciation.

Nguyen (2019) conducted a study over seven years on six countries between 2007 and 2013 to inspect the short and long term dynamics of currency and equity values. He used stock indices as a dependent variable as well as currency swap rate as an independent variable. The findings of multivariate causality analyses in China and India revealed no short-run connection between the variables. In the case of Brazil, however, there is bidirectional causation amid equity values as well as swap rates.

Methodology
The purpose of the current study is to investigate the regime shift behaviour and interrelatedness between stock market volatility and exchange rate movements, causal linkage, and impact of the stock market on the exchange rate. From 1st Jan 2011 to 30th Apr 2021, secondary daily data was used regarding emerging stock markets of (Pakistan, India, and China) and developed stock markets (the USA, UK and Japan). The web source of yahoo finance is used to obtain the indices data of emerging markets Pakistan, India, and China and developed markets USA, UK, and Japan; secondly, oanda.com and other exchange rate data websites are used to get currencies exchange rate. To confirm the volatility impact amid rate of swap and equity market of developed and emerging economies (Pakistan, India, China, USA, UK, and Japan) variables GARCH (1, 1) model used with explanatory variable change in the exchange rate and COVID period. Markov switching regression applied to check the regime shift behavior among the sample economies. Granger causality test was used to measure the causal association between swap rate and equity market of developed and emerging economies (Pakistan, India, China, USA, UK, and Japan).

Markov switching regression
Markov switching regression was applied to check the regime shift behaviour among the sample economies. According to the first-order Markov assumption, there must be a relationship between the likelihood of entering a given regime and its initial state.

\[ y_t = \mu_s + x_t \alpha + z_t \beta_s + \epsilon_{s,t} \]

Where
- \( y_t \) = Dependent variable
- \( \mu_s \) = state dependent intercept
- \( x_t \) = vector of exog. variables with states invariant coefficient \( \alpha \)
- \( z_t \) = vector of exog. variables with states dependent coefficient \( \beta_s \)
- \( \epsilon_{s,t} \sim iid N(0, \sigma^2_s) \)

GARCH
To confirm the volatility impact of exchange rate on equity market of developed and emerging economies (Pakistan, India, China, USA, UK, and Japan), GARCH (1, 1) model applied with explanatory variable change in the exchange rate and COVID period.

\[ h_t = \alpha + \beta^x X_t + u_t \]
\[ u_t | \varphi \sim iid M(0, h_t) \]
\[ h_t = \beta_0 + \sum_{i=0}^{p} \beta_1 h_{t-i} + \sum_{j=0}^{q} \gamma_j u^2_{t-j} \]

Variance Regressor
Variance regressor is the further addition in the GARCH model. The other independent variables are calculated in this that substantially influence the gain of equity markets.

\[ h_t = \beta_0 + \sum_{i=0}^{m} \beta_1 h_{t-i} + \sum_{m=0}^{n} = 0 \beta_2 u^2_{t-1} + \sum_{n=0}^{0} \gamma_l X_b \]
Granger Causality Test
The Granger Causality test was performed to see whether there was a relation between the stock and currency markets. In situations when we know that two variables are linked, but we don’t know which one affects the other, the Granger Causality test is utilized. We might conclude that the stock and currency market crises occurred simultaneously because of the similarity in their timing. However, the Granger Causality test determines whether the link flows from the stock market to the currency market or the other way around. It goes like this:

Suppose that E and S are two variables that represent the exchange rate and the stock index. Using the following equations, we can determine whether S or E granger is to cause.

\[ E_t = \beta_0 + \beta_1 E_{t-1} + \ldots + \beta_p E_{t-p} + \alpha_1 S_{t-1} + \ldots + \alpha_p S_{t-p} + \epsilon_t \]

In order to verify the directionality of the link, the Granger Causality test requires running two tests simultaneously. As a result, the second assessment is

\[ S_t = \beta_0 + \beta_1 S_{t-1} + \ldots + \beta_p S_{t-p} + \alpha_1 E_{t-1} + \ldots + \alpha_p E_{t-p} + \epsilon_t \]
## Result and Discussion

### Markov Switching regression

| Variable     | KSE Coefficient | KSE Std. Error | KSE z-Statistic | KSE Prob. | BSE Coefficient | BSE Std. Error | BSE z-Statistic | BSE Prob. | SSE Coefficient | SSE Std. Error | SSE z-Statistic | SSE Prob. |
|--------------|-----------------|----------------|----------------|-----------|-----------------|----------------|----------------|-----------|-----------------|----------------|----------------|-----------|
| Regime 1     |                 |                |                |           |                 |                |                |           |                 |                |                |           |
| R_EXRAT      | 0.019045        | 0.03449        | 0.552189       | 0.5808    | -0.6308         | 1.389822       | -0.453841      | 0.6499    | -0.025198       | 0.013749       | -1.832712      | 0.0668    |
| LOG(SIGMA)   | -5.010629       | 0.039          | -128.4769      | 0.000     | -2.4849         | 0.106435       | -23.3463       | 0.000     | -4.937497       | 0.030499       | -161.8914      | 0.000     |
| Regime 2     |                 |                |                |           |                 |                |                |           |                 |                |                |           |
| R_EXRAT      | -0.1406         | 0.070828       | -1.95086       | 0.0471    | -0.1196         | 0.03074        | -3.89005       | 0.0001    | -0.017426       | 0.010032       | -1.736986      | 0.0824    |
| LOG(SIGMA)   | -4.140119       | 0.043499       | -95.17666      | 0.000     | -4.6629         | 0.016485       | -282.8658      | 0.000     | -5.556744       | 0.022444       | -247.5815      | 0.000     |
| Transition Matrix Parameters | | | | | | | | | | | | |
| P11-C        | 3.018443        | 0.2296         | 13.14653       | 0.000     | -0.1494         | 0.397032       | -0.37636       | 0.7066    | 4.180497        | 0.423176       | 9.878851       | 0.000     |
| P21-C        | -2.179251       | 0.241554       | -9.021784      | 0.000     | -5.2941         | 0.444822       | -11.90156      | 0.000     | -4.738516       | 0.379698       | -12.47968      | 0.000     |
| Akaiake info criterion | -6.468107 | | | | -6.342992 | -7.771481 | |
| Schwarz criterion | 8004.58 | | | | 7964.112 | 9724.351 | |
| Log likelihood | -6.444592 | | | | -6.319757 | -7.748185 | |
| Regime 2     |                 |                |                |           |                 |                |                |           |                 |                |                |           |
| R_EXRAT      | 0.22074         | 0.032477       | 6.796784       | 0.000     | 0.282216        | 0.036381       | 7.757334       | 0.000     | 0.836339        | 0.13361        | 6.259569       | 0.000     |
| LOG(SIGMA)   | -5.181608       | 0.028518       | -181.6964      | 0.000     | -5.012547       | 0.025746       | -194.6905      | 0.000     | -3.812203       | 0.052068       | -73.21578      | 0.000     |
| Transition Matrix Parameters | | | | | | | | | | | | |
| P11-C        | 0.388966        | 0.119793       | 3.246981       | 0.0012    | -0.599875       | 0.128398       | -4.672004      | 0.000     | 0.45237         | 0.04346        | 10.40885       | 0.000     |
| P21-C        | -3.995327       | 0.037959       | -105.2549      | 0.000     | -4.032953       | 0.038667       | -104.2994      | 0.000     | -4.67894        | 0.026701       | -175.2365      | 0.000     |

### Transition Matrix Parameters

| Variable     | NYSE Coefficient | NYSE Std. Error | NYSE z-Statistic | NYSE Prob. | LSE Coefficient | LSE Std. Error | LSE z-Statistic | LSE Prob. | TSE Coefficient | TSE Std. Error | TSE z-Statistic | TSE Prob. |
|--------------|-----------------|----------------|----------------|-----------|-----------------|----------------|----------------|-----------|-----------------|----------------|----------------|-----------|
| Regime 1     |                 |                |                |           |                 |                |                |           |                 |                |                |           |
| R_EXRAT      | 0.22074         | 0.032477       | 6.796784       | 0.000     | 0.282216        | 0.036381       | 7.757334       | 0.000     | 0.836339        | 0.13361        | 6.259569       | 0.000     |
| LOG(SIGMA)   | -5.181608       | 0.028518       | -181.6964      | 0.000     | -5.012547       | 0.025746       | -194.6905      | 0.000     | -3.812203       | 0.052068       | -73.21578      | 0.000     |
| Regime 2     |                 |                |                |           |                 |                |                |           |                 |                |                |           |
| R_EXRAT      | 0.388966        | 0.119793       | 3.246981       | 0.0012    | -0.599875       | 0.128398       | -4.672004      | 0.000     | 0.45237         | 0.04346        | 10.40885       | 0.000     |
| LOG(SIGMA)   | -3.995327       | 0.037959       | -105.2549      | 0.000     | -4.032953       | 0.038667       | -104.2994      | 0.000     | -4.67894        | 0.026701       | -175.2365      | 0.000     |

| Variable     | Transition Matrix Parameters Coefficient | Transition Matrix Parameters Std. Error | Transition Matrix Parameters z-Statistic | Transition Matrix Parameters Prob. |
|--------------|------------------------------------------|----------------------------------------|------------------------------------------|-----------------------------------|
| P11-C        | 3.762744                                  | 0.22178                                | 16.96612                                 | 0.000                             |
| P21-C        | -2.616209                                 | 0.222995                               | -11.73217                                | 0.000                             |
| Log likelihood | -6.778609                                 |                                       | 8583.916                                 | 7659.945                          |
| Akaiake info criterion | 8784.909 | | | 6.613125 | 6.073795 | |
| Schwarz criterion | -6.755978 | | | -6.590523 | -6.050645 | |
We see, from the upper part of the table, the differences in the regime specific means (Regime 1, Regime 2:) for the emerging (Pakistan, India, China) and developed (USA, UK, Japan) economies, we termed the pre and post COVID (in this case, the pre and post-COVID) growth rates for the emerging (Pakistan, India, China) and developed (USA, UK, Japan) stock market price for the period under study (2011 – 2021). We can also observe that both regimes are significant at (p<0.10, 0.05, 0.01) in the case of China USA, UK and Japan. This implies that the dynamics in both regimes are substantial. We can also observe that regime 2 is significant at (p<0.05, 0.01), while regime 1 is not because (p>0.05) in the case of Pakistan and India. This implies that the dynamics in the first regime is not substantial. Further, the transition probabilities (P11) are also higher than (P21) in the case of Pakistan USA and the UK. It indicates the persistence of two different volatility regimes. Whereas the transition probabilities (P11) are less than (P21) in the case of India, China and Japan, which indicates the no persistence of two different volatility regimes. The bottom section of the table shows the standard descriptive statistics for the equation. AIC, SIC and log-likelihood confirm that model is good fit or not.

- **GARCH**

| Statistics          | Parameter | KSE      | BSE      | SSE       | NYSE     | LSE       | TSE       |
|---------------------|-----------|----------|----------|-----------|----------|-----------|-----------|
| Mean Equation       | C         | 0.000906 | 0.001658 | -0.0000336| 0.000696 | 0.000303  | 0.000893  |
|                     | p-value   | 0.000    | 0.000    | 0.7229    | 0.000    | 0.0429    | 0.000     |
|                     | R_SI(-1)  | 0.176613 | -0.013284| -0.086219 | -0.033437| 0.004797  | -0.018914 |
|                     | p-value   | 0.000    | 0.616    | 0.000     | 0.1411   | 0.8298    | 0.4017    |
| Variance Equation   | C         | 0.00000757| 0.0000409 | 0.00000208| 0.0000437| 0.0000424 | 0.0000088 |
|                     | p-value   | 0.000    | 0.000    | 0.000     | 0.000    | 0.000     | 0.000     |
|                     | RESID(-1)^2| 0.149979 | 1.337006 | 0.031277  | 0.209544 | 0.145298  | 0.141647  |
|                     | p-value   | 0.000    | 0.000    | 0.000     | 0.000    | 0.000     | 0.000     |
|                     | GARCH(-1) | 0.779288 | 0.136992 | 0.960709  | 0.737739 | 0.805472  | 0.811104  |
|                     | p-value   | 0.000    | 0.000    | 0.000     | 0.000    | 0.000     | 0.000     |
|                     | R_EXRAT   | 0.000549 | 0.000299 | -0.0000446| -0.000212| -0.000639 | -0.000691 |
|                     | p-value   | 0.0012   | 0.2627   | 0.5965    | 0.0428   | 0.575     | 0.000     |
| Diagnostic Test     | COVID     | 0.00000113| 0.0000434| 0.00000048| 0.0000596| 0.00000686| 1.21E-06  |
|                     | p-value   | 0.4362   | 0.000    | 0.3708    | 0.000    | 0.0002    | 0.4439    |
|                     | AIC- statistics | -6.4647  | -5.991772| -7.761829 | -6.843412| -6.62642  | -6.005779 |
|                     | SIC- statistics | -6.4482  | -5.975524| -7.745538 | -6.828486| -6.61061  | -5.989589 |
|                     | Log likelihood | 8007.013 | 7529.67  | 9720.929  | 8877.228 | 8608.089  | 7580.287  |

The table results showed GARCH (1, 1) with explanatory variables (R_EXRAT and Dummy COVID Period). The C and R_SI (-1) in the mean equation are positively or negatively significant and insignificant. The statistically current and past value is substantial because the p-value is lower than the level of significance. The α1+ β1 measures the degree of persistence of volatility shocks. The analysis also found that the sum of GARCH coefficients (α + β) is very close to one in the present study accept BSE, indicating that volatility shocks are pretty persistent and long retention in the conditional variance in five country’s stock markets accept BSE. Findings also concluded that change in the exchange rate affects the stock market except for India, China and UK. It was confirmed that the COVID period affected the stock market except for Pakistan, China and Japan. The bottom section of the table shows the standard descriptive statistics for the equation. AIC SIC and log-likelihood confirm whether the model is good fit or not.

- **Granger Causality test**

| Country | Null Hypothesis | F Statistics | Probability |
|---------|-----------------|--------------|-------------|
|         |                 |              |             |

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The above table presents the results of Granger causality tests for the residual series. There is strong evidence of bi-directional Granger causality between stock prices and exchange rates. Granger causality test shows bi-directional causal relations between stock prices and exchange rates for Japan. There is a significant Granger causality from stock prices to exchange rate for Pakistan, but the reverse causality is not statistically significant. Results also reveal a unidirectional relationship for China and USA from exchange rate to stock prices; therefore, the reverse causality is not statistically significant. India and UK exhibit no significant causal relations in either direction. Similar to the results of the analyses, the majority of the countries show significant unidirectional causalities between exchange rates and stock prices. These analyses support both the goods market and portfolio balance hypotheses regarding the causal relations between stock prices and exchange rates.

**Conclusion**

This research examined the volatility dynamics between the stock and currency markets in developing and established countries (Pakistan, India, China, the United States of America, the United Kingdom, and Japan) during the pre and post COVID period from 1st Jan 2011 to 30th Apr 2021. Firstly, the study concluded that the Markov-Switching Regression model is a high-degree flexible model because it captures regime shifts in the mean and variance equation of all economies. Moreover, the sum of GARCH coefficients ($\alpha + \beta$) is very close to one in all economies except India in the present study indicating that volatility shocks are pretty persistent. The study also concluded that change in exchange rate statically affect the stock market of Pakistan, USA and Japan, and the COVID period affect the India, U.S.A. and U.K. Granger causality test confirmed unidirectional relationship for Pakistan, China and USA. For Japan bi-directional relationship and for India and the UK no directional exist.

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