8. TIME-VARYING IMPACTS OF MACROECONOMIC VARIABLES ON STOCK MARKET RETURNS AND VOLATILITY: EVIDENCE FROM PAKISTAN

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Abstract

This paper investigates the time-varying return and volatility spillover impact of exchange rates, interest rates, consumer prices, and industrial production on stock market returns in Pakistan by using monthly data covering the time period 2000-2018. For this purpose, we first estimate GARCH models to obtain the conditional variance. Next, we employ the Gaussian state-space model, which allows the coefficients to vary over time, to estimate the time-varying return and volatility spillover impacts of the underlying variables on stock market returns. We find a significant time-varying impact of inflation rate, interest rates, and exchange rates on stock returns, suggesting that the impacts of these variables on stock returns change over time. The findings also confirm the time-varying volatility impacts, indicating that the intensity and magnitude of the transmission of macroeconomic volatility to stock returns' volatility significantly changes over time. This empirical analysis is helpful for investors and firm managers to design and implement more effective hedging strategies to minimize interest rate, consumer price, and exchange rate risks.

Keywords: *returns and volatility, time-varying, interest rate, exchange rate, IPI, CPI, stock prices, GARCH model, state-space model*

JEL Classification: C32; E31; E43; E44; E47

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1. Introduction

Since the Great Depression, stock market performance is considered one of the key indicators to reflect as well as determine macroeconomic performance of an economy. Specifically, it plays a dual role in an economy. On the one hand, stock market is considered to have the ability to instantaneously respond to the internal and external shocks. On the other hand, it works as an important transmission mechanism for various policy changes towards real, monetary, and financial sectors of an economy. Moreover, being the key component of the financial sector, it not only presents the current state of an economy but also signals the future course of actions for investors and policy makers.

A stable stock market reflects the financial soundness of an economy and therefore provides signals to domestic and foreign investors, mobilizes resources, and also offers better hedging opportunities. Given the crucial importance of stock market, it is imperative for researchers, investors, and policy makers to examine the factors that influence the stock market performance. Macroeconomic factors affect stock market performance and efficiency in several ways. For instance, the arbitrage pricing theory proposed by Ross (1976) explains the link between macroeconomic risks and expected asset returns. Macroeconomic factors can become part of risk factors in the equity market by influencing the discount rates, expected returns on investment, firms' ability to generate cash flows and payment of future dividends and other financial liabilities. In particular, downturns in economic activities reflect a recession and adversely affect businesses' revenues by increasing unemployment and declining consumer spending. On the other hand, an increase in output reflects boom in the economy and thus spurs investment in the country (Rashid, 2008).

Financial theories proposed that interest rates and exchange rates impart important implications on stock markets by influencing the market value and cash flow of firms. Specifically, the relationship between exchange rates and stock market has been explained by three important theories. The portfolio balance approach by Frankel (1984) states that an increase in stock prices leads to increase public wealth, which increases demand for money. Higher demand for money further pushes the interest rate upward which attracts foreign capital inflows leading to appreciation of domestic currency, thus establishing an inverse relationship between exchange rate and stock market. The traditional approach, on the other hand, proclaims a positive relationship between stock market and exchange rates. Depreciations in local currency make domestic investors more competitive, which, in turn, results in an increase in exports, consequently increasing the value of firms' stock. In contrast, the asset market approach by Frenkel (1977) indicates the absence of any link between exchange rate and stock market return.

Theoretically, the interest rate is considered to have a significant influence on the stock market performance by altering the opportunity cost of investment, changing prices of stocks, and causing variations in financial risk. Consequently, it affects the value of firms' stock (Joseph and Vezos, 2006). Additionally, the significant direct and indirect impacts of inflation for stock market are also reported in the existing literature (Barasa, 2014). Inflation redistributes wealth from borrowers to lenders, generates uncertainty in stock market, and dampens the real value of stock returns and dividends (Taylor, 1996). Specifically, higher inflation may weaken economic growth, diminish profitability of firms, and thus, adversely affect asset returns. Alternatively, an increase in inflation escalates uncertainty-induced risk, which may help investors to acquire higher premiums on financial assets (Saleem, Zafar and Rafique, 2013).

On the empirical grounds, indeed, a large body of literature has examined the impact of various macroeconomic factors on stock market returns and volatility (Bekhet and Matar, 2013; Inci and Lee, 2014; Ajaz, Nain, Kamaiah, and Sharma, 2017; Lawal, Somoye, Babajide, and Nwanji, 2018; Aljarayesh, Asfour and Al-Abdallah.,2018; and Gopinathan and Durai, 2019). These studies provided the evidence of a significant link between macroeconomic variables and stock market returns. Yet, the main focus of these studies was on the linear association between macroeconomic indicators and stock returns/prices. The econometric methods and analytical frameworks utilized by these studies do not have ability to capture any kind of potential nonlinearities present in the relationship of the underlying variables.

Another strand of the literature scrutinized the presence of nonlinear and/or asymmetric relationship between different macroeconomic variables and stock market performance indicators. These studies including, among several others, Falk (1986), Ramsey and Rothman (1996), and Bradley and Jansen (1997) support various forms of nonlinear adjustment between key macroeconomic variables and stock market performance. In addition, Boucher (2007) and Kizys and Pierdzioch (2009) also highlighted that the relationship between the stock market and macroeconomic variables is asymmetric and this relationship changes in the long run (Zhou, 2010; and Tang and Zhou, 2013). These empirical evidences and theoretical assertions suggest that the macroeconomic variables-stock returns relationship in likely to be nonlinear and may change considerably over time: A theme of the study at hand.

The stock market of Pakistan has undergone various developments and advancements since its inception. Broadly speaking, the development in capital market can be explained by four phases. The first phase of capital market development started in the 1950s with main emphasis on the expansion of the market. The second phase, ranging from 1973 to 1988, shifted the attention towards the establishment of Islamic banking and capital market. The third phase started in the early 1990s with a specific focus on the liberalization and privatization of domestic and international capital and equity markets. Finally, the fourth phase has emphasized the expansion and deepening of the overall financial system.

In 2016, Bloomberg has categorized the Pakistan Stock Exchange (PSX) as the best in the Asia and the fifth best-performing stock market in the world. Particularly, the process of liberalization in stock exchange market has not only changed its scope but also its significance on both national and international fronts. The liberalization of the stock market resulted in an increase in foreign portfolio investment, lower restrictions on holding foreign currency, transfer of dividends and capital gains, and increased foreign companies' engagement in the PSX. Similarly, the process of liberalization enlarged the number of firms enrolled on the PSX. The official statistics of the PSX revealed that there are 559 firms registered with total market capitalization of $84 billion (February 23, 2018), 883 domestic investors, 0.22 million retail investors, and 1886 foreign investors. On the contrary, the post-liberalization period has shown an enormous increase in the volatility of stock prices (Bekaert and Harvey, 2002).

Like many other stock markets, the PSX also plays a pivotal role in the financial sector of Pakistan. It not only responds to macroeconomic fluctuations but it also indicates the overall economic health of the country. Being an emerging market, it presents a suitable case to examine the impact of various macroeconomic factors on its performance, both in terms of returns and volatility. The literature on the link between stock market performance and macroeconomic variables is immense. However, the prime focus yet remains on examining the static and linear relationship, in Pakistan. Thus, we have limited knowledge and empirical evidence on whether there is any nonlinearity in the relationship between macroeconomic

factors and stock market return and whether this relationship changes over time. The literature is abundant on individual effect of exchange rate, interest rate, inflation and economic growth on stock market performance measured in various forms (Farooq, Keung and Kazmi, 2004; Rashid, 2008; Ali, 2014). In the similar vein, the literature on examining the link between macroeconomic factors and stock market performance in other emerging market economies provides interesting insights, yet, with mixed findings (Delgado, Delgado, and Saucedo, 2018; Igbinosa and Uhunmwangho, 2019; Adeniyi and Kumeka, 2020; Al-Hajj, Al-Mulali and Solarin, 2021).

The literature is scarce not only on the combined effect of different macroeconomic variables such as the rate of inflation, interest rates, exchange rates, output, etc. but also on the impact of macroeconomic volatilities on stock market performance, specifically for Pakistan. Nevertheless, besides the effects on stock market performance of macroeconomic conditions, it would be worthwhile to explore how variations in macroeconomic indicators affect stock market volatility - a second moment of the distribution. Keeping in view the gaps left in the existing empirical literature, we contribute to the existing set of studies on several important grounds. Firstly, the study examines the combined effect of macroeconomic variables, namely, interest rates, exchange rates, consumer prices and industrial production on stock market returns. Secondly, the study scrutinizes the impact of volatility of each of the macroeconomic variable on stock return volatility. Thirdly, a significant contribution of the study is that it attempts to identify the time-varying impacts of selected macroeconomic variable and their respective volatilities on stock market returns and volatility, respectively. Finally, to estimate the time-varying scale and volatility impact, the Gaussian state-space model by applying the Kalman filter approach has been utilized as this technique allows coefficients to vary across different periods. The empirical analysis is based on the monthly data from January 2000 to December 2018. To estimate the volatility of each series through the conditional variance, the GARCH model is being employed. Hence, the empirical examination of the paper answers to numerous research questions. For instance: Is there any time-varying effect of macroeconomic variables on stock return? Does the impact of macroeconomic volatility on stock return volatility change over time? Do different macroeconomic performance indicators impact stock market returns and volatility differently? Is the impact on stock market performance and volatility of macroeconomic indicators long lasting?

The rest of the paper is organized as follows. Section 2 explains the literature review of the related studies. Section 3 defines the empirical methodology and data used in this paper. The empirical findings and discussions are given in Section 4. Finally, the conclusion is given in Section 5.

2. Literature Review

There is extensive literature available which examines the impact of macroeconomic variables on either stock prices or stock returns. However, the existing findings are inconclusive, at best. Ibrahim (2000) showed no long-term relationships between exchange rate and stock prices in the Malaysian economy. In contrast, Wu (2000) documented unidirectional causal relationship between exchange rate and stock prices in Singapore. Amare and Mohsin (2000) examined the relationship of stock prices and the exchange rate for several counties and a long-term relationship only for Singapore and the Philippines.

Gupta and Inglesi-Lotz (2012) documented that the exchange rate, the interest rate, and stock prices are correlated. Muhammad and Rasheed (2002) tested the association of stock

prices with the exchange rate in four South Asian countries and found no significant association for Pakistan and India. Kanas (2003) showed significant volatility spillovers for Canada, France, Japan, the UK, and the USA. Kim (2003) showed a positive association between stock prices and industrial production index, whereas, a negative relationship with the other variables. Gunasekarage, Pisedtasalasai and Power (2004) studied the linkages between money supply, exchange rates, interest rates, and consumer price index in Sri Lanka. They reported a negative relationship for all the variables with stock returns except the variable money supply.

Phylaktis and Ravazzolo (2005) found positive relationships between stock prices and exchange rates in the United States. Similarly, Oben, Pech and Shakur (2006) provided robust evidence on the relationship between exchange rates and stock prices in New Zealand. Kumar (2008) examined the association of exchange rates with stock prices for the Indian economy and reported a bidirectional linear as well as nonlinear causality. Rashid (2008) investigated the impact of four macroeconomic variables (industrial production, exchange rates, interest rates, and consumer prices) on stock returns by taking into account the possible structural breaks in the data. The author has documented the long-run equilibrium relationship between stock prices and all the macroeconomic variables. By applying error correction and cointegration model, Aydemir (2009) examined the association of the exchange rate with stock prices in Turkey and showed negative linkages between selected variables. Yau and Nieh (2009) confirmed the presence of long-run associations between exchange rates and stock prices in Taiwan and Japan.

Similarly, Stefanescu and Dumitriu (2009) examined the effect of the exchange rate volatility on the Romanian stock market and found a significant stable long-run relationship. Zhao (2010) studied the association between stock prices and exchange rates and found no relationship between the two variables. Ahmad and Rehman (2010) found a negative relationship between the interest rate and stock returns. In contrast, Al-Jafari, Salameh, and Habbash (2011) found no association among the interest rate, exchange rate and stock prices in the developed and emerging economies. Diamandis and Drakos (2011) found positive associtaions between exchnage rates and stock prices in the USA. Tsai (2012) empirically tested the connection between stock prices and exchange rates and found a negative relationship. Liang, Lin, and Hsu (2013) examined the association between stock prices and exchange rate by applying ADRL model and found the association between the variables is stronger in crisis time than the regular time. Toraman and Başarir (2014) examined the connection of the stock market capitalization rate with the interest rate in Turkey by applying the co-integration approach and found no significant relationship. Suriani, Kumar, Jamil, and Muneer (2015) analyzed the association between exchange rate and stock market of Pakistan and documented that these variables do not have any significant relationship.

Reboredo, Rivera-Castro, and Ugolini (2016) examined the link between downside and upside risk spillovers from stock prices to exchange rates and vice versa. The results showed positive relations between the currency value and stock prices in the emerging economies with respect to US dollar and Euro. Moreover, the study has reported an asymmetric relationship not only between upside and downside spillover risk but also in the size of risk spillovers. Sui and Sun (2016) examined the relationship among the domestic interest rate, stock returns, the exchange rate, and US S&P returns in the BRICS countries and indicated strong effects of the exchange rate on stock returns. Similarly, Akdogu and Birkan (2016) found statistically significant linear causal relationships between exchange rates and stock prices in the developing economies. Balogun, Dahalan, and Hassan (2016)

studied the impact of interest rate liberalization on stock market development in the African economies and indicated a negative impact of interest rate liberalization and stock market development.

Cheah, Yiew and Hee (2017) scrutinized the nonlinear relationship between exchange rates and stock prices in Malaysia. The study reported an asymmetric response of stock market towards exchange rate changes *i.e*., appreciations and depreciations in the exchange rate. The study reported that the nature of relationship varies across different time period. Dahir, Mahat, Razak and Ariffin (2018) examined the association between the exchange rate and stock prices in the BRICS countries and found a positive relationship in Brazil and Russia, whereas, a negative relation is observed in the case of India. Delgado *et al*. (2018) found a negative and significant effect of the exchange rate on the stock market index.

Igbinosa and Uhunmwangho (2019) explained that macroeconomic factors play an important role in determining the stock market performance and liquidity in Africa. Adeniyi and Kumeka (2020) concluded that exchange rate variations neither impact symmetrically nor asymmetrically on the Nigerian stock market. Mokni (2020) identified that the reaction of stock market towards crude oil price is not only time-varying but also asymmetric. The response of stock market towards negative oil shocks is more intense than to positive oil market shocks in both oil-importing and oil-exporting countries. Sheikh, Asad, Ahmed, and Mukhtar (2020) reported that investors respond differently to negative and positive shocks to gold process, exchange rates, interest rates and oil prices. Hence, the relationship between macroeconomic aggregates and stock market is asymmetric. Al-Hajj *et al*. (2021) reported that oil-price shocks deliver significant negative impacts on sectoral stock market returns.

The review of above-stated literature highlighted that the findings of the existing studies are inconclusive regarding the relationship of macroeconomic variables with stock market performance. Further, while examining the impacts of macroeconomic variables on stock prices/returns, the published studies have supposed the relationship is linear and does not change over time. There are only few studies that have documented that the relationship between exchange rates, interest rates and stock prices is different in different time periods. However, in principle, it is very likely that the association between macroeconomic variables and stock returns may significantly change over time because several advancements in trading mechanisms, structural changes and policy reforms have been occurred during the past several decades. Moreover, the financial sector development across the globe invites more diversified and innovative analysis of stock markets particularly of the developing countries. Keeping these aspects in mind, this study attempts to examine the time-varying effects of exchange rates, interest rate, inflation and output and their respective volatilities on stock market performance in terms of returns and stability in Pakistan. Empirical analysis of whether the impacts of macroeconomic variables on stock prices are different in different times has several important policy and managerial implications. This type of empirical examination would also be helpful for investors and firm managers to design and implement more effective and result-oriented hedging strategies to minimize risks associated with interest rate and exchange rate changes.

3. Methodology and Data

3.1 Gaussian State-Space Model

At the first step, we compute the volatilities of the above-mentioned series by calculating the conditional variance of each series (detail is available in supplementary material available online). At the next step, we estimate the Gaussian state-space model, which allows the regression coefficients to vary over time. The similar model is also used by the studies of Todorov and Bidarkota (2014), Chow, Liu and Niu (2011), Koop, Leon-Gonzalez and Strachan (2009), and Kang, Ratti and Yoon (2015) to conduct time-varying analysis in different fields of financial economics. Generally, the Gaussian state-space model comprises of the following two equations.

$$Sr_t = \alpha + \beta_t Z_t + \mathcal{E}_t \qquad \mathcal{E}_t \sim NID(o, M_t) \tag{1}$$

$$\beta_t = \gamma_t \beta_{t-1} + N_t \eta_t \qquad \eta_t \sim NID(o, P_t) \tag{2}$$

where: Sr_t is stock returns, β_t is the time-varying coefficient ($\beta_t = \beta_1, \beta_2, \beta_3, \ldots\ldots\ldots, \beta_t$). In this model, Z_t is the matrix of explanatory variables, namely exchange rate return, the interest rate, the rate of inflation and changes in industrial production index. M_t, γ_t, N_t and P_t are constant but the selection of these elements depends upon unknown parameters.

The first equation is known as the measurement/observation equation, which relates the observed state vector y_t with unobserved state vector β_t. The second equation is called the state or transition equation, which describes the dynamics of the state variables based on the past available information. The transition matrix γ_t determines the dynamic development of the state vector and follows the AR (1) process. The $\mathcal{E}_t$ vector of dimensions (1×1) and η_t vector of $m \times 1$ are the corresponding error terms of the measurement and state equation, respectively, which are normally distributed with zero mean and variance-covariance structure collected in 1×1 matrix H_t and $m \times m$ matrix $\mathrm{Q_t}$.

The state vector β_1 is a vector of order $m \times 1$ and is assumed to be normally distributed with the $m \times 1$ mean vector α_1 and the $m \times m$ covariance matrix $\mathrm{P_1}$

$$\beta_1 \sim NID\ (\alpha_1, \mathrm{P_1})$$

where: α_1 and $\mathrm{P_1}$ are presumed to be known. To examine the volatility impact, the model is explained as follows:

$$\sigma^2_{srt} = \alpha + \beta_t \sigma^2 z_t + \mathcal{E}_{it} \qquad \mathcal{E}_t \sim NID(o, M_t) \tag{3}$$

$$\beta_t = \theta_t \beta_{t-1} + N_t \eta_t \qquad \eta_t \sim NID(o, P_t) \tag{4}$$

where: σ^2_{srt} is the conditional variance of the stock returns and $\sigma^2 z_t$ is the conditional variance matrix of (exchange rate, consumer price index, industrial production index and interest rate).

3.3. Data

We use the monthly stock market index of the Pakistan Stock Exchange, the foreign exchange rate defined as the price of per unit of US dollar in Pak rupee, the market interest rate, inflation rate and industrial production index. The study covers the time period from

January 2000 to December 2018. The data are taken from "yahoo finance": www.oanda.com, the State Bank of Pakistan and International Financial Statistics.

4. Discussion of Findings

4.1 Measuring Volatilities

The estimated results for the GARCH (1, 1) model for all the underlying variables are given in Table 1 (available online). The results provide clear evidence that the lagged residuals and volatility have significant impacts on the current period volatility. Moreover, the findings also reveal that volatility shocks are highly persistent in all the variables except for industrial production index.

4.2 Time-varying Return Impacts

We use the Kalman filter approach to estimate the state-space model and use the results of this model to estimate the time-varying coefficient value of β_s (smooth state estimates). The outcomes of the time-varying return and volatility impacts are presented in Tables 2 and 3, respectively. σ_ε^2 and σ_η^2 are the variance of the error terms of the measurement and the state equations, respectively. These are calculated by taking the square root of the exponent of the coefficient value.

Table 2 explains the return impacts of the state-space model presented in equations (1) and (2). The coefficient value of σ_η^2 should be zero in the case of no return impact of the underlying variables on stock returns. The results demonstrate that the coefficient value of σ_η^2 is non zero and statistically significant at the 1% significance level for all the variables, showing the presence of the return impact of the exchange rate, consumer price index, industrial production index, and the interest rate on stock returns. The findings also confirm the time-varying return impact of all variables except IPI. The coefficient β_t is persistent as the estimated value of AR (1) coefficient (γ) is statistically significant for all the variables except for IPI. Further, the coefficient value of γ is close to 1 for all the variables. These findings provide strong evidence of the time-varying impact of the underlying macroeconomic indicators on stock returns in Pakistan. This implies that the relationship between macroeconomic conditions and stock market performance in terms of returns is not static. Rather, it changes, in terms of both sign and statistical significance, over time. Some past studies have also reported the asymmetric impacts of some macroeconomic indicators on stock returns, although they have used different methods and analytical frameworks than the ones used in this study. For example, Boucher (2007) and Kizys and Pierdzioch (2009) also highlighted that the relationships between the stock market and macroeconomic variables is asymmetric and this relationship changes in the long run.

In the case of exchange rates, the coefficient value of γ is 0.9629 and we observe that the coefficient σ_η^2 is non-zero (0.2345), providing strong evidence of significant return effects transmitting from changes in the exchange rate to stock returns. This finding implies that any shock in exchange rate returns significantly affects and transmits to stock market returns. In other words, the returns of both exchange rates and stock prices are highly related and any change in exchange rate returns significantly leads to changes in stock returns. The results also confirm that the spillover effect is significantly changing over time. The significant association between exchange rate returns and stock returns presented in this paper is consistent with the findings of several past studies. Yet, as we mentioned earlier, most of

past studies have documented the linear relationship. For instance, Phylaktis and Ravazzolo (2005), Oben *et al*. (2006), Vardar, Aksoy, and Can (2008), Kumar (2008), and Inci and Lee (2014) reported a significant association between exchange rate and stock market. Specifically, Gupta and Inglesi-Lotz (2012) documented that the exchange rate, the interest rate, and stock prices are correlated. Nevertheless, there are few sudies in the lietarure that have provided evidence of the time-varying nature of the relationship. Liang *et al*. (2013) found the association between exchange rate and stock prices is stronger in crisis time than in normal time. Cheah, *et al.* (2017) reported an asymmetric response of stock market towards exchange rate changes. Similarly, Sharif, Loganathan, and Jammazi (2018) and Okpara (2019) found a strong association between exchange rates and stock prices.

Turning to the case of CPI, we observe that the estimated coefficient value of γ is -0.6759 and the coefficient σ_η^2 is non-zero (0.1318) and both the coefficients are statistically significant at the acceptable level of significance. These estimates provide the evidence of the existence of time-varying return impact and transmission effect from changes in consumer prices to stock returns. This piece of evidence implies that consumer prices are significantly related to stock returns. Yet, the intensity of the impact is quite different in different time periods. These findings support the existing literature. For instance, Antonakakis, Gupta, and Tiwari (2017) reported that the nature of relationship between inflation and stock prices varies across different time periods. Similarly, Mokni (2020) identified that the reaction of stock market towards crude oil prices is not only time-varying but also asymmetric. For the IPI, our results reveal that the estimated coefficient value of γ is 0.418, which is statistically insignificant. However, the coefficient value of σ_η^2 is non-zero (2.0121) and appears statistically significant. The insignificant value of γ implies that there are no time-varying impacts of log changes in IPI on stock returns. It means that any change in industrial production index does not significantly transmit to stock returns during the examined period. There could be several explanations for the absence of any significant association between industrial production and stock returns. For instance, the growth of Pakistan's industrial sector is not substantial and persistent over the examined period. Therefore, although investors pay due attentions to other macroeconomic indicators such as exchange rates and interest rates, they do not take into account industrial production while investing in the stock market. Secondly, most of investors may have opportunist behavior and generally invest based on speculations. Thus, they may pay less attention to any real change in the economy. Some past studies have also reported the insignificant impact of output on the stock market performance. For example, Davis and Kutan (2003) explained that macroeconomic volatility measured by real output movements exerts a weak predictive power for stock market volatility and returns.

When we turn to the case of interest rate, we find that the interest rate has the highest coefficient value of γ, which is 0.9988, and it appears statistically significant. The higher value of γ indicates that the estimator β_t is highly persistent over the time, which provides strong evidence of the presence of time-varying return impact of the interest rate on stock returns. This implies that any shock in the interest rate significantly transmits to stock returns. However, the degree of transmission is different in different periods. In sum, the results reported in Table 2 provide robust evidence of the existence of the time-varying return spillovers from the underlying macroeconomic variables to stock returns, except for IPI. In the case of IPI, we did not get any significant evidence of the presence of the time-varying return impacts over the examined period. The existing studies such as Beirne, Maria, and Spagnolo (2009) and Ferrer, Bolós, and Benítez (2016), found that the interest rate

significantly influences the stock prices. Celebi and Hӧnig (2019) concluded that government bond yields have stronger influence on the stock market during the crisis period as compared to pre- and post-crisis. In contrast, Toraman and Başarir (2014) found no significant relationship between stock market capitalization and the interest rate.

Table 1. Estimated Results of Time-varying Return Impact

	c	σ_{ε}^2	γ	σ_{η}^2	Log-likelihood	AIC	BIC
ΔLEXR	22.076*** (0.000)	63.139*** (0.000)	0.962*** (0.002)	0.234*** (0.000)	-1111.285	11.4593	11.5600
ΔLCPI	0.015*** (0.000)	0.0724*** (0.000)	-0.675** (0.024)	0.131*** (0.000)	261.4517	-2.2682	-2.2079
ΔLIPI	0.010 (0.256)	0.059*** (0.000)	0.418 (0.141)	2.012*** (0.000)	115..4322	-0.9772	-0.9016
ΔIR	0.016*** (0.000)	0.065*** (0.000)	0.998*** (0.000)	0.051*** (0.000)	190.896	-1.6290	-1.5385

*Notes: The values in the parenthesis are p-values. *** and ** denote the significance at the 1% and 5% level of significance, respectively.*

Overall, the findings also show that the β_t coefficient is persistent as the estimated coefficient value of AR(1), γ, is statistically significant and lower than unit for all the variables included in the study. These findings show that any change in exchange rates, and CPI significantly transmit to stock returns. Further, these findings also suggest that the return impacts vary over the time. In other words, the impacts of changes in exchange rates, consumer price index, and interest rates on stock returns significantly change with time. These findings suggest that changes in these macroeconomic variables affect stock returns very differently in different periods. Further, these findings support the literature on the asymmetric and nonlinear relationship between macroeconomic indicators and stock prices. Sheikh *et al.* (2020) found that the relationship between macroeconomic aggregates and stock market is asymmetric. We further add to this literature by providing robust evidence that the impacts of exchange rates, interest rates, and consumer prices on stock market returns are very much time-dependent. Our findings imply that the extent of the transmission of any change in macroeconomic variables to stock returns is quite different in different time periods. Thus, stock market investors and policymakers should keep in mind such time-varying nature of the macroeconomic indicators – stock returns relationship when making any investment decisions and designing any performance-enhancing strategy based on macroeconomic indicators.

4.3 Time-varying Volatility Impact

The estimates of the time-varying volatility spillovers obtained from the state-space model are reported in Table 3. The results provide evidence of the significant time-varying volatility impacts of exchange rates, consumer price index, industrial production index, and interest rates on stock return volatility. The results also provide strong evidence of the persistence in time-varying volatility impacts. We observe that the estimated value of the coefficient of AR (1) term (γ) is lower than unit and it is statistically significant in β_t regression equation for all the variables. Further, one may see in the table that the estimated coefficient value of σ_{η}^2 is non-zero and statistically significant. Thus, it provides strong evidence of the existence of time-varying volatility spillover impacts from the unexpected variations in selected macroeconomic indicators to stock market return volatility. In other words, any

volatility shock in the exchange rate, consumer price index, industrial production index, and the interest rate significantly transmits to stock market volatility. However, the extent to which the volatility of the underlying macroeconomic factors transmits to stock return volatility considerably differs in different periods. This finding suggests that there are asymmetric and time-varying effects of macroeconomic volatility on the stock market volatility.

By looking at the results of each variable individually, we observe that in the case of exchange rates, the estimated coefficient value of γ is positive, 0.9344, and statistically significant at the 1% level of significance. In the same way, the estimated coefficient value of σ_η^2 is non-zero and positive and statistically significant. The results suggest a significant time-varying volatility impact of exchange rates on stock return volatility. Further, this implies that any increase in the volatility of exchange rate significantly causes stock returns' volatility. Some existing studies also documented the significant link between exchange rate volatility and stock market performance /volatility. For instance, Walid, Chaker, Masood, and Fry (2011) explained that changes in exchange rate play crucial role in determining the shift between stable and instable periods in emerging equity markets. Lim and Sek (2014), Lawal and Ijirshar (2013) and also confirmed that increased exchange rate volatility significantly influences performance of stock market. Kennedy and Nourizad (2016) and Mechri, Hamad, and Peretti (2018) found a significant association between exchange rate volatility and stock market fluctuations.

In the case of CPI, the findings reveal that the calculated coefficient value of γ is 0.9524 and statistically significant at the 1 % significance level. This indicates that the volatility impact is highly persistence. Further, the estimated coefficient value of σ_η^2 is greater than zero (0.0636) and statistically significant, which confirms the presence of the time-varying volatility impact of volatility of CPI on stock returns' volatility. In past studies, we have mixed findings. For instance, Davis and Kutan (2003) found that inflation volatility carries a weak predictive power for stock market volatility and returns. Rashid, Ahmad, Azim, and Rehman (2011) concluded that any change in inflation rate has a significant power of explaining stock exchange volatility in Pakistan.

For the IPI, we find that the γ has the highest coefficient value of 0.9791. This highest coefficient value implies the existence of highly persistent volatility impact transmitting from IPI volatility to stock returns' volatility during the examined period. Similarly, the coefficient value of σ_η^2 is also significantly positive and non-zero, which suggests the existence of the time-varying spillovers from IPI volatility to stock returns' volatility. This finding is consistent with the findings of Kamaly and Tooma (2009) that suggested that increased output volatility is likely to induce high stock market volatility. However, the evidence of the significant time-varying volatility spillovers from IPI to stock prices is in contrast to the findings of Davis and Kutan (2003). One possible reason could be their analytical framework as they supposed a static relationship. Departing from the assumption of time-invariant relationship, in this paper, we implement the dynamic analytical framework, which captures the time-varying nature of the relationship between macroeconomic volatilities and stock market volatility.

Finally, in the case of interest rates, we may see from the results that the coefficient value of γ is positive, reaching a value of 0.9212 and appears statistically significant, confirming the persistence of time-varying volatility impact of interest rate volatility on stock return volatility during the examined period. Likewise, the estimated coefficient value of σ_η^2 is also positive and statistically different from zero, providing evidence of the time-varying volatility impacts. Bomfim (2003) reported that increases in the federal funds rate have a more severe impact on the stock market and its volatility than a decrease in the rate. Another study by

Kim and Nguyen (2008) documented that unexpected changes in interest rate causes volatility in stock market. In sum, the results provided in Table 3 suggest the following. First, there is a significant volatility impact transmission from the exchange rate, consumer price index, industrial production index, and the interest rate to stock returns' volatility during the examined period. Secondly, the results indicate that the macroeconomic-volatility spillovers are quite different in different time periods, confirming the time-varying nature. Third, findings also suggest that there is significant persistence in the time-varying volatility impacts from all the variables to stock returns. Finally, for all the variables, the coefficient value of σ_η^2 is statistically different from zero and highly significant. This positive and non-zero value of σ_η^2 confirms the presence of time-varying volatility spillover impacts from all the variables to the volatility of stock returns.

Taken together, the findings reported in Tables 2 and 3 confirm our supposition of the time-varying return and volatility spillovers from macroeconomic conditions to the stock market of Pakistan. The findings support the results of the earlier studies that have reported the asymmetric impact of exchange rate and interest rate changes on stock prices. The empirical evidence on the time-varying return and volatility spillovers from macroeconomic conditions to equity market helps enhance our understanding of the role of the macro-economy in stock market performance and stability. Further, such findings are of great importance for building well-diversified investment portfolios and devising any strategy to minimize the unwanted variations in stock prices.

Table 2. Estimated Results of Time-varying Volatility Impact

	c	σ_ε^2	γ	σ_η^2	Log-likelihood	AIC	BIC
ΔVEXR	0.0055*** (0.0000)	0.0003*** (0.0000)	0.9204*** (0.0000)	9.6316*** (0.0000)	12375.578	-10.8989	-10.8081
ΔVCPI	0.0061*** (0.0000)	0.0008*** (0.0000)	0.9524*** (0.0000)	0.0636*** (0.0000)	1112.089	-9.8061	-9.7455
ΔVIPI	0.0047*** (0.0000)	0.0005*** (0.0000)	0.9791*** (0.0000)	0.0264*** (0.0055)	1141.144	-10.0901	-9.9990
ΔVIR	0.0059*** (0.0000)	0.0002*** (0.0000)	0.9212*** (0.0000)	0.0019*** (0.0000)	1262.176	-11.1166	-11.0258

*Notes: The values in the parenthesis are p-values. *** denotes the significance at the 1% level.*

4.4 Smoothed State Estimates of β_t

The estimates given in Tables 2 and 3 provide strong evidence of the existence of the time-varying return and volatility impacts of macroeconomic factors on stock returns and its volatility over the examined period. Particularly, we find that the estimated coefficient value of γ is positive and non-zero, providing strong evidence that β_t significantly varies over the selected time period. Thus, it would be interesting to recognize whether at any point of time during the selected time period, the estimated β_t is equal to zero or not. We test this by plotting the smoothed estimates of β_t with the 95% confidence interval against the time period. In doing so, we have plotted β_t smoothed state estimates along with corresponding confidence intervals for the underlying variable in Figures 1 and 2, respectively, to observe the time-varying return and volatility impacts.

In the case of the exchange rate and stock prices, we find that the smoothed state estimate of β_t is negative for most of the examined time period. However, the smoothed state

estimate of β_t remains within the 95% confidence interval during the study period. As one may see from the graph, β_t is positive at the start of the sample period. However, it started to decline afterwards and becomes negative from 2002 to 2013. After 2013, the value of β_t starts increasing though remains negative. Notably, at the end of the sample period, it remains constant around zero. It suggests that at the end of the sample period, the shocks in exchange rates become less important to stock market returns.

Figure 1: Graphs of the Time-varying Return Impact

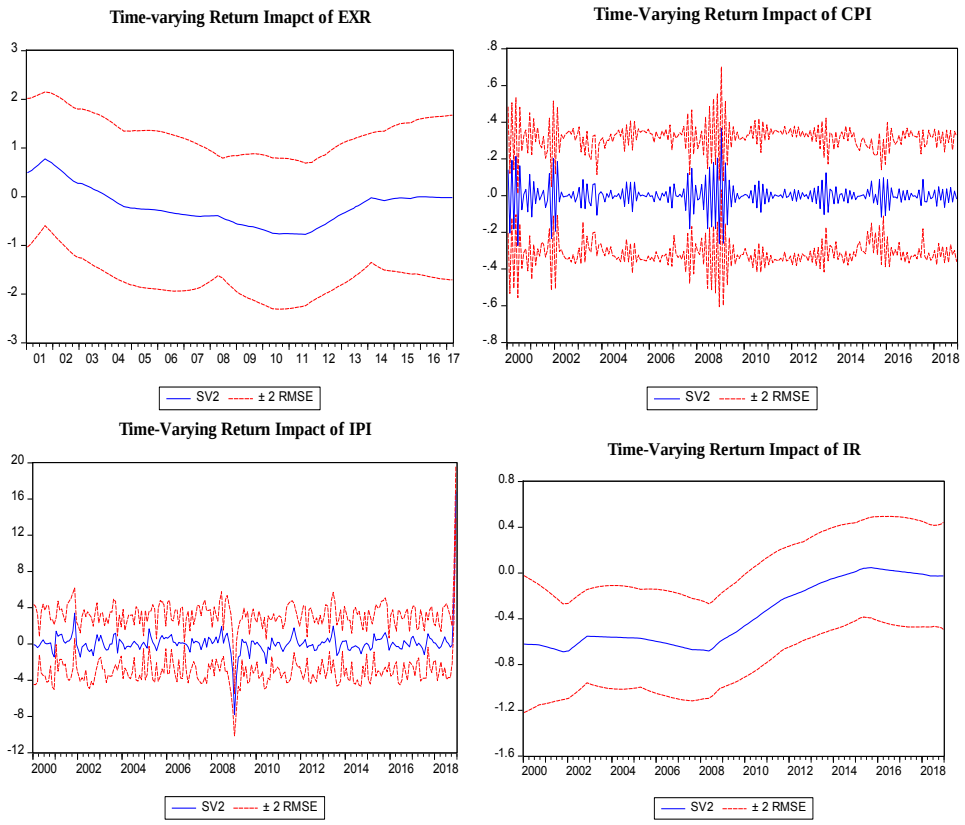
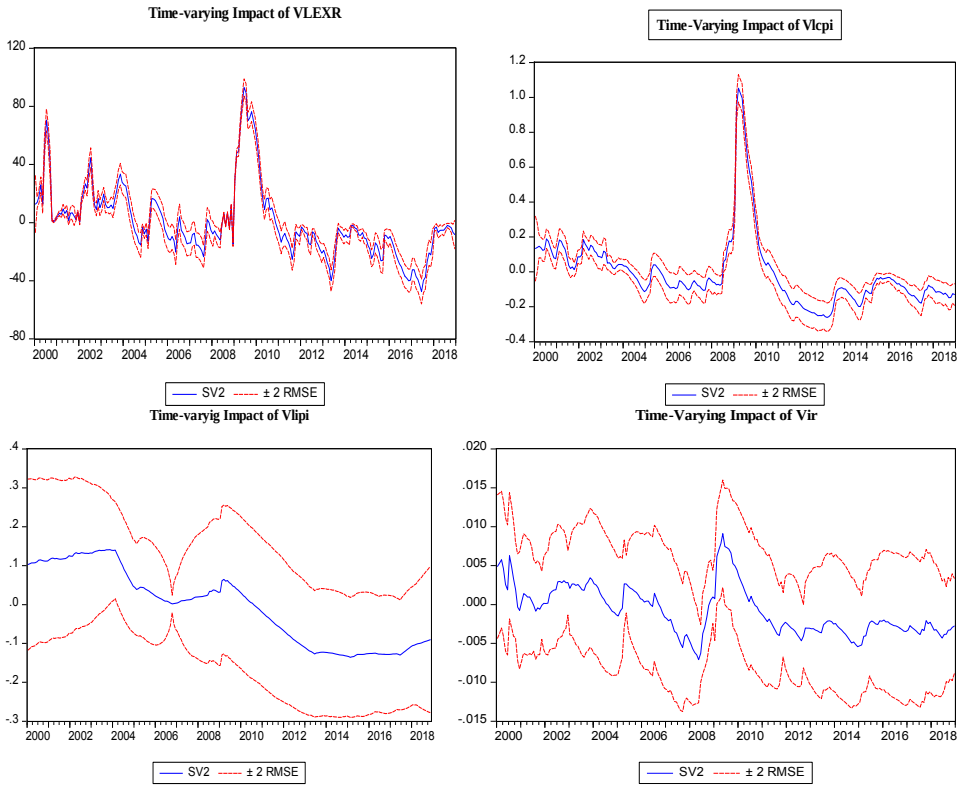


Figure 2: Graphs of the Time-varying Volatility Impact



Turning to the graph of volatility spillovers from the exchange rates and stock market, we plot β_t the smoothed state parameter along with the 95% confidence interval against the time period. The graph displays that the association between the volatility of exchange rate and stock returns' volatility is positive at the beginning of the sample period. However, it starts declining and becomes negative during the period 2004-2008. As it is indicated from the graph, this association become positive and reached the maximum level during the period of global financial crisis. One may also observe from the graph that after the crisis period, the strength of the positive association between exchange rate and stock price volatility continuously decreases and even finally becomes negative. It means that after the crisis period, volatility shocks in the exchange rate negatively affect the stock market volatility in Pakistan.

In the case of IPI, the results given in Table 3 provide evidence that the calculated parameter σ_η^2 is statistically insignificant, suggesting the absence of the time-varying return impact from IPI to stock market during the investigated period. When we plotted the β_t smoothed estimates with the 95% confidence intervals, the graph also portrays the similar picture. Particularly, we observe that the time-varying parameter β_t remained around zero with an exception of the 2007-08 period of global financial crisis. Therefore, we can conclude that

the impact of any change in IPI on stock returns does not vary during the examined time period.

Turning to look at the time-varying volatility impact from IPI to stock market volatility, we notice that the volatility impact significantly varies over the selected time period. Specifically, we observe that the smoothed state estimate β_t is positive at the beginning of the sample period and shows increasing trend till 2004. Afterwards, a decline in the value of β_t is witnessed though the estimate remains positive till the end of 2006. However, it starts to increase during the period of global financial crisis, 2007-2008. While in the post crisis period, the estimate of β_t shows a decline and subsequently becomes negative during the period 2009 to 2014. This finding suggests that the volatility of IPI significantly influences the volatility of stock market during the examined period. The finding also reveals that the strength and sign of the association is different in different periods, confirming the time-varying response of the equity market volatility to IPI volatility.

For CPI, the results reported in Table 3 show that the estimated coefficient value of γ is -0.6759. We also find that the estimated coefficient of σ_η^2 is non zero (0.1318). Further, we may see that the estimated coefficients are highly significant. These outcomes provide the evidence of the existence of the time-varying return impact and transmission form consumer price index to stock returns. However, when we plot the graph of β_t with the 95% confidence interval, the graph of inflation variable is clearly different from the graphs of other variables. We can see that β_t moves around the zero during most of the time period with an exception of the period of global financial crisis of 2007-2008. Thus, we can conclude that in general, shocks in consumer prices do not significantly transmit to stock market returns in Pakistan.

Moving to examine the volatility graph we observe that association between CPI volatility and stock market volatility is positive, however, continuously decreasing and becomes negative during the period 2004-2008. Afterwards, the value of β_t turns positive and reaches the highest value during the global financial crisis. Finally, in the post-crisis period, that is 2009 onwards, the value of β_t becomes negative and remains constant around the zero till the end of the sample period. It explains that in the post-crisis period, inflation volatility negatively influences the stock market volatility in Pakistan.

The visual presentation of the estimates provides strong evidence of the presence of the time-varying return and volatility spillovers from the underlying macroeconomic factors to equity market in Pakistan. These findings confirm the hypothesis of the paper that the impacts of macroeconomic conditions on stock market's performance and instability are different in different time periods. The presence of these time-varying spillovers implies that the models and analytical frameworks that suppose the linear and static relationship between macroeconomic factors and stock market may provide incomplete picture of how macroeconomic shocks are transmitted to equity markets. The findings of this paper have several important implications and guidelines for both stock market investors and policymakers. Specifically, the findings suggest that the investors should keep in mind the time-varying nature of return and volatility spillovers while designing and investment strategy and applying any method based on macroeconomic indicators to predict the behavior of stock market. Policymakers should also pay due considerations to time-varying impacts on the stock market performance of macroeconomic indicators whenever they attempt to stabilize stock prices through macroeconomic policies.

5. Conclusions and Recommendations

The link between macroeconomic performance and stock market performance is always a topic of discussion for researchers and policymakers. The published studies have examined this association by assuming that the effects of macroeconomic indicators on stock markets are linear and symmetric. However, in this paper, we assume that this relationship has evolved over time with developments in both size and scope of stock markets, growing macroeconomic uncertainty, and increasing global financial integration. This warrants new research to examine the relationship in a different dimension. Like many developing countries, Pakistan's stock exchange market has also witnessed several developments in its services and a considerable expansion in its scope, on the one hand, while an increase in the exposure to risk, on the other hand. A large body of the literature is devoted to examine the linear and symmetric impact of various internal and external factors on stock market performance of Pakistan with inconclusive findings. However, we do not have any empirical evidence on whether the effect of macroeconomic factors on the stock market changes over time. Therefore, to fill this gap, in this paper, we examine the time-varying return and volatility spillover effects of exchange rates, interest rates, CPI, and IPI on stock market return and volatility in Pakistan using monthly data for the period 2000-2018.

To gauge the volatility, we estimate the ARCH/GARCH models for each underlying series. To quantify the time-varying return and volatility spillovers from macroeconomic variables towards stock market return and volatility, we estimate the Gaussian state space models that allow the parameter of interest to vary over time. The results indicate that there are significant time-varying returns impacts from all the macroeconomic variables except for industrial production to stock market returns. The graphical presentation of the estimated impact provides robust evidence of the asymmetric nature of the impact of changes in exchange rates, interest rates, and consumer prices on stock market returns. These results suggest that the relationship between macroeconomic variables and stock market returns significantly changes over time as we predicted in this study.

The estimates of the time-varying volatility spillovers also confirm that the exchange rate volatility, the interest rate volatility, the consumer price volatility and the industrial production volatility significantly transmit to the stock return volatility. Furthermore, the estimates provide evidence that the extent to which the macroeconomic volatilities transmit to the stock market volatility is different in different periods. These differences appear more profound when we compare the estimates of pre-financial crisis period with the post-financial crisis period. These findings are also consistent with our supposition of the time-varying nature of volatility effects.

Empirical findings on the time-varying return and volatility spillovers from macroeconomic indicators to the stock market that we present in this study have several important policy and managerial implications. Specifically, the findings suggest that the macroeconomic policies and instruments that are useful to reduce unexpected variations in stock market in one period may not be effective for another period. The findings also suggest that policymakers should keep in mind the time-varying association between macroeconomic indicators and stock market performance while designing any policy with respect to stock market. The findings of the study are also helpful for investors and firm managers to forecast stock prices based on the information of macroeconomic indicators. Further, the findings are useful in determining the need and time for applying effective hedging strategies for different types of risk associated with exchange rates, interest rates, and consumer prices. We quantify the

time-varying return and volatility spillovers by assuming that the estimate of smoothed parameter follows an auto regression process. However, by applying some other processes such as random walk, higher order auto regression, moving average, etc., one may extend this research.

References

Adeniyi, O. and Kumeka, T., 2020. Exchange rate and stock prices in Nigeria: Firm-level evidence. *Journal of African Business*, *21*(2), pp.235-263. https://doi.org/10.1080/15228916.2019.1607144.

Adjasi, C.K., Biekpe, N.B. and Osei, K.A., 2011. Stock prices and exchange rate dynamics in selected African countries: a bivariate analysis. *African Journal of Economic and Management Studies, 2*(2), pp.143-164. https://doi.org/10.1108/20400701111165623

Afshan, S., Sharif, A., Loganathan, N. and Jammazi, R., 2018. Time–frequency causality between stock prices and exchange rates: Further evidences from cointegration and wavelet analysis. *Physica A: Statistical Mechanics and its Applications, 49*(1x), pp.225-244. https://doi.org/10.1016/j.physa.2017.12.033

Ahmad, M. and Rehman, R.A., 2010. Do Interest Rate, Exchange Rate Effect Stock Returns? A Pakistani Perspective. *International Research Journal of Finance and Economics, 4*(50), pp.146-150.

Ajaz, T., Nain, M.Z., Kamaiah, B. and Sharma, N.K., 2017. Stock prices, exchange rate and interest rate: evidence beyond symmetry. *Journal of Financial Economic Policy, 9*(1), pp.2-19. https://doi.org/10.1108/JFEP-01-2016-0007

Akdogu, S.K. and Birkan, A.O., 2016. Interaction between Stock Prices and Exchange Rate in Emerging Market Economies. *Research in World Economy, 7*(1), pp.80-94. http://dx.doi.org/10.5430/rwe.v7n1p80

Alam, M. and Uddin, G., 2009. Relationship between interest rate and stock price: empirical evidence from developed and developing countries. *International Journal of Business and Management, 4*(3), pp. 43-51.

Al-hajj, E., Al-Mulali, U. and Solarin, S.A., 2021. Exploring the nexus between oil price shocks and sectoral stock returns: a new evidence from stock exchange in Malaysia. *Economic Change and Restructuring*, *54*(1), pp. 199-217. https://doi.org/10.1007/s10644-020-09271-y

Ali, H., 2014. Impact of Interest Rate on Stock Market; Evidence from Pakistani Market. *Journal of Business and Management, 16*(1), pp.64-69.

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), pp. 27-435. https://doi.org/10.1080/09603107.2011.617691.

Al-Jafari, M.K., Salameh, R.M. and Habbash, M.R., 2011. Investigating the relationship between stock market returns and macroeconomic variables: evidence from developed and emerging markets. *International Research Journal of Finance and Economics*, *79*, pp.6-30.

Aljarayesh, N.I.A., Asfour, L.K. and Al-Abdallah, S.Y., 2018. Interest rates volatility and its consequences on stock returns: The case study from Amman Stock Exchange, Jordan. *Journal of Economics Library*, *5*(2), pp.149-160. OI: http://dx.doi.org/10.1453/jel.v5i2.1654.

Al-Mukit, D.M., 2012. Effects of Interest Rate and Exchange Rate on Volatility of Market Index at Dhaka Stock Exchange. *Journal of Business and Technology (Dhaka), 7*(2), pp.1-18.https://doi.org/10.3329/jbt.v7i2.16451.

Amare, T. and Mohsin, M., 2000. Stock prices and exchange rates in leading Asian economies: short run versus long run dynamics. *Singapore Economic Review, 42*(2), pp. 165-181.

Antonakakis, N., Gupta, R. and Tiwari, A. K., 2017. Has the correlation of inflation and stock prices changed in the United States over the last two centuries? *Research in International Business and Finance, 42*(5), pp.1-8. https://doi.org/10.1016/j.ribaf.2017.04.005

Aydemir, O.D., 2009. The Relation between Stock Prices and Exchange Rates.Evidence from Turkey. *International Research Journal of Finance and Economics, 23*(3), pp.207-215.

Balogun, W.O., Dahalan, J.B. and Hassan, S.B., 2016. Interest rate liberalization, quality institutions and stock market development in selected Sub-Saharan African countries. *International Journal of Economics and Financial Issues*, *6*(2), pp.786-792.

Barasa, J.W., 2014. *Macro-economic determinants of stock market performance in Kenya: case of Nairobi securities exchange* (Doctoral dissertation, University of Nairobi). University of Nairobi. http://hdl.handle.net/11295/74949

Beirne, J., Maria, G. and Spagnolo, N., 2009. Market, Interest rate and exchange rate risk effects on financial stock returns: A GARCH-M approach. *Quantitative and Qualitative Analysis in Social Sciences, 3*(2), pp.44-68. https://doi.org/10.1080/23322039.2015.1125332

Bekaert, G. and Harvey, C.R., 2002. Research in Emerging Markets Finance: Looking to the future. *Emerging Markets Review*, 3(4), pp.429–448. https://doi.org/10.1016/S1566-0141(02)00045-6

Bekhet, H.A. and Matar, A., 2013. Co-integration and causality analysis between stock market prices and their determinates in Jordan. *Economic Modelling*, *35*, pp.508-514. https://doi.org/10.1016/j.econmod.2013.07.012

Bhattacharya, B. and Mukherjee, J., 2003. C ausal relationship between stock market and exchange rate, foreign reserves and value of trade balanve: A case study for India . *Money and Finance in the Indian Economy*, pp.1-24.

Binswanger, M., 2004. How do stock prices respond to fundamental shocks?. *Finance Research Letters*, *1*(2), pp.90-99. https://doi.org/10.1016/j.frl.2004.03.005

Bollerslev, T., 1986. Generalised Autoregressive Conditional Heteroskedasticity. *Journal of Econometrics, 31(3)*, pp.307-322. https://doi.org/10.1016/0304-4076(86)90063-1

Bomfim, A. N., 2003. Pre-announcement effects, news effects, and volatility: Monetary policy and the stock market. *Journal of Banking and Finance*, *27*(1), pp.133-151. https://doi.org/10.1016/S0378-4266(01)00211-4

Boucher, C., 2007. Asymmetric adjustment of stock prices to their fundamental value and the predictability of US stock returns. *Economics Letters*, *95*(3), pp.339-347. https://doi.org/10.1016/j.econlet.2006.11.004

Bradley, M.D. and Jansen, D.W., 1997. Nonlinear business cycle dynamics: cross-country evidence on the persistence of aggregate shocks. *Economic Inquiry*, *35*(3), pp.495-509. https://doi.org/10.1111/j.1465-7295.1997.tb02027.x

Cheah, S.-P., Yiew, T.-H. and Hee, T., 2017. A nonlinear ARDL analysis on the relation between stock price and exchange rate in Malaysia. *Economics Bulletin, 37*(1), pp.336-346. http://www.accessecon.com/Pubs/EB/2017/Volume37/EB-17-V37-I1-P30.pdf

Cheung, Y.W. and Ng, L.K., 1998. International evidence on the stock market and aggregate economic activity. *Journal of empirical finance*, *5*(3), pp. 281-296. https://doi.org/10.1016/S0927-5398(97)00025-X

Chow, G.C., Liu, C. and Niu, L., 2011. Co-movements of Shanghai and New York stock prices by time-varying regressions. *Journal of Comparative Economics*, *39*(4), pp.577-583. https://doi.org/10.1016/j.jce.2011.06.001

Cochrane, J.H., 1991. Production-based asset pricing and the link between stock returns and economic fluctuations. *The Journal of Finance*, *46*(1), pp. 209-237. https://doi.org/10.1111/j.1540-6261.1991.tb03750.x

Dahir, A. M., Mahat, F., Ab Razak, N. H. and Ariffin, A. B., 2018. Revisiting the dynamic relationship between exchange rates and stock prices in BRICS countries: A wavelet analysis. *Borsa Istanbul Review, 18*(2), pp. 101-113. https://doi.org/10.1016/j.bir.2017.10.001

Dar, A.B., Billah, M., Bhanja, N. and Samantaraya, A., 2013. The Relationship between Stock Price Index and Exchange Rate in Asian Markets: A Wavelet Based Correlation and Quantile Regression Approach. *SSRN*. https://doi.org/10.1016/j.intfin.2012.04.005

Davis, N. and Kutan, A.M., 2003. Inflation and output as predictors of stock returns and volatility: international evidence. *Applied Financial Economics*, *13*(9), pp.693-700. https://doi.org/10.1080/09603100210139429

Delgado, N. A., Delgado, E. B. and Saucedo, E., 2018. The relationship between oil prices, the stock market and the exchange rate: Evidence from Mexico. *North American Journal of Economics and Finance, 45*(3), pp. 266-275. https://doi.org/10.1016/j.najef.2018.03.006.

Diamandis, P.F. and Drakos, A.A., 2011. Financial liberalization, exchange rates and stock prices: exogenous shocks in four Latin America countries. *Journal of Policy Modeling, Elsevier, 33*(3), pp.381–394. https://doi.org/10.1016/j.jpolmod.2010.11.004

Falk, B., 1986. Further evidence on the asymmetric behavior of economic time series over the business cycle. *Journal of Political Economy*, *94*(5), pp.1096-1109.

Fama, E.F., 1981. Stock returns, real activity, inflation, and money. *The American economic review*, *71*(4), pp.545-565.

Fama, E.F., 1990. Stock returns, expected returns, and real activity. *The Journal of Finance*, 45(4), pp. 1089-1108. https://doi.org/10.1111/j.1540-6261.1990.tb02428.x

Farooq, M.T., Keung, W.W. and Kazmi, A.A., 2004. Linkage between Stock Market Prices and Exchange Rate: A Causality Analysis for Pakistan [with Comments]. *The Pakistan Development Review*, pp.639-649.

Ferrer, R., Bolós, V.J. and Benítez, R., 2016. Interest rate changes and stock returns: A European multi-country study with wavelets. *International Review of Economics and Finance, 44*, pp.1-12. https://doi.org/10.1016/j.iref.2016.03.001

Frankel, J., 1984. Tests of monetary and portfolio balance models of exchange rate determination. Exchange Rate Theory and Practice. *University of Chicago Press, 84*(1), pp.239–260. https://doi.org/10.1016/B978-0-12-444281-8.50038-6

Frenkel, J.A., 1976. A Monetary Approach to the Exchange Rate: Doctrinal Aspects and Empirical Evidence. *The Scandinavian Journal of Economics*, 78(2), pp.200-224.https://doi.org/10.1007/978-1-349-03359-1_7

Geetha, C., Mohidin, R., Chandran, V. and Chong, V., 2011. The relationship between inflation and stock market: Evidence from Malaysia, United States and China. International Journal of Economics and Management Sciences, 1(2), pp.1-16.

Geske, R. and Roll, R., 1983. The fiscal and monetary linkage between stock returns and inflation. *The journal of Finance*, 38(1), pp.1-33. https://doi.org/10.1111/j.1540-6261.1983.tb03623.x

Giri, K.A. and Pooja, J., 2017. The impact of macroeconomic indicators on Indian stock prices: An empirical analysis . *Studies in Business and Economics, 20*(1), pp.61-78. https://doi.org/ 10.1515/sbe-2017-0005

Gopinathan, R. and Durai, S.R.S., 2019. Stock market and macroeconomic variables: new evidence from India. *Financial Innovation*, *5*(1), pp.1-17. https://doi.org/10.1186/s40854-019-0145-1

Gunasekarage, A., Pisedtasalasai, A. and Power, D.M., 2004. Macroeconomic Influence on the Stock Market: Evidence from an Emerging Market in South Asia. *Journal of Emerging Market Finance, 3*(3), pp.285-304. https://doi.org/10.1177/097265270400300304

Gupta, R. and Inglesi-Lotz, R., 2012. Macro Shocks and Real US Stock Prices with Special Macro Shocks and Real US Stock Prices with Special. *Applied Econometrics and International Development, 12*(2), pp.123-136.

Ibrahim, M.H., 2000. Cointegration and Granger Causality Tests of Stock Price and Exchange Rate Interactions in Malaysia. *Asean Economic Bulletin , 1*(17), pp.36-47.

Igbinosa, S.O. and Uhunmwangho, M., 2019. Macroeconomic aggregates and stock market liquidity: Evidence from African stock markets. *International Journal of Economics and Financial Management*, *4*(1), pp.18-27.

Inci, A.C. and Lee, B.S., 2014. Dynamic relations between stock returns and exchange rate changes. *European Financial Management*, *20*(1), pp.71-106. https://doi.org/10.1111/j.1468-036X.2011.00621.x.

Joseph, N.A. and Vezos, P., 2006. The sensitivity of US bank's stock returns to interest rate and exchange rate changes. Managerial Finance, 32(2), pp.182-199. https://doi.org/10.1108/0307435061064193

Junior, P.O., Boafo, B.K., Awuye, B.K., Bonsu, K. and Obeng-Tawiah, H., 2018. Co-movement of stock exchange indices and exchange rates in Ghana: A wavelet coherence analysis. *Cogent Business and Management*, *5*(1), pp.1481559-1481559. https://doi.org/10.1080/23311975.2018.1481559

Kamaly, A. and Tooma, E. A., 2009. Calendar anomolies and stock market volatility in selected Arab stock exchanges. *Applied Financial Economics*, *19*(11), pp. 881-892. https://doi.org/10.1080/09603100802359976

Kanas, A., 2003. Non-linear cointegration between stock prices and dividends. *Applied Economics Letters*, *10*(7), pp. 401-405. https://doi.org/10.1080/1350485022000044020

Kanas, A., 2005. Nonlinearity in the stock price–dividend relation. *Journal of International Money and Finance*, *24*(4), pp, 583-606. https://doi.org/10.1016/j.jimonfin.2005.03.003

Kang, W., Ratti, R.A. and Yoon, K.H., 2015. Time-varying effect of oil market shocks on the stock market. *Journal of Banking and Finance*, *61*, pp.S150-S163. https://doi.org/10.1016/j.jbankfin.2015.08.027

Kennedy, K. and Nourizad, F., 2016. Exchange rate volatility and its effect on stock market volatility. *Int. J. Hum. Cap. Urban Manage*, *1*(1), pp.37-46. https://doi.org/10.7508/ijhcum.2016.01.005

Khalid, W., 2017. Effects of interest rate and exchange rate on the stock market performance of Pakistan: A cointegration approach. *Journal of Finance and Economics*, *5*(5), pp. 219-232. https://doi.org/ 10.12691/jfe-5-5-4

Khalid, W. and Khan, S., 2017. Effects of Macroeconomic Variables on the Stock Market Volatility: The Pakistan Experience. *International Journal*, *5*(2), pp.42-59. https://doi.org/ DOI:10.12691/ijefm-5-2-4

Kim, K.-h., 2003. Dollar exchange rate and stock price: evidence from multivariate cointegration and error correction model. *Review of Financial economics, 12*(3), pp.301-313. https://doi.org/10.1016/S1058-3300(03)00026-

Kim, S.J. and Nguyen, T., 2008. The Reaction of the Australian Financial Markets to the Interest Rate News from the Reserve Bank of Australia and the US Fed. *Research in*

International Business and Finance, pp.*22*(3). https://doi.org/10.1016/j.ribaf.2008.02.001

Kizys, R. and Pierdzioch, C., 2009. Changes in the international comovement of stock returns and asymmetric macroeconomic shocks. *Journal of International Financial Markets, Institutions and Money*, *19*(2), pp.289-305. https://doi.org/10.1016/j.intfin.2008.01.002

Koop, G., Leon-Gonzalez, R. and Strachan, R.W., 2009. On the evolution of the monetary policy transmission mechanism. *Journal of Economic Dynamics and Control*, *33*(4), pp.997-1017. https://doi.org/10.1016/j.jedc.2008.11.003

Kumar, M., 2008. A Bivariate Linear and Nonlinear Causality between Stock Prices and Exchange Rates. *Economics Bulletin, 29*(4), pp. 2884-2895.

Lawal, A.I., Somoye, R.O., Babajide, A.A. and Nwanji, T.I., 2018. The effect of fiscal and monetary policies interaction on stock market performance: Evidence from Nigeria. *Future Business Journal*, *4*(1), pp.16-33. https://doi.org/10.1016/j.fbj.2017.11.004

Lawal, M. and Ijirshar, V.U., 2013. Empirical analysis of exchange rate volatility and Nigeria stock market performance. *International Journal of Scientific and Research*, *4*(4), pp.1592-1600.

Lee, B.S., 1992. Causal relations among stock returns, interest rates, real activity, and inflation. *The Journal of Finance*, *47*(4), pp.1591-1603. https://doi.org/10.1111/j.1540-6261.1992.tb04673.x

Liang, C.C., Lin, J.B. and Hsu, H.C., 2013. Reexamining the relationships between stock prices and exchange rates in ASEAN-5 using panel Granger causality approach. *Economic Modelling, 32*(3), pp.560–563. https://doi.org/10.1016/j.econmod.2013.03.001

Lim, S.Y. and Sek, S.K., 2014. Exploring the inter-relationship between the volatilities of exchange rate and stock return. *Procedia Economics and Finance*, *14*, pp. 367-376. https://doi.org/10.1016/S2212-5671(14)00725-4

Mechri, N., Hamad, S.B. and Peretti, C., 2019. *The Impact of the Exchange Rate Volatilities on Stock Market Returns Dynamic* (working Paper No. hal-01766742). https://hal.archives-ouvertes.fr/hal-01766742v2

Mishra, A., 2004. Stock market and foreign exchange market in India: Are they related? *South Asia Economic Journal, 5*(2), pp.209–232. https://doi.org/ 10.1177/139156140400500202

Mokni, K., 2020. A dynamic quantile regression model for the relationship between oil price and stock markets in oil-importing and oil-exporting countries. *Energy*, *213(C)*, pp.118639. https://doi.org/10.1016/j.energy.2020.118639

Muhammad, N. and Rasheed, A., 2002. Stock Prices and Exchange Rates: Are they related? Evidence from South Asian Countries. *The Pakistan Development Review*, *41*(4), pp.535-550.

Mukherjee, T.K. and Naka, A., 1995. Dynamic relations between macroeconomic variables and the Japanese stock market: an application of a vector error correction model. *Journal of financial Research*, *18*(2), pp.223-237. https://doi.org/10.1111/j.1475-6803.1995.tb00563.x

Nasseh, A. and Strauss, J., 2000. Stock prices and domestic and international macroeconomic activity: a cointegration approach. *The quarterly review of economics and finance*, *40*(2), pp.229-245. https://doi.org/10.1016/S1062-9769(99)00054-X

Oben, J., Pech, A. and Shakur, S., 2006. Analysis of the relationship between the share market performance and exchange rates in New Zealand: A cointegrating VAR approach. *New Zealand Economic Papers,, 40*(2), pp.147–180. https://doi.org/10.1080/00779954.2006.9558559

Okpara, G.C., 2019. Analysis of the relationship between exchange rate and stock prices: Evidence from Nigeria . *International Journal of Current Research, 4*(3), pp. 175-183.

Phylaktis, K. and Ravazzolo, F., 2005. Stock prices and Exchange rate dynamics. *Journal of International Money and Finance, 24*, pp.1031-1053. https://doi.org/10.1016/j.jimonfin.2005.08.001

Rahman, M.L. and Uddin, J., 2009. Dynamic Relationship between Stock Prices and Exchange Rates: Evidence from Three South Asian Countries. *International Business Research, 2*(2), pp.167-174.

Ram, R. and Spencer, D.E., 1983. Stock returns, real activity, inflation, and money: comment. *The American Economic Review*, *73*(3), pp.463-470.

Ramsey, J. B. and Rothman, P., 1996. Time irreversibility and business cycle asymmetry. *Journal of Money, Credit and Banking*, *28*(1), pp.1-21.

Rashid, A., 2008. Macroeconomic Variables and Stock Market Performance: Testing for Dynamic Linkages with Known Structural Break. *Saving and Development,* XXXII(1), pp.77-102.

Rashid, M.T., Ahmad, K., Azim, P. and Rehman, H., 2011. Measuring the impact of inflation on conditional stock market volatility in Pakistan: An application of IGARCH model. *Middle Eastern Finance and Economics*, *13*(1), pp.36-42.

Reboredo, J.C., Rivera-Castro, M.A. and Ugolini, A., 2016. Downside and upside risk spillovers between exchange rates and stock prices. *Journal of Banking and Finance, 62*, pp.76-96. https://doi.org/10.1016/j.jbankfin.2015.10.011

Ross, S.A., 1976. The arbitrage theory of capital asset pricing. Journal of economic theory, 13(3), pp.341-60. https://doi.org/10.1142/9789814417358_0001

Saleem, F., Zafar, L. and Rafique, B., 2013. Long run relations between inflation and stock: Evidence from Pakistan. *Social Sciences and Humanities, 4*(2), pp.407-415.

Salimullah, A.H., 2016. Granger Causality of Interest Rate and Exchange Rate on Stock Volatility at Chicago Options Market. *Scientia et Humanitas , 6(2016)*, pp.35-56.

Schwert, G.W., 1990. Stock returns and real activity: A century of evidence. *The Journal of Finance*, *45*(4), pp.1237-1257. https://doi.org/10.1111/j.1540-6261.1990.tb02434.x

Sheikh, U.A., Asad, M., Ahmed, Z. and Mukhtar, U., 2020. Asymmetrical relationship between oil prices, gold prices, exchange rate, and stock prices during global financial crisis 2008: Evidence from Pakistan. *Cogent Economics and Finance*, *8*(1), pp.1757802. https://doi.org/10.1080/23322039.2020.1757802

Śmiech, S. and Papież, M., 2013. Fossil fuel prices. Exchange Rate, and Stock Market: A Dynamic causality analysis on the European market. *Economics Letters, 118*(1), pp.199–202. https://doi.org/10.1016/j.econlet.2012.10.010

Stavárek, D., 2005. Linkages between Stock Prices and Exchange Rates in the EU and the United States. *Czech Journal of Economics and Finance, 55*(3-4), pp.141-161.

Stefanescu, R. and Dumitriu, R., 2009. Impact of the global crisis on the financial linkages between the stock market and the foreign exchange market from Romania. *Economics and Applied Informatics., 2*(1), pp.1-16.

Sui, L. and Sun, L., 2016. Spillover effects between exchange rates and stock prices: Evidence from BRICS around the recent global financial crisis. *Research in International Business and Finance, 36*, pp. 459-471. https://doi.org/10.1016/j.ribaf.2015.10.011

Suriani, S., Kumar, M.D., Jamil, F. and Muneer, S., 2015. Impact of exchange rate on stock market. *International Journal of Economics and Financial Issues*, *5*(Special Issue), pp. 385-388.

Tang, X. and Zhou, J., 2013. Nonlinear relationship between the real exchange rate and economic fundamentals: evidence from China and Korea. *Journal of International Money and Finance*, *32*, pp.304-323. https://doi.org/10.1016/j.jimonfin.2012.04.010

Taylor, B., 1996. World Stock Market Returns 1990-1995: Domestic Real Stock Market Performance. *Global Financial Data*, pp.1-47.

Todorov, G. and Bidarkota, P., 2014. Time-varying financial spillovers from the US to frontier markets. *Macroeconomics and Finance in Emerging Market Economies*, *7*(2), pp.246-283. https://doi.org/10.1080/17520843.2014.919330.

Toraman, C. and Başarir, Ç., 2014. The Long Run Relationship between Stock Market Capitalization Rate and Interest Rate: Co-integration Approach. *Procedia - Social and Behavioral Sciences, 143*, pp.1070-1073. https://doi.org/10.1016/j.sbspro.2014.07.557

Tsai, I.-C., 2012. The relationship between stock price index and exchange rate in Asian markets: A quantile regression approach. *Journal of International Financial Markets, Institutions and Money, 22*(3), pp.609-621. https://doi.org/10.1016/j.intfin.2012.04.005

Vardar, G., Aksoy, G. and Can, E., 2008. Effects of Interest and Exchange Rate on Volatility and Return of Sector Price Indices at Istanbul Stock Exchange. *European journal of Economics, Finance and Administrative Sciences, 11*, pp.126-135.

Walid, C., Chaker, A., Masood, O. and Fry, J., 2011. Stock market volatility and exchange rates in emerging countries: A Markov-state switching approach. *Emerging Markets Review*, *12*(3), pp.272-292. https://doi.org/10.1016/j.ememar.2011.04.003

Wongbangpo, P. and Sharma, S.C., 2002. Stock market and macroeconomic fundamental dynamic interactions: ASEAN-5 countries. *Journal of Asian Economics*, *13*(1), pp.27-51. https://doi.org/10.1016/S1049-0078(01)00111-7

Wu, Y., 2000. Stock prices and exchange rates in VEC model—The case of Singapore in the 1990s. *Journal of Economics and Finance, 24*(3), pp.260–274. https://doi.org/ 10.1007/BF02752607

Yau, H.Y. and Nieh, C.C., 2009. Testing for cointegration with threshold effect between stock prices and exchange rates in Japan and Taiwan. *Japan and the World Economy, 21*(3), pp.292-300. https://doi.org/10.1016/j.japwor.2008.09.001

Yoshida, Y., 2009. Financial crisis, exchange rate and stock market integration. *Kyushu Sangyo University Discussion Paper*, *38*. https://www.kyusan-u.ac.jp/keizai-kiyo/dp38.pdf

Zafar, N., Urooj, S.F. and Durrani, T.K., 2018. Interest rate volatility and stock return and volatility. *European Journal of Economics, Finance and Administrative Sciences, 14*(1), pp.135-140.

Zhao, H., 2010. Dynamic relationship between exchange rate and stock price: Evidence from China. *Research in International Business and Finance, 24*(2), pp.103–112. https://doi.org/10.1016/j.ribaf.2009.09.001

Zhou, J., 2010. Testing for cointegration between house prices and economic fundamentals. *Real Estate Economics*, *38*(4), pp.599-632. https://doi.org/10.1111/j.1540-6229.2010.00273.x