7 COMPARATIVE ANALYSIS OF ASYMMETRIC EFFECTS OF MACROECONOMIC INDICATORS ON STOCK INDEXES IN PAKISTAN, INDIA, AND CHINA: A NONLINEAR AUTOREGRESSIVE DISTRIBUTED LAG (NARDL) APPROACH

Saghir Pervaiz GHAURI[1]

Rizwan Raheem AHMED[2,3]

Rohit RAMPAL[4,5]

Dalia STREIMIKIENE[6,*]

Hina QADIR[7]

Muhammad AQIL[8]

Justas STREIMIKIS[9]

Abstract

This study examines the impacts of macroeconomic indicators, such as exchange rate, interest rate, money supply, and inflation, on the stock index of Pakistan (PSX), India (BSE), and China (SSE). The researchers have taken monthly data from Jul 2001 to March 2023 and employed a Nonlinear Autoregressive Distributed Lag (NARDL) approach to investigate the asymmetric

[1] *Faculty of Management & Economics, Jinnah University for Women, 5C, Block-5, Nazimabad, Karachi, Pakistan; Email:saghir.ghauri@gmail.com (S. P. G.)*

[2] *Faculty of Management Sciences, Indus University, Block-17, Gulshan, Karachi, Pakistan; rizwanraheemahmed@gmail.com (R.R.A)*

[3] *School of Business and Economics, State University of New York Plattsburgh, New York 12901, USA*

[4] *School of Business and Economics, State University of New York Plattsburgh, New York 12901, USA; rramp001@plattsburgh.edu (R.R)*

[5] *Thapar Institute of Engineering and Technology, Patiala, Punjab, 147004, India*

[6] *Lithuanian Sports University, Institute of Sports Science and Innovations, Sporto str. 6, Kaunas, Lithuania. Email:dalia.streimikiene@lei.lt (D.S.)*

[7] *Faculty of Management Sciences, Indus University, Block-17, Gulshan, Karachi, Pakistan; hinabrohi@gmail.com (H.Q.)*

[8] *Faculty of Management Sciences, Shaheed Zulfikar Ali Bhutto Institute of Science & Technology, 100 Clifton, Block-5, Karachi – 75600, Sindh, Pakistan; muhammad.aqil@szabist.edu.pk (M.A.)*

[9] *Lithuanian Institute of Agrarian Economics, A. Vivulskio g. 4A-13, 03220 Vilnius, Lithuania; University of Economics and Human Science in Warsaw, Okopowa 59, 01-043 Warsaw, Poland, Email:jutas.streimikis@gmail.com (J.S.)*

effects of the variables. The Bound test result for the cointegration relationship demonstrated a long-run relationship (or cointegration) between LPSX, LSSE, and macroeconomic variables. However, no long-run relationship or Cointegration of LBSE and macroeconomic determinants exists. The findings of Asymmetric ARDL (NARDL) exhibited that the overall goodness of fit of LPSX, LBSE, and LSSE as the Adjusted R^2 is 99.51%, 99.3%, and 94.3%, respectively, which means the exchange rate, interest rate, money supply, and inflation variables determine the changes in LPSX, LBSE, and LSSE. The findings of CUSUM and CUSUMSQ tests suggested that the overall model is stable for LPSX, LBSE, and LSSE. The findings of the asymmetric short and long coefficients of the NARDL model demonstrated a long and short-run relationship between LPSX and LSSE and macroeconomic indicators. However, in the case of LBSE, there is only a short-run relationship between LBSE and macroeconomic indicators. The findings provide essential implications for policymakers in Pakistan, India, and China to manage and sustainably develop the stock markets successfully.

Keywords: *Macroeconomic indicators, Stock markets, Nonlinear ARDL, Asymmetric effects, cointegration.*

JEL Classification: *C32, E44, G15.*

1. Introduction

According to economic theory, several researchers have argued that net income traditionally exhibits the economic motion level, whereas stock returns should suggest anticipations for future organizational performance (Delgado et al., 2018; Emeka & Aham, 2016). Stock returns might be used as prominent signs of prospective economic movement if the stock prices redirect the causal essentials (Celis, 2017). Therefore, the association between macroeconomic variables and stock prices has been the topic of significant interest research by practitioners and scholars for the last several years (Abbasi et al., 2022; Tiwari et al., 2019). The previous literature demonstrated that macroeconomic indicators such as inflation rate, exchange rate, interest rate, industrial output, and money supply significantly influenced stock prices (Cheah et al., 2017; Tsai, 2012). According to Neifar (2021), financial models are scarce, confirming macroeconomic indicators' effect on developed, emerging, and developing stock markets.

The increasing trend of the stock market has been proven to be a great source of capital in an economy, ensuring its sustainable development (Sheikh et al., 2020a; Ahmed et al., 2013). Economic analysts and policymakers have increased concern about stock market development and its factors, mainly macroeconomic indicators (Salvatore, 2019). Most researchers and analysts are more concerned with finding the relationship between macroeconomic factors like inflation, exchange rate, money supply, and interest rate to stock markets (Simbolon & Purwanto, 2018; Tripathi & Seth, 2014). The relationship between these factors and the stock market is essential to understanding and making better economic policies and investment decisions (Xie et al., 2020; Wei et al., 2019). Fluctuations in these factors, like interest rates, exchange rates, inflation, and money supply, can change stock market returns (Ahmed & Mustafa, 2019; Giri & Joshi, 2017). For this purpose, several studies have incorporated the Nonlinear Autoregressive Distributed lag approach (NARDL) to find these macroeconomic factors' relation to the stock markets of emerging and developed economies (Liang et al., 2020; Chkir et al., 2020).

Many previous studies have examined the relationship between macroeconomic indicators and the stock market, which has driven the current study to conduct the research using the NARDL approach (Sheikh et al., 2020b; Al-hajj et al., 2018; Ahmed et al., 2018). Moreover, several studies have found an indirect relationship between the exchange rate and the stock market in the long and short run (Abbasi et al., 2022; Akbar et al., 2019; Tsai, 2012). Besides this, other studies by Al-hajj et al. (2018) and González et al. (2018) have examined the relationship of these factors with the stock market using the nonlinear model.

The macroeconomic factors are the reason behind financial markets' fluctuations, which ultimately influence the behavior and outcome of the stock market (Wen et al., 2022; Ahmad et al., 2018). This study has focused on the impact of macroeconomic factors like interest rate, exchange rate, inflation, and money supply on the stock market, especially in three South Asian countries: PSX of Pakistan, BSE of India, and SSE of China. This study has analyzed the stock market of these countries from the period July 2001 to March 2023, which is about two decades of analysis. This study also used the NARDL model to fill previous research gaps and assess the relationship of factors with PSX, BSE, and SSE stock markets. The study has incorporated a proper model, inclusive literature review, methodology, and statistical results.

Additionally, unit root tests, bound tests, diagnostic tests, and NARDL models are used as statistical tests to examine the short- and long-run relation of macroeconomic factors with the stock market (Ghauri et al., 2024; Liang et al., 2020). In this study, the researchers employed the NARDL model proposed by Shin et al. (2014); thus, researchers used the NARDL method to test the impact of these macroeconomic factors on the stock market. Hence, this study has used such new linear models for the analysis. The NARDL model gives a better and more subtle analysis of how direct and indirect changes in these macroeconomic variables can impact the stock index of respected countries (Allen & McAleer, 2021). Likewise, the study has used a bound test (Pesaran et al., 2001) for further analysis of the relation of macroeconomic factors with the stock market, especially the test, which can give the analysis of the long-run impact of interest rate, exchange rate, inflation, and money supply on PSX, BSE, and SSE. Moreover, the study has used the ECM-Error correction model based on NARDL for the short-run analysis of the macroeconomic variables (Chkir et al., 2020; Kumar, 2019) on the PSX (Pakistan stock index), BSE (India stock index), and SSE (China stock index).

From this analysis, the objective of this study is to analyze the impact of macroeconomic indicators such as exchange rate, interest rate, inflation rate, and money supply on the stock prices of the Pakistan Stock Market (PSX), Bombay Stock Market (BSE), and Shanghai stock market (SSE). The outcome of this study is beneficial for policymakers of China, India, and Pakistan in making appropriate policies and management concerning the growth of the stock market and the economy. This study provides insights into the relationship between macroeconomic factors and stock markets. Therefore, it contributes to in-depth knowledge and analysis of financial market fluctuations. It enables better economic governance by implementing appropriate policies.

The rest of the paper is comprised of six sections: 2) part two consists of literature review, 3) section three comprises of data and methodology, and 4) part four empirical findings of the study. However, 5) section five contains on discussions, 6) part six comprises of theoretical, managerial and policy implications, and finally, 7) section seven consists of conclusion.

2. Literature review

The stock market growth has become an essential source of capital and plays a role in sustainable economic development. Considering the importance of stock market development, policymakers extensively examine the relationship of macroeconomic determinants with the stock market (Ahmed et al., 2017; Aravind, 2017). Many researchers and studies have increased their interest in analyzing macroeconomic factors like interest rate, exchange rate, inflation, and money supply and their relationship with significant economies' stock markets, including the developed and emerging stock markets (Andriansyah & Messinis, 2019). As it is essential to understand the relation of these variables for making better policies and investment decisions in the country, the changes in factors like interest rate, exchange rate, inflation, and money supply significantly impact stock market returns.

Many studies and research analyses have been conducted to find the relationship between stock market returns and macroeconomic factors (Ahmed et al., 2013). In many studies, Arbitrage pricing theory (APT) is used even though this model assumes a constant risk-free rate of return. Apart from this, many studies have identified the adverse relation of interest rates with the stock market; as the interest rates are increased, the stock prices will decrease because profit expectations are high with increased risk (Hung, 2022). Thus, the investment declines eventually; inflation also hurts the stock market, and price increases discourage investors from investing (Chang et al., 2019).

A study of Vietnam's stock market suggested a significant short- and long-run impact of macroeconomic variables, including exchange rate, inflation, interest rate, and money supply, on Vietnam's stock market. The NARDL model of the study elaborated that money supply improves Vietnam's stock market. At the same time, interest rates and inflation hamper the stock market, and the exchange rate has an insignificant impact on its stock market (Phong et al., 2019). Another study was conducted in Kuwait to analyze the impact of the exchange rate on the stock prices of the economy. The NARDL models suggested an insignificant asymmetric exchange rate relation with Kuwait's stock market in the long run but not in the short run (Şahin & Mohamed, 2020).

Additionally, a study analyzed the long-term impact of macroeconomic variables on the Brazilian stock market. The study's NARDL approach analyzed the significant asymmetric relation of government debt, interest rate, and liquidity ratio with the stock market of Brazil (de Melo & Gomes, 2021). Syed (2021) and Sultana and Reddy (2017) carried out studies in the Indian economy to assess the symmetric and asymmetric impact of macroeconomic variables on India's stock market, BSE. The NARDL result showed the symmetric relation of the macroeconomic variables with the stock market and asymmetric relation in the short run.

Furthermore, Neifar (2023) analyzed with the application of the NARDL model and GFH the relation of macroeconomic variables like interest rate, consumer price, and exchange rate on the stock market of the UK and found that there is a relation between deflation and stock price while no result found with inflation. The exchange rate showed a significant negative relation with stock prices, while the interest rate has a significant negative relation with the stock market both in the short and long run (Neifar, 2023). In this regard, Saidi et al. (2021) found the impact of the exchange rate and its volatility on Indonesia's stock prices. They employed the ARDL and NARDL models, and the study concluded a symmetric relation between the exchange rate and the stock market in the short run. At the same time, its volatility lacks a symmetric relation. However, both variables have no symmetric and asymmetric impact on stock prices (Saidi et al., 2021).

This research analyzes macroeconomic factors on the stock market of PSX-Pakistan, BSE-India, and SSE-China by applying the NARDL model. This NARDL model provides better insight into how macroeconomic factors' positive and negative fluctuations affect the stock market. This research has analyzed the data of stock markets for approximately two decades, from July 2001 to March 2023, and has analyzed the monthly data along with short- and long-run changes in the market. This study used various statistical tools like a bound test, unit root test, diagnostic test, and NARDL model to analyze better the relationship between macroeconomic factors and the stock market and provide practical exposure to investors and policymakers about the stock market. Today, many studies have been conducted to see the relationship between macroeconomic factors and the stock market, especially studies that have analyzed the relationship between interest rate, exchange rate, inflation, and money supply with the stock market in the South Asian region, suggesting the variety and different relations between these factors (Sheikh et al., 2018; Mazuruse, 2014).

2.1 Exchange rate and stock market

Many researchers have analyzed the relationship between the exchange rate and stock market performance (Keswani & Wadhwa, 2018). Saidi et al. (2021) and Demir and Gozgor (2018) found that changes in the exchange rate can significantly impact the stock market, with positive and negative effects. Another study has suggested a negative relationship between the exchange rate and the stock market and highlighted the need to use other methodologies for analyzing the relationship (Ahmed et al., 2017).

2.2 Interest rate and stock market

Many studies have focused on finding the relationship between interest rate and stock market performance. Previous studies have analyzed the indirect relationship between interest rates and the stock market (Al-Naif, 2017). Stoica et al. (2014) and Filis (2010) have also explored the indirect relationship between interest rates and stock market performance using the NARDL model.

2.3 Money supply and stock market

Many studies have also analyzed the relationship between money supply and stock market performance. In this regard, studies have suggested that fluctuations in money supply can significantly impact stock market performance (Syed, 2021; Sheikh et al., 2020a; Ahmed et al., 2013). Additionally, Ahmed and Mustafa (2019) have analyzed the indirect relationship between the money supply and the stock market, highlighting that positive and negative changes in money supply led to different impacts on stock market performance.

2.4 Inflation and stock market

Many studies have examined the impact of inflation on stock market performance. Eldomiaty et al. (2020) and Fama (1981) have analyzed inflation as having an adverse impact on stock market performance. Other studies have analyzed the nonlinear impact of these factors to identify the direction of these variables (Zhang, 2021; Chauque & Rayappan, 2018).

2.5 The framework of the methodology-NARDL approach

Shin et al. (2014) introduced the NARDL-Nonlinear Autoregressive Distributed lag approach to identify the indirect relationship of the variables. Other studies, such as Demir and Gozgor (2018) and Omay and Kan (2014), have used the NARDL method to analyze the impact of macroeconomic variables on stock market performance. In the context of previous studies, this study helps to analyze the relationship between macroeconomic factors and the stock markets of Pakistan, India, and China. Implementing the NARDL method aids in a better understanding of indirect relations of the variables that are beyond the work of linear models. Through this test, this study aims to provide valuable information to policymakers and enable the stock market management of South Asia to reach its efficiency level.

3. Data and Methodology

3.1. Sources of data collection

This study has used the time series data from July 2001 to March 2023. The macroeconomic indicators affecting the stock market in this study are EXH, M2, PSX, CMR, and CPI, which are analyzed through natural logarithms. These variable data have been taken from SBP-State Bank of Pakistan monthly statistical reports. This study has analyzed the newest data series of all the variables to identify the short and long-run relation of the study's variables.

3.2. Methodology

3.2.1 Unit Root Test

In terms of better and more efficient econometric modeling, it is essential to check the stationarity of the data series. This study used two-unit root tests: ADF-Augmented Dickey-Fuller (1981) and

PP-Philips Perron (1988). ADF unit root test supports the distribution theory, which suggests that error terms are independent and have constant variance. The PP unit root test takes generalization of the ADF test, which enables mild assumptions in the distribution of the errors. The generalized equation form of the ADF test is as follows:

$$\Delta y_t = \alpha + \gamma y_{t-1} + \sum_{i=1}^{p} \beta_i \Delta y_{t-i} + \epsilon_t \tag{1}$$

3.2.2 Cointegration and NARDL model

A long-term relationship or stationary linear combination of the variables is necessary for the cointegration of the variables. There are many methods to examine the cointegration of the variables, like Engle-Granger's two-step method, and the studies mostly use Johansen. In this regard, when variables are integrated at I (1) or I (0), then two-period residual Engle-Granger and the maximum likelihood of Johansen may provide the biased outcome of the long-run relationship of the variables (Johansen, 1990). Regarding this issue, Pesaran and Shin (1999) suggested the ARDL-Autoregressive Distributed Lag method for enabling unbiased results regardless of whether the variables are integrated at I (1) or I (0) in the model. This ARDL model has two elements in the analysis of time series data; firstly, DL-Distributed Lag is related to independent variables, which affect the dependent variable. Secondly, it is another component of AR-Autoregressive lag related to a dependent variable, which can also affect its current value. For further detailing, simple case ARDL (1,1) is shown as:

$$Y_t = \alpha_o + \alpha_1 Y_{t-1} + \beta_o X_t + \beta_1 X_{t-1} + \epsilon_t \tag{2}$$

The ARDL (1,1) approach suggests that independent and dependent variables have a lag order of 1. In this regard, the regression coefficient of X in the run approach is as follows:

$k = \frac{\beta_o + \beta_1}{1-\alpha_1}$, ECM model based on ARDL(1,1) can be shown as:

$$\Delta Y_t = \alpha_o + (\alpha_1 - 1)(Y_{t-1} - kX_{t-1}) + \beta_o \Delta X_{t-1} + \epsilon_t \tag{3}$$

The general ARDL model for one dependent variable *Y* and a set of independent variables $X_1, X_2, X_3, \ldots\ldots, X_n$ is denoted as ARDL($p_0, p_1, p_2, \ldots\ldots\ldots p_n$), in which p_0 is the lag order of *Y*. The rest are the lag orders of $X_1, X_2, X_3, \ldots\ldots, X_n$.

ARDL($p_0, p_1, p_2, \ldots\ldots\ldots p_n$) is written as:

$$\Delta Y_t = \alpha + \sum_{i=1}^{p_o} (\beta_{o,i} Y_{t-i}) + \sum_{j=0}^{p_1} (\beta_{1,j} X_{1,t-j}) + \sum_{k=0}^{p_2} (\beta_{2,k} X_{2,t-k}) + \sum_{l=0}^{p_3} (\beta_{3,i} X_{t-l}) + \ldots \ldots \ldots + \sum_{m=0}^{p_n} (\beta_{n,m} X_{n,t-m}) + \epsilon_t \tag{4}$$

This ARDL method uses the bound test to analyze the cointegration among the variables or the long-run relation among the variables. The UECM-Unrestricted Error Correction model of ARDL is shown below:

$$\Delta Y_t = \alpha + \sum_{i=1}^{p_o} (\beta_{o,i} Y_{t-i}) + \sum_{j=0}^{p_1} (\beta_{1,j} X_{1,t-j}) + \sum_{k=0}^{p_2} (\beta_{2,k} X_{2,t-k}) + \sum_{l=0}^{p_3} (\beta_{3,i} X_{t-l}) + \ldots \ldots \ldots + \sum_{m=0}^{p_n} (\beta_{n,m} X_{n,t-m}) + \lambda_0 Y_{t-1} + \lambda_1 X_{1,t-1} + \lambda_3 X_{3,t-1} + \cdots \ldots + \lambda_n Y_{n,t-1} + \epsilon_t \tag{5}$$

This study has tested the hypothesis to explore the relation among the variables: the null hypothesis H_0: $\lambda_0 = \lambda_1 = \lambda_2 = \ldots = \lambda_n = 0$, which suggests that there is no cointegration among the variables, and the alternative hypothesis H_1: $\lambda_0 \neq \lambda_1 \neq \lambda_2 \neq \ldots \neq \lambda_n \neq 0$ suggests that there is cointegration among the variables. If the F statistic is more significant than the upper bound critical value of significance level, then the H_0 (Null hypothesis) is rejected. On the other hand, if the F statistic value is smaller than the lower bound critical value of the significance level, then the H_0 is not rejected. However, if the F statistic value lies between two critical values, no conclusion about the H_0 can be drawn. Apart from this, once the cointegration is examined, then other tests are conducted to ensure the stability and reliability of the ARDL method (Pesaran & Shin, 1999), like the Wald test, Ramsey's reset test taking the square of fitted values, LM-Lagrange multiplier test, CUSUM-Cumulative sum of recursive residuals and CUSUMSQ-Cumulative sum of the square of recursive residuals. This test identifies the serial correlation, heteroscedasticity, and residual stability. Afterward, short and long-run tests are examined when the stability and reliability of the ARDL model are confirmed. As discussed, ARDL methods provide the allowance of *I(1)* and *I(0);* besides this, the ARDL method provides other benefits compared to other methods. ARDL can also provide statistically significant results with a small sample size, while the Johansen (1990) method only provides significant results with a large sample size. Another benefit of ARDL is that it allows various lag orders, while other cointegration tests use the same lag orders of variables. The ARDL models examine only one equation of OLS methods, but other methods use many equations. Lastly, the ARDL method provides unbiased long-run results, suggesting that some variables depend on the model. Based on the above benefits of the ARDL method, this study examines the effect of independent variables, namely interest rate, exchange rate, inflation, and money supply, on the dependent variable, i.e., PSX through the NARDL model of Shin et al. (2014) under conditional error version is shown below:

$$\Delta lpsx_t = \alpha + \sum_{i=1}^{p_o}\left(\beta_{o,i}\Delta lpsx_{t-i}\right) + \sum_{j=0}^{p_1^+}\left(\beta_{1,j}^+\Delta lexh_{t-j}^+\right) + \sum_{j=0}^{p_1^-}\left(\beta_{1,j}^-\Delta lexh_{t-j}^-\right) + \sum_{k=0}^{p_2^+}\left(\beta_{2,k}^+\Delta lM2_{t-k}^+\right) + \sum_{k=0}^{p_2^-}\left(\beta_{2,k}^-\Delta lM2_{t-k}^-\right) + \sum_{l=0}^{p_3^+}\left(\beta_{3,l}^+\Delta lCMR_{t-l}^+\right) + \sum_{l=0}^{p_3^-}\left(\beta_{3,l}^-\Delta lCMR_{t-l}^-\right) + \sum_{m=0}^{p_4^+}\left(\beta_{4,m}^+\Delta lCPI_{t-m}^+\right) + \sum_{m=0}^{p_4^-}\left(\beta_{4,m}^-\Delta lCPI_{t-m}^-\right) + \lambda_0 lpsx_{t-1} + \lambda_1^+ lexh_{t-1}^+ + \lambda_1^- lexh_{t-1}^- + \lambda_2^+ lm2_{t-1}^+ + \lambda_2^- lm2_{t-1}^- + +\lambda_3^+ lcmr_{t-1}^+ + \lambda_3^- l_{imit-1}^- + \lambda_4^+ cpi_{t-1}^+ + \lambda_4^- lcpi_{t-1}^- + \epsilon_t \quad (6)$$

In equation (6), all variables, PSX, EXH, M2, CMR, and CPI, are transformed to natural logarithms, and "+" and "-"notations of the independent variables, respectively denote the partial sum of positive and negative changes: specifically (all following equations are named (7):

$$lexh_t^+ = \sum_{i=1}^{t}\Delta lexh_i^+ = \sum_{i=1}^{t}\max(\Delta lexh_i, 0)$$

$$lexh_t^- = \sum_{i=1}^{t}\Delta lexh_i^+ = \sum_{i=1}^{t}\min(\Delta lexh_i, 0)$$

$$lm2_t^+ = \sum_{k=1}^{t}\Delta lm2_k^+ = \sum_{k=1}^{t}\max(\Delta lm2_k, 0)$$

$$lm2_t^- = \sum_{k=1}^{t}\Delta lm2_k^- = \sum_{k=1}^{t}\min(\Delta lm2_k, 0)$$

$$lcmr_t^+ = \sum_{l=1}^{t}\Delta lcmr_l^+ = \sum_{l=1}^{t}\max(\Delta lcmr_l, 0)$$

$$lcmr_t^- = \sum_{l=1}^{t}\Delta lcmr_l^- = \sum_{l=1}^{t}\min(\Delta lcmr_l, 0)$$

$$lcpi_t^+ = \sum_{m=1}^{t}\Delta lcpi_m^+ = \sum_{m=1}^{t}\max(\Delta lcpi_m, 0)$$

$$lcpi_t^- = \sum_{m=1}^{t}\Delta lcpi_m^- = \sum_{m=1}^{t}\min(\Delta lcpi_m, 0) \quad (7)$$

Like the linear ARDL method, Shin et al. (2014) introduces the bound test for identifying asymmetrical cointegration in the long run. The null hypothesis states that the effect is symmetrical in the long run ($H_0: \lambda_0 = \lambda_1^+ = \lambda_1^- = \lambda_2^+ = \lambda_2^- = \lambda_3^+ = \lambda_3^- = \lambda_4^+ = \lambda_4^- = 0$). On the contrary, the alternative hypothesis states that the effect is asymmetrical in the long run ($H_a: \lambda_0 \neq \lambda_1^+ \neq \lambda_1^- \neq \lambda_2^+ \neq \lambda_2^- \neq \lambda_3^+ \neq \lambda_3^- \neq \lambda_4^+ \neq \lambda_4^- \neq 0$). The F statistic and critical values are also used to conclude H_0. If H_0 is rejected, an asymmetrical effect exists. When cointegration among the variables is found, the calculation method of NARDL is the same as ARDL (Pesaran et al., 2001). Additionally, the Wald test, LM TEST, Functional form, CUSUM, and CUSUMSQ tests are essential to confirm the stability and reliability of the NARDL model

4. Empirical findings

4.1 Descriptive statistics

This study uses monthly time series data from July 2001 to March 2023 for the Pakistan Stock Exchange (PSX), Bombay Stock Exchange (BSE), and Shanghai Stock Exchange (SSE). Table 1 shows the descriptive statistics of all the LPSX, LBSE, and LSSE variables. The study has 258 observations, and all variables are in natural log form. The variable variation is analyzed by standard deviation, which is minimal in the EXH (exchange rate) and LCPI (inflation rate) for PPSX and LBSE. Similarly, the coefficient of variation is minimal in the LM2 (Money supply) for both LPSX and LBSE; however, in LSSE, the standard deviation is minimal in LXH (exchange rate) and LCMR (interest rate), and the coefficient of variation is minimal in the LCMR (interest rate). Four of the five variables in LPSX have negative skewness, but only the LEXH (exchange rate) has a positive skewness. In the case of LBSE, three macroeconomic indicators have negative skewness, but the LEXH (exchange rate) and the LCMR (interest rate) have positive skewness. However, in the case of LSSE, two variables have negative skewness, but the other three variables, LEXH (exchange rate), LCPI (inflation rate), and LCMR (interest rate), have positive skewness. In the case of LPSX and LBSE, four variables have a kurtosis below 3, which is platykurtic, while LCMR (interest rate) has a kurtosis above 3, which is leptokurtic. In the case of LSSE, all five variables have kurtosis below 3, which is platykurtic. Furthermore, a p-value of Jarque-bera statistics shows that all variables are less than 0.05, which is a 95% confidence interval. This means the Null hypothesis (H_0) of normality is rejected; hence, all the variables are non-normal in LPSX, LBSE, and LSSE.

Table 1. Descriptive statistics

PSX (Pakistan Stock Exchange)					
	LPSX	LEXH	LM2	LCPI	LCMR
Mean	9.6269	4.5417	15.7644	4.2860	2.0379
Maximum	10.8315	5.4401	17.1456	5.2826	2.9972
Minimum	7.0330	4.0489	14.2332	3.4505	-0.3011
Std. Dev.	0.9753	0.3645	0.8264	0.5197	0.5331
Coefficient of variation	10.13	8.03	5.24	12.13	26.16
Skewness	-0.7104	0.3647	-0.1268	-0.1424	-1.8204
Kurtosis	2.7253	2.3739	1.8948	1.7955	7.2038
Jarque-Bera	22.51	9.93	13.82	16.47	332.48
Probability	0.0000	0.0070	0.0010	0.0003	0.0000

BSE (Bombay Stock Exchange)					
	LBSE	LEXH	LM2	LCPI	LCMR
Mean	9.7428	4.0119	4.6985	1.8461	31.7385
Maximum	11.0525	4.4124	5.3504	2.3273	32.9637
Minimum	7.9415	3.6731	4.0439	1.4469	30.1805
Std. Dev.	0.8244	0.2091	0.4207	0.1997	0.8403
Coefficient of variation	8.46	5.21	8.95	10.82	2.65
Skewness	-0.6227	0.2082	-0.1399	0.0964	-0.3216
Kurtosis	2.5487	1.5712	1.5465	3.2184	1.8097
Jarque-Bera	18.8609	23.8082	23.5539	0.9124	19.6776
Probability	0.0001	0.0000	0.0000	0.6337	0.0001
SSE (Shanghai Stock Exchange)					
	LSSE	LEXH	LM2	LCPI	LCMR
Mean	7.7968	2.0519	4.6970	29.6158	-1.1064
Maximum	8.6919	2.0606	4.9476	30.1400	1.5851
Minimum	6.9667	2.0468	4.4741	28.8497	-3.5066
Std. Dev.	0.3608	0.0038	0.1622	0.3394	1.5996
Coefficient of variation	4.63	0.18	3.45	1.15	-144.57
Skewness	-0.4435	0.7706	0.0914	-0.5065	0.3687
Kurtosis	2.4682	2.6331	1.4310	2.0676	1.5396
Jarque-Bera	11.4988	26.9805	26.8222	20.3776	28.7740
Probability	0.0032	0.0000	0.0000	0.0000	0.0000

Source: Authors' calculations

4.2 ADF and PP for stationarity tests

The essential and primary condition for the ARDL method is that no variable is stationary at the second difference. For this purpose, two tests, the Augmented Dickey-Fuller (ADF) and Phillipe-Perron (PP) tests, are used in this study. Table 2 shows the results of these tests, which show that LPSX (Pakistan stock exchange) and LM2 (Money supply) are stationary at levels. At the same time, other variables, LEXH (Exchange rate), LCPI (Inflation rate), and LCMR (Interest rate) are stationary at first difference. Table 2 further exhibited that the LBSE (India Stock Exchange) is stationary at levels. However, other variables, LEXH (Exchange rate), LM2 (Money supply), LCPI (Inflation rate), and LCMR (Interest rate), are stationary at 1st difference. Finally, the findings of Table 2 demonstrated that the LSSE (Shanghai Stock Exchange) is stationary at levels. However, other variables, LEXH (Exchange rate), LCPI (Inflation rate), LM2 (Money supply), and LCMR (Interest rate) are stationary at first difference. As the stationary levels are variants, that is, I (1) and I (0), and no variable is I (2) thus, the ARDL model is applied to examining the short and long-run relation of macroeconomic variables with LPSX, LBSE, and LSSE.

Table 2

The ADF and PP for stationarity tests

Variable	ADF test statistic				PP test statistic				Stationarity Decision	
	At level		at 1st Difference		At level		at 1st Difference			
	Value	P-value	Value	P-value	Value	P-value	Value	P-value	ADF	PP
PSX (Pakistan Stock Exchange)										
LPSX	-3.0052	0.0357			-3.0435	0.0323			I(0)	
LEXH	1.5652	0.9994	-7.5231	0.0000	1.7117	0.9997	-10.8065	0.0000	I(1)	I(1)
LM2	-2.1101	0.2410	-2.5379	0.1078	-2.9594	0.0402			I(0)	
LCPI	1.4422	0.9992	-13.4431	0.0000	1.2377	0.9984	-13.9013	0.0000	I(1)	I(1)
LCMR	-2.2923	0.1753	-23.1616	0.0000	-2.9490	0.0413			I(1)	I(0)
BSE (Bombay Stock Exchange)										
LBSE	-1.3059	0.6274	-18.5244	0.0000	-1.2627	0.6473	-18.5274	0.0000	I(1)	I(1)
LEXH	0.0463	0.9609	-11.9560	0.0000	0.2703	0.9764	-11.9161	0.0000	I(1)	I(1)
LM2	-3.7858	0.0035			-4.2077	0.0008			I(0)	I(0)
LCPI	-0.6814	0.8480	-2.6361	0.0871	-0.2581	0.9276	-11.6527	0.0000	I(1)	I(1)
LCMR	-1.5815	0.4906	-14.8317	0.0000	-1.6509	0.4551	-14.8330	0.0000	I(1)	I(1)
SSE (Shanghai Stock Exchange)										
LSSE	-2.1853	0.2123	-17.5237	0.0000	-2.1757	0.2158	-17.5328	0.0000	I(1)	I(1)
LEXH	-2.9190	0.0445			-3.0237	0.0340			I(0)	I(0)
LM2	-1.3277	0.6171	-16.0656	0.0000	-1.3300	0.6160	-16.0656	0.0000	I(1)	I(1)
LCPI	-0.0173	0.9552	-3.5892	0.0066	0.8209	0.9943	-19.1788	0.0000	I(1)	I(1)
LCMR	-2.3239	0.1652	-22.8756	0.0000	-2.8227	0.0565			I(1)	I(0)

Source: Authors' calculations

4.3 F-Bounds Test

Table 3, the Bound test result for the cointegration relationship demonstrated that the F-statistic (5.43) is greater than the upper bound (I (1)) critical values for all significance levels, which shows that there is a long-run relationship (or cointegration) between LPSX and other macroeconomic variables (determinants of LPSX). The findings of Table 3, the Bound test result for the cointegration relationship, demonstrate that the F-statistic (2.33) is lower than the lower bound (I (0)) at critical values for all significance levels: 1%, 5%, and 10%. This shows no long-run relationship or Cointegration of LBSE and macroeconomic determinants. In Table 3, the Bound test result for the cointegration relationship demonstrates that the F-statistic (3.06) is greater than the upper bound (I (1)) at critical values for all significance levels: 1%, 5%, and 10%. This shows a long-run relationship or Cointegration of LSSE and macroeconomic determinants.

Table 3. F-Bounds Test: Null Hypothesis - No levels of relationship

		PSX (Pakistan Stock Exchange)		
Test Statistic	Value	Significance	I(0)	I(1)
		Asymptotic: n=1000		
F-statistic	5.43	10%	1.85	2.85
K	8	5%	2.11	3.15
		2.5%	2.33	3.42
		1%	2.62	3.77
		BSE (Bombay Stock Exchange)		
Test Statistic	Value	Significance	I(0)	I(1)
		Asymptotic: n=1000		
F-statistic	2.33	10%	1.85	2.85
K	8	5%	2.11	3.15
		2.5%	2.33	3.42
		1%	2.62	3.77
Test Statistic	Value	Significance	I(0)	I(1)
		SSE (Shanghai Stock Exchange)		
		Asymptotic: n=1000		
F-statistic	3.06	10%	1.85	2.85
K	8	5%	2.11	3.15
		2.5%	2.33	3.42
		1%	2.62	3.77

Source: Authors' calculations

4.4 Asymmetric ARDL (NARDL) model estimation

This study has used AIC-Akaike information criteria with a maximum order of 4 lags. Moreover, based on this AIC, the NARDL model (2,0,0,0,0,0,1,2) is used for LPSX, which is shown in Table 4. The findings of Table 4 show the overall goodness of fit, as the Adjusted R^2 is high, 0.995, which means that the exchange rate, interest rate, money supply, and inflation variables determine 99.51% of the changes in LPSX. Based on this AIC, the NARDL model (2,1,1,3,2,0,1,2,0) is used for LBSE, as shown in Table 4. The findings show the overall goodness of fit, as Adjusted R^2 is high, 0.9926, which means that the exchange rate, interest rate, money, and inflation variables determine 99.3% of the changes in LBSE. Finally, based on this AIC, the NARDL model (4,3,0,0,0,1,0,0,0) is used for LSSE, shown in Table 4. The findings show overall goodness of fit, as the Adjusted R^2 is high, 0.9433, which means that the exchange rate, interest rate, money supply, and inflation variables determine 94.3% of the changes in LSSE. Thus, the results for LPSX, LBSE, and LSSE are satisfactory.

Table 4. Asymmetric ARDL (NARDL) model estimation

Dependent Variable: LPSX; Selected Model: ARDL (2, 0, 0, 0, 0, 0, 0, 1, 2)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.*
$LPSX_{t-1}$	0.9244	0.0628	14.7242	0.0000
$LPSX_{t-2}$	-0.1167	0.0610	-1.9119	0.0571
$LEXH_t^+$	-0.0287	0.0905	-0.3168	0.7517
$LEXH_t^-$	-0.3759	0.2156	-1.7435	0.0825
$LCPI_t^+$	-0.2965	0.1509	-1.9653	0.0505
$LCPI_t^-$	-0.5607	1.0359	-0.5413	0.5888
$LCMR_t^+$	-0.0164	0.0114	-1.4377	0.1518
$LCMR_t^-$	-0.0134	0.0135	-0.9951	0.3207
$LM2_t^+$	-0.4150	0.3356	-1.2363	0.2175
$LM2_{t-1}^+$	1.0378	0.3743	2.7723	0.0060
$LM2_t^-$	1.1523	0.9159	1.2580	0.2096
$LM2_{t-1}^-$	1.6893	0.9286	1.8192	0.0701
$LM2_{t-2}^-$	-1.0862	0.7611	-1.4271	0.1549
Constant	1.4443	0.2535	5.6970	0.0000
R^2 = 0.9951; Adjusted R^2 = 0.9949; Durbin-Watson statistics = 1.9215; S.E. of regression = 0.0675				
Diagnostics Tests	*A: Serial Correlation*		*ChiSq(2)= 0.67 (0.7140)*	
	B: Functional Form		*t-stat= 1.88 (0.0680)*	
	C: Normality		*Jarque Bera= 2605.80 (0.0000)*	
	D: Heteroscedasticity		*ChiSq(8)= 10.21 (0.2508)*	
Dependent Variable: LBSE; Selected Model: ARDL(2, 1, 1, 3, 2, 0, 1, 2, 0)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.*
$LBSE_{t-1}$	0.6788	0.0622	10.9080	0.0000
$LBSE_{t-2}$	0.1694	0.0619	2.7371	0.0067
$LEXH_t^+$	-2.1891	0.4581	-4.7789	0.0000
$LEXH_{t-1}^+$	1.9701	0.4549	4.3305	0.0000
$LEXH_t^-$	-1.6296	0.6576	-2.4781	0.0139
$LEXH_{t-1}^-$	1.3454	0.6371	2.1119	0.0358
$LCPI_t^+$	0.1164	0.9382	0.1241	0.9014
$LCPI_{t-1}^+$	-1.2536	1.4305	-0.8764	0.3817
$LCPI_{t-2}^+$	3.7093	1.4196	2.6130	0.0096
$LCPI_{t-3}^+$	-2.9026	0.9090	-3.1932	0.0016
$LCPI_t^-$	0.2246	2.2652	0.0991	0.9211

$LCPI_{t-1}^{-}$	0.6110	3.1206	0.1958	0.8449
$LCPI_{t-2}^{-}$	-3.1822	2.1788	-1.4605	0.1455
$LCMR_{t}^{+}$	0.1040	0.0674	1.5442	0.1239
$LCMR_{t}^{-}$	0.4613	0.2775	1.6622	0.0978
$LCMR_{t-1}^{-}$	-0.4477	0.2822	-1.5861	0.1141
$LM2_{t}^{+}$	-0.3622	0.4629	-0.7824	0.4348
$LM2_{t-1}^{+}$	1.1818	0.5488	2.1534	0.0323
$LM2_{t-2}^{+}$	-0.6490	0.4729	-1.3724	0.1713
$LM2_{t}^{-}$	0.4611	0.4275	1.0787	0.2818
Constant	1.2060	0.2909	4.1465	0.0000

R^2 = 0.9926; Adjusted R^2 = 0.9919; Durbin-Watson statistics = 1.9894; S.E. of regression = 0.0721

Diagnostics Tests	*A: Serial Correlation*	*ChiSq(2)= 6.20 (0.7339)*
	B: Functional Form	*t-stat= 1.82 (0.0697)*
	C: Normality	*Jarque Bera= 2484.85 (0.0000)*
	D: Heteroscedasticity	*ChiSq(20)= 40.2679 (0.0046)*

Dependent Variable: LSSE; Selected Model: ARDL (4, 3, 0, 0, 0, 1, 0, 0, 0)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
$LSSE_{t-1}$	0.7639	0.0627	12.1763	0.0000
$LSSE_{t-2}$	0.0383	0.0787	0.4870	0.6267
$LSSE_{t-3}$	0.1756	0.0778	2.2553	0.0250
$LSSE_{t-4}$	-0.1084	0.0605	-1.7926	0.0743
$LEXH_{t}^{+}$	-25.2589	8.4913	-2.9747	0.0032
$LEXH_{t-1}^{+}$	14.5523	12.7749	1.1391	0.2558
$LEXH_{t-2}^{+}$	31.1148	12.7028	2.4495	0.0150
$LEXH_{t-3}^{+}$	-28.5344	8.6925	-3.2826	0.0012
$LEXH_{t}^{-}$	3.2335	2.8170	1.1478	0.2522
$LCPI_{t}^{+}$	0.2921	0.3050	0.9578	0.3391
$LCPI_{t}^{-}$	0.2624	0.5107	0.5138	0.6079
$LM2_{t}^{+}$	2.2622	0.6725	3.3637	0.0009
$LM2_{t-1}^{+}$	-2.0064	0.6698	-2.9954	0.0030
$LM2_{t}^{-}$	-0.0967	0.0353	-2.7353	0.0067
$LCMR_{t}^{+}$	0.0020	0.0054	0.3635	0.7166
$LCMR_{t}^{-}$	-0.0085	0.0070	-1.2123	0.2266
Constant	0.9181	0.2170	4.2319	0.0000

R2 = 0.9433; Adjusted R2 = 0.9949; Durbin-Watson statistics = 2.0651; S.E. of regression = 0.0890

Diagnostics Tests	*A: Serial Correlation*	*ChiSq(2)= 3.60 (0.1653)*
	B: Functional Form	*t-stat= 1.69 (0.0916)*
	C: Normality	*Jarque Bera= 1002.83 (0.0000)*
	D: Heteroscedasticity	*ChiSq(8)= 85.92 (0.0000)*

Note: The final equation sample is more significant than the selection sample
**Note: P-values and subsequent tests do not account for model selection.*
A: Breusch-Godfrey Serial Correlation LM Test
B: Ramsey RESET Test
C: Based on Jarque Bera's test statistics
D: Breusch-Pagan-Godfrey Heteroskedasticity Test

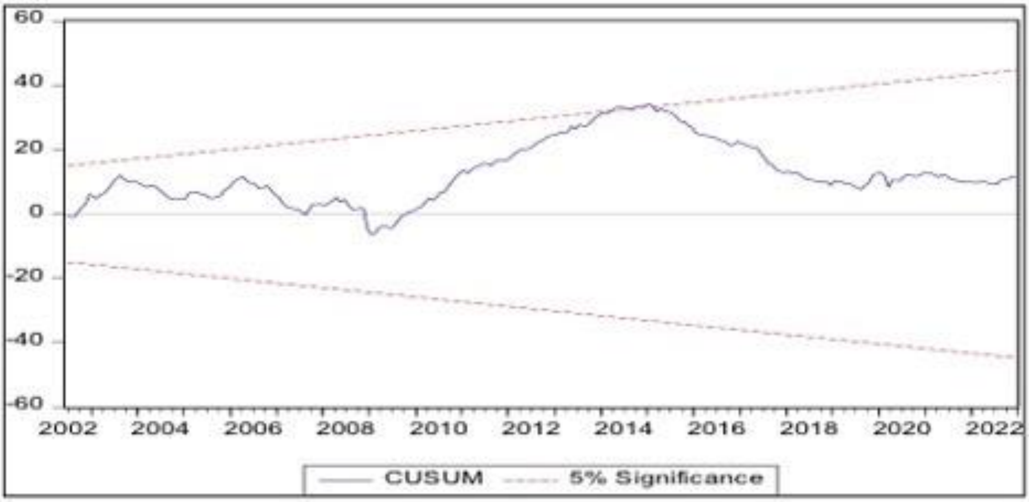
Source: Authors' calculations

4.5 CUSUM and CUSUMSQ stability test

Figure 1(a) and Figure 1(b) show the stability tests by CUSUM and CUSUMSQ for the PSX (Pakistan Stock Exchange). The result suggests that, overall, the model is stable; however, from 2009 to 2014, data in the CUSUMSQ graph shows that there is somehow instability.

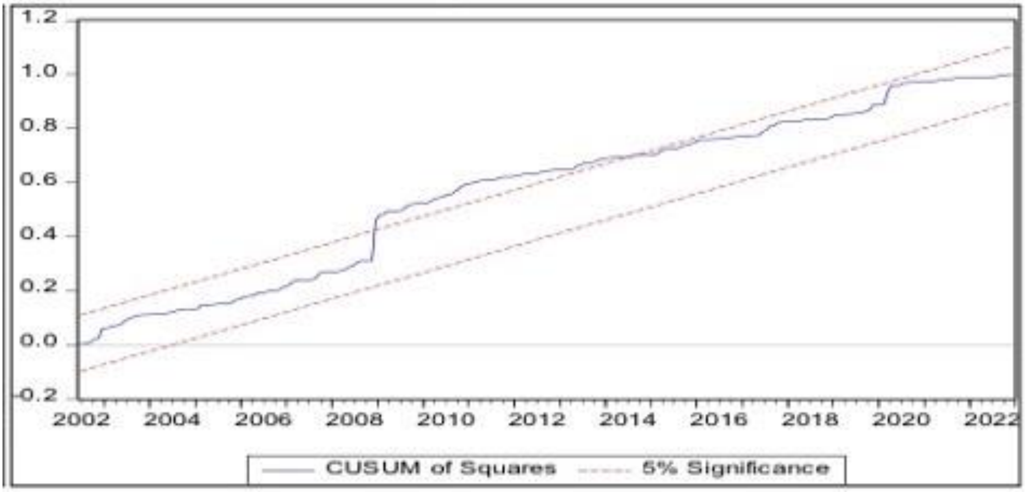
Figures 2(a) and Figure 2(b) show the stability tests CUSUM and CUSUMSQ for the BSE (India). The figures show that the overall model is stable except for the 2015 to 2018 period in the CUSUMSQ graph.

Figure 1(a). Cumulative Sum of Recursive Residuals (CUSUM)



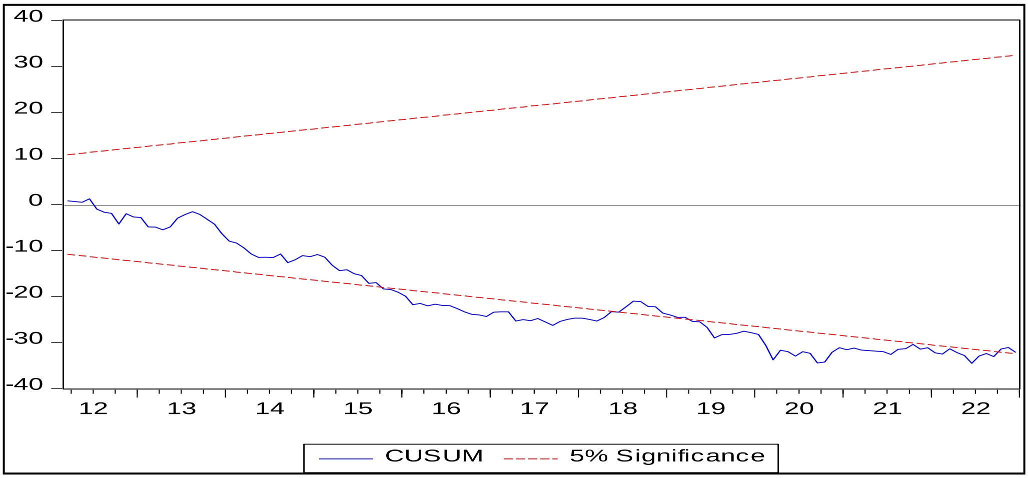
Source: Authors' calculations

Figure 1(b): Cumulative Sum of Squares of Recursive Residuals (CUSUMSQ)



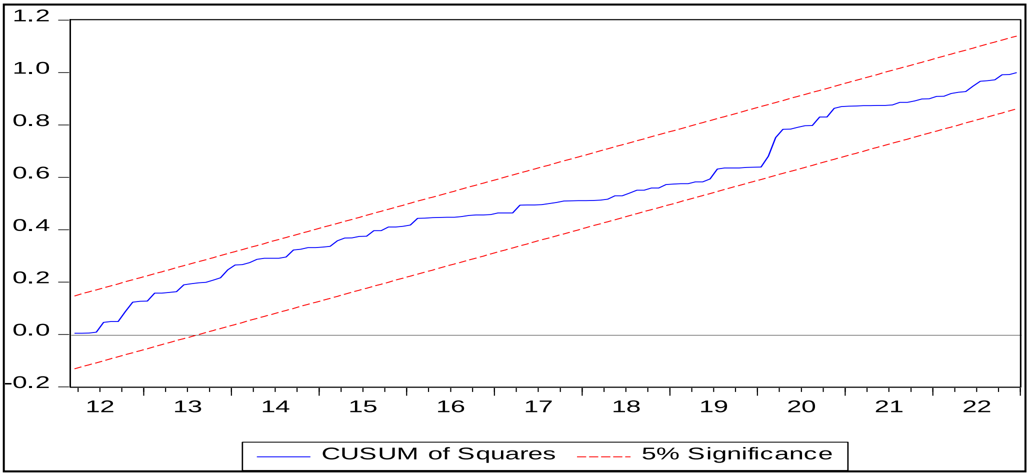
Source: Authors' calculations

Figure 2(a). Cumulative Sum of Recursive Residuals (CUSUM)



Source: Authors' calculations

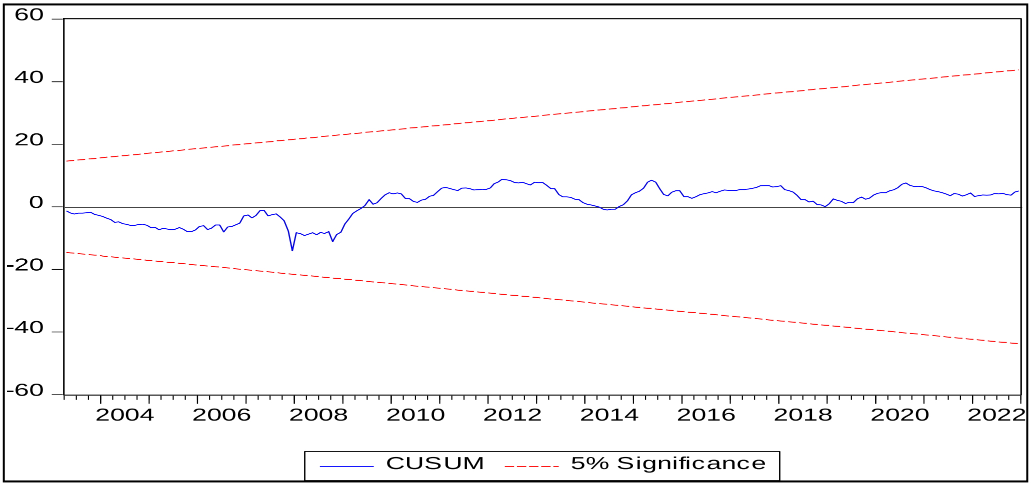
Figure 2(b). Cumulative Sum of Squares of Recursive Residuals (CUSUMSQ)



Source: Authors' calculations

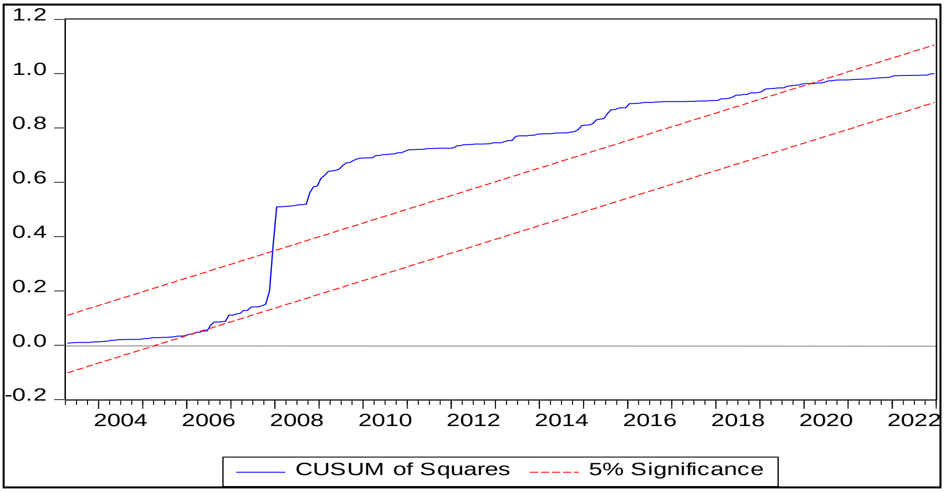
Figures 3(a) and Figure 3(b) show the stability tests CUSUM and CUSUMSQ for the SSE (Shanghai stock exchange). Figure 3(a) and Figure 3(b) show that the overall model is stable for the CUSUM test except for the 2008 to 2018 period in the CUSUMSQ graph, which is unstable.

Figure 3(a). Figure 3(a): Cumulative Sum of Recursive Residuals (CUSUM)



Source: Authors' calculations

Figure 3(b): Cumulative Sum of Squares of Recursive Residuals (CUSUMSQ)



Source: Authors' calculations

4.6 Asymmetric short-run and long-run coefficient

Table 5 shows the result of the asymmetric short and long coefficients of the NARDL model. It shows that the Error correction model (EC_{t-1}) is negative and significant at a 1% confidence interval, meaning long-run cointegration exists between the determinants and LPSX. It also shows a speed of adjustment from the short run towards the long run. Table 5 further shows the result of the asymmetric short-run coefficients of the NARDL model only because long-run cointegration does not exist for India's stock market (LBSE). The results show that the Error correction model (EC_{t-1}) is negative and significant at a 1% confidence interval, which means there is short-run cointegration between the determinants and LBSE, and the Bond test does not show the long-run relation of the variables. Table 5 also exhibits the result of the NARDL model's asymmetric short-run and long-run coefficients. The findings show that the Error correction model (EC_{t-1}) is negative and significant at a 1% confidence interval. This means there is long-run cointegration between the determinants and LSSE, and the speed of adjustment is shown from short to long-run.

Table 5. Asymmetric short-run and long-run coefficient

Asymmetries long-run coefficients (Dependent Variable: $LPSX_t$)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
$LEXH_t^+$	-0.1491	0.4705	-0.3168	0.7517
$LEXH_t^-$	-1.9552*	1.0511	-1.8602	0.0641
$LCPI_t^+$	-1.5425**	0.6890	-2.2381	0.0261
$LCPI_t^-$	-2.9163	5.3826	-0.5418	0.5885
$LCMR_t^+$	-0.0852	0.0608	-1.4006	0.1626
$LCMR_t^-$	-0.0697	0.0709	-0.9826	0.3268
$LM2_t^+$	3.2393***	0.7644	4.2377	0.0000
$LM2_t^-$	9.1301***	1.6835	5.4235	0.0000
Constant	7.5118***	0.1271	59.0926	0.0000

Asymmetries short-run coefficients (Dependent Variable: $LPSX_t$)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
$DLPSX_{t-1}$	0.1167**	0.0565	2.0661	0.0399
$DLM2_t^+$	-0.4150**	0.2256	-1.8391	0.0671
$DLM2_t^-$	1.1523*	0.6874	1.6762	0.0950
$DLM2_{t-1}^-$	1.0862*	0.6155	1.7648	0.0789
EC_{t-1}	-0.1923***	0.0256	-7.5017	0.0000
Asymmetries Short-run coefficients (Dependent Variable: $LBSE_t$)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
$DLBSE_{t-1}$	-0.1694***	0.0619	-2.7371	0.0067
$DLEXH_t^+$	-2.1891***	0.4581	-4.7789	0.0000
$DLEXH_t^-$	-1.6296**	0.6576	-2.4781	0.0139
$DLCPI_t^+$	0.1164	0.9382	0.1241	0.9014
$DLCPI_{t-1}^+$	-0.8067	0.9542	-0.8454	0.3987
$DLCPI_{t-2}^+$	2.9026***	0.9090	3.1932	0.0016
$DLCPI_t^-$	0.2246	2.2652	0.0991	0.9211
$DLCPI_{t-1}^-$	3.1822	2.1788	1.4605	0.1455
$DCMR_t^-$	0.4613*	0.2775	1.6622	0.0978
$DLM2_t^+$	-0.3622	0.4629	-0.7824	0.4348
$DLM2_{t-1}^-$	0.6490	0.4729	1.3724	0.1713
EC_{t-1}	-0.1519***	0.0309	-4.9202	0.0000
Asymmetries long-run coefficients (Dependent Variable: $LSSE_t$)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
$LSSE_{t-1}$	-0.1307***	0.0307	-4.2618	0.0000
$LEXH_{t-1}^+$	-8.1262**	3.2158	-2.5269	0.0122
$LEXH_t^-$	3.2335	2.8170	1.1478	0.2522
$LCPI_t^+$	0.2921	0.3050	0.9578	0.3391
$LCPI_t^-$	0.2624	0.5107	0.5138	0.6079
$LM2_{t-1}^+$	0.2558	0.2209	1.1580	0.2480
$LM2_t^-$	-0.0967***	0.0353	-2.7353	0.0067
$LCMR_{t+}$	0.0020	0.0054	0.3635	0.7166
$LCMR_t^-$	-0.0085	0.0070	-1.2123	0.2266
Constant	0.9181***	0.2170	4.2319	0.0000
Asymmetries short-run coefficients (Dependent Variable: $LPSX_t$)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
$DLSSE_{t-1}$	-0.1054*	0.0586	-1.7998	0.0732
$DLSSE_{t-2}$	-0.0671	0.0586	-1.1458	0.2530
$DLSSE_{t-3}$	0.1084*	0.0574	1.8895	0.0600
$DLEXH_t^+$	-25.2589***	7.3287	-3.4465	0.0007
$DLEXH_{t-1}^+$	-2.5804	8.0360	-0.3211	0.7484
$DLEXH_{t-2}^+$	28.5344***	7.6941	3.7086	0.0003
$DLM2_t^+$	2.2622***	0.5211	4.3409	0.0000
EC_{t-1}	-0.1307***	0.0232	-5.6330	0.0000

*Note: The asterisks ***, **, and * indicate the 1%, 5%, and 10% significance levels, respectively.*

5. Discussion

This study's results show a significant long-run impact of macroeconomic variables on PSX. Moreover, the NARDL-Nonlinear autoregressive distributive lag method test shows a significant asymmetric relationship between interest rate, exchange rate, money supply, and inflation with PSX in the long run. Additionally, money supply has shown positive and negative impacts on PSX, but its positive impact is more significant than the negative impact from the result. However, macroeconomic variables like interest rates have shown statistically insignificant relations in the long run. The exchange rate and inflation have shown an asymmetric relation with PSX, which indicates the need for efficient policymaking to manage the stock market. In terms of the short run, the result shows significant lagged values of PSX and money supply and its asymmetric impact on the stock market. Thus, policymakers and investors must be aware of these short-run changes in the stock market because this suggests the prompt response of PSX towards macroeconomic indicators. This study suggests adopting flexible strategies for analyzing and coping with the short-run changes in Pakistan's stock market.

The results of the Bound test of this study show that BSE does not have a long-run relationship with macroeconomic determinants. However, in short-run analysis, the NARDL model suggests a significant asymmetric impact of interest rates, exchange rates, and inflation on BSE. Moreover, from them, inflation is a more significant determinant of BSE, with overall positive numbers influencing the BSE. Additionally, this study's asymmetric relation of BSE and inflation matches that of previous studies, which suggests that inflation is a great challenge to the stability and efficiency of India's stock market. Thus, adopting effective policies and strategies is essential to boost investors' confidence and ensure macroeconomic indicators' stability. In this case, India's Reserve Bank can play an essential role in managing the economy, the interest rate, and the money economy, focusing on development strategies and escaping from sudden shocks of macroeconomic variables that may affect the stock market and economy.

The SSE also shows a significant long-term relationship with macroeconomic determinants, which is revealed from the bound test of this study. The NARDL model of this study further shows a significant asymmetric relation of exchange rate, broad money, with SSE in the long run. Interest rate and inflation show an insignificant relation with SSE. This study's short-run analysis shows the significance of broad money and lagged values of SSE, which suggest their essential role in changing the stock market's stability. Together with this, overall positive changes in the exchange rate and its lagged values show its importance in short-run changes in the market. Thus, from these results, investors and policymakers must review short and long-run changes in the market before making decisions on investment and implementing strategies in the market.

6. Theoretical, managerial and policy implications

6.1. Theoretical implications

This study contributes to the theoretical know-how of the relationship of macroeconomic determinants with the stock markets of Pakistan, India, and China. The use of the NARDL model in this study to identify the asymmetric relation of the variables further contributes to understanding such market changes, which is not shown from linear approaches. Moreover, this study's short-run and long-run analysis on stock markets enables us to get a detailed picture of the variables. This research has focused on time series analysis of the variables to identify the historic nature of the variables and their relationship with stock markets. Additionally, this study has analyzed the different characteristics of each stock market of selected countries. BSE-India's stock market shows no long-run relationship with macroeconomic variables, and different results of macroeconomic determinants in the stock markets of Pakistan, India, and China suggest the drastic need for applying proper strategies and policy decisions.

6.2. Managerial implications

The study has identified asymmetric influence on stock markets; this has increased the focus of investors and managers to adopt flexible strategies to mitigate the risk and to analyze the positive and negative changes of the variables. Looking at the different impacts of macroeconomic variables on stock markets allows managers to make analytical decisions when selecting a portfolio of securities in several countries. Moreover, the short-run changes in the stock market of this study enable the tactical strategies to cope with sudden changes in the market. In this regard, managers and investors should be very proactive in changing their strategies concerning sudden short-run changes in the market influenced by macroeconomic variables. Moreover, in terms of investment in different countries, managers and investors must develop strategies based on each country's unique characteristics, as shown in this study. Thus, understanding macroeconomic factors' short- and long-term impacts enables one to make effective investment decisions.

6.3. Policy implications

This study focuses on the importance of macroeconomic stability for stock market growth. In this regard, policymakers must maintain stable inflation, exchange, and interest rates and manage the money supply to achieve stability in the stock market. This study shows the different influences of interest rates in each of the three countries' stock markets, which suggests that policymakers make efficient monetary policies in their economies. Central banks and regulators of each country should adopt strategies concerning each country's economic situation to avoid sudden changes in the stock market. Furthermore, this study has found that inflation as a macroeconomic variable significantly impacts India's stock market. The policymakers of this economy must adopt effective strategies to cope with the asymmetric influence of inflation, as managing the inflation in the country boosts the confidence of investors and enables the country's economic growth. The study results suggest that investors and managers must be aware of and knowledgeable about the different impacts of macroeconomic variables. Such awareness will enable the investors to make proper decisions and strategies that align with economic conditions and mitigate the uncertainty related to the asymmetric impacts of the macroeconomic variables.

6.4. Limitations and potential areas of future studies

The study's limitation is observed from the period of data from July 2001 to March 2023. This period has current market situations that influence previous data and the stock market. Therefore, this study has a limited amount of current data, which limits the study's analysis concerning current market situations. Additionally, macroeconomic variables, like geopolitical factors and global economic changes, may impact the stock market. However, this study has only focused on exchange rates, interest rates, inflation, and money supply, which may limit the analysis of this study. Furthermore, the use of the NARDL model in this study is mainly for assessing the asymmetries, but it poses some complexity; its outcome is somehow sensitive to parameters, and the misspecification of the model may raise the question of a strong result or outcome. Thus, future studies may use Machine learning and Time-varying parameter models to better analyze the relationship between macroeconomic factors and the stock market. This study assumes stationarity in the data but may not be seen in all cases. Thus, the non-stationarity of data may impact the accuracy of results; for this purpose, future studies can use other methods to address this issue. Lastly, the results of this study are specific to three stock markets: PSX, BSE, and SSE, which may not be taken as a generalized result for other stock markets. Every market has unique characteristics and economic situations, so future research must be carefully individual while studying other markets. Additionally, future studies can incorporate investors' behavioral factors and sentiments to understand more about stock market fluctuations.

7. Conclusion

This study examines the impacts of macroeconomic indicators, such as exchange rate, interest rate, money supply, and inflation, on the stock index of Pakistan (PSX), India (BSE), and China (SSE). In the stock market of Pakistan, which is PSX, observed from the bound test and coefficient of error correction term, the macroeconomic variables have a significant long-run relationship with PSX. The NARDL model has examined the significant asymmetrical impact of exchange rate, inflation, and money supply on PSX in the long and short run. In this analysis, money supply shows a positive and negative impact on PSX, but its positive impact exceeds the negative impact. Policymakers must implement flexible strategies to manage the stock market because of the asymmetrical impacts of inflation and exchange rates on PSX. In terms of short-run analysis, this study has observed a significant lagged value of PSX, money supply, and asymmetric effects; this suggests a quick response to changing market conditions. These observations are practical exposure to managers and investors, enabling them to adapt their strategies to short-run changes in Pakistan's stock market. On the other hand, BSE does not show a long-run relation with macroeconomic variables but short-run relations. The NARDL model shows that inflation, exchange rate, and interest rate have a significant asymmetrical impact on BSE in short-run analysis. Inflation is a more important factor affecting the BSE, which previous studies have also analyzed. This asymmetric relation suggests that changes in inflation lead to adverse effects on BSE; this has raised concern about managing this macroeconomic variable to attain a stable stock market and investor confidence. Moreover, the results of BSE suggest that the Reserve Bank of India must implement flexible policies to manage the money supply and interest rate concerning market conditions and development strategies. Furthermore, this study has analyzed the fact that SSE has a long-run relation with macroeconomic variables like PSX results. The NARDL model of SSE shows the significant asymmetric relation of the exchange rate and money supply with SSE in the long run. Interest rate and inflation show an insignificant relation with SSE. The short-run analysis of this study shows the significance of the money supply and lagged values of SSE, which suggests their essential role in changing the stock market's stability. The overall positive changes in the exchange rate and its lagged values show its importance in short-run changes in the market. Thus, from these results, investors and policymakers must review short and long-run changes in the market before making decisions on investment and implementing strategies in the market. The results of this study have increased the concern of policymakers, investors, and researchers over the short and long-run impact of macroeconomic variables on the stock market. The study focuses on implementing proper strategies, whether in managing the money supply, which affects Pakistan's stock market, addressing the effect of inflation in India's stock market, or analyzing the sudden changes in the Chinese stock market.

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