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Symmetric and Asymmetric Effects of Exchange Rate Changes on Stock Prices in Fragile Five Economies: Analysis of the Global Crisis and Pandemic Period

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Abstract This study examined the symmetric and asymmetric effects of exchange rate changes on stock prices in the economies of India, Indonesia, Brazil, South Africa, and Turkey, collectively known as the "Fragile Five" due to their similar economic dynamics in light of the global financial crisis and pandemic period. The study uses monthly data from July 2000 to July 2022, and panel autoregressive distributive lag and panel nonlinear autoregressive distributive lag models to investigate the effects of exchange rate changes on stock prices in the Fragile Five economies. Prior to the global financial crisis, exchange rate changes have both long- and short-term asymmetric effects on stock prices in the Fragile Five economies. However, after the global financial crisis, exchange rate changes have both short- and long-term asymmetric and symmetric effects. Similarly, exchange rate changes also have asymmetric effects on stock prices during the COVID-19 period.

Keywords: Exchange rates, stock prices, panel ARDL, nonlinear panel ARDL

JEL Classifications: B22, C33, E44, F31

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I. Introduction

In the current financial literature, various studies on the relationship between exchange rate fluctuations and macroeconomic variables (e.g., trade balances, real oil prices, interest rate differentials, renewable energy, and inflation rates) have been conducted (Tsen, 2011; Ouyang et al., 2016; Deka and Dube, 2021; Kilian and Zhou, 2022). However, due to stock markets are the most sensitive sector of the economy and the easiest way for the openness of a country to be felt by the rest of the world, a certain emphasis has been placed on the market analyses conducted (Franck and Young, 1972; Aggarwal, 1981; Soenen and Henniger, 1988; Ma and Kao, 1990; Abdalla and Murinde, 1997; Yu, 1997; Ajayi et al., 1998; Granger et al., 2000;

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Muhammad and Rasheed, 2002; Litsios, 2013). Many macroeconomic variables may have an impact on stock markets, and exchange rate changes are one of these variables. Exchange rate fluctuations may affect firms operating in the stock market differently depending on whether they are export-oriented or use intensive imported input within the flow-oriented exchange rate model (traditional approach). Therefore, exchange rate changes may have positive and negative effects (Bahmani-Oskooee and Saha, 2016). In this context, especially in the flow-oriented exchange rate model (traditional approach) that addresses the trade balance between countries, any currency or exchange rate changes can affect a firm's competitiveness. It is also stated that this situation impacts the company's income, funding costs, and then the stock price. Changes in local product prices, which significantly impact international competitiveness and the current account balance, also substantially impact multinational firms' production levels, stock prices, and profitability levels. In addition, forming a positive expectation for future cash flows of firms with a significant competitive advantage may directly impact the stock price. According to the relevant model, the direction of the relationship is now from the exchange rate to the stock price, but the effect varies depending on whether the economy is import- or export-oriented (Dornbusch and Fischer, 1980). In the last 20 years, developing countries have integrated into international trade and investment through rapid economic expansion. Nonetheless, they have become more susceptible to global and local shocks and unpredictability. The global financial crisis of 2008-2009 increased exchange rate uncertainty and volatility. Caporale et al. (2014) stated that the dependence between stock markets and exchange rates increased during the crisis and that opportunities for asset diversification were limited during this period. Because of the unconventional monetary policies implemented in the aftermath of the global financial crisis, risk appetite initially favored developing countries, resulting in a positive differentiation between stock markets and local currencies (Hoque and Zaidi, 2020). However, after Federal Reserve Chairman Ben Bernanke announced in 2013 that he would reduce the asset program, volatility in the stock and currency markets of developing countries increased. The stock and foreign exchange markets of the fragile five countries (Turkey, India, Brazil, Indonesia, and South Africa) have been affected more than those of other developing nations (Yildirim, 2016). "Fragile five" is a term coined by a Morgan Stanley analyst to represent five developing countries that have become increasingly dependent on foreign investments. Moreover, these countries were sensitive to FED policy changes even before the global financial crisis (Chadwick, 2019). The second important development was the impact of the COVID-19 pandemic that emerged in 2019. The pandemic increased capital outflows in these countries, and its effects on the financial markets were quickly apparent. As a result of the sluggishness of globalization, the stock and currency markets were affected by expectations of a trade contraction and an economic shrinkage (Janus, 2021; Kusumahadi and Permana, 2021). In this study, the symmetric and asymmetric effects of exchange rate changes on stock prices are examined as a whole in the economies of developing countries, which are also known as the "fragile five," namely Turkey, India, Brazil, Indonesia, and South Africa, in 2013. Several studies on this issue exist in the related literature. However, unlike other studies, this study first examines the effect of exchange rate changes on stock prices using linear and nonlinear models. Second, the fragile five economies, which are more sensitive to global shocks than other developing countries, are examined using the panel autoregressive distributive lag (Panel ARDL) and panel nonlinear autoregressive distributive lag (Panel NARDL) models instead of individually for each country. Taking into account the effects of global shocks (the global financial crisis and pandemic), the long-term responses of stock markets to exchange rate shocks are determined by applying various global policy approaches. Thus, we can anticipate the responses of firms and investors to exchange rate shocks in the event of similar global developments in the future.

II. Literature Review

There is considerable literature on the relationship between exchange rates and stock prices, both with two variables and with multivariate.[1)] Considering the previous studies, the present study is limited to the fragile five economies as a whole because no studies have considered these specific countries regarding the effect of exchange rates on stock prices.

Lean et al. (2011) examined the interactions between exchange rates and stock prices using weekly data from 1990 to 2005 for Asian countries, allowing for structural breaks. They could not find a long-term effect on the Indonesian economy. Meanwhile, Lin (2012) estimated long-term cointegration and short-term causality relationships using monthly data from 1986 to 2010 and the ARDL method, taking into account crisis periods for developing Asian countries like India and Indonesia. They found that during times of crisis, the common movement between exchange rates and stock prices strengthened. Yang et al. (2014) conducted another study on the relationship between stock returns and exchange rates using daily data from 1997 to 2010. The Granger causality test carried out in quantiles showed heterogeneous causal effects between exchange rates and stock prices in different quantiles and periods in India and Indonesia during the Asian financial crisis. Moreover, the relationship between the stock and currency markets is negative.

According to Sultana and Reddy (2017), a significant correlation exists between the exchange rate and the Indian stock market among the macroeconomic variables affecting the Indian stock market. The long-term relationship between these variables was investigated from 2006 to 2016. Likewise, Kumar (2019) found bidirectional linear causality between exchange rates and stock

1) For a detailed literature review on the subject, refer to the study titled "On the relation between stock prices and exchange rates: a review article" by Bahmani-Oskooee, M., & Saha, S. (2015) in the Journal of Economic Studies, 42(4), 707–732.

markets in the Indian economy, and unidirectional but nonlinear causality from exchange rates to stock markets during 1994-2015. In another study that examined asymmetric relationships in the Indian economy, Ajaz et al. (2017) analyzed the asymmetric effects of interest rate and exchange rate changes on stock prices before and after the global financial crisis. They found that stock prices responded asymmetrically to changes in interest rates and exchange rates across the entire sample and before the global financial crisis, but no asymmetric response was observed after the crisis.

Adjasi et al. (2011) conducted a study examining the symmetric relationship between stock prices and exchange rate movements in seven African countries and observed that exchange rate shocks impacted stock prices in South Africa and that prices increased. Banda et al. (2019) conducted a similar study that did not take asymmetric effects into account, and contrary to expectations, exchange rate shocks positively affected stock prices. Using quarterly data for 1995-2017, they found a positive relationship between inflation and stock prices and a negative relationship with interest rates, but no relationship between gross domestic product (GDP) and stock prices. Chkili and Nguyen (2014) analyzed the impact of increasing uncertainty in financial markets on the relationship between stock prices and exchange rates using nonlinear time series models following the 2008 global financial crisis. The findings indicated that changes in the exchange rate did not affect the stock market returns of BRICS countries independent of regimes.

Bahmani-Oskooee and Saha (2016) attempted to determine whether the effect of exchange rate changes was symmetric or asymmetric on stock prices in nine countries including Brazil. Positive exchange rate shocks were found to have significant positive short-term effects on stock prices in the Brazilian economy, whereas negative shocks had no effect. This suggests that exchange rate fluctuations have an asymmetric effect on Brazilian stock prices. In examining the Indonesian economy, in the linear model, they found that short-term exchange rate changes had a significant effect on stock prices, but this effect did not persist over the long term. According to the nonlinear model, the negative exchange rate shocks had an impact only in the short term on stock prices.

Sikhosana and Aye (2018) examined the volatility spillover effect between the exchange rate market and the stock market in the South African economy. They found that negative exchange rate shocks had a greater impact on stock market volatility. Meanwhile, Kusumahadi and Permana (2021) measured the effects of exchange rate changes on stock returns using daily data for 15 countries during COVID-19. Findings revealed that currency fluctuations significantly and negatively impacted stock returns during the pandemic period in Brazil, Indonesia, and South Africa. In another study that considered the pandemic period, Alimi and Adediran (2023) concluded that the relationship between exchange rates and stock prices was negative and asymmetric and that these effects were more pronounced during the pandemic period.

In the context of Turkey, Buberkoku (2013) included developed and developing countries and used monthly data from 1998 to 2008 to examine the relationship between stock prices and exchange rates. Applying the Engle-Granger and Johansen cointegration and Granger causality tests, Buberkoku (2013) found no long-term relationship between stock prices and exchange rates in Turkey, but stock prices affected exchange rates in the short term. Meanwhile, Tuncer and Turaboglu (2014) examined the short- and long-term relationships between Turkish stock prices and exchange rates using quarterly data from 1990 to 2008. Moreover, using the Johansen cointegration test, they showed a long-term relationship between stock prices and other variables and identified a causal relationship between the real effective exchange rate and stock prices. Tursoy (2019) examined the relationship between stock prices and the Turkish Lira exchange rate using monthly data from January 2001 to September 2016 and applied the ARDL, error correction model (ECM), and Granger causality tests. The study found cointegration between exchange rates and stock prices and a short-term unidirectional causal relationship between exchange rates and stock prices. Furthermore, Kassouri and Altintas (2020) modeled intricate asymmetric effects and nonlinear relationships between exchange rates and stock prices. They found that an increase in the exchange rate negatively affected stock prices in Turkey between 2003 and 2018, whereas a decrease in the exchange rate had no statistically significant impact on stock prices.

Reviewing the related literature yields the following[2]: i) the relationship between exchange rates and stock markets was analyzed more using symmetric estimation methods; ii) especially in developing countries, the exchange rate is considered an external variable and affects stock prices unidirectionally, both symmetrically and asymmetrically; iii) the effect of exchange rates on stock prices fluctuates based on global economic developments (e.g., the global financial crisis and the pandemic period), and this effect is generally asymmetric; and iv) generally, analyses are carried out country-specific in studies conducted. In the present study, however, the symmetric and asymmetric effects of exchange rates on stock prices were examined collectively by analyzing the fragile five economies. Therefore, the study is expected to contribute to the existing literature in this respect.

III. Data Set and Method

This study aims to investigate the symmetric and asymmetric effects of nominal exchange rates on stock price indices in five countries called the "fragile five": Brazil, India, South Africa, Indonesia, and Turkey. The global financial crisis has caused structural changes in stock prices and exchange rates in these fragile five economies, resulting in distinct series with varying dynamics. Furthermore, the COVID-19 pandemic has increased uncertainties in both the stock and exchange markets in these economies with similar economic dynamics. Using monthly long-

2) Appendix A provides a summary of the literature on the fragile five economies.

and short-term data before and after the global financial crisis and during the COVID-19 pandemic, this study evaluated the symmetric and asymmetric effects of exchange rates on stock prices in these five countries with similar economic dynamics and vulnerable structures. First, panel data covering 480 monthly observations from July 2000 to June 2008 covers the pre-global financial crisis period. Second, panel data covering 645 monthly observations from June 2009 to February 2020 are used to cover the post-global financial crisis period. For the duration of the COVID-19 pandemic, panel data consisting of 145 monthly observations from March 2020 to July 2022 are processed. Moreover, the International Financial Statistics database was used to obtain exchange rate data (exchange rate, national currency per the US dollar, end of period). Since financial markets in the fragile five economies are thought to be better explained by changes in the U.S. dollar (Druck et al., 2018; Wen and Cheng, 2018), we use the U.S. dollar exchange rate. For index data on stock prices, see the IBOVESPA Index in Brazil, the NIFTY 50 Index in India, the Jakarta Composite Index in Indonesia, the Johannesburg Stock Exchange in South Africa, and the BIST100 Index in Turkey. These index data are obtained from the websites of investing.com and finance.yahoo.com. We also consider the control variables (e.g., inflation rates, interest rates, and economic growth) as the determinants of stock prices (Fama, 1981; Spiro, 1990) to accurately evaluate and compare the findings obtained. Meanwhile, the consumer price index and the industrial production index, which are obtained from the OECD database, are used as the inflation variable and economic growth indicator, respectively. The interest rate data come from the IMF and CBRT Electronic Data Delivery System databases. All variables except for the interest rate variable are transformed into logarithmic form.

We use the panel ARDL and panel NARDL models in the study to test the effect of exchange rates on stock prices in the fragile five economies. In linear and nonlinear ARDL modeling approaches, the variables used should not be second difference stationary. However, if the variables used in the model are stationary at the level and/or first difference (integrated at different levels), this allows for the estimation of these modeling approaches (Pesaran et al., 2001; Shin et al., 2014).

Before estimating the models used in the study, we must determine the cross-sectional dependence in the data. In this context, the Breusch and Pagan (1980) Lagrange multiplier (LM), Pesaran et al. (2008) LM Test, and Pesaran (2004) Cross-Sectional Dependence (CD) Test are used to detect cross-sectional dependence for the variables used in the models. The detection of cross-sectional dependence provides preliminary information regarding the unit root test to employ for the model's variables.

First, the LM test developed by Breusch and Pagan (1980) is applied to detect cross-sectional dependence. To test the null hypothesis obtained from the LM test, we obtained the following:

$$LM = T\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\hat{\rho}_{ij}^{2} \tag{1}$$

where $\acute{p}_{ij}^{2}$ is the sample estimate of the pairwise correlations of the error terms obtained from the least squares estimator for each country. The LM test is valid for relatively small N and sufficiently large T samples. When both the time (T) and country (N) dimensions are large, we can investigate cross-sectional dependence using the CD_{LM} test developed by Pesaran (2004).

$$CD_{LM} = \left(\frac{N}{N-1}\right)^{1/2} \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \left(T\acute{p}_{ij}^{2} - 1\right) \sim N(0,1) \tag{2}$$

In the cases where N is large and T is small, the CD_{LM} test may be subject to size distortions. Pesaran (2004) developed more general statistics on CD test. The CD test is as follows:

$$CD = \sqrt{\frac{2T}{N(N-1)}} \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \acute{p}_{ij}^{2} \sim N(0,1) \tag{3}$$

In large panel data, Pesaran et al. (2008) transformed the LM test using the average and variance of LM statistics (LM_{adj}). In Equation 4, they obtained the mean (μ_{Tij}^{2}) and variance (v_{Tij}^{2}) based on $(T-k)\acute{p}_{ij}^{2}$:

$$LM_{adj} = \sqrt{\frac{2T}{N(N-1)}} \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \acute{p}_{ij}^{2} \frac{(T-k)\acute{p}_{ij}^{2} - \mu_{Tij}^{2}}{\sqrt{v_{Tij}^{2}}} \sim N(0,1) \tag{4}$$

The test results on cross-sectional dependence are shown in Table 1:

Table 1. *Results of Cross-Sectional Dependence Test*

Variables	Breusch-Pagan LM Test	Pesaran et al. LM Test	Pesaran CD Test
Pre-Global financial crisis Period			
LSM	891.99^{***} (0.00)	199.22^{***} (0.00)	29.86^{***} (0.00)
LER	117.05^{***} (0.00)	23.93^{***} (0.00)	6.75^{***} (0.00)
LER^{+}	842.55^{***} (0.00)	186.16^{***} (0.00)	28.99^{***} (0.00)
LER^{-}	875.34^{***} (0.00)	193.49^{***} (0.00)	29.56^{***} (0.00)
LCPI	861.05^{***} (0.00)	190.30^{***} (0.00)	29.33^{***} (0.00)
IR	223.53^{***} (0.00)	47.72^{***} (0.00)	10.85^{***} (0.00)
LIP	666.89^{***} (0.00)	146.88^{***} (0.00)	25.35^{***} (0.00)
Post-Global financial crisis Period			
LSM	734.64^{***} (0.00)	162.03^{***} (0.00)	25.53^{***} (0.00)
LER	1124.60^{***} (0.00)	249.23^{***} (0.00)	33.51^{***} (0.00)
LER^{+}	721.45^{***} (0.00)	156.26^{***} (0.00)	23.45^{***} (0.00)
LER^{-}	739.13^{***} (0.00)	171.02^{***} (0.00)	24.55^{***} (0.00)

Table 1. *Continued*

Variables	Breusch-Pagan LM Test	Pesaran et al. LM Test	Pesaran CD Test
LCPI	1244.99*** (0.00)	276.15*** (0.00)	35.28*** (0.00)
IR	184.53*** (0.00)	39.02*** (0.00)	1.84* (0.06)
LIP	774.92*** (0.00)	171.04*** (0.00)	7.78*** (0.00)
COVID-19 Period			
LSM	193.27*** (0.00)	40.98*** (0.00)	13.71*** (0.00)
LER	47.96*** (0.00)	8.48*** (0.00)	2.07*** (0.03)
LER^+	81.90*** (0.00)	10.11*** (0.00)	3.22*** (0.00)
LER^-	93.28*** (0.00)	10.64*** (0.00)	5.15*** (0.00)
LCPI	264.54*** (0.00)	56.82*** (0.00)	16.25*** (0.00)
IR	118.87*** (0.00)	24.34*** (0.00)	5.93*** (0.00)
LIP	175.55*** (0.00)	37.01*** (0.00)	13.00*** (0.00)

Note. ***, ** and * denote 1%, 5%, and 10% significance levels, respectively, whereas values in parentheses are p values.

The test results in Table 1 show that the null hypothesis of no cross-sectional dependence in the variables used in the study is rejected for all periods. Therefore, we apply the Cross-Sectionally Augmented IPS (CIPS) second-generation panel unit root test developed by Pesaran (2007) to determine the stationarity of the variables.

In the test developed by Pesaran (2007), the statistics values of the cross-sectionally augmented Dickey-Fuller (CADF) test are calculated for all units that form the panel. The arithmetic mean of these tests is then used to calculate the statistical values of the CIPS test for the panel. Moreover, CADF test results analyze stationarity for each country in the panel, whereas CIPS test results analyze stationarity for the entire panel. Moreover, it is a robust test despite low horizontal cross-sectional dependence and small samples (Pesaran, 2007). The CIPS statistic can be derived as follows:

$$CIPS(N,T)=\left(\frac{1}{N}\right)\sum_{i=1}^{N} t_i(N,T) \tag{5}$$

Since the variables are stationary at different levels, the panel ARDL and panel NARDL models are used to measure the effect of exchange rates on stock prices and identify linear and nonlinear relationships in the fragile five economies. The panel ARDL model with error correction term is presented in Equation 6:

$$\Delta LSM_{it} = \gamma_i \epsilon_{i,t-1} + \sum_{j=1}^{p1} \pi_{1ij} \Delta LSM_{i,t-j} + \sum_{j=0}^{p2} \pi_{2ij} \Delta LER_{i,t-j} + \mu_i + \epsilon_{it} \tag{6}$$

The panel ARDL model including control variables is shown in Equation 7:

$$\begin{aligned}\Delta LSM_{it} = \ & \delta_i \epsilon_{i,t-1} + \sum_{j=1}^{q1} \theta_{1ij} \Delta LSM_{i,t-j} + \sum_{j=0}^{q2} \theta_{2ij} \Delta LER_{i,t-j} \\ & + \sum_{j=0}^{q3} \theta_{3ij} \Delta LCPI_{i,t-j} + \sum_{j=0}^{q4} \theta_{4ij} \Delta LIP_{i,t-j} \\ & + \sum_{j=0}^{q5} \theta_{5ij} \Delta IR_{i,t-j} + \mu_i + \xi_{it} \end{aligned} \quad (7)$$

The LSM variable represents the stock price index in the fragile five economies as the dependent variable, and the LER variable represents the exchange rate as the independent variable. $LCPI$, LIP, and IR variables are consumer price index, industrial production index and interest rate variables, respectively; they represent the independent variables added to the model as control variables. Meanwhile, ϵ_{it-1} denotes the long-run equilibrium in the linear Panel ARDL model, and γ_i and δ_i are the speed of adjustment to the long-term equilibrium. If parameters γ and δ are negative and significant, a long-term linear cointegration relationship exists between exchange rates and stock prices in the fragile five economies. p and q denote the number of lags of the dependent and independent variables, respectively. Meanwhile, i and t denote country and time, respectively. Accordingly, the panel ARDL model is shown in Equation 8:

$$\begin{aligned}\Delta LSM_{it} = \ & \beta_{0i} + \beta_{1i} LSM_{i,t-1} + \beta_{2i} LER_{it-1} + \sum_{j=1}^{p1} \pi_{1ij} \Delta LSM_{i,t-j} \\ & + \sum_{j=0}^{p2} \pi_{2ij} \Delta LER_{i,t-j} + \mu_i + \epsilon_{it} \end{aligned} \quad (8)$$

Equation 9 depicts the panel ARDL model including control variables:

$$\begin{aligned}\Delta LSM_{it} = \ & \alpha_{0i} + \alpha_{1i} LSM_{i,t-1} + \alpha_{2i} LER_{i,t-1} + \alpha_{3i} LCPI_{i,t-1} + \alpha_{4i} LIP_{i,t-1} \\ & + \alpha_{5i} LIR_{i,t-1} + \sum_{j=1}^{q1} \theta_{1ij} \Delta LSM_{i,t-j} + \sum_{j=0}^{q2} \theta_{2ij} \Delta LER_{i,t-j} \\ & + \sum_{j=0}^{q3} \theta_{3ij} \Delta LCPI_{i,t-j} + \sum_{j=0}^{q4} \theta_{4ij} \Delta LIP_{i,t-j} \\ & + \sum_{j=0}^{q5} \theta_{5ij} \Delta IR_{i,t-j} + \mu_i + \xi_{it} \end{aligned} \quad (9)$$

According to Equation 9, β_1, β_2, α_1 , and α_2 denote long-run coefficients; π_1, π_2, θ_1 , θ_2, θ_3, θ_4, and θ_5 denote short-run coefficients; μ_i denotes fixed effects in the equation; and ϵ_{it} and ξ_{it} denote uncorrelated idiosyncratic error. Considering studies on the effect of exchange rates on stock prices, there is also evidence that the relationship is asymmetric. Therefore, the asymmetric effect of exchange rates on stock prices in the fragile five economies is also estimated using the panel NARDL model. Equation 10 shows the panel NARDL error correction model:

$$\begin{aligned}\Delta LSM_{it} = \ & \rho_i \epsilon_{i,t-1} + \sum_{j=1}^{p1} \eta_{1ij} \Delta LSM_{i,t-j} \\ & + \sum_{j=0}^{p2} \left(\eta_{2ij}^{+} \Delta LER_{i,t-j}^{+} + \eta_{2ij}^{-} \Delta LER_{i,t-j}^{-} \right) + \mu_i + \epsilon_{it} \end{aligned} \quad (10)$$

The panel NARDL error correction model including control variables is shown in Equation 11:

$$\begin{aligned}\Delta LSM_{it} = \ & \lambda_i \epsilon_{i,t-1} + \sum_{j=1}^{q1} \phi_{1ij} \Delta LSM_{i,t-j} \\ & + \sum_{j=0}^{q2} \left(\phi_{2ij}^{+} \Delta LER_{i,t-j}^{+} + \phi_{2ij}^{-} \Delta LER_{i,t-j}^{-} \right) + \sum_{j=0}^{q3} \phi_{3ij} \Delta LCPI_{i,t-j} \\ & + \sum_{j=0}^{q4} \phi_{4ij} \Delta LIP_{i,t-j} + \sum_{j=0}^{q5} \phi_{5ij} \Delta IR_{i,t-j} + \mu_i + \xi_{it} \end{aligned} \quad (11)$$

ϵ_{it-1} denotes the long-run equilibrium in the linear panel NARDL model, and ρ_i and λ_i are the speed of adjustment to the long-run equilibrium. If parameters ρ and λ are negative and significant, a long-run linear cointegration relationship exists between exchange rates and stock prices in the fragile five economies. Equation 12 shows the panel NARDL model:

$$\begin{aligned}\Delta LSM_{it} = \ & \beta_{0i} + \beta_{1i} LSM_{it-1} + \beta_{2i}^{+} LER_{i,t-1}^{+} + \beta_{2i}^{-} LER_{i,t-1}^{-} \sum_{j=1}^{p1} \pi_{1ij} \Delta LSM_{i,t-j} \\ & + \sum_{j=0}^{p2} \left(\pi_{2ij}^{+} \Delta LER_{i,t-j}^{+} + \pi_{2ij}^{-} \Delta LER_{i,t-j}^{-} \right) + \mu_i + \epsilon_{it} \end{aligned} \quad (12)$$

The panel NARDL model including control variables is shown in Equation 13:

$$\begin{aligned}\Delta LSM_{it} = \ & \alpha_{0i} + \alpha_{1i} LSM_{i,t-1} + \alpha_{2i}^{+} LER_{i,t-1}^{+} + \alpha_{2i}^{-} LER_{i,t-1}^{+} + \alpha_{3i} LCPI_{i,t-1} \\ & + \alpha_{4i} LIP_{i,t-1} + \alpha_{5i} LIR_{i,t-1} + \sum_{j=1}^{q1} \theta_{1ij} \Delta LSM_{i,t-j} \\ & + \sum_{j=0}^{p2} \left(\theta_{2ij}^{+} \Delta LER_{i,t-j}^{+} + \theta_{2ij}^{-} \Delta LER_{i,t-j}^{-} \right) + \sum_{j=0}^{q3} \theta_{3ij} \Delta LCPI_{i,t-j} \\ & + \sum_{j=0}^{q4} \theta_{4ij} \Delta LIP_{i,t-j} + \sum_{j=0}^{q5} \theta_{5ij} \Delta IR_{i,t-j} + \mu_i + \xi_{it} \end{aligned} \quad (13)$$

where LER^{+} and LER^{-} denote positive and negative shocks to the exchange rate. These shocks are calculated as either positive or negative according to the intended method as follows (Shin et al. 2014):

$$LER_{it}^{+} = \sum_{k=1}^{t} \Delta LER_{i,k}^{+} = \sum_{K=1}^{T} \max\left(\Delta LER_{i,k}, 0 \right) \quad (14)$$

$$LER_{it}^{-} = \sum_{k=1}^{t} \Delta LER_{i,k}^{-} = \sum_{K=1}^{T} \min\left(\Delta LER_{i,k}, 0 \right) \quad (15)$$

Using the Wald test statistic, we calculated the asymmetric effects of positive and negative shocks on the exchange rate. If the positive and negative exchange rate shocks are not equal, then exchange rate shocks have an asymmetric effect on the stock price index in both the short and long term. Likewise, if the error correction parameters are statistically significant and negative, a long-run nonlinear cointegration relationship exists between the exchange rate and stock prices in the fragile five economies.

While using panel ARLD and panel NARDL econometric models, we applied the Hausman test to determine which of the mean group (MG; Pesaran and Smith, 1995) and pooled mean group (PMG; Pesaran et al. 1999) estimators is the efficient estimator. On the basis of the Hausman test statistics, the null hypothesis that there is no difference between the MG and PMG estimates cannot be rejected. Therefore, PMG is the preferred estimator for measuring the symmetric and asymmetric effects of exchange rates on the stock price index in the fragile five economies.

IV. Empirical Findings

Due to cross-sectional dependence in the variables used in the study, the second-generation panel unit root test, that is, the CIPS panel unit root test, developed by Pesaran (2007), was applied. The results obtained are shown in Table 2.

Table 2. *Panel Unit Root Test Results*

	CIPS Unit Root Test			
	Level		First Difference	
	Constant	Constant and Trend	Constant	Constant and Trend
Pre-Global financial crisis Period				
LSM	-2.84***	-2.95**	-11.53***	-11.49***
LER	-2.19	-2.44	-9.54***	-9.64***
LER^+	-1.40	-2.65	-7.75***	-7.83***
LER^-	-2.20	-2.59	-8.54***	-8.69***
LCPI	-1.51	-1.36	-5.26***	-5.70***
IR	-2.37*	-2.66*	-.3.41***	-.3.86***
LIP	-2.45*	-2.76*	-10.28***	-10.47***
Post-Global financial crisis Period				
LSM	-2.01	-1.91	-11.32***	-11.26***
LER	-1.79	-2.00	-12.51***	-12.50***
LER^+	-1.50	-1.66	-10.58***	-10.61***
LER^-	-1.67	-1.80	-10.09***	-10.11***
LCPI	-.0.68	-.2.41	-6.83***	-.7.13***
IR	-.1.09	-1.53	-7.52***	-7.51***
LIP	-2.25	-2.28	-9.43***	-9.47***

Table 2. *Continued*

CIPS Unit Root Test				
	Level		First Difference	
	Constant	Constant and Trend	Constant	Constant and Trend
COVID-19 Period				
LSM	-1.83	-3.02**	-4.28***	-4.35***
LER	-2.18	-2.33	-5.41***	-3.56***
LER+	-1.60	-1.93	-4.09***	-4.08***
LER-	-1.77	-2.03	-3.99***	-3.77***
LCPI	-.0.68	-.2.41	-3.22***	-.3.56***
IR	-.1.09	-1.53	-3.09***	-5.15***
LIP	-2.25	-2.28	-4.37***	-3.49***

Note. ***, **, and * denote 1%, 5%, and 10% significance levels, respectively.

As shown in Table 2, all variables used during the periods studied in the fragile five economies did not become stationary at the second difference. The stock price index variable remains unchanged at its level prior to the global financial crisis. In addition, the exchange rate variable has been found to be stationary at the level where the trend effect is considered monthly during the COVID-19 period. The consumer price index, industrial production index, and interest rate variables, which are added to the models as control variables, become stationary when their first differences are calculated in both constant and trend form. Since the variables used in the study become stationary to varying degrees and are not stationary at the second degree, it is appropriate to use the panel ARDL and NARDL methods for symmetric and asymmetric analysis of the effect of exchange rates on stock prices in the fragile five economies.

Table 3 shows that in the pre-global financial crisis period, the linear ECT term in the panel ARDL model for fragile five economies is not statistically significant and negative. Therefore, a long-term symmetric relationship between exchange rates and stock price indices could not be established during this period. In the pre-global financial crisis period, however, the panel NARLD model results reveal that the nonlinear ECT term is statistically significant and negative, and asymmetric relationships have been identified between exchange rates and stock price indices in the fragile five economies. Moreover, the panel NARLD results before the global financial crisis show that investors investing in stock markets in the fragile five economies responded to positive and negative shocks in exchange rates. Both the appreciation and depreciation of local currencies negatively affected the stock market during this period. However, the effect of the appreciation of local currencies against the U.S. dollar on the stock market was greater in these countries. It can be stated that the appreciation of local currencies negatively affects export competitiveness by decreasing stock prices in these countries. This result shows that these countries adhere to flow-oriented models. The negative impact of the depreciation of local currencies in these fragile nations on the stock market can be attributed to their high external financing requirements. The high foreign ownership of these countries' stock markets increases country risks and negatively affects the stock market as the local currency loses value. Similar results were found to be effective in the short-term, and the stock market had a greater negative reaction to local currency losses or positive shocks in the first lag. Therefore, shocks in exchange rates are effective in the stock market with a one-month delay.

Table 3. *Panel ARDL and Panel NARDL Model Estimation Results in the Pre-Global Financial Crisis Period*

Pre-Global financial crisis Period		
Variables	Panel ARDL model	Panel NARDL model
LER	2.26(0.35)	
LER^{+}		$-0.73^{***}(0.00)$
LER^{-}		$-1.55^{***}(0.00)$
D(LER)	-0.08(0.28)	
$D(LER)_{t-1}$	$-0.88^{***}(0.00)$	
$D(LER^{+})$		0.15(0.23)
$D(LER^{-})$		-0.19(0.17)
$D(LER^{+})_{t-1}$		$-1.13^{***}(0.00)$
$D(LER^{-})_{t-1}$		$-0.60^{**}(0.04)$
Linear ECT	0.003(0.56)	
Nonlinear ECT		$-0.05^{**}(0.05)$
Wald Test for Short Run		$3.54^{**}(0.05)$
Wald Test for Long Run		$125.77^{***}(0.00)$
Hausman Test	$3.86^{**}(0.05)$	4.45(0.10)
The number of Observations	480	480

Note. ***, **, and * denote 1%, 5%, and 10% levels of significance, respectively, whereas values in parentheses are p values.

In the period before the global financial crisis, control variables are added to the model to test the results' robustness and to accurately evaluate and compare the effect of exchange rates on stock prices. The results obtained are shown in Table 4:

Table 4. *Panel ARDL and Panel NARDL Model Estimation Results with Control Variables in the Pre-Global Financial Crisis Period*

Pre-Global financial crisis Period		
Variables	Panel ARDL Model	Panel NARDL Model
LER	$-1.02^{***}(0.00)$	
LER^{+}		$-0.58^{***}(0.00)$
LER^{-}		$-1.03^{***}(0.00)$
LCPI	$3.14^{***}(0.00)$	1.09(0.15)
IR	$-0.02^{***}(0.00)$	$-0.02^{***}(0.00)$
LIP	-.0.93(0.17)	-0.35(0.67)

Table 4. *Continued*

Pre-Global financial crisis Period		
Variables	Panel ARDL Model	Panel NARDL Model
D(LER)	0.12(0.19)	
$D(LER)_{t-1}$		
$D(LER^{+})$		$-0.78^{***}(0.02)$
$D(LER^{-})$		-0.19(0.32)
$D(LER^{+})_{t-1}$		$1.09^{***}(0.00)$
D(LCPI)	0.65(0.60)	0.47(0.56)
D(IR)	-0.02(0.78)	-0.11(0.57)
D(LIP)	0.26(0.03)	0.12(0.22)
Linear ECT	-0.16(0.11)	
Nonlinear ECT		$-0.13^{*}(0.09)$
Wald Test for Short Run		1.78(0.18)
Wald Test for Long Run		$4.78^{***}(0.02)$
Hausman Test	$8.23^{*}(0.08)$	$10.5^{*}(0.08)$
Number of Observations	480	480

Note. ***, **, and * denote 1%, 5%, and 10% levels of significance, respectively, whereas values in parentheses are p values.

Table 4 shows that the linear ECT term in the panel ARDL model for the fragile five economies in the pre-crisis period is statistically insignificant and non-negative even when control variables are included in the model. Therefore, similarly to Table 3, there is no symmetric long-term relationship between exchange rates and stock price indices in this period. However, in the pre-global financial crisis period, according to the panel NARDL model results, the nonlinear ECT term is statistically significant. Moreover, negative and similarly asymmetric relationships between exchange rates and stock price indices in the fragile five economies are found when control variables are added to the model. By comparing the results, we find that investors in the equity markets of the fragile five economies respond to positive and negative shocks in exchange rates of similar magnitude. In both models, local currency appreciation and depreciation have a negative effect on the stock market. Similar effects are found in the short run, where the stock market reacts negatively to positive shocks or losses in the local currency, but these effects are symmetrical. Only the interest rate is negative and statistically significant among the control variables, but its impact is minimal.

Table 5. *Panel ARDL and Panel NARDL Model Estimation Results in the Post-Global Financial Crisis Period*

Post-Global financial crisis Period		
Variables	Panel ARDL Model	Panel NARDL Model
LER	-0.19(0.35)	
LER^{+}		$-0.55^{***}(0.00)$
LER^{-}		$-1.03^{**}(0.03)$
D(LER)	$-0.71^{***}(0.00)$	
$D(LER)_{t-1}$	$0.72^{***}(0.00)$	
$D(LER^{+})$		$-0.16^{*}(0.05)$
$D(LER^{-})$		$-0.57^{***}(0.00)$
$D(LER^{-})_{t-1}$		$1.03^{***}(0.00)$
Linear ECT	$-0.08^{**}(0.01)$	
Nonlinear ECT		$-0.09^{**}(0.02)$
Wald Test for Short Run		$3.64^{*}(0.05)$
Wald Test for Long Run		$7..07^{***}(0.00)$
Hausman Test	6.69(0.10)	3.39(0.18)
Number of Observations	645	645

Note. ***, **, and * denote 1%, 5%, and 10% significance levels, respectively, whereas values in parentheses are p values.

Table 5 shows that the ECT term is negative and statistically significant in the fragile five economies in the period after the global financial crisis until the pandemic. Therefore, both symmetric and asymmetric effects from the exchange rate to the stock prices are detected in the long run. However, the symmetric effect of the exchange rate on stock prices in the long run is statistically insignificant. The panel NARDL model results reveal that in post-crisis, equity investors in the fragile five economies responded to positive and negative shocks in exchange rates. In this period, both the appreciation and depreciation of local currencies negatively affected the stock market. However, the appreciation of local currencies relative to the U.S. dollar had a greater impact on the stock markets in these countries. By decreasing stock prices, the appreciation of local currencies harms export competitiveness in these nations. This result suggests that these countries employ flow-oriented models in their policies. As a result of the quantitative easing policies of the U.S. Federal Reserve, the local currencies of fragile five countries appreciated relative to the U.S. dollar in the post-crisis period. However, the high proportion of export-oriented firms operating on the stock markets harmed the stock markets. After 2013, as policies aimed at reducing the asset program increased, the depreciation of local currencies against the U.S. dollar in these countries increased country risks. Increased risks harm stock markets, where foreign investors are concentrated. The short-run results are similar to the long-run results, but negative exchange rate shocks positively affect the stock market with a one-month lag.

Table 6 displays the results obtained from the model with the addition of control variables after the global financial crisis:

Table 6. *Panel ARDL and Panel NARDL Model Estimation Results with Control Variables in the Post-Global Financial Crisis Period*

Post-Global financial crisis Period		
Variables	Panel ARDL Model	Panel NARDL Model
LER	-0.41(0.20)	
LER^+		$-1.11^{***}(0.00)$
LER^-		-0.33(0.37)
LCPI	0.55(0.44)	$2.65^{***}(0.00)$
IR	$-0.01^{*}(0.07)$	-0.01(0.20)
LIP	-0.31(0.60)	-0.11(0.79)
D(LER)	$-0.75^{***}(0.00)$	
$D(LER)_{t-1}$	$0.76^{***}(0.00)$	
$D(LER^+)$		-0.14(0.19)
$D(LER^-)$		$-0.68^{***}(0.00)$
$D(LER^-)_{t-1}$		$1.07^{***}(0.00)$
D(LCPI)	0.45(0.22)	-0.09(0.82)
D(IR)	0.01(0.25)	-0.13(0.34)
D(LIP)	0.08(0.28)	0.08(0.41)
Linear ECT	$-0.08^{**}(0.01)$	
Nonlinear ECT		$-0.09^{**}(0.02)$
Wald Test for Short Run		1.78(0.18)
Wald Test for Long Run		$4.78^{***}(0.02)$
Hausman Test	2.65(0.20)	$10.5^{*}(0.08)$
Number of Observations	645	645

Note. ***, **, and * denote 1%, 5%, and 10% levels of significance, respectively, whereas values in parentheses are p values

As shown in Table 6, the results obtained in the post-global financial crisis period are similar to those obtained in the model without control variables in both the short and long run, and both symmetric and asymmetric effects from exchange rate to stock prices are found in the long run. Therefore, the effect of exchange rate on stock prices is consistent in both the short and long run when both models are considered. Moreover, stock prices are negatively affected by positive and negative shocks in the exchange rate in the post-crisis period. In the symmetric model, as control variables, the effect of interest rate on stock prices is negative but relatively low. According to the panel NARDL results of the model, increases in the inflation rate positively affected the value of stock assets.

Table 7. *Panel ARDL and Panel NARDL Model Estimation Results in the COVID-19 Period*

	COVID-19 Period	
Variables	Panel ARDL Model	Panel NARDL Model
LER	-0.07^{***}(0.00)	
LER^{+}		-1.39^{***}(0.00)
LER^{-}		-1.97^{***}(0.00)
D(LER)	-0.20(0.52)	
$D(LER)_{t-1}$	0.59^{*}(0.06)	
$D(LER^{+})$		-0.99^{*}(0.07)
$D(LER^{-})$		0.55^{*}(0.05)
$D(LER^{+})_{t-1}$		1.23^{***}(0.00)
Linear ECT	-0.30^{*}(0.06)	
Nonlinear ECT		-0.27^{***}(0.00)
Wald Test for Long Run		15.53^{***}(0.00)
Wald Test for Short Run		4.91^{***}(0.02)
Hausman Test	0.46(0.50)	2.96(0.22)
Number of Observations	145	145

Note. ***, **, and * denote 1%, 5%, and 10% levels of significance, respectively, whereas values in parentheses are p values

According to Table 7, the nonlinear ECT term is statistically negative and significant in the long run. Therefore, despite limited observations, asymmetric relationships are found. Positive exchange rate shocks, i.e., depreciation of local currencies, had a negative impact on the stock price index during the COVID-19 period. Conversely, negative exchange rate shocks negatively affect the stock price index. However, the effects of negative shocks are greater than those of positive shocks. In this period of economic contraction due to the slowdown in international trade caused by the pandemic and the increase in global uncertainty, changes in the exchange rate have a negative effect on stock prices. However, negative shocks have greater effects than positive ones. Similar to the pre-pandemic period, the correlation between the exchange rate and the stock price index during the COVID-19 period indicates that the flow-oriented models remain valid in the fragile five economies.

Only asymmetric effects are observed when control variables are added to the model during the pandemic period, similar to the results in Table 7. Moreover, the findings are very similar to the bivariate model. According to Table 8, the effect of positive and negative shocks in the exchange rate on stock prices is negative, and the effect of negative shocks is greater than in previous periods. In the short run, the effect of exchange rate fluctuations on stock prices is positive. Meanwhile, increases in the inflation rate and industrial production have a positive effect on stock prices during the pandemic. As in many countries attempting to combat economic stagnation under pandemic conditions, there is a positive effect on stock prices in countries that reduce their interest rates.

Table 8. *Panel ARDL and Panel NARDL Model Estimation Results with Control Variables in the COVID-19 Period*

COVID-19 Period		
Variables	Panel ARDL Model	Panel NARDL Model
LER	-3.58^{***}(0.00)	
LER^{+}		-0.70^{***}(0.00)
LER^{-}		-2.18^{***}(0.00)
LCPI	1.43(0.34)	2.30^{***}(0.00)
IR	-0.38^{**}(0.02)	-0.02^{***}(0.00)
LIP	-0.08(0.67)	0.40^{***}(0.00)
D(LER)	0.23(0.34)	
$D(LER)_{t-1}$	0.44^{*}(0.05)	
$D(LER^{+})$		0.07^{***}(0.00)
$D(LER^{-})$		0.85^{**}(0.02)
$D(LER^{+})_{t-1}$		0.75^{*}(0.08)
D(LCPI)	-0.11(0.90)	-0.21(0.80)
D(IR)	0.001(0.98)	-0.07(0.02)
D(LIP)	0.23(0.12)	-0.07(0.61)
Linear ECT	-0.18(0.11)	
Nonlinear ECT		-0.40^{**}(0.02)
Wald Test for Short Run		0.66(0.41)
Wald Test for Long Run		9.91^{***}(0.00)
Hausman Test	3.24(0.51)	1.52(0.91)
Number of Observations	145	145

Note. ***, **, and * denote 1%, 5%, and 10% significance levels, respectively, whereas the values in parentheses are the p values

V. Conclusion

Using linear and nonlinear panel ARDL, this study analyzes the symmetric and asymmetric effects of exchange rate fluctuations on stock price indices in the so-examined "fragile five" economies: India, Indonesia, Brazil, South Africa, and Turkey. The data period is analyzed in three different processes, considering global developments: the pre-crisis period, the post-crisis, and the pandemic. In the study, two models are used for each period. The bivariate model analyzes the symmetric and asymmetric effects of exchange rates on stock prices. In the second model, the consumer price index, the interest rate, and the industrial production index are added as control variables. Thus, both the effect of the exchange rate on stock prices and the robustness of the results are accurately evaluated. In all periods, the results obtained from both models are identical. When the fragile five economies are considered collectively, the effect of exchange rate on stock prices in the short and long run is consistent with Lin (2012) and Tuncer and Turaboglu (2014). Furthermore, the asymmetric and negative effect detected as a result of the analysis supports the studies of Yang et al. (2014), Ajaz et al. (2017), Sikhosana and Aye (2018), Kumar (2019), Tursoy (2019), and Kassouri and Altintas (2020). In the post-crisis period, symmetric and asymmetric effects are detected in the long term, and the effects of positive and negative changes in the exchange rate in the long term are found to be statistically significant. Meanwhile, long-term and short-term effects are similar to pre-crisis, with exchange rate changes negatively affecting stock prices. This is consistent with the findings of Kumar (2019), Tursoy (2019), and Kassouri and Altintas (2020).

Finally, despite limited data, this study found that an increase and decrease in the exchange rate harm the stock market and are asymmetric during the pandemic period. These results are similar to those of Kusumahadi and Permana (2021) and Alimi and Adediran (2023), who consider daily data. During the pandemic period, the effect of the consumer price index and the industrial production index, among the control variables, on stock prices was detectable. Although increases in interest rates harm stock prices in all three period studied, such as Ajaz et al. (2017) and Banda et al. (2019), the level of this effect is quite low. The findings indicate that the effects of exchange rate changes on stock prices are more asymmetric in the fragile five economies. Moreover, the effects of negative shocks on the exchange rate are typically greater than the effects of positive shocks. Due to an increase in the volatility of local currencies versus the U.S. dollar, the flow-oriented approach is applicable in these countries. It also shows that these countries' stock markets are sensitive to foreign portfolio investments.

Considering these findings, we can infer that firms, investors, and policymakers in the fragile five economies should consider the asymmetric effects of exchange rates on stock prices. Investors and firms in these countries, which are sensitive to global developments, are believed to facilitate their risk management if they take measures to minimize the effects of high exchange rate volatility. Similarly, policymakers' policy measures to stabilize exchange rates and support stock markets will reduce the sensitivity of these economies to global shocks. Thus, the pressure on stock prices due to the volatility of the exchange rate may decrease.

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Appendix

Table A1. *Summary of Literature on Fragile Five Economies*

Author(s)	Year	Country(ies)	Data	Methodology	Key Findings
Lean et al.	2011	Asian countries (Indonesia)	Weekly from 1990-2005	Allowed for structural breaks cointegration tests	No long-term effect found for Indonesia
Adjasi et al.	2011	Seven African countries (South Africa)	1992-2005	Symmetric relationship analysis	Exchange rate shocks had a positive impact on stock prices in South Africa
Lin	2012	Asian countries (India and Indonesia)	Monthly from 1986-2010	ARDL approach	The common movement between exchange rates and stock prices strengthened during crisis periods
Buberkoku	2013	Developed and developing countries (including Turkey)	Monthly from 1998-2008	Engle-Granger and Johansen cointegration tests, Granger causality test	No long-term relationship was found between stock prices and exchange rates in Turkey; Stock prices affected exchange rates in the short term
Yang et al.	2014	Asian countries (India and Indonesia)	Daily from 1997-2010	Granger causality test conducted in quantiles	Heterogeneous causal effects were found between exchange rates and stock prices in different quantiles and periods during the Asian financial crisis; negative relationship between stock and currency markets
Tuncer and Turaboglu	2014	Turkey	Quarterly from 1990-2008	Johansen cointegration test	The long-term relationship found between stock prices and other variables; causal relationship identified from the real effective exchange rate to stock prices
Chkili and Nguyen	2014	BRICS countries	March 1997 to February 2013	Nonlinear time series models	Exchange rate changes did not affect stock market returns independent of regimes
Bahmani-Oskooee and Saha	2016	Nine countries	Different period for a different country.	Symmetric (ARDL)/asymmetric (NARDL) effects analysis	Positive exchange rate shocks had significant positive short-term effects on stock prices in Brazil; negative shocks had no effect
Sultana and Reddy	2017	India	Monthly from 2006-2016	Correlation analysis	Strong and long-term relationship found between exchange rates and stock market
Azaj et al.	2017	India	Monthly from April 1991 to December 2015	NARDL	Asymmetric reaction of stock prices to changes in interest rate and exchange rate in full sample and pre-crisis. However, no asymmetry was found in the post-crisis period.
Sikhosana and Aye	2018	South Africa	Daily from 2002-2015	Volatility spillover effect analysis	Negative shocks in the exchange rate market had a greater impact on volatility in the stock market
Kumar	2019	India	Quarterly from 1994-2015	Linear and nonlinear causality analysis, NARDL	Bidirectional linear causality found between exchange rates and stock markets; Unidirectional nonlinear causality found from exchange rates to stock markets
Tursoy	2019	Turkey	Monthly from 2001-2016	ARDL, Granger causality tests	Cointegration found between exchange rates and stock prices; One-way causal relationship found from exchange rates to stock prices in the short term

Table A1. *Continued*

Author(s)	Year	Country(ies)	Data	Methodology	Key Findings
Banda et al.	2019	South Africa	The third quarter of 1995 to the second quarter of 2017	Vector error correction model (VECM) and Granger causality tests	The inflation and exchange rates have a significant and positive relationship with stock prices. However, a negative relationship was found between interest rates and stock prices and no relationship was identified between gross domestic product (GDP) and stock prices.
Kassouri and Altintas	2019	Turkey	January 2003 to December 2018.	Nonlinear modeling	Increase in the exchange rate negatively affected stock prices in Turkey between 2003-2018; the effect of a decrease in the exchange rate on stock prices was statistically insignificant.
Kusumahadi and Permana	2021	Fifteen countries (including Brazil, Indonesia, and South Africa)	Daily during COVID-19 pandemic	Regression analysis	Currency fluctuations had a significant and negative impact on stock returns during the pandemic period
Alimi and Adediran	2023	Advanced and emerging economies	COVID-19 period, Daily data	Dynamic Common Correlated Effect Model	The negative relationship between the price and exchange rate in advanced and emerging economies, with the magnitude of the effects being more prominent during the COVID-19 pandemic. The relationship between the two variables is asymmetric (positive and negative changes to the variables differ in impacts),