The dynamic relationship between ASEAN+6 exchange rates and stock markets: application of the ARDL model

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Abstract

Purpose – This study investigates the short- and long-run relationship between stock prices and exchange rates in the Association of Southeast Asian Nations (ASEAN)+6 markets. In the short run, support is found for both the theory of a goods market where exchange rates influence stock returns and portfolio balance theory, where stock returns influence exchange rates.

Design/methodology/approach – The co-integration approach of linear and nonlinear augmented autoregressive distributed lag (ARDL) models was applied to daily data from 2 January 2017 to 30 June 2023.

Findings – The findings provide evidence that the goods market theory is supported solely in Indonesia and Singapore, while the portfolio balance theory is supported for Australia, China, India and Malaysia.

Practical implications – Policymakers and investors should seriously consider the importance of the study findings. The results show that all ASEAN+6 countries experience a short-term interaction between the two markets. This illustrates that exchange rates and stock price movements play vital roles in other markets. Stakeholders, particularly policymakers, should be aware of this critical relationship.

Originality/value – This is the first study to dynamically examine how the ASEAN+6 framework influences currency rates and stock markets.

Keywords ASEAN+6, Co-movement, Exchange rate, Nonlinear ARDL, Stock market

Paper type Research paper

1. Introduction

The COVID-19 outbreak had a significant global economic impact, including in the Association of Southeast Asian Nations (ASEAN)+6 [1] countries. The COVID-19 epidemic started in China and has spread across the continent. Thailand was the first country outside of China to disclose a case of COVID-19 infection in a visiting tourist (World Bank, 2020). Throughout the pandemic, travel restrictions were implemented for all global destinations. According to the OECD report, ASEAN countries accounted for 70.1% of all passengers in 2019. The ASEAN region was one of the areas most severely affected by COVID-19, and the region's tourism economy has ground to a halt. This has a considerably negative influence on the ASEAN economy, as this sector accounts for a sizable portion of ASEAN GDP.

During periods of uncertainty, such as the COVID-19 epidemic or Russia–Ukraine conflict, the relationship between stock returns and foreign currency is complex and influenced by several factors. Depreciating currency rate benefits exporters by making products more affordable for foreign buyers. Consequently, profits increase as stock returns are potentially higher. However, a stronger currency can benefit importing companies by allowing them to purchase foreign goods at lower prices, potentially leading to both higher stock returns and profits. The link between stock returns and foreign currency rates in the ASEAN+6 region during the COVID-19 pandemic was affected by many variables, including changes in trade patterns, government policies and global market volatility. Some countries in the region, like Indonesia and Malaysia, have implemented measures to limit foreign capital outflows, which can result in weaker currencies and lower stock returns. Other countries, like Thailand, experienced an increase in foreign investment during this period, resulting in a stronger currency and higher stock returns. Lockdowns and travel restrictions can also impact the relationship between stock returns and foreign currency rates since they alter trade patterns.

The ASEAN region is gaining increasing global recognition. To enhance its potential as a worldwide economic force, ASEAN members initiated a trajectory towards regional economic and monetary unions among the member states. The ASEAN+6 framework was established to foster integration by promoting collaboration, facilitation and liberalisation. The group includes both ASEAN founding members and other nations. Furthermore, all nations within the ASEAN+6 group have become members of the World Trade Organization and are gradually implementing policies to facilitate foreign investment through market liberalisation. Extensive research investigating the relationship between returns in regional and global markets has shown that the ASEAN+6 markets offer promising opportunities for international portfolio diversification (Chantathaweewat, 2014; Jantarakolica and Sakayachiwakit, 2015; Kang *et al.*, 2019; Sethapramote, 2015).

During times of economic uncertainty, such as the COVID-19 outbreak, currency fluctuations especially impact stock performance. Investors and decision-makers must better understand what causes stock market movements and make wise investment choices by quickly and closely examining the relationship between these two variables. In response to the pandemic's economic impact, the central banks of the ASEAN+6 countries implemented various monetary policy measures. Investigating the correlation between stock returns and foreign currency rates can provide insights into the efficacy of these measures in promoting financial market stability. Exchange rate fluctuations substantially influence the volatility of investment portfolios, particularly for investors with exposure to foreign markets. Gaining a comprehensive understanding of the correlation between stock returns and foreign currency rates is crucial for investors to effectively manage risk and diversify their portfolios. Within the context of the COVID-19 epidemic, this study's purpose is to investigate the relationship between stock returns and foreign currency in the ASEAN+6 region.

This research makes several contributions to the literature. This study represents the inaugural examination of dynamic fluctuations in exchange rates and stock markets within the ASEAN+6 framework. This analysis employs daily data from 2 January 2017 to 30 June 2023, unlike previous studies that used monthly data, to analyse the correlation between the ASEAN stock market and currency rates (Liang *et al.*, 2013; Lin, 2012; Bahmani-Oskooee and Saha, 2018; Wongbangpo and Sharma, 2002). Moreover, we analyse the correlation between currency rates and stock markets using an augmented autoregressive distributed lag (ARDL) model of Pesaran *et al.* (2001), which has several advantages over Johansen's co-integration test (Johansen, 1991, 1995). In contrast to alternative techniques for assessing cointegration, the ARDL bound test is applicable regardless of whether the variables are $I(0)$, $I(1)$ or a combination of both. However, when the ARDL bound test is used, the series cannot be $I(2)$. Using the ordinary least squares (OLS) bound test approach, co-integration can be assessed

after determining the lag order of the model. Introducing lag variables in the ARDL technique helps prevent endogeneity.

In addition, we utilize the nonlinear ARDL (NARDL) model proposed by Shin *et al.* (2014), accounting for a partial sum decomposition of the explanatory variables to accommodate both short- and long-term asymmetries in the link between stock prices and exchange rates. Differentiating between positive and negative movements in stock values and between appreciation and depreciation of currencies introduces the asymmetry, we can test two hypotheses on the asymmetric impact of stock prices and currency rates using the NARDL methodology: that the impact is countercyclical, dominated by negative shocks and characterized by overshooting. To check for co-integration between the variables, a vector autoregressive model is also estimated using the Johansen method (Johansen, 1991, 1995). Applying the Granger (1969) causality test, these findings are utilized to ascertain which way the variables are causally related.

The remainder of the paper is arranged as follows: Section 2 comprehensively assesses the existing literature. Section 3 describes the empirical models employed in this study. Section 4 summarises the findings and examines their implications for policy choices. Section 5 reports the results of robustness tests, and Section 6 concludes the paper.

2. Literature review and hypothesis development

Worldwide, empirical research and publications over the last 30 years have investigated the correlation between stock prices and currencies. Nevertheless, existing findings provide conflicting information about the relationship between stock prices and currency rates or its magnitude. Inconclusive results have been obtained using different sample periods, variables and econometric methodologies. The research findings can be classified into three primary theories. First, the goods market theory states that as the home currency appreciates, exporters' shares become less appealing, which negatively affects not only exporters but also the stock markets of nations that heavily rely on exports. This theory presupposes an inverse relationship between exchange rates and stock markets. For example, assuming that Thailand is an export-oriented country, the goods market theory suggests that Thailand's stock market index is prone to decline due to the recent appreciation in the Thai Baht. Second, portfolio balance theory posits that the stock market has a causal effect on currency rates. However, the findings of related empirical research are inconsistent (Tian and Ma, 2010). Finally, the feedback theory suggests that there is a two-way link between stock prices and currency rates.

The good market theory posits a unidirectional association between currency rates and stock prices (Dimitrova, 2005). Wu (2001) demonstrates a one-way association between exchange rates and stock performance, which aligns with Pan *et al.* (2007), who discuss the correlation between the currency and stock markets. Dogan and Yalcin (2007), Kisaka and Mwasaru (2012) and Hsing and Hsieh (2012) report comparable outcomes in Turkey, China, Kenya and Poland. Liang *et al.* (2013) employed panel Granger causality and dynamic OLS (DOLS) techniques to analyse the links between ASEAN-5 equity and currency markets. Their results corroborate the "stock-oriented" exchange rate theory, positing that exchange rates negatively influence stock prices via capital movement. Wong (2017) indicates a negative and statistically significant association between exchange rate and stock returns in Malaysia, Singapore, Korea and the UK. Consistently, Sreenu (2023) uses the ARDL model to analyse how exchange rates influence stock returns in the Indian stock market and finds that exchange rates negatively impact stock returns. Similarly, Endri *et al.* (2020) and Tian *et al.* (2023) investigate the potential spillover from currency rates to stock markets and discover indications of asymmetry.

H1. Causality runs from the exchange rate to the stock market.

Second, portfolio balance theory posits a one-way causal relationship from stock prices to currency rates (Richards *et al.*, 2009). Kutty (2010) uses Granger causality to demonstrate that stock prices have a considerable short-term influence on exchange rates but finds no significant long-term link between the two factors. Wu *et al.* (2012) and Nusair and Olson (2022) find one-way Granger causality of stock indices on currency rates. However, Lin (2012) posits that during crisis periods, the association between exchange rates and stock prices is augmented.

H2. Causality runs from the stock market to the exchange rate.

Finally, according to feedback theory, stock prices and currency rates are bidirectionally related; that is, stock prices and currency affect one another. Several studies demonstrate a bidirectional connection in multiple countries. Wongbangpo and Sharma (2002) examined the correlation between exchange rates and stock prices in five ASEAN nations. They show that stock prices in these nations have a reciprocal relationship with exchange rates, as indicated by the Granger causality test. These findings are consistent with those of other studies (Caporale *et al.*, 2014; Rjoub, 2012; Rutledge *et al.*, 2014; Singhal *et al.*, 2022; Yang and Ma, 2012; Zhao, 2010) that each revealed a bidirectional relationship between stock prices and currency. Singhal *et al.* (2022) suggest that the Norwegian stock market and currency rates have a long-run equilibrium connection and discover a bidirectional relationship between them.

The neutrality hypothesis applies when there is no direct causal relationship between stock prices and currencies (Liu and Wan, 2012; Rutledge *et al.*, 2014). Mishra (2004) finds no indication of Granger causation between Indian stock performance and currency. Additionally, according to economic theory and as demonstrated by Chakraborty *et al.* (2015), a firm's level of involvement in international trade plays a crucial role in determining the extent and direction of its exposure to currency risk. The stock performance of companies focused on imports is shown to have a positive correlation with the dollar's performance. In contrast, the stock performance of companies focused on exports is negatively correlated with the dollar's performance. COVID-19 significantly impacted the global economy, especially in ASEAN regions, with foreign exchange rates being one of the most affected areas. Exchange-rate variations increase investment portfolio volatility. Syahri and Robiyanto (2020) examine how the exchange rate affected the Composite Stock Price Index (CSPI) and stock volatility during the COVID-19 pandemic, as well as the exchange rate–CSPI dynamic relationship. GARCH is used to determine how USD price fluctuations affect CSPI and stock volatility and reveals that CSPI and currency rates are negatively correlated.

Understanding the correlation between stock returns and foreign exchange rates can help investors manage risk and diversify portfolios. The existing finance literature is inconclusive regarding the relationship between exchange rate movements and stock returns. Owing to the unprecedented nature of the COVID-19 outbreak and its global economic impact, little literature specifically examines the relationship between stock returns and foreign exchange rates in the ASEAN+6 region during this period. This study sheds light on government policy and the global market's ability to control exchange rate volatility, which has influenced stock returns throughout the pandemic. Clarifying the relationship is crucial, as three main theories have been proposed. The goods market theory suggests that when the local currency strengthens, exporters suffer as their shares become less desirable, ultimately damaging the stock markets of countries that rely heavily on exports. Portfolio balance theory proposes a one-way causal relationship from stock prices to currency rates, while the feedback theory indicates that stock prices and currency rates have a bidirectional relationship. By providing

additional evidence with substantial implications for international investors' portfolio diversification decisions, this study fills a void in the literature.

Table A1 [2] provides summaries of some of the literature on the relationship between exchange rates and stock prices.

3. Data and methodology

Daily data were collected for the 12 ASEAN+6 countries for two variables: exchange rates (denoted by "*ex*") and stock prices for individual countries (denoted by "*sp*"). The sample period differs for each ASEAN+6 country due to data availability. The data were obtained from Refinitiv Eikon DataStream for the sample period from 2 January 2017 to 30 June 2023. Brunei, Cambodia, Laos and Myanmar were excluded as they lacked sufficient data. This study is based on Bahmani-Oskooee and Saha (2018) and Nusair and Olson (2022). While Bahmani-Oskooee and Saha (2018) use monthly time series data from 24 countries and the NARDL approach to demonstrate that exchange rate fluctuations may have asymmetric effects on stock prices. This result also holds true when they consider how fluctuations in stock prices affect currency values. Asymmetric co-integration receives comparatively more support than symmetric co-integration when nonlinearity is introduced.

Nusair and Olson (2022) investigate the short- and long-term relationships between stock prices and exchange rates in the G7 nations using both linear ARDL and NARDL models. In the short term, support is found for both the flow-oriented and portfolio-balance theories. In four of the countries, the NARDL model provides evidence in favour of the portfolio balancing strategy, but neither model is supported over the long term with linear ARDL models. This study's methodology examines the relationships and interactions between stock prices and currency rates. The long-term correlation between the two variables is shown in equation (1):

$$sp_t = \alpha_0 + \alpha_1 ex_t + \varepsilon_t, \tag{1}$$

where α_0 and α_1 are constant and independent variable parameters, respectively, while ε_t is the white noise term. The logarithmic form is used for the variables. An increase in the effective exchange rate denotes strengthening of the ASEAN+6 country currency being investigated.

Equation (1) tests the flow-oriented model's claim that exchange rates impact stock prices (also known as the product market method). Accordingly, equation (1) solely accounts for the long-term impact of stock prices on exchange rate fluctuations. Equation (1) can be transformed into an error-correction model to account for short-term impacts. However, because it estimates both short- and long-run effects in a single phase, Pesaran *et al.'s* (2001) ARDL is a practical solution. Another useful feature of the ARDL model is its ability to be applied whether the variables are $I(0)$, $I(1)$ or a combination of both (Pesaran *et al.*, 2001). The co-integration model can be expressed as in equation (2):

$$\Delta sp_t = \beta_0 + \beta_1 sp_{t-1} + \beta_2 ex_{t-1} + \sum_{i=1}^{n} \beta_{3i} \Delta sp_{t-i} + \sum_{i=1}^{n} \beta_{4i} \Delta ex_{t-i} + \beta_5 D_{jt} + \mu_t, \tag{2}$$

where Δ indicates the first difference, and β_0 denotes the constant parameter. The summation signs represent the error correction dynamics, whereas $\beta_1, \beta_2, \beta_3$ and β_4 are long-run multipliers corresponding to long-run connections, and β_5 represents the dummy variable coefficient. The null hypothesis in both equations is $\beta_1 = \beta_2 = 0$, in other words, that there is no long-term link between the variables, while μ_t is a random error term with zero mean and finite variance. The Wald F-test was used to examine this relationship. The F-statistic and upper and lower critical values are determined by the combined significance of the lagged values of the variables in the equation. When F-statistics are above the upper and below the

lower critical values, co-integration exists. The outcome is considered inconclusive if the F-statistic lies between the upper and lower bounds. D_{jt} is a vector of j dummy variables, where $D_{jt} = 1$ if observation t belongs to the jth period and 0 otherwise. The dummy variables included in the ARDL and NARDL models are: D_{1t} for the period from 1 January 2020 to 23 February 2023 to capture the effect of the COVID-19 pandemic and D_{2t} for the period from 24 February 2023 to 30 June 2023 to capture the effect of the Russia–Ukraine war.

The co-integrating equation (3) is approximated using the long-term error, commonly known as the error correction term (ECT) in the error correction model, after co-integration among the variables has been established. It provides a long-term indication of how quickly the variables shift, which, in turn, provides insights into the relationship's stability.

$$\Delta sp_t = \gamma_0 + \sum_{i=1}^{n} \gamma_1 \Delta sp_{t-1} + \sum_{i=1}^{n} \gamma_2 \Delta ex_{t-1} + \theta ECT_{t-1} + \mu_t, \tag{3}$$

where ECT_{t-1} denotes the long-run rate of adjustment following the shock. To evaluate the model's goodness-of-fit, diagnostic tests such as functional form, serial correlation, non-normality and heteroskedasticity tests were performed.

According to Pesaran et al. (2001), using the linear ARDL model shows that stock prices symmetrically react to changes in exchange rates. However, considering the discussion of asymmetry in the relationship between stock prices and exchange rates, this assumption might not hold. We use the Shin et al. (2014) NARDL model, an asymmetric enlargement of Pesaran et al.'s (2001) linear ARDL model, to account for relationship asymmetries. According to Shin et al. (2014), the asymmetric long-run relationship can be defined as in equation (4):

$$sp_t = \alpha_0 + \delta^+ ex_t^+ + \delta^- ex_t^- + \mu_t, \tag{4}$$

where ex_t^+ and ex_t^- are partial sum processes of positive and negative changes in exchange rates, calculated as in equations (5) and (6):

$$ex_t^+ = \sum_{i=1}^{t} \Delta ex_t^+ = \sum_{j=1}^{t} \max(\Delta ex_i, 0), \tag{5}$$

$$ex_t^- = \sum_{i=1}^{t} \Delta ex_t^- = \sum_{j=1}^{t} \min(\Delta ex_i, 0), \tag{6}$$

where Δex_t^+ and Δex_t^- represent positive and negative exchange rate changes, respectively, indicating depreciation and appreciation of the home currency. Therefore, the long-run parameters $\delta+$ and $\delta-$ represent the effects of appreciation and depreciation, respectively, of the native currency. The NARDL model (equation (7)) is then derived by substituting $ex+$ and $ex-$ for the exchange rates in the linear ARDL model in equation (3), in accordance with Shin et al. (2014):

$$\Delta sp_t = \beta_0 + \beta_1 sp_{t-1} + \beta_2^+ ex_{t-1}^+ + \beta_{2i}^- ex_{t-i}^- + \sum_{i=1}^{n} \beta_{3i} \Delta sp_{t-i} + \sum_{i=1}^{n} \beta_{4i}^+ \Delta ex_{t-i}^+ + \sum_{i=1}^{n} \beta_{4i}^- \Delta ex_{t-i}^-$$

$$+ \beta_5 D_{jt} + \mu_t. \tag{7}$$

Equations (1) through (7) are modified to investigate the portfolio balance theory by swapping the dependent and independent variables. This provides us with the subsequent ARDL models, both linear (equation (8)) and nonlinear (equation (9)):

$$\Delta ex_t = \beta_0 + \beta_1 ex_{t-1} + \beta_2 sp_{t-1} + \sum_{i=1}^{n} \beta_{3i} \Delta ex_{t-i} + \sum_{i=1}^{n} \beta_{4i} \Delta sp_{t-i} + \beta_5 D_{jt} + \mu_t, \qquad (8)$$

$$\Delta ex_t = \beta_0 + \beta_1 ex_{t-1} + \beta_2^+ sp_{t-1}^+ + \beta_{2i}^- sp_{t-i}^- + \sum_{i=1}^{n} \beta_{3i} \Delta ex_{t-i} + \sum_{i=1}^{n} \beta_{4i}^+ \Delta sp_{t-i}^+ + \sum_{i=1}^{n} \beta_{4i}^- \Delta sp_{t-i}^-$$
$$+ \beta_5 D_{jt} + \mu_t, \qquad (9)$$

where sp_t^+ and sp_t^- are defined as partial sum processes of positive and negative changes in stock prices.

4. Empirical results

Figure A1 [2] illustrates the two variables for each country across the sample period to examine any potential co-movement between each country's exchange rate and stock prices. The stock price index is represented by the solid blue line (left scale), whereas the nominal effective exchange rate is represented by the dashed red line (right scale). Generally, all panels in Figure A1 [2] show similar trends in exchange rates and index prices. Although the degree of co-movement varies among the ASEAN+6 nations, a visual assessment reveals that the two variables moved together to some extent. Specifically, the findings suggest that variations in stock market index values may impact changes in exchange rates. Existing literature shows that fluctuations in each nation's exchange rate can be attributed to the volatility of stock market indices. Figure A1 [2] demonstrates the volatility of the stock market indices of ASEAN+6 nations compared with their exchange rates.

Descriptive statistics for the ASEAN+6 stock prices and exchange rates are reported in Tables A2 [2] and A3 [2], respectively. Table A2 [2] shows that ASEAN+6 stock prices are positive on average, and the VNE and TSE have the lowest and highest daily means, respectively. In terms of risk, the KLSE and TSE movements in the stock market indices of Malaysia and Japan show the smallest and largest standard deviations, respectively, than the other ASEAN+6 nations. Table A3 [2] demonstrates that ASEAN+6 exchange rates are positive on average. VND had the highest level of depreciation over the period under consideration, followed by IDR, whereas SGD appeared to be the strongest, with the lowest standard deviation. Essentially, SGD enjoys a relatively stable exchange rate on average over the study period. The null hypothesis of a normal distribution could potentially be rejected in every situation, according to the skewness, kurtosis and Jarque–Bera statistical probability in both tables.

Tables A2 [2] and A3 [2] also report the results of the unit root tests. These tests are applied to the variable levels and first differences, including constant and time trends. For the augmented Dickey–Fuller (ADF), Dickey–Fuller generalized least squares (DF-GLS) and Phillips–Perron (PP) tests, the null hypothesis is that the series is non-stationary, whereas the opposite is true for the Kwiatkowski–Phillips–Schmidt–Shin (KPSS) test. According to the four tests, all variables are non-stationary in their levels but stationary in their first differences, which rules out the possibility of $I(2)$ variables. In addition, it is critical to check the variables for structural breaks (SB) given the lengthy and unstable sample period. A structural break test developed by Zivot and Andrews (ZA) was used to achieve this goal. Although break dates vary among ASEAN+6 nations, they typically coincide with significant occasions that occurred throughout the sample period.

4.1 The goods market theory

To investigate how exchange rate fluctuations impact stock prices and determine whether they are symmetrical or asymmetrical, the goods market theory is applied (also known as the flow-oriented model). Accordingly, OLS was used to estimate the ARDL models. The best number of lags is calculated using the Akaike information criterion (AIC) with a maximum of 12 lags. Table A4 [2] presents the outcomes of the linear ARDL model estimation. The table includes short- and long-run estimations in Panels A and B and various diagnostic tests in Panel C. Focusing on the short-run impacts of exchange rate fluctuations on stock prices, Panel A demonstrates that all nations have at least one statistically significant coefficient. This suggests that exchange rate fluctuations affect stock prices in the short-run in ASEAN+6 nations. The impact is negative in all countries except Japan, implying that these nations' stock values increase as a result of currency depreciation. This finding implies that the nations have more export-oriented businesses. Therefore, currency depreciation enhances their ability to compete globally, leading to increased exports, predicted cash flows and stock values.

Panel B's long-run estimations show that exchange rates have substantial coefficients only in Korea and Singapore. Curiously, in both countries, the long-run coefficient estimate is negative, suggesting that over time, currency depreciation raises stock prices. Nevertheless, the F statistics in Panel C are significant only for Singapore, indicating co-integration. The relevance of the error correction term (ECM_{t-1}) can also be examined to determine cointegration; a significant and negative ECM_{t-1} indicates co-integration. According to Panel C, this term is significant and negative for India at the 10% level; Australia, Indonesia, Thailand and Vietnam at the 5% level; and China, Japan, Korea, Malaysia, New Zealand, the Philippines and Singapore at the 1% level. These findings imply either no or weak evidence of co-integration. The finding of a significant short-run relationship and some long-run relationships between exchange rates and stock prices is generally consistent with earlier research (Bahmani-Oskooee and Saha, 2018; Nusair and Olson, 2022). Finally, the diagnostic checks indicate neither functional misspecification nor residual serial correlation, and the computed coefficients are generally stable.

The series under investigation's short- and long-term linear effects (the symmetric relationship) are captured by the ARDL model. The asymmetric relationship between the series under examination or the results of a quick shift in the variables, is not captured using this method. Additionally, the estimation of both short- and long-term asymmetries can be done simultaneously using the NARDL model. To determine whether exchange rate fluctuations have symmetric or asymmetric effects on stock prices in each nation, we turn to the NARDL model estimates; Table A5 [2] reports these findings. Since Δex_t^+ and Δex_t^- contain distinct lag orders, we discover "adjustment asymmetry" in all ASEAN+6 nations based on the short-run estimates. The long-term findings in Panel B show that ex_t^+ or ex_t^- carry substantial coefficients in Australia, Indonesia, Korea, Malaysia, the Philippines, Singapore and Vietnam, which is corroborated by one of the cointegration significance tests. The number of countries in which appreciation, depreciation or both may have substantial long-term impacts on stock prices appears to expand with the introduction of the nonlinear exchange rate adjustment; the coefficient of ECM_{t-1} is significant in all ASEAN+6 countries. Regarding the other statistics, since the LM statistic is negligible in all optimal models except those of Australia, Indonesia and New Zealand, serial correlation is not indicated in any of the models. Additionally, most models show that the RESET statistic is negligible, particularly in the seven nations (Australia, India, Indonesia, Japan, Malaysia, the Philippines and Singapore) where co-integration was found. Consequently, the ideal models are appropriately identified for the nations where co-integration is present. Finally, the CUSUM tests indicate that nearly all the predicted coefficients are stable.

4.2 The portfolio balance theory
In light of the previous results of testing the flow-oriented model and the absence of a substantial long-run relationship between stock prices and exchange rates in all circumstances, the portfolio balance theory, sometimes referred to as the stock-oriented model, is investigated next. The outcomes of the ARDL model are shown in Table A6 [2]; the short- and long-run estimates are presented in Panels A and B, respectively, and certain diagnostic checks are presented in Panel C. According to Panel A of Table A6 [2], stock price fluctuations significantly impact the exchange rates of all countries in the short run. Additionally, Panel B shows that the long-run coefficient estimates are significant for Japan and Malaysia at the 5% level and for China at the 1% level. However, in the co-integration test results in Panel C of Table A6 [2], a comparison of F statistics and ECM_{t-1} reveals support for co-integration for all ASEAN+6 countries. Stock price impacts on exchange rates are primarily short-term, and no proof of co-integration or a strong long-term association is found. According to the diagnostic checks, the models are free of serial correlation and functional misspecification, and the estimates are stable.

Our short-run findings, which suggest a bidirectional link between stock prices and exchange rates, are consistent with most research on this topic (Rutledge *et al.*, 2014; Singhal *et al.*, 2022; Yang and Ma, 2012; Zhao, 2010). However, our long-run findings suggest a more complex relationship between stock prices and currency rates than those of other studies. This study demonstrates a limited but significant long-term correlation that supports using a portfolio-balancing approach in certain ASEAN+6 countries. This finding is consistent with those of previous studies (Nusair and Olson, 2022; Singhal *et al.*, 2022) that also demonstrate that the stock market has a moderate long-term impact on exchange rates.

Table A7 [2] indicates that stock price fluctuations markedly impact exchange rates in the short term. This is primarily because both Δsp_t^+ and Δsp_t^- have at least one significant coefficient. The nonlinear model produces notable short-term consequences in more nations than the linear model does. Moreover, evidence shows both short-run asymmetric effects and short-run adjustment asymmetry in most of our sample nations. Along with the lag lengths, Δsp_t^+ and Δsp_t^- also have differing short-run estimates in terms of size and sign. We find evidence of substantial long-run asymmetric impacts in China, India, Japan, Korea, Malaysia and Vietnam when we consider the long-term effects of changes in stock values on currency rates. Either sp_t^+ or sp_t^- had significant coefficients in these nations. All ASEAN+6 countries appear to have substantial coefficients for ECM_{t-1}. Regarding the other statistics, none of the models showed any signs of serial correlation based on the low LM statistic in all optimal models – except for Vietnam. Furthermore, most models indicate that the RESET statistic is insignificant, especially in the seven countries (India, Indonesia, Japan, Korea, Malaysia, New Zealand and Vietnam) where co-integration was detected. Consequently, the optimal models are suitable for the countries in which co-integration occurs. Finally, almost all the projected coefficients are stable, according to the CUSUM tests.

5. Robustness checks
We now investigate the relationship between exchange rates and stock prices in each country using a vector autoregressive model to verify the validity of our main findings. Applying the Johansen approach (Johansen, 1991, 1995), a vector autoregressive model is utilised to test for co-integration between variables. The Granger (1969) causality test is then used to establish the direction of causation between the variables. According to Table A8 [2], the findings are consistent with those of the ARDL models in that no evidence exists of co-integration between exchange rates and stock prices except in Singapore. In Australia, China, India, Japan and Korea, a Granger causality test demonstrates evidence of causality from stock prices to exchange rates but no reverse causality. This lends credence to the portfolio balance concept,

which holds that exchange rates are influenced by stock prices. For Singapore, we find evidence of Granger causality from exchange rates to stock prices, supporting the flow-oriented model; however, this link is not supported in the other ASEAN+6 nations.

6. Conclusion

This study collects daily data from 2 January 2017 to 30 June 2023 to analyse the correlation between stock prices and exchange rates in ASEAN+6 countries. Using linear ARDL and NARDL models, we determine whether the goods market theory, which holds that changes in exchange rates affect stock prices, is more accurate than portfolio balance theory, which holds that changes in stock prices affect exchange rates. The study evidence reveals that both models are more likely to occur in the short run than in the long run. Stock prices have a major short-run impact on exchange rates in all ASEAN+6 countries, and exchange rates have a short-run impact on stock prices in all ASEAN+6 countries. Consequently, currency markets and stock markets are correlated with the short term. Conversely, portfolio balance theory is strongly supported over the long term, whereas the good market theory model is not. Except for our study's increased endorsement of the portfolio balancing strategy compared to other research, our findings align closely with the existing body of knowledge.

Changes in stock prices have only short-term effects on the exchange rates of all ASEAN+6 countries but have both short- and long-term effects on those of China, India, Japan, Korea, Malaysia and Vietnam. Consistent with portfolio balance theory, the results show that rising (falling) stock values cause the dollar to appreciate (depreciate) in the near term. However, rising stock prices over time result in currency depreciation, which is contrary to the portfolio balance strategy. Therefore, the overall conclusions from our ARDL models offer strong support for portfolio balance theory in terms of how stock prices affect exchange rates.

Both investors and policymakers should regard these findings as significant and worthy of careful consideration. All ASEAN+6 countries are affected by short-term interactions between the two markets. Because changes in stock prices or currency rates occur rapidly and reach other markets, decision-makers should be aware of this connection. Our findings suggest that measures that reduce stock market uncertainty may reduce exchange rate volatility in ASEAN+6 countries. Therefore, actions to calm stock markets could also stabilise foreign exchange markets. Additionally, decision-makers should understand that domestic stock prices affect a nation's exchange rate over the long term, but not vice versa. Therefore, trying to influence exchange rates in the long run to enhance stock markets and/or using data from foreign currency markets to forecast stock prices may not be the best course of action. Finally, since exchange rate and stock price fluctuations have short-term impacts on one another, investors may be able to use data from one market to assist in forecasting another market's behaviour for short-term hedging and speculation.

Notes

1. The ASEAN+6 countries including: ASEAN: Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, the Philippines, Singapore, Thailand and Vietnam; +6 countries: Australia, China, India, Japan, South Korea and New Zealand.

2. Please see it in the Online Appendix.

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Supplementary online appendix
The supplementary material for this article can be found online.

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