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G20 PRESIDENCY AND THE ECONOMIC SYMBIOSIS OF INDIA AND INDONESIA BASED ON THE STOCK MARKET, EXCHANGE RATE, AND FOREIGN TRADE

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ABSTRACT

Introduction/Main Objectives: The primary aim of the research is to assess the long-run and short-run dynamic interaction of the stock market, exchange rate and foreign trade between India and Indonesia during the period covered by their successive G20 presidencies. **Background Problems:** Given the economic significance of India and Indonesia, it is important to examine the performance of their stock market, exchange rate and foreign trade, and explore any connections between them, with the two-year period covered by their recent G20 presidencies providing an interesting window. **Novelty:** Despite India and Indonesia being emerging economic powerhouses, there are no studies exploring their economic nexus in the context of their successive G20 presidencies. This period is chosen because under the G20 framework, both countries intensified their economic and climate collaboration, in turn enhancing their interdependence to make it pivotal. **Research Methods:** This study examines the empirical relationship between exchange rates, foreign trade, and the stock market indices of India and Indonesia during their G20 presidencies. It analyses historical data from December 2021 to November 2023 using econometric methods to understand the dynamic interactions among these variables. **Finding/Results:** Over the two years analysed, all economic variables are non-stationary and integrated at level one. Johansen's cointegration test shows long-run equilibrium between the chosen variables. The VECM suggests that short-run deviations in the JKSE are corrected by other variables. The OLS regression finds that changes in the JKSE are significantly explained by Indonesia's net trade. Additionally, the study confirms short-run interaction between the selected economic variables. **Conclusion:**The study uncovers connections between India and Indonesia's key economic variables, empowering both countries to make informed decisions on bilateral trade, currency policies, and economic cooperation. This understanding of short-term dynamics and long-term associations also assists investors in shaping investment strategies and managing risks effectively.

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INTRODUCTION

The stock market, exchange rate and foreign trade are crucial economic indicators that provide accurate insights into a country's economic health. The stock market reflects the performance of listed companies and also acts as a barometer of investor confidence in the country's economy. The exchange rate is also a vital economic indicator, impacting the country's trade balance and foreign trade competitiveness, as well as influencing inflation and interest rates domestically. Stable currency values indicate confidence in the country's economic stability. Foreign trade, comprising exports, imports and net trade, is a comprehensive measure and indicator of the economic performance of a nation with outside world. Growth in foreign trade signifies increased economic exchange and economic integration with other nations. Conversely, a decline in foreign trade signals economic downturn or protectionist policies. These indicators are not exhaustive but give a snapshot of the economic condition of a country.

The increase in trade and strategic partnership between Indonesia and India during the period covered by theirsuccessiveG20 presidencies in 2022 and 2023 highlights the need to monitor the economic indicators outlined above to better understand their evolving economic relationship and the broader impact on stability and growth. India and Indonesia are among the largest democracies in the world and share a long-standing friendship; their diplomatic relationship was established way back in 1951. They are involved in significant bilateral trade and have agreed to establish a strategic partnership. The relationship between the two countries goes beyond economic benefits. They have a shared vision of maritime cooperation in the Indo Pacific and very strong political, cultural and religious ties. Bilateral trade has increased over time, from US$ 4.3 billion in 2005–06 to US$ 38.84 billion in 2022–23, and was targeted to reach $50 billion by 2025. Among other products, India mainly imports coal, crude palm oil, rubber, minerals, and paper from Indonesia and in turn exports commercial vehicles, refined petroleum, agricultural commodities, and telecommunications equipment to Indonesia.

India and Indonesia are two important sovereign countries in the G20, an intergovernmental forum that includes 19 countries, the European Union, and the African Union. The main objective of the G20 is to address pressing global issues such as reducing the impact of climate change, ensuring global financial stability, and promoting development. Indonesia's G20 presidency commenced on December 1, 2021 and ended on November 30, 2022. The Bali submit hosted by Indonesia was the 17thmeeting of the G20, and the first to be held since the start of Russia–Ukraine war. It took place at a time of geo-political strain, economic slump, and increasing food and energy prices. Alongside other G20 countries, India and Indonesia played an important role in resolving geo-political differences and arriving at a final summit declaration. India assumed presidency of the G20 after Indonesia, marking a significant turning point in its global leadership role. Inclusive growth, digital innovation, climate resilience, and equitable access to international health care were top priorities during India's presidency, under the motto—"One Earth, One Family, One Future".

Considering the economic and strategic significance of India and Indonesia, it is intriguing and at the same time important to assess their stock market, exchange rate, and foreign trade as indicators of their economic performance, and further, whether their economies exhibited any nexus over their

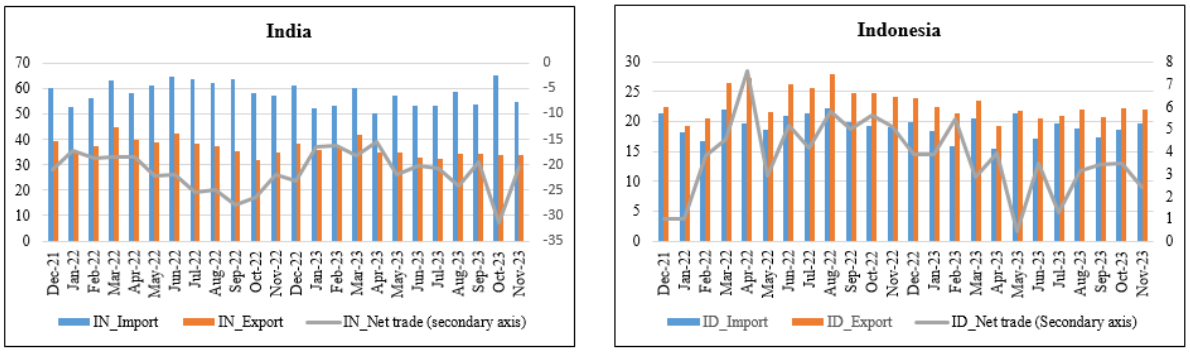
combined G20 presidency period. Notwithstanding the COVID-19 epidemic, it is evident that India's core economic metrics have shown resilience and stability in recent times (Roy-Chaudhury & de Estrada, 2018). Research carried out in India and more widely has strongly linked macroeconomic variables, economic growth and the stock market (Abbas et al., 2019; Mohanasundaram&Karthikeyan, 2015; Thaddeus et al., 2024).Over the past two decades, India has witnessed substantial improvements in its economic and stock market performance, marked by noteworthy increases in exports, foreign exchange reserves, foreign investment, and a reduction in inflation. The evolution of the Indian stock market, with the introduction of innovative trading assets, procedural modifications, an expanded network of participants, and other significant developments, has prompted experts to reassess the correlation between the stock market and other economic variables. Indonesia has also undergone significant economic transformation in recent decades following the 1997–98 Asian Financial Crisis. Structural reforms and strengthened regulatory oversight have promoted sustained economic growth, making it one of Southeast Asia's largest economies. The stock market has expanded considerably in terms of market capitalization, sectoral diversification, and investor participation.

The bilateral trade and investment between India and Indonesia have created numerous economic benefits across various sectors. As depicted in Figure 1, both India and Indonesia enjoyed a surge in their mutual foreign trade during the two years covered by their G20 presidencies. The G20 presidencies of these two nations showcased their geopolitical and economic potential. The two-year period covering their successive G20 presidencies provides an ideal window to examine the dynamic interplay of economic variables between the two countries. Accordingly, this study aims to investigate the interrelationship between their stock markets, exchange rate and foreign trade from December 2021 to November 2023. Assessing the behavior and connection between these economic variables in both the long and short run is crucial for informing investment, regulatory, and policy decisions for investors and stakeholders.

LITERATURE REVIEW

Several theoretical frameworks addressing market interconnections and the influence of price, information, and size of economy have been applied in studies of economic and financial market integration. The law of one price (LOP), efficient market hypothesis (EMH),

Figure 1. Trends in Foreign Trade of India and Indonesia



Source: Authors based on data collected from www.tradingeconomics.com

and gravitational models are prominent examples. According to LOP, identical assets should have same price after adjusting for exchange rates and transaction costs. Van Tassel (2020)Also applying LOP, Yeyati et al. (2009) studied the price differences between domestic stocks and their depositary receipts (DRs) in global markets. They found that liquidity and capital controls are important factors in how quickly prices align, with more liquid stocks adjusting faster. Agoraki et al. (2019) analysed data from four major markets and found partial evidence of cointegration among stock indices, with temporary price differences adjusting at varying speeds, indicating partial adherence to the LOP.

The second framework, EMH, states that it is impossible to earn consistent returns that are higher than the market average on a risk-adjusted basis. It proposes that markets are highly integrated so information spreads faster, with no opportunity for arbitrage. Elangovan et al. (2022)applied EMH to examine the Indian stock market's weak-form efficiency, finding that deviations are mainly caused by low liquidity and regulatory gaps. An EMH study by Dong et al. (2013) examined 44 indices to assess the causal connections of global financial markets. The findings provide long-term evidence of EMH violations. Borges (2010) analysed the stock markets of the UK, France, Germany, Spain, Greece, and Portugal from January 1993 to December 2007, finding mixed evidence for EMH. The data for France and the UK did not support EMH, while Germany and Spain were the most efficient.

Gravitational models, initially developed for trade flows, have been applied to assess stock market integration using economy size, distance, and institutional factors. Flavin et al. (2002) used gravity models to study stock market connections, identifying factors like shared borders and similar trading hours as strongly influencing market integration. Based on an extended gravity model, Bonga-Bonga and Manguzvane (2023) examined the effect of geographical distance on stock market correlations within the EU and NAFTA. The results indicated that distance reduces correlations, but the effect is weaker in economically integrated blocs. Unlike previous studies, this suggests that foreign investors can reallocate portfolios to seek high returns and safe havens amid capital market liberalization. While researchers have used the LOP, EMH, and gravitational models to study market connections, PPP/cointegration — a variant of LOP — is more commonly applied to analyse economic variables over time. It establishes long-term links, enabling error correction to align price differences across markets.

Many research studies on stock markets have been carried out in the past. In order to grasp the complexities of how different stock markets are linked, it is crucial to understand how they interact with each other. One key aspect of stock market interactions is their impact on portfolio diversification, with diversification benefits observed to diminish with increasing convergence in stock markets (Worthington & Higgs, 2004). A wide-ranging study on stock market integration across both developed and emerging economies revealed significant impacts on investment decisions and risk perceptions (Ali et al., 2011). A number of studies have examined market integration in the context of Asian markets(Lee & Chou, 2012). Kusumah et al. (2022)found that Asian markets exhibited unidirectional relationships during the Asian financial crisis, whereas the subprime crisis led to bidirectional relationships among developed nations. Abdul Karim and Xin Ning (2013) delved into the consequential effects on integration of economic fundamentals, portfolio

inflows, and the dynamics of stock markets, reporting that trade and market volatility were significant factors.

Numerous empirical studies around the world have reported findings that are inconsistent with the EMH (Frankfurter & McGoun, 2000; Woo et al., 2020). Danila (2023) investigated the impact of macroeconomic variables on the volatility of the Indonesian Islamic stock market, finding that inflation and short-term interest rates had a positive effect on market volatility following the 2008 financial crisis. Discrepancies in financial markets are termed anomalies, and these irregularities may either be short- lived or reoccur (Latif et al., 2011; Lizarzaburu Bolanos et al., 2015). Few studies have focused on interactions between macroeconomic variables and stock markets. In their study involving Taiwan, Hong Kong, and China, Lai et al.(2013) noted that foreign stock markets have a bigger impact on the local stock market compared to domestic macroeconomic variables. Barakat et al. (2016)analysed the connection between macroeconomic factors and the stock markets of Egypt and Tunisia, identifying the presence of a causal relationship and cointegration between the variables in these developing countries. In a study of developed countries, Camilleri et al. (2019)discovered that stock prices displayed a significant relationship with inflation in Belgium, France, Germany, the Netherlands, and Portugal. Moreover, they observed that stock prices led industrial production in four of the five nations studied.

Numerous studies have examined the cointegration of stock markets. Wuthisatian (2015) examined the existence of cointegration links between Thailand and its 11 primary trading markets by studying daily stock prices from 1997 to 2013. The results indicated a weak long-term connection between Thailand and the selected economies, offering advantageous opportunities for investors through portfolio diversification. India, like Indonesia, has been experiencing a substantial increase in foreign investment in recent decades, which bodes well for the growth of its stock market (Mohanasundaram & Karthikeyan, 2015). As countries become more economically integrated, there is an argument that their financial markets will also follow suit. This is significant as the global integration of financial markets has been shown to diminish the advantages of portfolio diversification and amplify the risk of contagion (Paramati et al., 2016). Furthermore, Caporale et al. (2019)found that Asia is more connected to the global financial system than to its neighbouring regions, and this connection is growing. The United States, in particular, has had a big influence on Asian financial markets. For example, Sutha and Vanitha(2020) identified co-movement and causal connection between the global stock market, exchange rates, and the Indian stock market, suggesting that investors should consider diversifying their investment portfolios in the long term.

Relatedly, Gupta and Agarwal (2011) analysed the cointegration of India's stock market with several Asian stock markets. The results indicated that since there is a long-term equilibrium among the markets, foreign investors from China, Japan, Hong Kong, Singapore, and South Korea would not gain from diversifying their portfolios to include the Indian stock market. Conversely, Saji (2022)reported limited price convergence in Asian markets. The asymmetrical stock price relationships they identified in Asia have notable implications for the pricing efficiency of national markets, presenting opportunities for global investors to enhance returns through diversified portfolios across key regional stock markets. More widely, Mishra and Mishra (2022) found the COVID-19 pandemic weakened the equity market

performance and market integration of BRIC nations. Narrowing the focus to Indonesia, numerous studies have been conducted on stock market integration in Indonesia. Sharma et al. (2019) explored the price discovery process in the Indonesian stock market, revealing that pricing behavior is influenced by the credit risk market. Octavia and Wijaya (2020)reported cointegration and causality relationships between the Indonesian stock market and selected global stock markets including India. Overall, the research suggests improved opportunities for global portfolio diversification and emphasizes the importance of managing macroeconomic risks, such as inflation, interest rates, and exchange rate fluctuations, to support stable economic conditions and long-term equity market integration during crises.

A considerable body of research has modeled stock market volatility, with numerous recent studies analysing volatility spillover, both before and after the COVID-19 pandemic. Prior to the pandemic, Jebran and Iqbal (2016) examined the spillover effects of returns and volatility across Asian stock markets. They identified a bilateral spillover between China and Japan for both returns and volatility. Furthermore, two-way volatility spillover was observed between Hong Kong and Sri Lanka, as well as between China and Sri Lanka. Another pre-pandemic study by Dey & Sampath (2020) analysed the volatility and spillover returns of five major Indian financial assets, revealing that India is susceptible to shocks from the US economy, particularly those emanating from the gold and forex markets. Endri et al. (2020) examined the impact of macroeconomic variables and stock indices on the Indonesian stock exchange, identifying combined effects alongside global stock indices on increased market volatility.

Certain studies have specifically looked into how the COVID-19 pandemic has affected the Indonesian stock market. Rahmayani and Oktavilia (2020) established both short-term and long-term impacts. In the short term, foreign interest rates and commodity prices have been positive factors for the stock market, while the exchange rate has seen a negative effect. The other variables, like domestic and foreign interest rate, inflation, and total cases accumulative of Covid-19, have no significant effect on Indonesia's stock market in the short-term. Looking at the long term, the pandemic has negatively affected the stock market. Nugroho et al. (2022) analysed the short-term impact of the COVID-19 pandemic on Indonesian stock prices to find that almost all economic sectors were affected similarly. However, investors' perception of the finance sector was more favourable relative to other sectors during the pandemic. Thangamuthu et al. (2022) investigated spillover effects from other countries on stock market volatility in India before and after the pandemic. Pre-COVID, there was a substantial negative volatility spillover from Australia, China, Japan, and Germany, which persisted post-COVID. Additionally, a positive return and volatility spillover from the US market to the Indian stock market was observed in the post-COVID-19 period. Table 1 summarizes the development of research relevant to the study context over time, serving as a key tool for identifying research gaps.

Table 1. A comprehensive table summarizing the literature review

Existing studies	Focus / Outcome
Stock Market integration studies	
Worthington & Higgs (2004)	The integration of stock markets led to reduced benefits from investment diversification.
Ali et al. (2011)	Stock market integration revealed significant effects on investment decisions and risk perceptions.
Gupta & Agarwal (2011)	Asian markets showed long-term equilibrium, limiting diversification benefits for investors from China, Japan, Hong Kong, Singapore, and South Korea.
Lee & Chou (2012)	Trading activity in Asian emerging markets directly boosted market integration and intensified volatility.
Abdul Karim & Xin Ning (2013)	Examined the impact of market integration on economic fundamentals, portfolio inflows, and stock markets, highlighting trade and volatility.
Barakat et al. (2016)	Discovered cointegration and causality between macroeconomic factors and the stock market in Egypt and Tunisia.
Wuthisatian (2015)	Identified a subtle long-term cointegration between Thailand and 11 key trading markets.
Paramati et al. (2016)	Economic integration increased financial market unification,thus reducing diversification benefits and increasing contagion risks.
Caporale & Chen (2019)	Asia is increasingly tied to the global financial system, with strong U.S. influence on its markets.
Octavia & Wijaya (2020)	Exposed cointegration and causality between global markets, including India and Indonesia, emphasizing portfolio diversification and macroeconomic risk management for long-term stability during crises.
Sutha & Vanitha (2020)	The global market, exchange rates, and Indian stock market showed co-movement and causal links, with implications for long-term portfolio diversification.
Mishra & Mishra (2022)	Analysed COVID-19's impact on equity market performance and integration in BRIC nations.
Effect of macroeconomic variables on stock markets and other related studies	
Lai et al. (2013)	Foreign stock markets showed a bigger impact on the local stock market compared to domestic macroeconomic variables.
Lizarzaburu Bolanos et al. (2015)	Focused on anomalies in financial markets, finding them to be short-lived.
Mohanasundaram & Karthikeyan (2015)	India and Indonesia’s foreign investment surge has driven stock market growth.
Camilleri et al. (2019)	Stock prices led inflation in Belgium, France, Germany, the Netherlands, and Portugal, and industrial production in four of these nations.
Sharma et al. (2019)	Credit risk market influenced pricing behavior on the Indonesian stock exchange.
Endri et al. (2020)	Macroeconomic variables and global stock indices, together, influenced volatility on the Indonesian stock exchange.
Rahmayani & Oktavilia (2020)	COVID-19 negatively impacted Indonesia's stock market in the long-run. In the short-run, foreign interest rates and commodity prices had a positive impact, while the exchange rate had a negative effect. The other variables, like domestic interest rate, inflation, and total cases accumulative of Covid-19, have no significant effect on Indonesia’s stock market in the short-term.
Woo et al. (2020)	Results supported Efficient Market Hypothesis.

Existing studies	Focus / Outcome
Kusumah et al. (2022)	Asian markets showed unidirectional relationships during the Asian financial crisis, while the subprime crisis fostered bidirectional relationships among developed nations.
Nugroho et al. (2022)	Investors' perception of the finance sector was more favourable compared to other sectors during the pandemic.
Saji (2022)	Limited price convergence and asymmetrical stock relations in Asia offer portfolio opportunities for global investors.
Thangamuthu et al. (2022)	India experienced negative spillovers from Australia, China, Japan, and Germany both pre-and post-Covid 19, and positive spillover from the US market post-COVID.
Danila (2023)	Inflation and short-term interest rates positively influenced market volatility after the 2008 crisis.

While existing research studies have explored the connection between economies and stock markets, few studies have specifically examined the relationship between the economy and financial markets in India and Indonesia (Gupta & Agarwal, 2011; Seth & Panda, 2019).Despite Indonesia and India being among the world's largest democracies and its top 20 economies, the impact of economic and financial factors on their economic and stock market integration during their successive G20 presidencies remains unexplored. This study addresses this gap by examining their bilateral integration during a period of intensified collaboration, offering unique insights into their interdependence and global leadership. As future drivers of global growth, understanding Indonesia and India's dynamic economic interactions provides valuable insights for investors and holds significant potential for future research.

THEORETICAL CONTRIBUTION

The theoretical basis for examining the interconnectedness of India and Indonesia is derived from three key theories – the Law of One Price, Efficient Market Hypothesis, and Gravitational Models. According to the Law of One Price (LOP), in efficient markets with minimal transaction costs and free movement of capital, identical assets or goods should have same price when denominated in a common currency. If any deviation in prices occurs, arbitrageurs will come into play to restore the equilibrium and foster price convergence. This study extends the LOP principle to the context of financial markets and foreign trade by examining whether stock prices, exchange rates, and trade between India and Indonesia exhibit tendencies toward long-run convergence. Such convergence would indicate the presence of economic and financial symbiosis between the two nations. Thus, the LOP model provides a sound theoretical base from which to examine co-movement and convergence of stock prices, exchange rates and trade between the two economies, particularly during the period covered by their successive G20 presidencies, highlighting this period's distinct role in strengthening bilateral integration.

The efficient market hypothesis (EMH) states that asset prices should consider all available information in the market and respond quickly to shocks, new economic data or policy announcements. In the context of India and Indonesia, EMH offers a strong theoretical base for analysing how their respective stock markets and exchange rates, as well as bilateral trade, respond to the flow of global economic information and news. During their respective G20 presidency tenures, both India and Indonesia were at the forefront of major global discussions on financial stability, cross-border

trade, and economic cooperation. These periods generated a constant flow of new information for both nations through policy reforms, trade initiatives, and capital investments, influencing market expectations in addition to macroeconomic performance. If the EMH holds true, the stock market, exchange rates, and trade flows should all react quickly to such information. By examining the movement of both countries' financial markets and economic activities within the G20 framework, we explore whether their economies are becoming more connected and mutually responsive, thereby indicating the presence of economic symbiosis. The EMH thus provides a foundation for evaluating the economic synchronization of the two countries, as driven by shared information and global economic leadership.

Newton's gravity model is widely regarded as one of the powerful frameworks in global economics for explaining patterns of financial and trade interaction between countries. According to this model, larger economies are naturally attracted to each other. However, this interaction becomes weaker when geographical distance or other barriers make trade difficult. When this idea is applied to India and Indonesia, it helps explain their growing economic connection during their G20 presidencies. Both India and Indonesia are big economies with active markets and growing consumer demand. This makes them natural allies in trade, investment, and financial flows. At the same time, the distance between two economies – measured not just geographically but also through costs, regulatory barriers, and exchange rate risks – shapes the intensity of their economic ties. By incorporating stock market activity, exchange rates, and bilateral trade into the Gravity model, this study aims to capture the forces strengthening or hindering economic symbiosis between India and Indonesia. During the period covered by their G20 presidencies, they reduced institutional and policy-related distance between them, promoting dialogue and coordinated economic initiatives. Thus, the Gravity Model provides a suitable theoretical lens for studying the economic symbiosis between India and Indonesia.

Collectively, these three models offer a comprehensive theoretical basis for investigating the economic symbiosis between the two countries. Furthermore, this integrated framework also helps explain how global forums like the G20 can promote closer market alignment and policy coordination between India and Indonesia.

METHOD, DATA, AND FRAMEWORK

The study uses the unit-root test to determine whether the time series data of the underlying variables are stationary or not. Cointegration, the vector error correction model (VECM) , and Granger causality test are applied to assess the long-run and short-run relationship of influential variables belonging to India and Indonesia during the period covered by their consecutive G-20 presidencies. The aim of the current research is to investigate the relationship between their stock markets, exchange rates and foreign trade during this period. Additionally, the long-term and short-term interactions between the Indian and Indonesian stock markets are analysed to determine if financial market investors can benefit from diversifying their investment portfolios.

More specifically, this study objectively investigates the nexus between equity market indices (Sensex and JKSE) and trends in economic variables (exchange rate, export, import and net trade) for India and Indonesia. Time series data are collected with a view to establishing the long-run and short-run relationship between the variables across the two

countries. Table 2 shows the sources of daily / monthly data for these indices and economic variables during the period spanning December 2021 to November 2023.

1. Unit-root test

The daily closing price data are verified for the existence of unit-root by running the augmented Dickey-Fuller (ADF) test and Philips-Perron (PP) test. The ADF test equation for H_0: $\gamma = 0$ against H_1: $\gamma > 0$ is:

$$\Delta y_t = \alpha + \beta t + \gamma y_{t-1} + \delta_1 \Delta y_{t-1} + \cdots + \delta_p \Delta y_{t-p} + \varepsilon_t \quad (1)$$

where, α is an intercept and β is the time-trend measurement; δ_p is the parametric quantity of the lagged 1st difference of y_t; ε_t represents the error component that is white noise.

The PP test regression is given in Eq. 2:

$$\Delta y_t = \beta_0 D_t + \pi y_{t-1} + u_t \quad (2)$$

where, u_t may have varying variance. The PP test adjusts for any autocorrelation and heteroskedastic characteristics in the error-term u_t by altering the test statistics $t\pi = 0$ and $T\hat{\pi}$.

2. Cointegration test

The cointegration model is applied in order to assess the presence of a cointegrating relationship between the chosen markets. The existence of cointegration between national stock indices indicates equilibrium conditions, i.e., a stable and long-run relationship, which prevents the variables from deviating too much over the long term (Gonzalo & Granger, 1995).Any co-movement during the period is due to the fact that indices have similar stochastic tendencies. If the outcome of the study indicates no cointegration, then there is no long-run connection between the variables. The most common cointegration tests include the Engle-Granger test and the Johansen test. Johansen's maximum likelihood (ML) method is applied in this study because it considers many variables that are integrated in the same order (i.e., integrated after one differencing), allowing for multiple cointegrating relationships among the variables.

3. VECM

The vector error correction model (VECM) is used whenever a cointegration relationship is proved between multiple time series variables. It is used to model the short-run dynamics while maintaining the long-run equilibrium relationships. It contains an error correction term to adjust the short-run deviations from the long-run equilibrium by using the cointegration relationship found in the cointegration test. The "error correction term" (ECT) is a one-period ahead residual derived from the cointegration test. The ECT has long-run information as it is the residual derived from the cointegration relationship. The VECM equation is shown in Eq.3.

$$\Delta x = \sum_{i=1}^{k} \propto + \Delta x_{t-i} + \sum_{i=1}^{k} \beta \, \Delta y_{t-i} + \lambda \mu_{t-1} + v_{1t} \quad (3)$$

Table 2. Data sources of stock indices and economic variables

Index / Variable	Country	Sources
Sensex	India	www.bseindia.com
JKSE	Indonesia	www.yahoofinance.com
Import, Export and Net Trade	India	www.tradingeconomics.com
Import, Export and Net Trade	Indonesia	www.tradingeconomics.com
Exchange Rate	India & Indonesia	www.investing.com

Source: Compiled by authors

where, λ is the ECT. If 'λ' is negative and has statistical significance, then 'y' has a long-run causality on x. This means 'λ' differs signify-cantly from zero and helps in error correction, i.e., errors in short-run are being corrected.

4. Multiple linear regression

Multiple linear regression (MLR) is a statistical technique used to find the relationship between several explanatory variables and the outcome. Eq. 4 conveys how changes in the explanatory variables influence the dependent variable.

$$JKSE = \beta_0 + \beta_1 SENSEX + \beta_2 INRIDR + \beta_3 IDNT + \beta_4 INNT + \mu \quad (4)$$

where, JKSE = Jakarta Stock Exchange Compo-site (Indonesia); Sensex = Stock Exchange Sensitive Index (India); IDNT = Indonesian Net Trade; INNT = Indian Net Trade; β_0 = intercept; β_1 *to* β_n = partial regression coefficient; μ = random error term.

5. Granger-Causality Tests

The Granger-cause model is utilized to determine whether one time series aids in predicting the other. If 'Y_t' is forecast accurately using 'X_t' and its historical data as opposed to not using it, then we can conclude 'X_t' Granger-causes 'Y_t'. The variables need to be stationary. The Granger-causality model is used under the VAR framework to study the lead-lag relationship. The Granger causality model is given in Eq.4.

$$\Delta Y_t = \alpha_1 + \beta_{11}\Delta Y_{t-1} + \ldots + \beta_1 n\Delta Y_{t-n} + \gamma_{11}\Delta X_{t-1} + \ldots + \gamma_{1n}\Delta X_{t-n} + u_t \quad (5)$$

where, ΔY_t is the 1st difference of stock index Y; 'α' is the intercept; β_j and γ_j are parameters; X is the other country stock indices; and u_t is the error term.

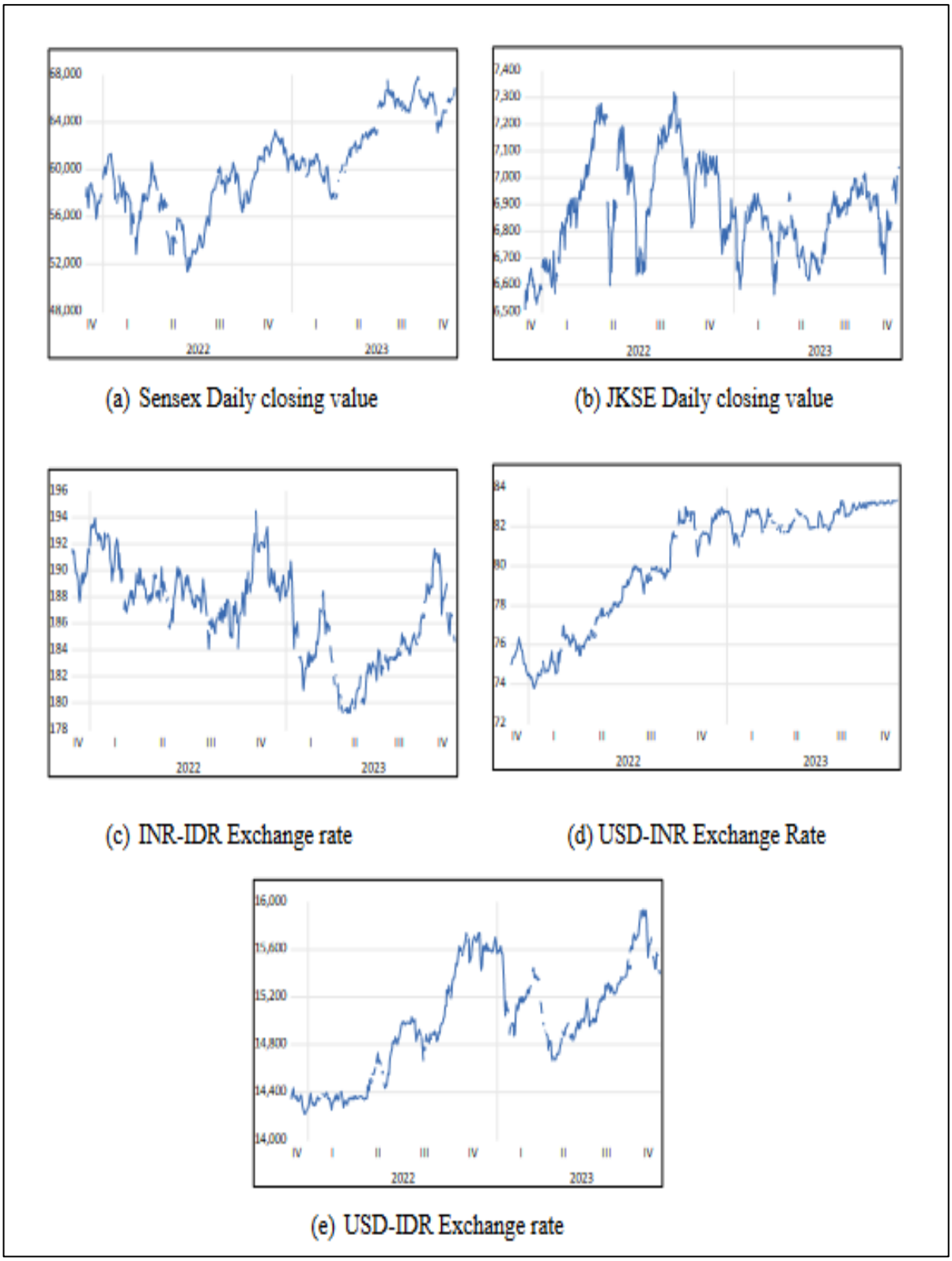
ANALYSIS, FINDINGS AND DISCUSSION

The initial step in examining any time-series data is to plot the underlying data against time and detect its movement. Figure 2 depicts the daily time series data from Dec 2021 to November 2023 for the stock indices, in other words, Sensex and JKSE, and currency exchange rate IDR-INR.

The study also seeks to examine the interplay between stock indices, exchange rates, and the cross-border trade data of India and Indonesia. Accordingly, a monthly time series plot spanning from December 2021 to November 2023 is presented in Figure 3 to elucidate the relationship between these variables.

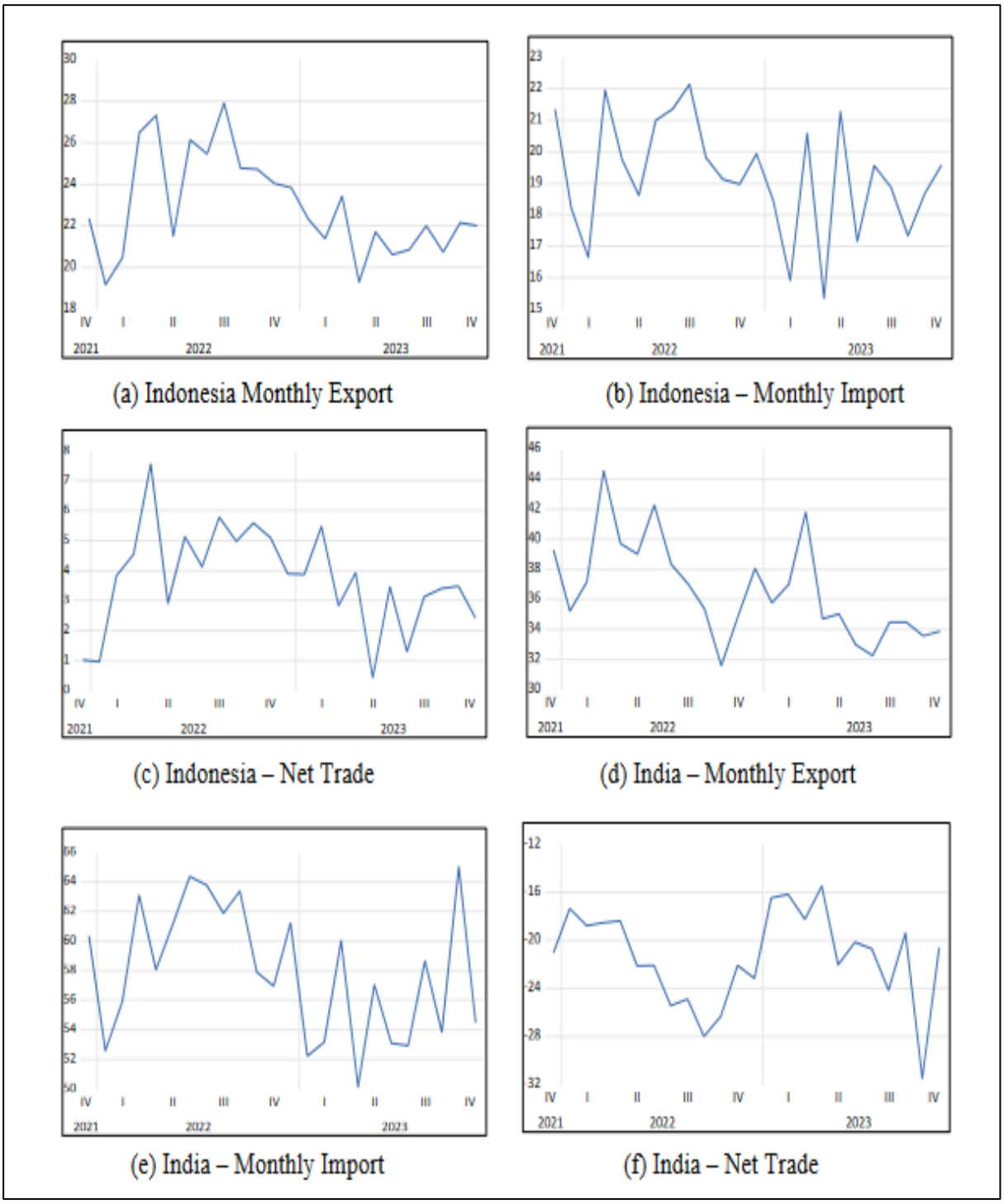
It is evident from Figures 2 and 3 that neither the daily nor monthly time series of the variables exhibit mean-reversion, indicating that these stock indices may be non-stationary processes. To verify this, we employ the ADF unit-root test. The outcome of the test is shown in Table 3.

Figure 2. Daily time series plot of Sensex, JKSE and INR-IDR



Source: www.bseindia.com, www.yahoofinance.com, and www.investing.com

Figure3. Monthly time series plot of export, import and net trade



Source: www.investing.com

Table 3. ADF Unit-root test

H_0: Time series data has unit-root					
Daily Data					
Variables	ADF (level)		ADF (1st difference)		Result
	t- statistic	Prob.	t-statistic	Prob.	
Sensex	0.7142	0.8641	-21.1402	0.000*	I(1)
JKSE	0.3967	0.7978	-24.1149	0.000*	I(1)
INR-IDR	-0.4299	0.5277	-24.0667	0.000*	I(1)
USD-INR	1.6021	0.9736	-22.5881	0.000*	I(1)
USD-IDR	0.7817	0.8817	-19.7012	0.000*	I(1)
Monthly Data					
Variables	ADF (level)		ADF (1st difference)		Result
	t- statistic	Prob.	t- statistic	Prob.	
Sensex	0.7990	0.8784	-4.9213	0.000*	I(1)
JKSE	0.5558	0.8288	-4.4131	0.000*	I(1)
INR-IDR	-0.4512	0.5081	-4.6324	0.000*	I(1)
IN_Net Trade	0.1819	0.7278	-2.4683	0.016*	I(1)
ID_Net Trade	-0.4762	0.4971	-10.0439	0.000*	I(1)

Note: * indicates rejection of null hypothesis at 5 per cent sig. level.
Source: authors

All the variables in Table 3 are found to be integrated at order 1,i.e., stationary after one differencing. It is common for economic variables to exhibit non-stationary conduct. However, these variables may exhibit a long-term relationship despite having some short-term variations. Such long-term associations suggest these variables move together over time. To assess whether the chosen variables of both economies have long-run relationships, Johansen's cointegration test is applied. One of the pre-conditions for using this cointegration test is that all the variables should integrate in the identical order. As all stock indices are I(1), Johansen's cointegration test can be used to find the long-term equilibrium among the variables. As the outcome of this analysis is sensitive to the lag length in determining the relationship, it is important find the optimum lag length to obtain a robust result.

Table 4 presents the optimal lag length determination for the cointegration analysis, focusing on daily data for the Sensex, JKSE index, INR-IDR, USD-INR, and USD-IDR variables. Similarly, it also illustrates determination of the optimal lag length for the cointegration tests using monthly data for the Sensex, JKSE index, INR-IDR, India's net trade, and Indonesia's net trade variables. Akaike information criterion (AIC) indicates the optimum lag length as two for daily data model and one for monthly data model.

Table 4. Optimum lag-length determination

Lag	LogL	LR	FPE	AIC	SC	HQ
Daily Data						
1	-8395.273	7485.457	5.15e+09	36.55216	36.82114#	36.65807#
2	-8360.626	67.6393	4.94e+09#	36.5103#	37.00345	36.70448
Monthly Data						
1	-449.1558	90.4281#	6.11 e+12#	43.5598#	45.0476#	43.9103#
2	-428.762	20.3965	1.42 e+13	43.9783	46.7059	44.6209

Source: authors. Note: # minimum criterion value

Johansen's cointegration analysis is used to investigate the cointegration relationship between the variables considered for the daily data model and monthly data model. The results of the cointegration test are provided in Table 5.

Johansen's cointegration analysis discloses a significant long-term association between the variables, viz., Sensex, JKSE index, INR-IDR, USD-INR, and USD-IDR, within the framework of daily data modeling. The findings show the presence of one cointegration relationship among these variables, as displayed by both the trace test and the eigenvalue test. This implies the existence of continuous association and interconnectedness between these variables over time, Johansen's cointegration analysis also reveals a long-term relationship between the variables, namely Sensex, JKSE index, INR-IDR, India's net trade, and Indonesia's net trade, based on monthly data. Both the trace test and eigenvalue test results reveal the presence of a cointegration relationship between the variables. Thus, the selected economic variables of both economies share a long-term association despite the short-term variations.

Next, the vector error correction model (VECM) is employed to study the dynamic interactions among the designated variables and understand how a change in one variable interrupts other variables in the system over time. The model detects deviations among the variables in the short run but the system returns to a long-term equilibrium state.

Table 5. Cointegration analysis

NH: No cointegration among the variables				
Number of CEs	Eigenvalue	Trace test.	C.V. (5%)	Prob.*
Data Frequency: Daily	Variables: Sensex, JKSE, INR-IDR, USD-INR, USD-IDR			
		Trace Test		
None	0.285085	194.3460	69.81889	0.0000*
At most 1	0.042621	37.9605	47.8561	0.3037
		Eigen value Test		
None	0.285085	156.3855	33.8769	0.0000*
At most 1	0.042621	20.29729	27.5843	0.3209
Data Frequency: Monthly	Variables: Sensex, JKSE, INR-IDR, IN Trade, ID Trade			
		Trace Test		
None	0.803867	83.24857	69.81889	0.0029*
At most 1	0.651435	48.9273	47.85613	0.0395*
		Eigenvalue Test		
None	0.792985	34.64919	33.87687	0.0404*
At most 1	0.651435	23.18647	27.58434	0.1657

*Note: * H_0 is rejected at 5 percent significance level.*
Source: Authors

Table 6. VEC model

Dependent variable: D(JKSE)	Data Frequency: Daily			
	Coefficient	S.E.	t-statist.	P value*
Cointegration Equation	-0.008672	0.003705	-2.340756	0.0197*
Dependent variable: D(JKSE) Data Frequency: Monthly				
	Coeff.	Std_Error	t-statist.	P value*
Cointegration Equation	-1.257499	0.245654	-5.118990	0.0001*

Note: Significance at 5 percent.
Source: Authors

Table 6 shows the outcome of vector error correction model with the optimum lag length of two. The equation is said to reflect error correction if the t-statistic is significant and the coefficient is negative. Using both daily data and monthly data, error correction occurs when the JKSE index is a dependent variable and the other variables are explanatory variables. In the daily data model, Sensex, INRIDR, USDINR and USDIDR are the explanatory variables. This implies that fluctuations in the system caused bythe JKSE index are offset by the explanatory variables in the subsequent periods, leading to the attainment of a long-term equilibrium. In the monthly data model, the explanatory variables Sensex, INRIDR, India's net trade, Indonesia's net trade correct the deviations in the system.

As cointegration (i.e., stable long-term relationship) between the variables is proven in the monthly data model, OLS regression analysis is then performed. The regression estimation results of the non-stationary variables are shown to be reliable and consistent if the variables are cointegrated. The OLS regression results from the monthly data model are given in Table 7.

The regression analysis conducted on the daily data model does not reveal any statistically significant relationships. Consequently, a regression analysis is conducted using monthly data, yielding the above outcomes. The outcome of the OLS regression analysis indicates that changes in the JKSE index are significantly affected by Indonesia's net trade. Specifically, Indonesia's net trade has a positive impact on the JKSE index, implying that a trade surplus contributes to its growthwhile a trade deficit has an adverse effect. However, other variables such as Sensex, INRIDR, and India's net trade do not exhibit statistical significance in explaining changes in the JKSE stock index. The R-square value is 48.34, indicating that the model explains a significant portion of variation in the dependent variable. The Durban-Watson statistic is closer to two, indicating no first-order autocorrelation in the error terms. To ensure the correctness and validity of the regression result, it is important verify its underlying assumptions. One important assumption of OLS regression is that its error variance is constant, i.e., homoscedasticity. In the presence of heteroscedasticity in error terms, the standard errors of the regression coefficients may be biased, leading to incorrect inferences about the statistical significance of the coefficients. In such a case, appropriate corrective measures need to be taken to obtain valid statistical inferences. An autocorrelation test is therefore carried out to verify the assumption concerning independence of the error terms in the regression model. The presence of autocorrelation leads to inefficient estimates of the regression coefficient in time series data. Table 8 shows the outcome of the heteroscedasticity test and autocorrelation test.

Table 7. Regression output

NH: Independent variables does not explain the variations in the dependent variable				
Dependent Variable: JKSE Index (Monthly data)		Sample: 2021M12 to 2023M11		
Variable	Co-eff.	S.E.	t-stat.	P value
C	5784.76	1916.59	3.0182	0.0071
Sensex	0.0071	0.0092	0.7702	0.4507
INRIDR	2.0042	9.1081	0.2200	0.8282
Indonesia Net Trade	75.2223	18.6042	4.0433	0.0007*
India Net Trade	-2.4563	8.1085	-0.3029	0.7652
R-Sq.	0.4834	Adj. R-Sq.		0.3746
F-Statist.	4.4449	F- Stat (Prob value)		0.0105*
Durban-Watson statist.	2.0371			

Note: Significance at 5 percent. Source: Authors

Table 8. Heteroscedasticity and autocorrelation test results

Heteroscedasticity Test: ARCH			
NH: No Heteroscedasticity in error variance			
F-Stats.	0.029582	Prob. F (1, 21)	0.8651
Obs*R-sq.	0.032354	Prob. Chi-Sq.	0.8573
Autocorrelation Test: Breusch-Godfrey Serial Correlation LM Test			
NH: No serial correlation in error variance			
F-Stats.	0.167945	Prob. F (2, 17)	0.8468
Obs*R-sq.	0.465011	Prob. Chi-Sq.	0.7925

Source: Authors

The results of the ARCH test suggest there is no evidence to reject the null hypothesis of "No heteroscedasticity", as indicated by a p-value greater than 0.05. Similarly, the Breusch-Godfrey serial correlation test results show that the null hypothesis of "No serial correlation" cannot be rejected, as the p-value exceeds 0.05. The residual plot of the regression analysis depicts the residuals against the fitted values. It offers valuable insights on the adequacy of the regression model. The residual plot of around zero indicates the model is a good fit. Figure 4 displays the residual plot of the regression model.

The Cumulative Sum test (CUSUM) is conducted to assess the stability of the model's parameters. After the cointegration relationship is proven, it is assumed that stable long-run relationships exist. The CUSUM test is then used to examine whether the estimated parameters remain stable over time. Figure 5 shows that the model is stable and the estimated coefficients are consistent at the 5 percent significance level, as the cumulative sum of the residuals remains within the 5 percent significance bounds.

Figure 4. CUSUM test result

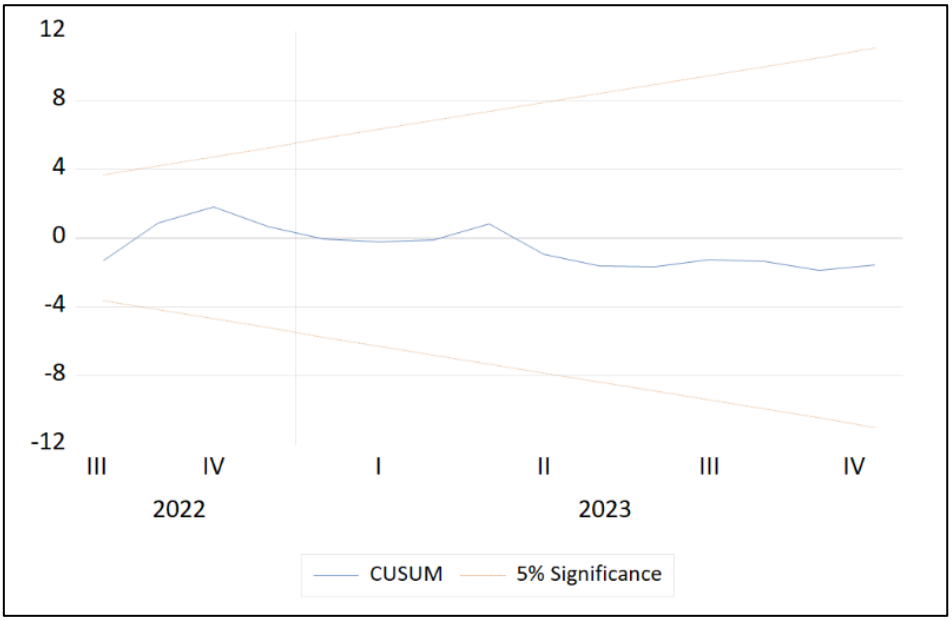
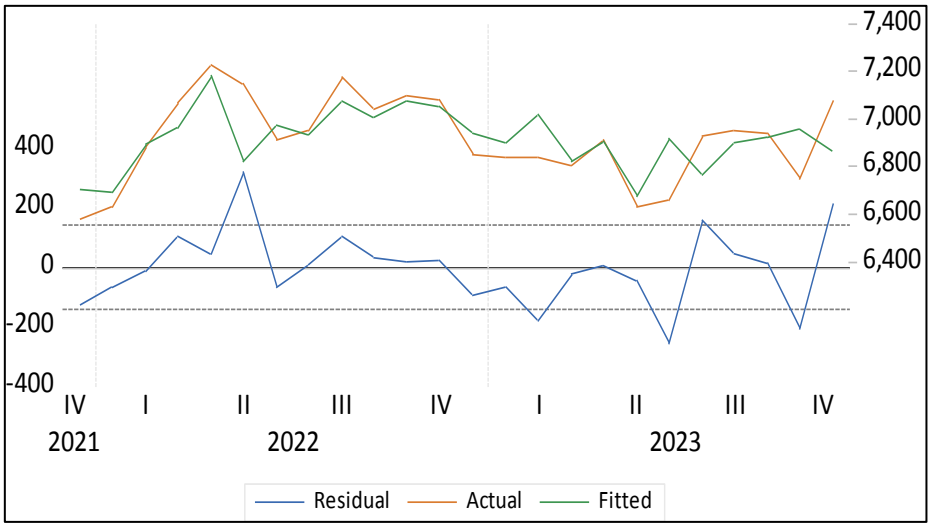


Figure 5. Residual plot



The residual plot shows that the residuals fluctuate around the zero line without displaying any discernible pattern. Based on this observation, we can infer that the model adequately captures the relationship between the variables. The Granger-causality (GC) / block exogeneity Wald test using daily data assists in determining whether the time series of one economic variable is useful in predicting another. Further, it throws light on whether one variable precedes change in another variable, indicating lead-lag relationship between the chosen variables. A stationary time series is a precondition of this test. Thus, differenced daily time series of the variables are considered to determine lead-lag relationship. Table 9 presents the GC test outcomes.

Table 9. Granger causality / Block exogeneity Wald test

VAR GC / Block Exogeneity Wald Test					
Dep. Variable: D(JKSE)			Dep. Variable: D(Sensex)		
Variables	Chi-Sq.	p.value	Variables	Chi-Sq.	p.value
D(Sensex)	3.9158	0.1412	D(JKSE)	0.0148	0.9927
D(USD-IDR)	14.5297	0.0007*	D(USD-IDR)	4.4339	0.1089
D(USD-INR)	3.7233	0.1554	D(USD-INR)	4.6399	0.0983
D(INR-IDR)	13.1475	0.0014*	D(INR-IDR)	0.2430	0.8856
Dep. Variable: D(USD-IDR)			Dep. Variable: D(USD-INR)		
Variables	Chi-Sq.	p.value	Variables	Chi-Sq.	p.value
D(JKSE)	10.6493	0.0049*	D(JKSE)	2.5619	0.2778
D(Sensex)	6.4418	0.0399*	D(Sensex)	5.6760	0.0585
D(USD-INR)	51.7415	0.0000*	D(USD-IDR)	18.1388	0.0001*
D(INR-IDR)	243.3499	0.0000*	D(INR-IDR)	279.0234	0.0000*
Dep. Variable: D(INR-IDR)					
Variables	Chi-Sq.	p.value			
D(JKSE)	2.6232	0.2694	Sample: 1st Dec 2022 to 30th Nov 2023		
D(Sensex)	3.1404	0.2080	Number of observations: 466		
D(USD-IDR)	0.8458	0.6552			
D(USD-INR)	0.4529	0.7973			

*Note: * Statistical significance at 5 percent level.*
Source: Authors

Although a cointegration relationship exists between the variables, Granger causality / block erogeneity Wald tests show changes in JKSE index are significantly defined by the USD-IDR exchange rate and INR-IDR exchange rate in the short-run. In the short run, the Sensex is not significantly explained by other variables. All the economic variables are found to be statistically significant in explaining the variations in USD-IDR. Similarly, changes in USD-INR tend tobe preceded by the exchange rate USD-IDR and INR-IDR currency pairs.

CONCLUSION AND POLICY IMPLICATIONS

The hosting of the G20 by Indonesia in 2022 and India in 2023 sparked our interest in analysing the economic performance of these two nations and their interactions during their combined leadership tenure of the forum. Daily data on stock indices and exchange rate and monthly data on stock indices, exchange rate and foreign trade (export, import and net trade) were used to study the performance of the chosen economic variables and their interactions between the two nations. All variables were found to be non-stationary initially, requiring first-order differencing to achieve stationarity. As the variables were integrated at the same order, Johansen's cointegration test was employed to examine whether there was long-run equilibrium between these variables. The cointegration results based on optimum lags indicated a cointegration (long-run equilibrium) relationship between these variables in both the daily data model and monthly data model. VECM analysis was carried out to model the long-run relationship while accounting for short-run dynamics. The error correction term was applied to capture the adjustment process and speed of adjustment to attain long-run equilibrium. The results indicated adjustment occurred from Sensex, the exchange rate (INR-IDR) and net trade of India and Indonesia to the JKSE index. OLS regression results are not spurious if the variables have long-run equilibrium despite being non-stationary. The regression model using monthly data clearly showed net trade had statistically signifycant explanatory power on the JKSE index. The key assumptions of the regression model were proven via homoscedasticity and independence of the error terms, thus confirming the validity of the model.

The study's results align with Wuthisatian (2015), who identified long-term cointegration between Thailand and its key trading markets, and with Paramati et al. (2016), who found that trade intensity significantly increases stock market interdependence in both the short and long run in the context of Australia and Asia, leading to higher contagion risk and reduced diversification benefits for investors. Additionally, our findings of a significant bilateral relationship during their successive G20 presidencies are consistent with Octavia and Wijaya (2020), who observed cointegration and causality between global markets, including India and Indonesia.

The study offers useful implications to policy makers, investors, financial institutions and business firms. Policy makers in India and Indonesia can formulate more effective policies by understanding the dynamic interactions of the economic variables analysed in the study. As we observed, both the Indian and Indonesian economies grew and integrated during their G20 leadership tenures. The findings of the study can be applied to help both economies make informed decisions related to bilateral trade, currency policies, and economic cooperation for their mutual benefit. Moreover, the short-run dynamics and long-run association of their key economic variables will help investors frame investment strategies, decide on asset allocation

and apply precise risk management practices. The business firms of both nations can capitalize on the opportunities for growth and expansion.

For the research community, this study provides empirical evidence of the interrelationship between the economic variables of both countries, serving as a foundation for further research. Building on this groundwork, future research could examine industry-level co-integration between Indonesia and India to provide valuable insights into sector-specific economic dynamics. Such analysis would enable policymakers to develop more targeted and effective strategies for strengthening bilateral economic collaboration. A limitation of this study is the exclusion of Morgan Stanley Capital International (MSCI) data, which provides a standardized basis for comparing countries with different exchange rates. Future research could consider incorporating MSCI data to enhance the robustness of the cross-country analysis.

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