3 Stock Market Linkages between QUAD Economies: Role of Bilateral Trade

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Abstract

This paper analyses the stock market linkages between the four QUAD economies and the role of bilateral trade in affecting these linkages. While existing literature has extensively explored dimensions such as return co-movements, contagion effects, and volatility spillovers, limited studies have studied the effect of trade on stock market linkages. This study also examines the impact of shocks on stock market linkages. The study uses monthly secondary data like S&P 500 (United States), BSE Sensex (India), Nikkei 225 (Japan), and ASX 200 (Australia), from January 2004 to December 2024. GDP and bilateral trade data are used to calculate the aggregate trade intensity. VARX (1) model is employed to analyse the linkages between the stock market returns and to evaluate the effect of trade on market returns. We have incorporated lagged aggregate trade intensity as an exogenous variable in this model. The results reveal that cross-market return linkages are weak. The findings of the study show that the aggregate trade variable significantly and negatively affects the stock market returns of the select economies. Stock market returns of QUAD economies are also affected significantly by global financial crisis and COVID-19. The study uses the portmanteau test to check for serial autocorrelation in the estimated model. In order to further examine the dynamics of stock market linkages, the study employed Granger Causality tests, Impulse Response Functions (IRFs), and Forecast Error Variance Decomposition (FEVD). While impulse response functions analysis reveals that US market acts as a net transmitter of return shocks on the other markets, the forecast error variance decomposition further shows that the US market is largely driven by its own shocks.

Keywords: Stock Market Linkages, Bilateral Trade, QUAD Economies, VARX, Crisis Effects.

Introduction

Globalisation has led to a tremendous surge in interconnectedness among many developing and developed economies over the past two decades. These economies are interlinked through global supply chains, international trade, capital flows, cross-border investments, and technological connectivity, thereby leading to more interconnected stock markets. Even if the country is geographically distant, movements in one country's stock market are often seen to be affected by other countries' stock markets. Further, stock markets are impacted by some macroeconomic indicators such as exchange rates, interest rates, and industrial production. (Suri et al., 2024). It is noteworthy that economies are impacted due to a financial shock originating in one major economy through trade ties, reallocations of portfolio, investor sentiment, and financial flows. For instance, some studies, like (Dua & Tuteja, 2013) which use multivariate GARCH and VAR-based models, show the existence of time-varying correlations and spillovers in global markets.

The Quadrilateral Security Dialogue (QUAD), including the United States, Japan, India, and Australia, has emerged as a significant economic grouping. Although QUAD group was formed for security purposes in the Indo-Pacific region, the relevance of the group extends beyond geographical and military considerations. The four economies share various bilateral economic ties (Table 1). Cooperation and ties between the four economies in specific sectors like defence manufacturing, renewable energy, maritime trade, critical minerals, semiconductor supply chains, artificial intelligence and digital technologies have risen in recent years. According to the results by (Paramati et al., 2018) These sectoral ties and trade are strong cross-border connections, increasing foreign direct investments and rising bilateral trade volumes, thereby making the stock markets more exposed to the effects of bilateral trade. The developed economies are mostly seen as the main transmitters of shocks, whereas the developing or emerging economies have always been on the other side, acting as receivers of those shocks. (Choudhary & Singhal, 2020; Yadav, Kushwah, et al., 2025). A study by (Syed et al., 2024) identifies the presence of cross-market spillover effects among QUAD stock markets. Using VAR and impulse response functions, they find that the Indian stock market is significantly influenced by movements in US and Australian markets.

One of the key channels of market linkages is bilateral trade. Trade connects economies at the firm and industry level through production networks, supply chains, exports, imports, and revenues. The interdependence among the countries eventually affects corporate earnings, exchange rates, investor expectations, and ultimately stock prices. Trade linkages continue to be one of the key factors influencing cross-national financial ties (Kristin Forbes MIT & Chinn, 2003). According to some empirical studies, such as (Gopane, 2023; Paramati et al., 2015) stock market co-movements are associated with increased trade intensity. Additionally, a

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recent study (Peter, 2010) shows that bilateral trade has a favourable impact on cross-country asset ownership, enhancing economic market integration. Further, some empirical studies on regional trade interdependency suggest that rising trade volumes are linked to long-term stock market cointegration (Kumar, 2020). It is noteworthy that despite the relevance of trade as a linkage channel, it has not been examined as a transmission channel in studies of QUAD stock market linkages.

Some empirical studies like (Suri et al., 2024) have shown that global shocks often play a key role in affecting the stock market linkages and co-movements. The global events such as the Eurozone sovereign debt crisis, Global Financial Crisis of 2008, recent geopolitical conflicts and the COVID-19 pandemic have shown that financial shocks are rarely confined to a single economy. Instead, the crises spread across borders through trade networks, capital flows, and investor behaviour by increasing correlations and reducing diversification benefits (Dua & Tuteja, 2023). Empirical studies such as (Khan, 2024) show that volatility spillovers and connectedness typically rise during times of crisis, suggesting increased stock market integration in stressful situations. For instance, a study by (Yadav, Puri, et al., 2025), showed that COVID-19 significantly increased the connectivity of QUAD markets, underscoring their vulnerability to worldwide shocks.

Several existing studies examine stock market integration in regional blocs such as BRICS, G7, ASEAN, or the European Union. Studies that include QUAD countries often analyse them individually rather than as a distinct group. The earlier studies on the QUAD economies have focused on effects of crises, price transmission of oil, volatility spillovers or ESG-related connectivity, but bilateral trade is rarely discussed. This accounts for a major gap in the literature. Therefore, this gap is addressed in this study by examining the effects of trade on stock market linkages. The study analyses how stock markets in the United States, Japan, India, and Australia are related. Further, we analyse the strength of their relationships and the extent to which market returns of these economies are explained by trade intensity. Additionally, we also examine how crises affect these linkages between the QUAD economies.

Table 1: Trade Linkages between USA, Japan, India and Australia (% share)

Exporter Country	Importer Country							
	USA		India		Japan		Australia	
	2004	2024	2004	2024	2004	2024	2004	2024
USA	-	-	0.74	2.02	6.67	3.86	1.75	1.67
India	2.49	18.27	-	-	16.75	1.31	0.86	1.77
Japan	22.73	20.01	0.53	2.43	-	-	2.08	2.26
Australia	8.08	4.59	4.61	4.82	18.59	13.69	-	-

Source: Authors' own estimation based on data from IMF Database[1]

[1] https://data.imf.org/en/Data-Explorer?datasetUrn=IMF.STA:IMTS(1.0.0)

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Trade linkages among QUAD economies have strengthened over the two decades from 2004 to 2024, showing that bilateral trade shares are rising across all country pairs. The USA and Japan remain the most prominent trading partners within the QUAD group, while India's trade integration with QUAD members has increased, reflecting its growing economic engagement.

Figure 1-4 shows the monthly stock price index of the four QUAD economies from January 2004 to December 2024

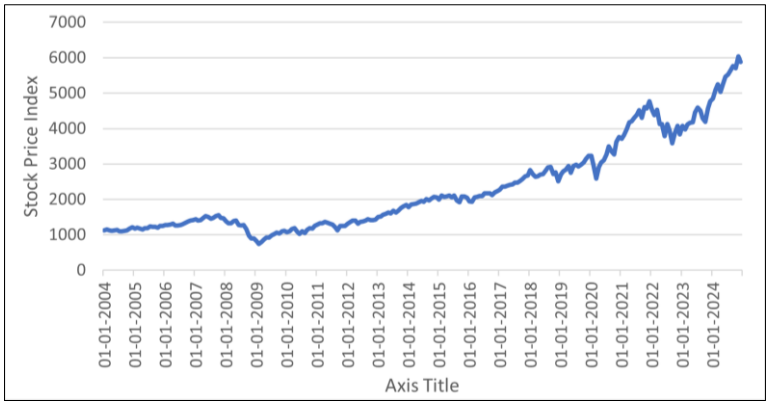

Figure 1: Monthly Stock Price Index of S&P 500 (USA), Jan 2004-Dec 2024

Source: Authors' own elaboration

Over the span of the two decades, the USA's S&P 500 index broadly shows an upward trend starting at about 1,100 in 2004 and rising to approximately 6,000 by the end of 2024. Two sharp downturns are visible, where a significant dip during the 2008-09 Global Financial Crisis and a brief but steep drop during the COVID-19 in early 2020. Both were followed by strong recoveries, with the post-COVID rally being particularly steep and long-lasting.

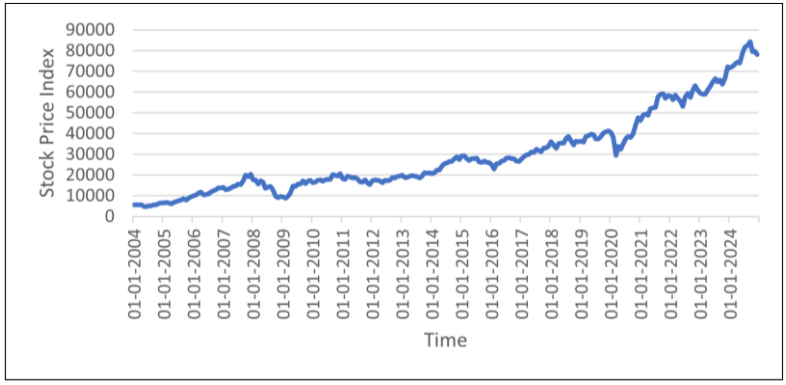

Figure 2: Monthly Stock Price Index of Sensex (India), Jan 2004-Dec 2024

Source: Authors' own elaboration

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India's BSE Sensex index increased from over 6,000 in 2004 to nearly 85,000 by late 2024, representing a nearly 14-fold rise. The index shows two significant declines coinciding with the GFC (2008-09) and COVID-19 (2020). The post-2020 bounce is especially steep, indicating India's strong domestic growth momentum.

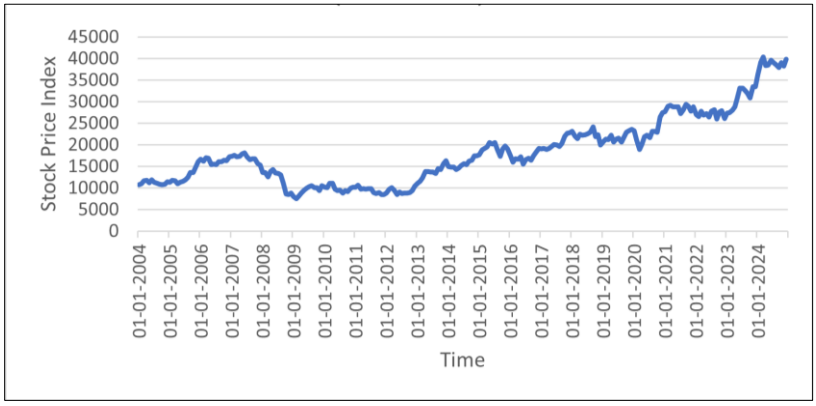

Figure 3: Monthly Stock Price Index of Nikkei 225 (Japan), Jan 2004-Dec 2024

Source: Authors' own elaboration

Japan's Nikkei index shows the range-bound movement between 8,000 and 20,000 from 2004 to 2020, with a significant drop during the GFC. But starting in 2021, the index increases significantly, reaching about 40,000 by 2024 in the post-pandemic performance.

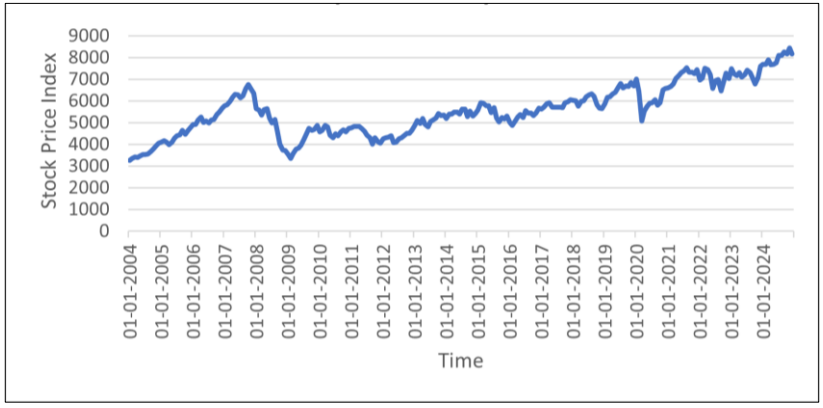

Figure 4: Monthly Stock Price Index of ASX 200 (Australia), Jan 2004-Dec 2024

Source: Authors' own elaboration

Over the duration of the sample period, Australia's ASX 200 indices have shown a comparatively steady and progressive increasing trend, beginning around 3,300 in 2004 and reaching over 8,300 by 2024. The GFC causes the most

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noticeable dip, falling from roughly 6,700 to 3,400. The COVID-19 shock results in a smaller correction, but the market quickly recovers later.

Data and Methodology

- **Data**

The research uses monthly secondary data on benchmark stock indices from January 2004 to December 2024, such as S&P 500 (United States), BSE Sensex (India), Nikkei 225 (Japan), ASX 200 (Australia), along with bilateral trade and GDP data. The stock market data are obtained from Yahoo Finance, and the bilateral trade data are taken from the International Monetary Fund (IMF). These indices are then combined to create an aggregate trade intensity variable, which represents the overall trade interconnectedness among the QUAD economies. Table 2 displays the descriptive statistics calculated to examine distributional characteristics, and Table 3 shows the unconditional correlation between the QUAD stock market returns.

Table 2: Descriptive Statistics

	R_{USA}	R_{IND}	R_{JPN}	R_{AUS}
Mean	0.65	1.04	0.52	0.36
Standard Deviation	4.29	6.04	5.29	4.04
Skewness	-0.80	-0.80	-0.85	-1.39
Kurtosis	1.83	4.15	2.61	4.98
Jarque-Bera	62.14	207.63	101.85	341.24
Minimum	-18.56	-27.29	-27.21	-23.80
Maximum	11.94	24.88	14.01	9.49

Note: $R_{USA}, R_{IND}, R_{JPN}, R_{AUS}$ denote the stock market returns of USA, Japan, Australia, and India, respectively

Source: Authors' own estimation

Australia has the lowest mean return (0.36%), while India has the highest mean return (1.04%) and the most volatility (SD = 6.04), indicating a risk-return trade-off throughout the QUAD stock markets. According to the Jarque-Bera statistics, all four markets show negative skewness and excess kurtosis, which are indicative of non-normal, fat-tailed return distributions common to both developed and emerging stock markets.

Table 3: Unconditional Correlation between the QUAD Stock Market Returns

	R_{USA}	R_{JPN}	R_{AUS}	R_{IND}
R_{USA}	1	0.68	0.77	0.61
R_{JPN}	0.68	1	0.61	0.53
R_{AUS}	0.77	0.61	1	0.63
R_{IND}	0.61	0.53	0.63	1

Note: $R_{USA}, R_{IND}, R_{JPN}, R_{AUS}$ denote the stock market returns of USA, Japan, Australia, and India, respectively

Source: Authors' own estimation

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The QUAD stock markets display moderate to high positive correlations, with the USA-Australia pair recording the strongest co-movement (0.77), followed by USA-Japan (0.68).

- **Econometric Methodology**

This study employs a systematic econometric framework to examine the linkages and shock transmission between the stock market returns of the QUAD countries, namely the USA, India, Japan, and Australia. In the first step, the Augmented Dickey-Fuller (ADF) test, the Phillips-Perron (PP) test and the Zivot–Andrews unit root test are used to assess the stationarity characteristics of each variable. The study further employs the Bai-Perron multiple structural break test to detect regime changes brought on by significant worldwide occurrences such as COVID-19, the Eurozone crisis, and the Global Financial Crisis. In the third step, a vector autoregression model with exogenous variables (VARX) is used to examine stock market linkages and the impact of trade on stock market returns in selected economies. Standard information criteria, such as AIC, HQC, SC, and FPE, are used to determine the ideal lag length in VARX model. The Portmanteau test is performed to check for serial autocorrelation in the residuals in order to ensure the adequacy of the model. The last step involves estimation of the Granger causality, Impulse Response Functions, and FEVD to examine the dynamic relationship among QUAD stock markets.

Empirical Model

The VARX (1) model used in this study is specified as follows:

$$Y_t = A_1 Y_{t-1} + BX_{t-1} + \delta D_{1t} + \theta D_{2t} + \varepsilon_t$$

where Y_t represents a 4x1 vector of endogenous variables that represent the QUAD countries' stock market returns *($R_{USA,t}$, $R_{IND,t}$, $R_{JPN,t}$,$R_{AUS,t}$)*. The matrix A_1 is a 4x4 coefficient matrix that captures both own-market impacts and cross-market spillovers. X_{t-1} is an exogenous variable that indicates one month lagged Aggregate Trade Intensity (ATI_{t-1}). The average trade intensity of six bilateral trade pairs between QUAD economies is used to calculate ATI. *B* is a 4x1 coefficient vector that measures how trade integration affects stock market returns.

$$D_{1t} = \begin{cases} 1, if\ t \in [2007-M12, 2009-M06] \\ 0, otherwise \end{cases}$$

$$D_{2t} = \begin{cases} 1, if\ t \in [2019-M12, 2020-M03] \\ 0, otherwise \end{cases}$$

The ε_t is a vector of white noise error terms.

Results

The unit root test results reveal that all stock market return series and trade intensity variables are stationary at levels (Table 4-6).

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Table 4: ADF Unit Root Test Results of Stock Market Returns

Country	ADF Statistic	1% critical value	Result
R_{USA}	-5.649	-3.462	Stationary
R_{IND}	-5.900	-3.462	Stationary
R_{JPN}	-5.788	-3.462	Stationary
R_{AUS}	-5.290	-3.462	Stationary

Note: $R_{USA}, R_{IND}, R_{JPN}, R_{AUS}$ denote the stock market returns of USA, India, Japan, and Australia, respectively

Source: Authors' own estimation

Table 5: The Results of Phillips–Perron Unit Root Test of Stock Market Returns

Country	PP Statistic Z(alpha)	p-value	Result
R_{USA}	-248.512	<0.05	Stationary
R_{IND}	-244.156	<0.05	Stationary
R_{JPN}	-228.015	<0.05	Stationary
R_{AUS}	-236.148	<0.05	Stationary

Note: $R_{USA}, R_{IND}, R_{JPN}, R_{AUS}$ denote the stock market returns of USA, Japan, Australia, and India, respectively

Source: Authors' own estimation

Table 6: Unit Root Test Results of the Aggregate Trade Variable

Test	Test Statistic	Critical value	Result
ADF	-2.973	-2.880**	Stationary
Zivot–Andrews	-25.324	-20.301*	Stationary

Source: Authors' own estimation
Significance Levels (= 1% level, ** = 5% level)

Table 7: VARX (1) Results

Variables	USA	India	Japan	Australia
R_{USA}	-0.1014 (0.1052)	0.0007 (0.1508)	0.0199 (0.1332)	0.0921 (0.0967)
R_{IND}	0.0531 (0.0573)	-0.0150 (0.0822)	0.0239 (0.0726)	0.0630 (0.0527)
R_{JPN}	0.0794 (0.0690)	0.0843 (0.0984)	0.0517 (0.0875)	0.0442 (0.0634)
R_{AUS}	-0.0949 (0.1064)	-0.0565 (0.1517)	-0.0439 (0.1348)	-0.1906 (0.0976) *
ATI (Trade)	-11.859 (4.443) ***	-15.255 (6.369) **	-10.288 (5.625) *	-10.567 (4.084) **
GFC	-3.576 (1.002) ***	-2.549 (1.428) *	-2.886 (1.1269) **	-3.186 (0.919) ***
COVID	-6.335 (2.055) ***	-10.211 (2.929) ***	-6.283 (2.604) **	-8.534 (1.885) ***
Constant	5.929 (1.846) ***	9.065 (2.631) ***	4.765 (2.339) **	5.272 (1.694) ***

Note: $R_{USA}, R_{IND}, R_{JPN}, R_{AUS}$ denote the stock market returns of USA, Japan, Australia, and India, respectively

Source: Authors' own estimation
Significance Levels (= 1% level, ** = 5% level, *** = 10% level)

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Table 8: Results of Portmanteau Test for Serial Correlation

Country	Q-Statistic	Degrees of Freedom	p-value	Conclusion
USA	2.4484	4	0.654	No serial correlation
India	4.8111	4	0.307	No serial correlation
Japan	2.0441	4	0.728	No serial correlation
Australia	6.8256	4	0.145	No serial correlation

Source: Authors' own estimation

Table 9: Granger Causality Results

Cause Variable	Chi-squared	Degrees of Freedom	p-value	Result
$\boldsymbol{R_{USA}}$	3.946	4	0.413	No Granger causality
$\boldsymbol{R_{IND}}$	0.822	4	0.935	No Granger causality
$\boldsymbol{R_{JPN}}$	0.927	4	0.921	No Granger causality
$\boldsymbol{R_{AUS}}$	5.169	4	0.270	No Granger causality

Note: $R_{USA}, R_{IND}, R_{JPN}, R_{AUS}$ denote the stock market returns of USA, Japan, Australia, and India, respectively

Source: Authors' own estimation

Table 10: Results of Impulse Response Functions

Shock Origin	Response of USA	Response of India	Result of Japan	Result of Australia	Duration	Overall Effect
R_{USA}	Strong immediate	Mild positive	Mild	Mild	2-3 periods	Short-lived transmission
R_{IND}	Moderate	Strong (own)	Weak	Weak	2-3 periods	Limited spillover
R_{JPN}	Moderate	Weak	Strong (Own)	Weak	2-3 periods	Weak transmission
R_{AUS}	Moderate	Weak	Weak	Strong (own)	2-3 periods	Limited spillover

Note: $R_{USA}, R_{IND}, R_{JPN}, R_{AUS}$ denote the stock market returns of USA, Japan, Australia, and India, respectively

Source: Authors' own estimation

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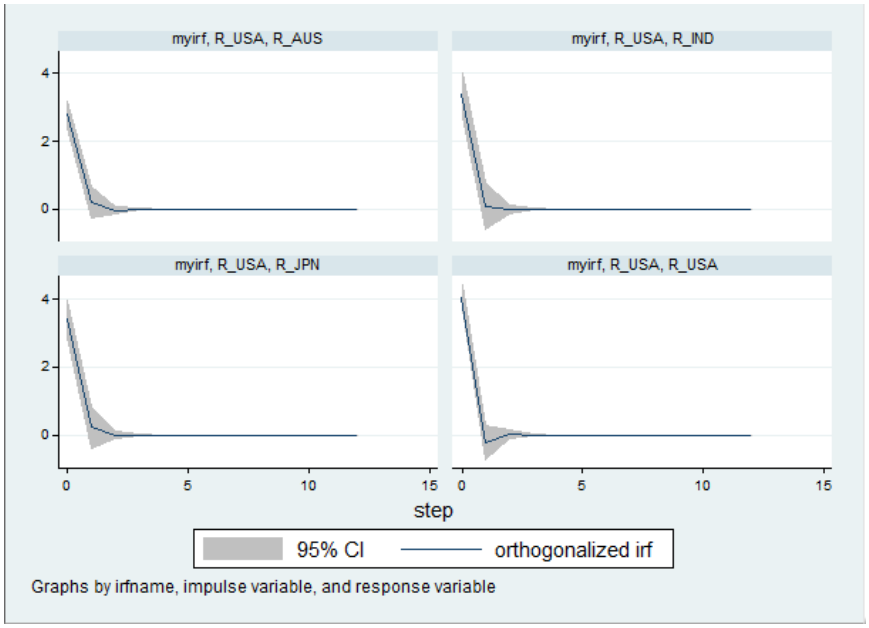

Figure 5: Impulse Response from USA Returns

Source: Authors' own estimation using STATA software

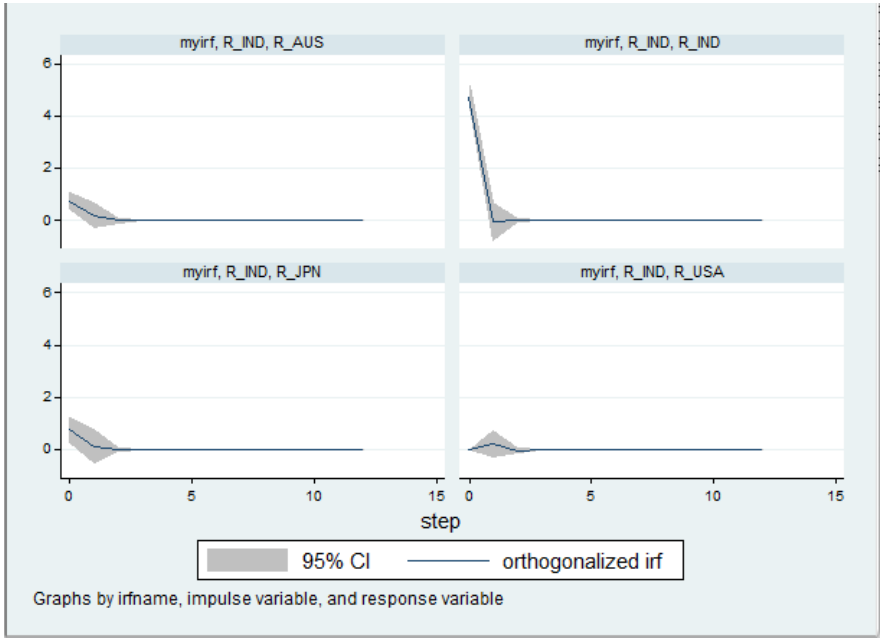

Figure 6: Impulse Response from India Returns

Source: Authors' own estimation using STATA software

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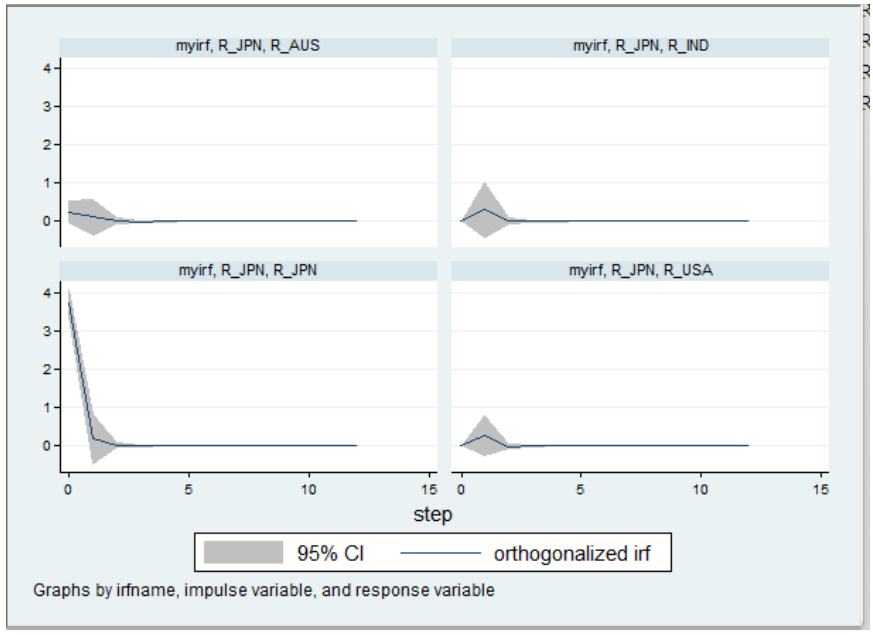

Figure 7: Impulse Response from Japan Returns

Source: Authors' own estimation using STATA software

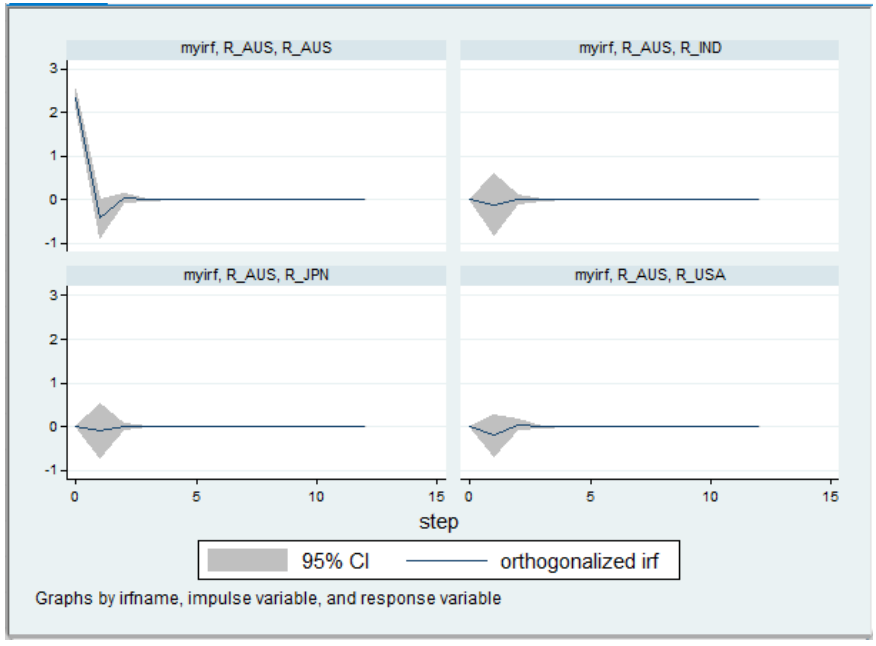

Figure 8: Impulse Response from Australia Returns

Source: Authors' own estimation using STATA software

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Table 11: Forecast Error Variance Decomposition (12th Period %) Results

Market	USA	India	Japan	Australia
USA	98.91	0.36	0.27	0.28
India	33.55	66.15	0.27	0.04
Japan	44.46	2.24	53.26	0.04
Australia	55.34	4.26	0.57	39.83

Source: Authors' own estimation

The optimal lag length selected for the VARX model is 1, based on standard lag selection criteria. The VARX (1) estimates reveal (Table 7) that own and cross-market returns are statistically insignificant, while all three exogenous variables, lagged aggregate trade variable, GFC, and COVID-19, exert significant negative effects across all QUAD markets. As shown in Table 8, the Portmanteau test results indicate the absence of serial autocorrelation in the residuals. The results of Granger causality (Table 9) show no significant causal relationships among the four QUAD economies. The findings of Impulse Response Functions (Table 10) show that the transmission of shocks across the QUAD stock markets is immediate but is short-lived, mainly within 2-3 periods. Further, graphs of impulse responses (Figure 5-8) show that each market responds strongly and immediately to its own shocks. It is noteworthy that the impulse response functions demonstrate convergence, as the effects of shocks across all four QUAD stock markets die out within 2-3 periods and return to the baseline, showing that the system is stable and mean-reverting. The short-lived nature of these shock transmissions indicates that fluctuations dampen gradually rather than persist or diverge, suggesting no market exerts a permanently destabilizing effect on the other markets. The findings of forecast error variance decomposition (Table 11) show that the USA exerts the strongest cross-market influence.

Policy Implications and Areas for Future Research

The findings show an inverse relationship between stock market returns and trade integration, indicating a higher vulnerability to external risks and volatility. The policymakers in QUAD economies can focus on strengthening financial stability, enhancing risk management frameworks, and encouraging partnership in trade and financial policies in order to better manage external shocks and ensure long-term economic resilience. Though the organization was primarily established for security purposes, this paper highlights the QUAD's growing importance from an economic perspective, particularly with regard to trade and financial linkages among member countries. Additionally, the effect of global shocks on stock markets suggests that stronger financial institutions with sound risk management techniques would help policymakers better manage unforeseen external shocks. Future studies can examine the impact of additional macroeconomic and financial factors in order to obtain greater knowledge of the changing relationship between trade and stock

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market linkages. Also, comparative studies of different regional blocs may be drawn to deduce generalisable results.

Conclusion

The study examines the stock market linkages between the QUAD economies and the role of bilateral trade using a VARX (1) model. The study uses this model to understand how trade influences stock market linkages and how shocks are transmitted across markets. Our findings reveal that there is a weak transmission of stock market returns among the QUAD economies. Further, the results show a significant and negative effect of trade on stock markets of these economies, implying that greater trade openness is linked with lower stock returns. Hence, our findings reflect that increased integration with global markets may expose economies to volatility. It is very important to strengthen trade partnerships and improve trade relations in order to boost capital markets growth, leading to economic resilience. The results of the study also show that the global financial crisis and COVID-19 significantly affect the stock market returns. Impulse response functions analysis reveals that transmission of shocks across the QUAD stock markets is immediate, though limited to 2-3 periods only. Also, we find that US market acts as a net transmitter of return shocks to the other markets. Further, the FEVD further shows that the US market is largely driven by its own shocks through strong outward spillovers and limited reverse effects, thereby reflecting asymmetric interdependence among the markets.

Limitations

This study is limited by its focus on the QUAD economies, which may restrict the generalization of the findings to other regional blocs. Further, this study uses bilateral trade as the primary explanatory variable, while other macroeconomic and financial factors affecting stock market linkages remain outside the scope. Despite these limitations, the results are robust and provide scope for future research.

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Declaration of interest statement

The author has no personal or financial interest that could affect or influence the work presented in this paper.

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