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Dynamic Spillover Effects of Member Economies on Foreign Financial Flows and Macroeconomic Indicators within the BRICS Bloc

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Abstract: The interdependence of emerging economies within the BRICS grouping—Brazil, Russia, India, China, and South Africa—has been analysed through a time-varying parameter vector autoregression (TVP-VAR) framework to quantify member-related spillovers affecting foreign financial flows and macroeconomic fundamentals. Using quarterly data spanning 1998 to 2023, obtained from the International Monetary Fund, World Bank, and Bloomberg Terminal, the analysis has focused on the dynamic interactions between foreign direct investment (FDI) and key domestic indicators, including inflation rates, real gross domestic product growth (RGDP), and central bank policy interest rates (IR). It has been observed that spillover effects are both time-dependent and asymmetric across member states. China and South Africa have consistently functioned as net transmitters of macro-financial shocks, whereas Brazil and Russia have primarily acted as net recipients. FDI flows have been found to be particularly sensitive to inflationary pressures and monetary policy adjustments within the bloc, with heightened responsiveness during periods of global economic volatility. The findings suggest that the internal propagation of macroeconomic disturbances within the BRICS network exerts a measurable influence on the direction and intensity of capital flows, thereby reinforcing the systemic importance of regional coordination. By identifying the nodes of shock origination and absorption, the study contributes to a more granular understanding of regional vulnerability and resilience. These insights hold significant implications for policymakers aiming to strengthen economic safeguards and for investors seeking to recalibrate risk exposure in emerging markets. Emphasis is placed on the need for synchronised macroeconomic policy frameworks to mitigate adverse contagion and enhance financial stability within the BRICS consortium.

Keywords: BRICS; Spillover effects; Foreign direct investment (FDI); Time-varying parameter vector autoregression (TVP-VAR); Macroeconomic interdependence; Inflation; Monetary policy; Emerging markets

JEL Classification: F3; F4; F42; G11

1. Introduction

Since its formal establishment in 2010, the BRICS alliance, comprising Brazil, Russia, India, China and South Africa, has emerged as a formidable economic and political counterweight to Western-dominated institutions, representing over 40% of the world's population and roughly 25% of global GDP (Bishop, 2022). Born of earlier intellectual discussions on the potential of large emerging markets, BRICS was conceived to deepen economic collaboration by enhancing trade and investment flows and fostering sustainable growth across member nations (Department of International Relations & Cooperation Republic of South Africa, 2023). Beyond aggregate measures of trade and foreign direct investment (FDI), the bloc's significance lies in its collective bargaining power, evident in initiatives such as the New Development Bank and the Contingent Reserve Arrangement, which seek to reduce reliance on Western-centric financial architecture and to promote a more multipolar world order

(Azevedo et al., 2024; Nach & Ncwadi, 2024; Naim & Hasanah, 2024). Annual summits serve as a vital forum for discussing economic plans, while the BRICS Business Council, established in 2013, promotes corporate collaboration and private-sector engagement (Department of International Relations & Cooperation Republic of South Africa, 2023). Political cooperation extends to advocating for reforms in institutions such as the IMF, World Bank, United Nations and G20 to secure more equitable representation for developing economies (Duggan et al., 2021).

Macroeconomic conditions in member countries, particularly inflation, policy interest rates (IR) and real gross domestic product (RGDP), play a critical role in shaping foreign financial flows, with relatively stable economies attracting larger shares of FDI (Nach & Ncwadi, 2024). Initiatives such as the BRICS Trade and Economic Cooperation Framework have reduced trade barriers and promoted intra-bloc trade, with China leading on trade policy, Brazil and India focusing on agricultural and technology exports, and Russia emphasising energy (Department of International Relations & Cooperation Republic of South Africa, 2023). Despite a burgeoning literature on BRICS integration, most studies adopt static, bilateral perspectives and treat FDI as an exogenous outcome, thereby overlooking the dynamic, directional spillovers that arise when macroeconomic shocks, whether from the 2008–09 global financial crisis, the COVID-19 pandemic or the Ukraine war, propagate through cross-border capital flows (Berezka et al., 2021; Iqbal, 2021; Nach & Ncwadi, 2024).

This paper models the time-varying interplay between key macroeconomic indicators, inflation, policy IR and RGDP, and FDI flows across all five BRICS countries over 1998–2024 using a time-varying parameter vector autoregression (TVP-VAR) framework alongside the Diebold–Yilmaz connectedness index. It quantifies the magnitudes and directions of spillovers between macroeconomic conditions and foreign investment within the BRICS grouping, traces how these spillovers have evolved in response to major global and regional crises and derives policy insights to enhance macro-financial coordination and stabilise investment inflows in a multipolar economic environment. By extending the dataset through 2024, our analysis offers the most current empirical assessment of BRICS macro-financial interdependence.

Employing a unified TVP-VAR and connectedness methodology reveals which countries and variables act as net transmitters or receivers of shocks, offering deeper insight than prior static or pairwise studies. Finally, our recommendations for coordinated monetary and fiscal settings and risk-management strategies aim to bolster the bloc's collective resilience and attractiveness to foreign investors. The remainder of this manuscript is organised as follows: Section 2 reviews the literature on macro-financial spillovers and dynamic connectedness methods; Section 3 describes our data sources and methodology; Section 4 presents our main results across key episodes; and Section 5 concludes with policy implications for enhanced BRICS coordination.

2. Literature Review

To address both theoretical and empirical dimensions of macro-financial spillovers within BRICS, this review touches on the theoretical foundations of FDI and macroeconomic interdependence, spillover channels and mechanisms, and empirical evidence of dynamic spillovers in the BRICS context.

2.1 Theoretical Review

Portfolio theory posits that FDI enables investors to diversify portfolios and optimise the risk–return trade-off (Prabhakar et al., 2015). Modern Portfolio Theory and the Capital Asset Pricing Model further suggest that cross-border allocations depend on systematic risk premiums, which macroeconomic shocks, through shifts in expected returns and volatility, can alter. The interest-rate parity condition implies that differentials in policy rates drive covered and uncovered arbitrage, influencing capital flows across open economies (Kodongo & Ojah, 2013). The Mundell–Fleming model extends the closed-economy IS–LM framework to an open economy, highlighting the policy trilemma: a country cannot simultaneously maintain a fixed exchange rate, free capital mobility and independent monetary policy (Wang, 2020). Heterogeneity in BRICS exchange-rate regimes, ranging from China's managed float to Brazil's and South Africa's flexible regimes, implies asymmetric spillover transmission when policy IR change (Ahmad et al., 2018; Letsie, 2021).

Real Business Cycle theory attributes business-cycle fluctuations to real shocks, such as productivity gains or resource discoveries, propagating through trade and investment linkages, causing synchronized output fluctuations across economies (Kose et al., 2003). Endogenous growth theory emphasises that FDI brings technology transfer and knowledge spillovers, which enhance long-term growth prospects and, in turn, attract further investment (Zamani & Tayebi, 2021). Theories of inflation and interest-rate differentials explain that relative price stability shapes competitiveness, terms of trade and cross-border investment patterns; persistent inflation divergences can deter FDI and encourage capital flight to lower-inflation member states (Gona, 2024). Corporate and regulatory reforms, including China's special economic zones and India's liberalisation measures, illustrate how policy interventions modify location-specific advantages and thus influence FDI flows (He, 2020). By integrating portfolio allocation, interest-parity, Mundell–Fleming, real-shock and growth-spillover frameworks, our study

captures how shocks to policy rates, inflation and output in one BRICS member generate endogenous FDI responses in others, underpinning the dynamic spillovers we empirically investigate.

Spillovers, defined as the unintended transmission of economic shocks from one country to another, can be categorised into trade, financial and policy channels, each with distinct positive and negative effects (Truelove et al., 2014). Positive trade spillovers stimulate regional growth, technology transfer and labour-market deepening, whereas tariff cuts within BRICS under the Trade and Economic Cooperation Framework disadvantage non-member suppliers and reshape global supply chains (Jha et al., 2018). Financial spillovers generate contagion when crises provoke asset sell-offs across interconnected markets (Kaminsky & Reinhart, 2000). Policy-driven spillovers arise when macroeconomic or monetary-policy shifts in one country alter capital flows and exchange-rate dynamics in its neighbours (Zhang et al., 2019). Real Business Cycle theory explains that productivity or resource shocks propagate through trade and investment linkages, amplifying or dampening business-cycle fluctuations across member states (Kose et al., 2003).

2.2 Empirical Review

Empirical studies consistently find that shocks in one BRICS economy materially affect others. Mohanty & Sethi (2019) and Bhundia & Ricci (2005) demonstrated that demand-side disruptions in China and the 1998 Russian crisis significantly reduced export earnings and capital inflows to commodity exporters like Brazil and South Africa. In contrast, Das et al. (2022) showed South Africa's robust financial regulation moderated adverse spillovers during regional downturns. While these papers agree on strong economic linkages, they differ in the assessed magnitude of contagion and the extent to which domestic policy buffers mitigate external shocks.

Building on this foundation, more recent work employs TVP-VAR models to capture the evolving nature of spillovers. Wang et al. (2024) used TVP-VAR to show that investor sentiment acts predominantly as a shock receiver within BRICS stock markets, with India and South Africa experiencing the highest sentiment spillovers. Dahir et al. (2020) applied TVP-VAR techniques to Bitcoin-equity networks, finding that nearly 45% of forecast-error variance in financial variables stems from spillovers between cryptocurrency and equity markets. Both studies confirm TVP-VAR's strength in detecting time-varying interconnectedness, although they focus on equity-market sentiment versus crypto-asset interactions. Extending this line of inquiry, Cepeda-López et al. (2018) decomposed trade-credit and banking-sector exposures, showing that up to 60% of exporter-to-importer spillovers within BRICS derive from financial linkages rather than pure trade volumes. Their results suggest that financial-sector vulnerabilities increasingly mediate the transmission of real-economy shocks, amplifying contagion risks.

A parallel strand of literature examines spillovers involving cryptocurrencies and broader asset markets. Aalborg et al. (2019) used multivariate regressions to link Bitcoin returns to blockchain activity metrics such as unique addresses and transaction volumes, identifying significant predictive relationships. Symitsi & Chalvatzis (2018) employed asymmetric VAR-GARCH models to reveal bidirectional volatility spillovers between Bitcoin and energy/technology equities, highlighting feedback loops between BRICS traditional and digital assets. Kajtazi & Moro (2019) applied the Conditional Value-at-Risk analysis and concluded that including Bitcoin in investment portfolios improves returns but increases overall volatility. Zhang et al. (2021) extended connectedness index of Diebold & Yilmaz (2008), finding that Bitcoin derivatives amplify bidirectional net spillovers with BRICS stock markets. Collectively, these studies confirm that crypto-asset shocks permeate BRICS markets, albeit through different mechanisms and with varying implications for financial stability.

At a macroeconomic level, several studies investigated capital flows, trade elasticity, and structural responses within BRICS. Nori & Mishra (2021) showed that long-term growth prospects mainly influence FDI, whereas portfolio flows are highly sensitive to global risk aversion and volatility spikes. De Conti & Diegues (2022) further demonstrated that external shocks and domestic monetary policy divergence shape inflation trends within BRICS. Bigerna (2023) highlighted that trade elasticities differ markedly across BRICS, with South Africa and Brazil exhibiting stronger terms-of-trade pass-through than China or India. At a micro-sectoral level, Huang (2024) and the New Development Bank (2023) revealed that technological innovation, energy-sector shocks, and agricultural disruptions propagate unevenly across BRICS economies. Their findings emphasise that sector-specific vulnerabilities, not just macro fundamentals, play a crucial role in cross-border shock transmission, necessitating differentiated and targeted policy interventions.

Finally, studies like Berezka et al. (2021) utilised the Diebold–Yilmaz connectedness framework within a TVP-VAR setting to show that monetary policy shocks, particularly changes in policy rates, transmit more strongly across BRICS financial systems than output shocks. Their results highlight the increasing synchronisation of monetary-policy spillovers within emerging-market blocs, an important dimension for understanding financial contagion in integrated economies.

3. Data and Methodology

3.1 Data

The data examined in this paper were sourced from official sources, such as the International Monetary Fund, the World Bank, and the Bloomberg Terminal. The data collected from these sources has proved reliable, as has been utilised by Kayani et al. (2024), Panda et al. (2023), and Samargandi et al. (2020). In keeping with the paper's aim, the sample consists of data from all five original BRICS countries (Brazil, Russia, India, China, and South Africa) over 25 years, from January 1998 to December 2023. The 25-year period effectively tests the long-run spillover relationships between the countries in the paper. This is consistent with Billah et al. (2022) and Maryam & Mittal (2020).

The study examines four variables, with FDI used as a proxy for foreign financial flows (Maryam & Mittal, 2020). The variables of interest used to measure macroeconomic conditions are the consumer price index (CPI), RGDP, and the central bank IR. These variables were used in papers by Maryam & Mittal (2020), Panda et al. (2023), and Samargandi et al. (2020). These macroeconomic variables are essential in explaining various relationships within a country, and this study seeks to find their spillover effects within the BRICS grouping. FDI is logged (Maryam & Mittal, 2020).

3.2 Methodology

Checking the variable's stationarity is valuable before estimating the TVP-VAR model. Like the VAR model, the TVP-VAR model needs the variables to have the same order of integration, I (0) (Nakajima, 2011). A series is stationary if its statistical properties, particularly the mean, variance, and covariance, are independent of time (Ramirez et al., 2020). Testing for stationarity or unit roots is frequently done using unit root tests, such as Dickey-Fuller (DF) and Augmented Dickey-Fuller (ADF). According to Nasir & Morgan (2023), a series posits a unit root if it is not stationary. In this paper, the ADF test will be used to assess the stationarity of the variables in the VAR model. The ADF test is the extension of the DF test, accounting for the dependent variable's lagged values. Following Brooks (2019), the ADF test is conducted by first estimating Eq. (1), shown below.

$$\Delta y_t = \varphi y_{t-1} + \sum_{i=1}^{n} \beta_i \Delta y_{t-i} + \varepsilon_t \quad (1)$$

where, y_t is the time series, y_{t-1} is the time series at lag i, Δ is the differencing operator. ψ represents the coefficient on the lagged value of y_t, and $\beta_1, \beta_2, \beta_3, \ldots \beta_p$ represents the coefficients on the lagged first differences of y_t. The null hypothesis that the series has a unit root (not stationary) is tested against the alternative that the series is stationary (Cheti & Ilembo, 2021). The test statistic is calculated as follows:

$$DF_\tau = \frac{\gamma}{SE_{(\gamma)}} \quad (2)$$

The null hypothesis is rejected if the test statistic is more negative than the critical value, indicating that the series y_t is stationary in levels or $y_t \sim$ I (0). Failing to reject the null hypothesis suggests that the series is not stationary in levels. Applying the first differences and conducting the test again is advisable (Paparoditis & Politis, 2015).

After ensuring stationarity, the study uses the TVP-VAR model to examine the dynamic relationships and spillover effects among the macroeconomic variables of BRICS countries and their net inflows for FDI (Panda et al., 2023; Samargandi et al., 2020). This model is ideal for capturing changing economic conditions and relationships over time, enabling the model's coefficients to change (Diebold & Yilmaz, 2012). The method allows us to investigate both the immediate and prolonged effects of FDI, inflation (CPI), GDP growth (RGDP), and central bank IR.

The TVP-VAR model improves upon standard VAR models by tackling the issue of fixed parameters, which might not accurately reflect changes in economic relationships over time (Dahir et al., 2020). The TVP-VAR model's ability to adapt to changing conditions has been used in earlier researches by Diebold & Yilmaz (2008) and Diebold & Yilmaz (2012), proving its effectiveness for analysing developing connections in a complex environment. The choice of TVP-VAR is motivated by the need to accommodate evolving structural relationships and regime shifts in the BRICS economies (Nyakurukwa & Seetharam, 2023). A traditional VAR assumes constant coefficients and covariance structures, which would implicitly smooth over significant events such as the 2008 global financial crisis and, more recently, the COVID-19 pandemic (Lim & Choi, 2024).

TVP-VAR allows coefficients and covariances to drift stochastically, capturing gradual trends and sudden breaks without exogenous windowing or discrete state assumptions (Cao & Xie, 2022). Alternative frameworks,

such as rolling-window VAR, Markov-switching VAR, and dynamic factor models, were considered but found less suitable. Rolling windows require arbitrary window lengths that trade-off between bias and variance; Markov-switching VAR imposes discrete regime switches, which may not map cleanly to continuously evolving economic linkages; and dynamic factor models summarise co-movement via latent factors without explicit bilateral shock transmission, thus obscuring country-to-country channels (Asomaning et al., 2024).

$$x_t = \sum_{i=1}^{p} \emptyset\, t_i x_{t-i} + \varepsilon_t \tag{3}$$

The vector x_t includes variables like logged FDI, inflation, RGDP, and central bank IR at time. The optimal lag length, p, is determined using criteria such as the Bayesian Information Criterion (BIC). The time-varying coefficients Φt and i change to reflect the evolving relationships among the variables. It is assumed that the error term ϵt follows a multivariate normal distribution with a time-varying covariance matrix St, which captures the changes in volatility within the system. This model enables a changing relationship between variables, enhancing comprehension of spillover effects and economic shock transmission between countries.

In line with researches by Diebold & Yilmaz (2008) and Diebold & Yilmaz (2012), this study employs forecast error variance decomposition (FEVD) to measure the transmission of effects between the variables. The FEVD offers information on the proportion of forecast error variance in one variable resulting from shocks in another. This approach does not depend on the sequence of variables, which is a significant benefit compared to standard Cholesky-based variance decompositions (Diebold & Yilmaz, 2012).

$$\emptyset_{ij}(H) = \frac{\sum_{h=0}^{H-1} e_i' A_h \sum e_j^2}{\sum_{h=0}^{H-1} e_j' A_h \sum A_h' e_i} \tag{4}$$

In this case, Ah denotes the coefficient matrices that change over time, while Σ represents the residuals' variance-covariance matrix. The term e_i is a vector with a value of 1 in the ith position and 0 in all other positions. This calculates the percentage of the H-step forecast error variance of variable i attributable to shocks in variable j.

The variance decomposition results are used to measure the total connectedness index (TCI), the directionality of connectedness, and the net spillover effects for analysing the interconnectedness (Dahir et al., 2020). The following are the definitions of these spillover metrics. Total Spillovers (TC) quantifies the overall impact of spillover effects among all variables, indicating how shocks are shared among the BRICS countries (Diebold & Yilmaz, 2012).

$$TC(H) = \frac{\sum i \neq j\, \emptyset_{ij}(H)}{N} * 100 \tag{5}$$

Directional Spillovers (To and From): According to Wang et al. (2024), from methodology by Diebold & Yilmaz (2012), these measures indicate the main variables responsible for transmitting shocks (To-directional spillovers) and those that are primarily affected by them (From-directional spillovers). One example is the To-directional connectedness for variable i, which quantifies variable i's impact on the forecast error variance of all other variables.

$$DC_{i\to j}(H) = \frac{\sum i \neq j\, \emptyset_{ij}(H)}{\sum ij\, \emptyset_{ij}(H)} * 100 \tag{6}$$

Net Spillovers: The net spillover effect measures if a country is giving or receiving economic shocks by comparing To-directional and From-directional spillovers for each variable.

$$NS_{ij}(H) = DC_{i\to j}(H) - DC_{j\to i}(H) \tag{7}$$

A positive net spillover indicates that variable i sends more shocks than it receives, while a negative value suggests that it mainly receives shocks. Bayesian estimation techniques are employed to estimate the parameters of the TVP-VAR model. By utilising the TVP-VAR model and variance decomposition methods, this research extensively examines spillover effects among the BRICS nations. Monitoring changes in these connections over time provides essential information on how significant economic disturbances spread between countries, which is vital for focusing on global economic connections (Lim & Choi, 2024).

4. Empirical Analysis

The empirical analysis explains descriptive statistics and unit root results in Table 1 and Table 2. We then discuss the results of spillovers between BRICS countries by looking at the connectedness between the variables.

4.1 Preliminary Results

The descriptive statistics (Table 1) for the grouped BRICS countries reveal notable key economic indicators, including FDI, RGDP, CPI, and IR. The average FDI is 0.0492, showing modest inflows, while the mean RGDP rate is also positive at 0.0448, pointing to economic expansion in general. Nevertheless, the slight CPI average increase of 0.0670 could impact competitiveness. The average IR is 9.81%, indicating considerable expenses associated with borrowing in BRICS countries. The median FDI of 0.0600, above the mean, demonstrates that certain countries saw notably higher inflows. In contrast, the median RGDP rate of 0.0500 indicates that a few countries with lower growth rates are bringing down the overall average.

Considerable disparities exist among countries based on the wide ranges of FDI (2.5600 to −2.3500) and RGDP (0.1400 to −0.0800) maximum and minimum values. Significant variability is evident in FDI (0.7143) and IR (0.0797) due to high standard deviations in these measures. Skewness measurements show that FDI tends to have positive skewness, suggesting that certain countries attract significant investments. Conversely, RGDP displays negative skewness, indicating that the majority of countries experienced relatively high growth rates. The very high kurtosis of IR (23.0364) suggests a distribution significantly impacted by outliers. In addition, the Jarque-Bera statistics exceed the chi-square critical value of 5.991 with a degree of freedom of 2. This indicates that the null hypothesis that the series follows a normal distribution is rejected in favour of the alternative hypothesis. Therefore, these variables deviate from the normal distribution.

Table 1. Summary descriptive statistics

	FDI	RGDP	CPI	IR
Mean	0.0492	0.0448	0.0670	0.0981
Median	0.0600	0.0500	0.0500	0.0800
Maximum	2.5600	0.1400	0.8400	0.600
Minimum	−2.3500	−0.0800	−0.0100	0.0300
Std. Dev.	0.7143	0.0394	0.0826	0.0797
Skewness	0.3953	−0.5231	6.8376	3.9500
Kurtosis	5.8348	3.5065	61.9637	23.0364
Jarque-Bera	46.5552*	7.2618*	19692.5100*	2493.2893*
Observations	25	25	25	25

Note: (*) indicates the rejection of the normality assumption

Table 2 shows the grouped ADF test results for variables in the TVP-VAR model. The *p* values for all variables exceed 1%, 5%, and 10%, indicating that the null hypothesis of a unit root is rejected. There is sufficient evidence to conclude that the variables are stationary in levels or integrated of order zero. Since all variables have the same order of integration, I (0), it is appropriate to continue estimating the TVP-VAR model.

Table 2. Group unit root (ADF) test

Variables	FDI	RGDP	CPI	IR
Levels (*p* values)	0.0000***	0.0000***	0.0000***	0.0008***
Order of Integration	I (0)	I (0)	I (0)	I (0)

Note: (***) Stationarity at 1%***, 5%**, and 10* significance level

4.2 Directional Dynamic Connectedness

Refer to Table 3 below.

4.2.1 Brazil

Brazil's FDI dynamics reflect a dual sensitivity to domestic monetary signals and external macro-shocks. Domestically, both the inflation index and policy IR exhibit a positive coefficient on Brazil's inward FDI, suggesting that rising prices and borrowing costs are interpreted by international investors as precursors to profitable opportunities, perhaps in sectors viewed as natural hedges against tighter credit conditions. Externally, Brazil benefits from positive spillovers originating in Russia: a one-unit increase in Russia's policy rate is associated with a (8.82%) rise in Brazil's FDI. In contrast, a one-unit uptick in Russia's GDP growth corresponds to an (5.54%) increase. By contrast, inflationary pressures in China and slower RGDP in India exert a dampening

effect (−0.47% and −2.58%, respectively), indicating that cost shocks in China and decelerating demand in India partly divert investment away from Brazil.

Bellak & Leibrecht (2024) document that pre-emptive policy rate hikes often coincide with FDI volatility spikes as investors rebalance into "inflation-safe" assets, a mechanism our positive domestic rate coefficient corroborates. Moreover, their analysis of Brazil's Agreements on Cooperation and Facilitation of Investment (ACFIs), notably with India in 2020 and the UAE in 2019, explains why stronger Russian growth can indirectly bolster Brazil: streamlined entry procedures and harmonised dispute resolution under ACFIs amplify Brazil's net "to" spillovers. Lastauskas & Nguyen (2024) emphasise the transmission of monetary tightening to emerging markets via capital-flow adjustments, a channel reflected in Brazil's sensitivity to foreign rate shocks. Nach & Ncwadi (2024) highlight Brazil's commodity-centric export profile, particularly agribusiness and minerals, as a key reason its FDI is more volatile in response to commodity-price-linked inflation than in more manufacturing-diversified BRICS peers. Brazil's FDI responsiveness emerges from domestic monetary cues, regional investment frameworks, and capital-flow cycles.

4.2.2 China

China's FDI volatility is dominated by pronounced negative spillovers from its macroeconomic fluctuations and those of its BRICS partners. Domestically, a one-percentage-point increase in China's inflation rate correlates with a (−5.20%) decline in FDI inflows, underscoring the power of the inflation–exchange-rate channel: higher CPI erodes the real exchange rate, compresses corporate margins, and weakens China's attractiveness to overseas investors. Internationally, rising inflation in India and Russia further curtails Chinese FDI by (−2.76%) and (−0.29%), respectively, reflecting how cost pressures abroad can dampen competitive arbitrage opportunities. Similarly, interest-rate hikes in Brazil and South Africa suppress China's FDI by (−2.98%) and (−4.05%), as higher yields elsewhere prompt portfolio reallocations away from Chinese projects.

These percentage figures echo established findings. Kishor & Singh (2015) employ a panel VAR across BRICS hosts and identify a significant negative relationship between domestic inflation shocks and FDI volatility, validating our (−5.20%) coefficient. Lastauskas & Nguyen (2024) show that, despite China's extensive bilateral investment treaties and RCEP-style investment chapters, global rate shocks still transmit through capital-flow channels, consistent with our findings on Brazilian and South African rate spillovers. Finally, Nach & Ncwadi (2024) highlight China's strategic pivot from export-led manufacturing to services and high-technology sectors; this structural evolution heightens vulnerability to partner-country policy shifts and value-chain disruptions, explaining why China's FDI volatility is now more sensitive to external macroeconomic disturbances than during its earlier growth phases.

4.2.3 India

India's net FDI inflows exhibit pronounced sensitivity to domestic and external inflationary pressures. A one-percentage-point rise in India's own CPI correlates with a (−3.10%) decline in net FDI, while similar inflationary shocks in China (−7.31%) and South Africa (−5.66%) further depress incoming capital. By contrast, inflationary increases in Brazil (+0.88%) and Russia (+0.70%) modestly bolster India's FDI, as higher costs in those commodity-exporting economies can make India comparatively more attractive for manufacturing and services investment. Monetary policy spillovers also play a key role. India's policy-rate hikes curb net FDI by (−8.24%), and rate increases in South Africa (−4.37%) and Brazil (−2.39%) similarly deter foreign investment. Conversely, rate rises in China (+0.33%) and Russia (+0.39%) generate small positive spillovers, suggesting that global yield differentials sometimes redirect portfolio flows towards India when its peers tighten more aggressively.

Although specific coefficients for real-GDP growth spillovers are not always uniform, the overall pattern is negative: stronger GDP growth in partner BRICS countries tends to siphon FDI away from India, likely through competition for the same pools of global capital and the diversion of multinational projects to faster-growing markets. These percentage-based results echo and extend existing literature. Panda et al. (2023) use quantitative panel methods to show significantly negative CPI coefficients for India, China, and South Africa on India's FDI volatility, corroborating our (−3.10%, −7.31%, and −5.66%) findings. Lastauskas & Nguyen (2024) demonstrate that monetary tightening in other countries affects India via global yield channels, consistent with our observation that policy-rate differentials drive FDI flows into and out of India. Finally, Nach & Ncwadi (2024) highlight India's dual economy, where high-value, mobile service exports coexist with capital-intensive infrastructure projects, explaining why inflation and rate shocks have a more muted impact on service-sector FDI than large infrastructure investments.

4.2.4 Russia

Russia's net FDI inflows exhibit modest domestic resilience and sizable external vulnerabilities when expressed in percentage. Domestically, a one-percentage-point uptick in Russia's inflation rate is associated with a (+2.27%) increase in FDI. A one-percentage-point rise in its policy rate corresponds to a (+0.51%) gain, signalling that stable macro conditions at home can bolster investment confidence. However, Russia is more sensitive to inflationary

and monetary shocks abroad. A one-percentage-point increase in China's CPI yields a (−6.87%) decline in Russian FDI. India's inflation shocks reduce Russia's inflows by (−3.00%), reflecting how higher costs in key trading partners undercut Russia's relative attractiveness. Rate hikes in India carry a substantial negative spillover of (−7.84%), as higher yields divert global capital away from Russian projects. By contrast, a one-percentage-point rise in China's policy rate contributes a +0.88% spillover boost, and inflation in Brazil adds (+0.32%), suggesting that Russia can capture inflows when peers tighten or face mild cost pressures.

Fang et al. (2024) demonstrate that FDI in Russia's energy sector, where over 60% of inflows target oil and gas, responds differently to commodity-price swings than renewable-energy projects, mirroring our observed heterogeneity between domestic stability and external shocks. Panda et al. (2023) highlight divergences between the Central Bank of Russia's rate and capital-flow volatility, consistent with the outsized negative spillover from Indian rate hikes and the modest positive spillover from Chinese rate moves. Moreover, Nach & Ncwadi (2024) emphasise that Russia's resource-intensive export profile amplifies sensitivity to commodity and monetary shocks, explaining why external inflation in China and India inflicts more severe FDI downturns than domestic fluctuations. Russia's FDI volatility is anchored by its relatively stable home-market signals. However, it remains heavily conditioned by partner-country inflation and interest-rate cycles, with energy-sector linkages and global rate differentials shaping the balance of positive and negative spillovers.

4.2.5 South Africa

South Africa's FDI volatility exhibits strong positive spillovers from Brazil and Russia, while remaining sensitive to adverse shocks from China and India. At home, a one-percentage-point rise in South African inflation correlates with a (+2.47%) increase in FDI inflows, and a one-percentage-point hike in the policy rate corresponds to a (+2.31%) gain, suggesting that, like Brazil, investors view domestic price, and rate increases as signals of valuable hedging or high-return opportunities. By contrast, RGDP domestically shows a (0.00%) effect, indicating that short-term output changes do not materially sway FDI decisions. Externally, Brazil's improved macro conditions, namely lower inflation and higher rates, translate into additional FDI to South Africa. In contrast, Russia's rising policy rate and GDP growth similarly boost South African inflows. Conversely, inflation shocks in China depress South Africa's FDI by (−0.69%), and stronger real-GDP growth in India reduces it by (−2.42%), reflecting competitive reallocation of investment toward those markets.

Table 3. Directional dynamic connectedness

Brazil	Value	China	Value	India	Value	Russia	Value	South Africa	Value
FDI (B) to CPI (B)	8.87	FDI (C) to CPI (B)	−0.21	FDI (I) to CPI (B)	0.88	FDI (R) to CPI (B)	0.32	FDI (SA) to CPI (B)	8.68
FDI (B) to CPI (C)	−0.47	FDI (C) to CPI (C)	−5.20	FDI (I) to CPI (C)	−7.31	FDI (R) to CPI (C)	−6.87	FDI (SA) to CPI (C)	−0.69
FDI (B) to CPI (I)	3.70	FDI (C) to CPI (I)	−2.76	FDI (I) to CPI (I)	−3.10	FDI (R) to CPI (I)	−3.00	FDI (SA) to CPI (I)	3.29
FDI (B) to CPI (R)	8.36	FDI (C) to CPI (R)	−0.29	FDI (I) to CPI (R)	0.70	FDI (R) to CPI (R)	2.27	FDI (SA) to CPI (R)	8.09
FDI (B) to CPI (SA)	2.39	FDI (C) to CPI (SA)	−6.36	FDI (I) to CPI (SA)	−5.66	FDI (R) to CPI (SA)	−7.63	FDI (SA) to CPI (SA)	2.47
FDI (B) to IR (B)	6.07	FDI (C) to IR (B)	−2.98	FDI (I) to IR (B)	−2.39	FDI (R) to IR (B)	−1.16	FDI SA) to IR (B)	5.67
FDI (B) to IR (C)	6.63	FDI (C) to IR (C)	−1.61	FDI (I) to IR (C)	0.33	FDI (R) to IR (C)	0.88	FDI (SA) to IR (C)	6.30
FDI (B) to IR (I)	−0.84	FDI (C) to IR (I)	−5.68	FDI (I) to IR (I)	−8.24	FDI (R) to IR (I)	−7.84	FDI (SA) to IR (I)	−1.02
FDI (B) to IR (R)	8.82	FDI (C) to IR (R)	−0.14	FDI (I) to IR (R)	0.39	FDI (R) to IR (R)	0.51	FDI (SA) to IR (R)	8.61
FDI (B) to IR (SA)	3.47	FDI (C) to IR (SA)	−4.05	FDI (I) to IR (SA)	−4.37	FDI (R) to IR (SA)	−4.64	FDI (SA) to IR (SA)	2.31
FDI (B) to RGDP (B)	4.06	FDI (C) to RGDP (B)	−4.55	FDI (I) to RGDP (B)	−2.72	FDI (R) to RGDP (B)	−2.56	FDI (SA) to RGDP (B)	3.88
FDI (B) to RGDP (C)	4.15	FDI (C) to RGDP (C)	−2.70	FDI (I) to RGDP (C)	−2.14	FDI (R) to RGDP (C)	−2.35	FDI (SA) to RGDP (C)	4.14
FDI (B) to RGDP (I)	−2.58	FDI (C) to RGDP (I)	−5.14	FDI (I) to RGDP (I)	−6.89	FDI (R) to RGDP (I)	−7.45	FDI (SA) to RGDP(I)	−2.42
FDI (B) to RGDP (R)	5.54	FDI (C) to RGDP (R)	−3.21	FDI (I) to RGDP (R)	−1.01	FDI (R) to RGDP (R)	−1.23	FDI (SA) to RGDP (R)	5.70
FDI (B) to RGDP(SA)	−0.23	FDI (C) to RGDP (SA)	−4.96	FDI (I) to RGDP (SA)	−6.27	FDI (R) to RGDP (SA)	−3.10	FDI (SA) to RGD(SA)	0.00

Source: Estimated by the authors

Samargandi et al. (2020) find that deeper regional trade agreements such as SACU and AfCFTA, magnify spillover effects by broadening market access and minimising policy uncertainty, helping to explain why Brazilian and Russian expansions feed positively into South African FDI. From a monetary-transmission perspective, Panda et al. (2023) show that US Fed rate hikes reprice emerging-market assets, lifting domestic yields and temporarily damping FDI until the South African Reserve Bank adjusts, consistent with the strong domestic inflation- and rate-driven upticks we observe. Furthermore, Nach & Ncwadi (2024) highlight South Africa's dual economy: mining-focused FDI (linked to global commodity cycles) displays higher connectedness to external shocks, whereas service-sector FDI remains relatively insulated, accounting for the mixed pattern of robust positive spillovers from commodity exporters alongside vulnerability to China's cost-push inflation.

4.3 Dynamic Connectedness (From, To and Net)

Table 4 specifies the volatility spillovers for the listed economic variables: CPI, FDI, IR and RGDP, for Brazil, Russia, India, China and South Africa. Each variable's connectedness can be estimated by evidence of how much it receives volatility from others (From connectedness) and how much it can transmit to others (To connectedness). The net connectedness value is the difference between the two, offering insights into which economies act as net transmitters or receivers across specific macroeconomic variables.

Table 4. Dynamic connectedness from, to and net

VARIABLES	FROM	TO	NET
CPI (B)	99.0813	17.0244	−82.0568
CPI (C)	89.7082	176.8913	87.1831
CPI (I)	93.7049	103.5013	9.7963
CPI (R)	98.2158	15.0375	−83.1782
CPI (SA)	91.3469	152.0795	60.7325
FDI (B)	90.4386	169.2261	78.7875
FDI (C)	96.6474	27.6256	−69.0217
FDI (I)	97.5792	37.9128	−59.6664
FDI (R)	96.2759	40.7434	−55.5324
FDI (SA)	90.3279	167.1622	76.8343
IR (B)	96.2326	65.4897	−30.7428
IR (C)	96.6620	36.9178	−59.7441
IR (I)	89.4461	179.2681	89.8220
IR (R)	99.0449	13.3521	−85.6928
IR (SA)	92.2174	123.5117	31.2943
RGDP (B)	95.8074	83.1951	−12.6123
RGDP (C)	93.9307	82.8030	−11.1277
RGDP (I)	90.4283	197.2153	106.7869
RGDP (R)	96.6069	54.6912	−41.9156
RGDP (SA)	91.7306	141.7849	50.0542

Sources: Estimated by the authors

4.3.1 FDI volatility spillovers

Brazil (+78.79) and South Africa (+76.83) act as net transmitters of FDI volatility, in contrast to China (−69.02), India (−59.67) and Russia (−55.53). Prior studies, such as Fang et al. (2024), focused on equity and debt flows; our emphasis on FDI extends their results by highlighting how greenfield investments and M&A activity propagate shocks. The COVID-19 hiatus in cross-border projects, stemming from travel restrictions and investment freezes, exacerbated Brazil's and South Africa's transmission roles, as delayed investments in mining and infrastructure in other BRICS intensified FDI volatility outflows.

4.3.2 CPI volatility spillovers

Brazil's CPI emerges as a pronounced net receiver (−82.06), while China stands as a dominant net transmitter (+87.18). These directional patterns mirror findings by Nyakurukwa & Seetharam (2023), who identified China's inflation dynamics as a key driver in emerging-market spillovers. The moderate net transmission from India (+9.80) and South Africa (+60.73) corroborates Sharma et al. (2022), who noted that mid-tier emerging economies can alternate between transmission and reception depending on global commodity cycles. During COVID-19, commodity-price shocks and global supply disruptions intensified China's inflation spillovers, as export slowdowns and domestic stimulus generated cross-border price pressures.

4.3.3 Interest-rate volatility spillovers

India (+89.82) and South Africa (+31.29) are net transmitters, whereas Brazil (−30.74), China (−59.74) and Russia (−85.69) are net receivers. This aligns with Sharma et al. (2022), who documented India's growing

monetary-policy clout amid pre-pandemic tightening. COVID-19's policy rate cuts and unconventional measures, especially in India, amplified directional spillovers, as global investors recalibrated rate expectations across BRICS. Financial markets' risk-off episodes transmitted Indian policy shifts into the currency and bond markets of Brazil and Russia more strongly than in prior crises.

4.3.4 RGDP volatility spillovers

India (+106.79) and South Africa (+50.05) transmit GDP growth volatility most strongly, while Brazil (−12.61), China (−11.13) and Russia (−41.92) receive it. These patterns extend Kumar & Sharma (2020) by pinpointing who sets the growth tone in the bloc. The COVID-19 induced recession, particularly India's deep contraction in Q2 2020, heightened its net transmission role, as coordinated lockdown effects in other BRICS followed India's GDP swing. South Africa's transmission also rose, reflecting synchronized downturns in commodities and services. Overall, our directional spillover results reinforce that India and South Africa act as key shock transmitters across multiple macroeconomic channels, while China, Brazil, and Russia are more often net receivers. The COVID-19 pandemic magnified these dynamics through trade, investment, monetary, and production linkages, underscoring the importance of crisis-specific analyses in spillover research.

Our results, which reveal persistently high TCI values, hovering around 99% over the 1998–2023 sample, are broadly consistent with the existing literature emphasizing strong macroeconomic interdependence among BRICS economies. Nyakurukwa & Seetharam (2023) documented high dynamic connectedness in major emerging markets, attributing this to intensified financial linkages and synchronized business cycles. Similarly, Fang et al. (2024) found significant spillover effects in GDP growth and inflation rates.

4.4 Total Dynamic Connectedness

Table 5 shows TCI values, which characterise the BRICS economies, consistently high at around ninety-nine percent, which justifies the strongly connected and highly interlinked nature of BRICS economies. This means that macroeconomic factors of another country, such as the IR, inflation, and GDP in BRICS countries have a relationship with each other. A high TCI shows that BRICS partners, as well as other large emerging markets, are very much dependent due to trade, investment and finance among BRICS during the global financial crisis, reflecting how external shocks propagate swiftly across these economies' linkages. Our finding of a modest downward trend in TCI from 99.70% in 1998 to 99.41% in 2023 echoes the observations of Panda et al. (2023), who noted a gradual weakening of connectedness following policy-driven diversification of trade partners beyond BRICS.

Table 5. Total dynamic connectedness for BRICS countries (1998 to 2023)

Date	TCI
1998	99,70829
1999	99,60483
2000	99,59122
2001	99,57797
2002	99,56473
2003	99,56168
2004	99,55636
2005	99,54367
2006	99,55199
2007	99,54896
2008	99,54714
2009	99,53719
2010	99,5264
2011	99,51744
2012	99,51339
2013	99,49242
2014	98,41168
2015	98,64817
2016	98,48192
2017	98,3235
2018	98,94478
2019	98,93588
2020	98,9315
2021	98,89555
2022	98,80035
2023	98,75065

Source: Estimated by the authors

However, where earlier studies largely focused on financial variables, our analysis extends the scope to encompass real-side variables such as FDI, inflation, central bank rates, and GDP growth, yielding a more comprehensive picture of macroeconomic spillovers. The pronounced drop to 98.94% in the third sub-period aligns with the findings of (Sayed & Charteris, 2024), who highlighted episodic dips in connectedness driven by policy shifts, such as IR adjustments and capital control measures in China and Russia. Moreover, our observation of increased volatility in subsequent periods complements the work of Sharma et al. (2022), who reported that rising geo-political tensions and trade disputes amplified the fragility of spillover channels, leading to sporadic de-correlation episodes.

4.5 The COVID-19 Pandemic and Underlying Mechanisms

The onset of the COVID-19 pandemic in early 2020 represents an unprecedented global shock that reconfigured both real and financial spillover mechanisms among the BRICS. The pandemic's dual impact, simultaneously disrupting supply chains and triggering capital flow reversals, transmitted shocks across member countries through several channels like trade dependencies, commodity and financial channels and policy divergence.

Trade dependencies and supply-chain linkages amplified the shockwaves from China's stringent lockdowns and logistical bottlenecks, the hub of many global value chains, resulting in acute shortages of intermediate inputs for manufacturing in India, South Africa, Brazil and Russia. Our directional-spillover analysis for 2020–2021 reveals a pronounced surge in China's transmission to the other BRICS, underscoring that trade dependence remains a potent conduit for industrial synchronisation declines (Moosavi et al., 2022). Concurrently, commodity and financial channels magnified these effects: as major exporters, Brazil and South Africa endured steep commodity-price collapses that reverberated to Russia via the oil market and to India through currency pressures. The swift reversal of portfolio flows, driven by a global risk-off sentiment, further exacerbated exchange-rate volatility and intensified interest-rate spillovers, in line with findings of Gupta et al. (2024) that financial connectedness heightened during market turmoil.

Policy coordination and divergence across advanced and emerging economies introduced additional asymmetries. While Europe and North America deployed large-scale fiscal and monetary stimuli in unison, BRICS responses varied significantly in both scale and timing. India's early, stringent lockdown precipitated a deeper initial contraction, whereas Russia's oil-linked stimulus helped to moderate its downturn. This heterogeneity in response trajectories contributed to the post-2020 decline in the TCI to 98.41%, as reflected in our data. Moreover, capital-flow and remittance shocks, especially poignant for India and South Africa, saw off a critical source of foreign currency inflows when diaspora remittances contracted sharply in 2020, exerting further downward pressure on local currencies and amplifying positive spillovers in inflation and IR across the group.

5. Conclusions

This study deepens the understanding of how emerging economies interlink by combining granular, country-level analysis with time-varying VAR connectedness measures, revealing that structural differences in commodity dependence, financial openness and policy regimes generate distinct spillovers across the BRICS. FDI was found to be responsive to home and foreign countries and external macroeconomic factors. The results also show that inflationary pressures tend to exhibit a significant spillover effect on net FDI inflows. When member countries' inflation rates rise, destabilising pressure is put on FDI across the group, particularly affecting China, India, and Russia. IR exhibits more varied effects; for Brazil and South Africa, positive spillover effects arise from higher IR in other countries of the BRICS. At the same time, the corresponding impacts are negative for India and Russia. Economic variables in the BRICS countries are highly correlated, and changes in the macroeconomic factors of a specific country can cause significant fluctuations within FDI in another country in the BRICS system.

Commodity exporters such as Brazil, Russia and South Africa would benefit from activating countercyclical fiscal tools through rule-based reserve spending or enhanced automatic stabilisers to smooth FDI inflows when shocks originate in partner economies. At the same time, China and South Africa face the dual challenge of managing volatile outbound capital and systemic leverage: they should therefore combine dynamic foreign-exchange interventions with countercyclical macroprudential measures, including adjustable capital buffers and tighter loan-to-value or debt-service-to-income limits. Given its growing integration with regional markets, India can mitigate interest-rate-driven FDI swings by expanding access to regional swap lines through the New Development Bank and bolstering domestic liquidity corridors.

Meanwhile, Russia should channel a greater share of commodity windfalls into sovereign reserves via transparent reserve-accumulation rules or sovereign-wealth allocations, thereby building a buffer against adverse external funding shocks. Across the entire BRICS grouping, these country-specific tools should be complemented by institutionalised, ongoing surveillance under the New Development Bank, aligning buffer requirements and cross-border liquidity facilities to manage systemic stress in a coordinated fashion.

Despite these practical insights, the study's reliance on a linear TVP-VAR framework may understate the

significance of abrupt regime shifts and non-linear threshold effects, phenomena starkly evident during the 2015 commodity slump and the COVID-19 crisis, and the aggregation of FDI into a single series obscures important heterogeneity by investment type and sector. Future research should adopt non-linear specifications such as Markov-switching or threshold VAR models while disaggregating FDI into greenfield versus M&A flows and parsing sectoral dynamics in manufacturing versus services to capture the full complexity of directional spillovers. Such refinements will sharpen our understanding of evolving integration patterns and crisis-period dynamics and enhance the prescriptive power of connectedness analysis for emerging-market policy coordination.

Data Availability

The data used to support the research findings are available from the corresponding author upon request.

Conflicts of Interest

The authors declare no conflict of interest.

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