Impact of financial development on international trade in BRICS countries: does the sector matter?

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Our study aims to examine whether sectoral value-added matters while analysing the impact of financial development on international trade for BRICS (Brazil, Russia, India, China and South Africa) countries. This indirect effect is captured in our study through the transmission channel of sectoral value additions arising from the agriculture, industry and service sectors. The study employs the pooled mean group approach of the panel autoregressive distributed lag (ARDL) model to check for the presence of co-integration and estimate short-run and long-run relationships among the variables of interest. The presence of co-integration between international trade, financial development, sectoral value added and the control variables, namely net foreign direct investment inflows and per-capita income, is found in the case of BRICS countries. The direct effect of financial development on international trade for BRICS countries is found to be positive and significant in the long run. While examining the indirect effect, it was found that the interaction term between the IMF index of financial development and industrial sectoral value added has a positive and significant impact on trade openness in the long run. In the case of service sector value added and financial development interaction, the impact on trade openness is found to be positive but insignificant, whereas in the case of agriculture value added, the impact is found to be negative and insignificant in the long run. Policies for enhancing the access, efficiency and depth of financial markets and financial institutions should be the top

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priority for BRICS countries, as they aim to become bigger players in the international trade arena. Targeted policy interventions for increasing the value additions emanating from the industry and service sectors will prove helpful in strengthening the indirect positive effect of financial development on international trade for BRICS countries, while also considering the degree of informality in each of these sectors in the member countries when designing such policies.

Keywords:
financial development,
international trade,
agriculture,
industry,
service sector,
BRICS

Introduction

The evolution of international trade patterns, financial markets and financial institutions of emerging market economies (EMEs) has captured the attention of policymakers in recent decades. International trade plays a pivotal role in accelerating economic growth, income convergence and poverty reduction in a country (Paulino–Uliafnova 2012). Financial development is regarded as a critical ingredient for boosting the international trade openness of a country. A strong financial system can build a concrete base for a country's foreign trade. Moreover, there is a direct link between the speed of financial development and the international trade performance of countries, and a lack of integration between the two sectors can result in economic disruptions (Liu 2022). International trade theory is based on the premise that differences in factor endowments, comparative advantage, technology and economies of scale are the major reasons why countries engage in international trade. A strand of thought that builds on early seminal works by Kletzer–Bardhan (1987) and Baldwin (1989) postulates that countries with a well-developed financial system may have a comparative advantage in industries that depend more on fixed capital and external financing. This has been further established empirically by supporting literature (Beck 2002, Svaleryd–Vlachos 2005, Hur et al. 2006, Manova 2013). Few studies have examined the different channels through which financial development can result in a comparative advantage in international trade. The liquidity constraints of firms are a relevant factor influencing trade participation (Chaney 2005). Lowering the credit constraint also acts as an incentive for firms to engage in international trade (Melitz 2003). In many developing economies in transition, capital market development faces hindrances pertaining to the development of institutional infrastructure and regulatory mechanisms while also having to avoid government interference in the functioning of markets. Expanding firms demand capital from both financial institutions and financial markets (Bonin–Wachtel 2003). Financial development has

short-run and long-run effects on international trade, and the effects are stronger for developing countries than for developed countries (Kim et al. 2010).

The 2008 global economic recession called into question the economic and political leadership of the United States and Europe in bringing the world economy out of the adverse effects of the financial crisis, resulting in the limelight shifting to the EMEs. The five leading emerging economies of the BRICS (Brazil, Russia, India, China and South Africa) have a strategic geopolitical role to play in influencing international trade, finance and investment both regionally and globally. BRICS has emerged as one of the world's most relevant economic blocs, comprising more than a quarter of the global GDP and 42% of the world population (UNCTAD 2023). The creation of the New Development Bank and the Contingent Reserve Arrangement has further strengthened their joint economic might. The acronym 'BRIC' was coined by the former economist of Goldman Sachs, Jim O'Neil, back in 2001. Goldman Sachs also put forth the forward-looking projection that the four BRIC countries would dominate the global economy by the year 2050. From 2006 onwards, these four countries began to form alliances in international forums to reap the benefits of collective bargaining power. South Africa joined this economic bloc in 2011. The share of BRICS countries in world trade and GDP kept expanding and peaked, especially in the aftermath of the 2008 global economic recession. However, global economic uncertainties that have surfaced in recent years, resulting from the United States–China trade war, the Covid-19 pandemic and the Russia–Ukraine war, are posing a serious challenge to the economic growth trajectory of the BRICS countries.

Trade as an engine of economic growth and structural transformation for regions grouped on the basis of socio-economic characteristics, such as the BRICS, continues to be a focal point of interest in international development circles. BRICS countries account for 16% of world trade (Government of India 2022). The share of exports of goods and services in the GDP of BRICS countries presents a contrasting picture compared to the world in general. Apart from India and South Africa, the total export share in national GDP has decreased for the other three countries in recent years. Within the BRICS, countries such as China and Russia have registered trade surpluses and positive external balances even during times of financial crisis in 2008 (Agarwal et al. 2022). In August 2023, leaders of BRICS countries voted in favour of the expansion of their membership in this economic bloc by including other developing countries such as Saudi Arabia, Iran, Ethiopia, Egypt, Argentina and the United Arab Emirates. Membership expansion is expected to have further implications for the existing world order, both politically and economically. This study aims to study the impact of financial development on international trade for BRICS countries via the transmission channel of sectoral value additions. The mediating role of value added arising from the agriculture, industry and service sectors in the relationship between financial development and international trade is explored in detail for the BRICS

countries. Drawing on the contribution of Svirydzenka (2016), this study uses the broad-based indicator of financial development, recently constructed by the IMF, which combines financial institutional (banking and non-banking) development and financial market development.

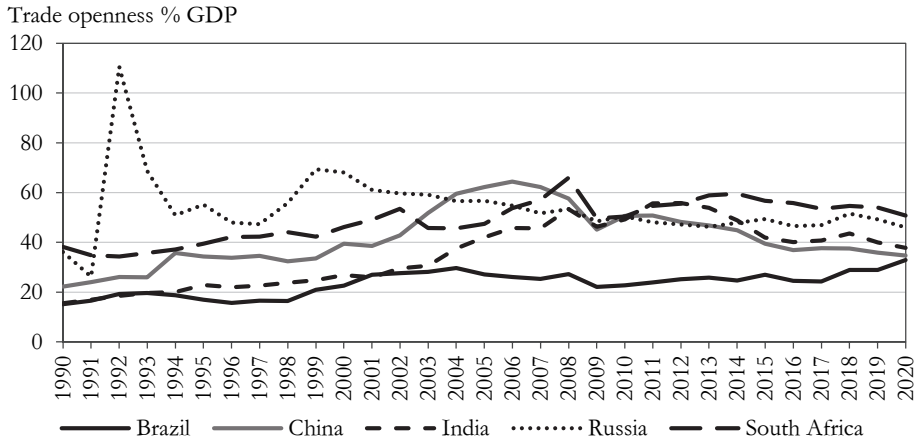
Figure 1 reveals the trade openness patterns of individual BRICS countries for the time span from 1990 to 2020. BRICS countries have been found to exhibit a rising share of international trade as a percentage of GDP during the past three decades, except for fluctuations that occurred during the 2008 financial crisis and the Covid-19 pandemic. In the pre-pandemic year of 2019, South Africa showcased the highest degree of trade openness, followed by Russia, India, China and Brazil. It is further observed that none of the BRICS countries registered an international trade share of more than 60% of their respective countries' GDP in the past decade. China is a major global player in merchandise exports, whereas India is a major global player in service exports. Brazil, South Africa and Russia are rich in natural resources and primary commodities. Russia experienced the biggest spike in trade openness in 1992, even exceeding 100% of the country's GDP, which could be attributed to the breakup of the USSR resulting in the formation of a nascent sovereign state. India registered its maximum trade openness of approximately 55% during the years 2011 and 2012. India had emerged as third-largest economy in the world in 2011, fuelled by increasing consumer demand and purchasing power, which could explain the greater magnitude of trade openness during those years. Trade openness for South Africa registered a peak of 66% during 2008, which could be attributed to the global financial crisis having severely affected its economic growth. China's trade openness reached its maximum during the year 2006, registering a share of approximately 65% of the country's GDP. 2006 was the final year of the 5-year transitional period after China's accession to the WTO, which boosted its export-led growth model. Although Brazil has been the laggard among the BRICS countries with regard to opening up the economy to international trade, it has witnessed an increasing trend in trade openness since the 1990s. Brazil registered a peak in trade openness of approximately 33% during the year 2020, despite the Covid-19 pandemic.

Figure 2 provides a comparative picture of the level of financial development in the BRICS countries. All of these countries underwent financial sector reforms, mainly in the banking sector, during the 1990s. Based on the IMF's broad-based financial development index (FIN) given in Figure 2, it is found that China, Brazil and South Africa have made impressive strides in financial development over the past three decades. Conversely, Russia and India are found to lag quite far behind in terms of the development of their financial institutions and financial markets. The value of the IMF index was found to be less than 0.7 throughout the study period for all BRICS countries. The IMF broad-based FIN can be decomposed into two dimensions, namely financial market development and financial institutional development. Historically, financial institutions in Brazil have been way ahead of its financial markets in terms of levels of development. Since the breakup of the USSR,

financial market development has been at a higher level than that of financial institutions in Russia up until 2011, after which the trend reversed. When the financial development scenario in South Africa is examined, financial institutions have turned out to be far more advanced than financial markets in the country in terms of levels of development. Since the implementation of the economic reforms in India in 1991, financial markets have consistently dominated over financial institutions in terms of their level of development. In the case of China post-1993, financial markets have exceeded financial institutions in terms of their levels of development, although the gap has come down in recent years (IMF 2023).

Figure 1

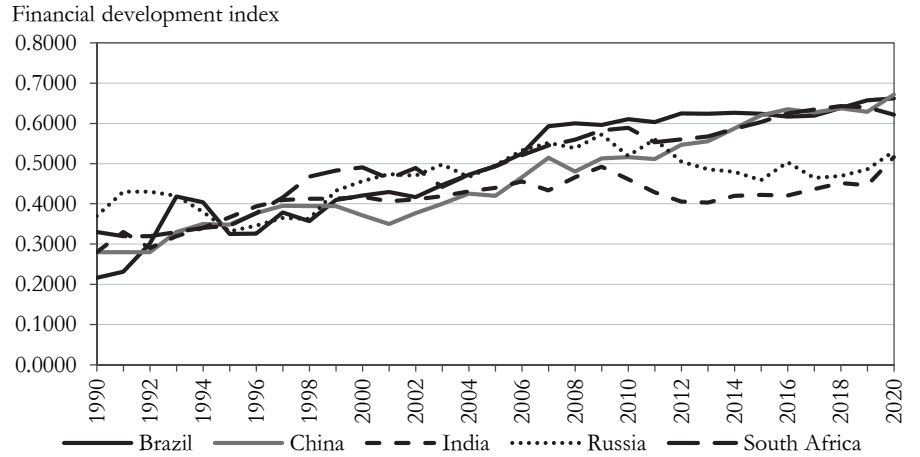
International trade of BRICS



Source: authors' compilation from World Development Indicators, World Bank (2023).

Figure 2

Financial development indices of BRICS

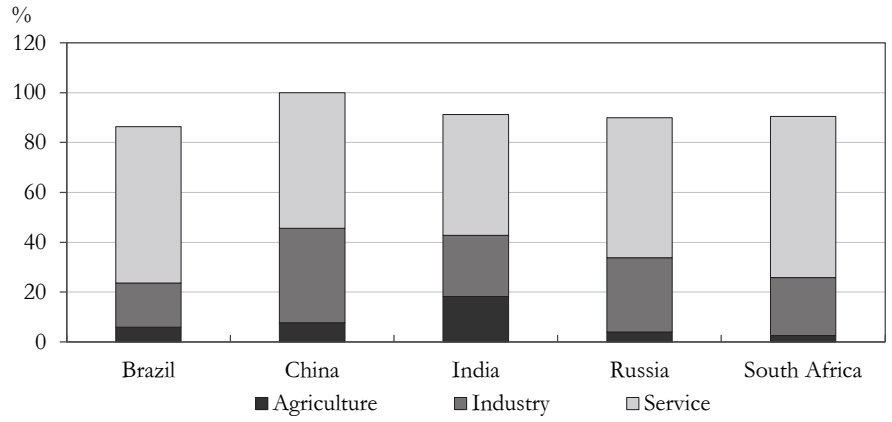


Source: authors' compilation from the IMF (2023).

Figure 3 throws light on the sectoral contributions to GDP for each of the BRICS countries. This becomes relevant while we are studying the impact of financial development on international trade via the transmission channel of sectoral value additions. Value added emanating from the service sector has been found to be the biggest contributor to national GDP in all five BRICS countries in recent years, with South Africa registering the highest service share of 64.7% in 2020. Industry value-added share in GDP among BRICS countries is found to be highest in the case of China, at 37.8% in 2020. By contrast, agriculture's value-added share in GDP among BRICS countries is found to be highest in India, at 18.6% in 2020. BRICS countries have been witnessing a declining share of agriculture in national output, whereas their economies have undergone structural transformation for many decades. Even in 1992, only India and China had an agriculture share in their countries' GDP exceeding 20%, whereas for the other three BRICS countries, it stood at less than 10%. Historically, industry has contributed the most to Chinese GDP, with the service sector overtaking it only in the past decade. More than half of national output for Brazil and South Africa could be attributed to the service sector, even in 1992. Russia and India also had a predominance of the service sector in their national output in 1992 (World Bank 2023). As is evident from Figure 3, all five BRICS countries currently exhibit a similar pattern with respect to the sectoral composition of their national GDP, with the service sector dominating in 2020, followed by industry and agriculture.

Figure 3

Sectoral contributions of BRICS countries to GDP, 2020



Source: authors' compilation from World Development Indicators, World Bank (2023).

The rest of the study is organised as follows. First there is a review of the literature on the topic of our study. In the following it is highlighted on the data sources, methodology and estimation technique used for this study. Then the empirical results

and a brief discussion about the same are spelled out. Finally, there are both relevant conclusions and policy implications emanating from this study.

Review of literature

Kletzer–Bardhan (1987) first examined the impact of the credit market on international trade, with finance treated as a factor endowment. The authors built a two-country, two-sector, two-factor general equilibrium model obtained from Heckscher–Ohlin theory to study this impact. The authors found that countries with a well-developed financial sector are able to gain a comparative advantage in industries that rely more on external finance. Beck (2002) also explored the link between financial development and trade in manufactured goods. He built a theoretical model based on the role of financial intermediaries to explain this nexus and empirically validated his model with a 30-year panel dataset for 65 countries. He found that economies with an advanced financial system tend to specialise in sectors with a comparative advantage and thereby achieve economies of scale. He also found that countries with higher levels of financial development were found to exhibit a higher export share and trade balance in manufactured goods. Rajan–Zingales (2003) studied the politics of financial development in the twentieth century with the help of interest group theory. The authors also empirically validated their theory for 24 countries. The authors found that industrial and financial incumbents oppose financial development since it breeds competition. Incumbents' opposition to financial development is found to be weaker when an economy is open to both trade flows and capital flows simultaneously. Baldwin (1989) found that economies with a better financial system are capable of diversifying risks and are more likely to engage in trade in riskier goods. Berthou (2010) examined the slow growth rate of the world trade margin over time. He found that financial development has a weak marginal effect on trade for countries with high zero trade flows. A study by Svaleryd–Vlachos (2005) supports the trade-enhancing role of finance, based on a country's comparative advantage and factor endowment. Hur et al. (2006) found that those countries with more developed domestic financial systems obtain a higher export share and trade balance in industries with higher intangible assets than tangible assets with a lower level of financial development. The impact of trade openness on economic development is uneven for developed and developing countries (Kim et al. 2011), with differentials based on the country's level of inflation and financial development. Becker et al. (2013) examined fixed costs to study the relationship between financial development and international trade. Firms incur large fixed and up-front costs to engage in exports and maintain competitiveness. Countries with developed financial systems were found to export more products from industries that require huge fixed costs. Manova (2013) analysed how financial market imperfections affect the trade performance of countries. The study found that poor financial markets restrict the country's ability to increase export

volume in financially vulnerable sectors. Geographical diversification of financial instruments results in efficiency gains in the capital market in the long term (Sztavrosz 2019). Exchange market pressure, which precipitates a currency crisis, remains a major challenge for developing countries. Foreign reserves adjusted for imports and short-term external debt have been found suitable for identifying this issue in sub-Saharan Africa (Klutse et al. 2022). Regional integration, investing in research and development, physical capital and foreign direct investment are key factors determining the export performance of technology-intensive manufactured products (Zapata et al. 2023). Regional responses to the Covid-19 pandemic have been found to depend on sectoral specialisation, stage of socio-economic development and degree of urbanisation (Chernova–Gridnev 2023). Global geopolitical risk in the form of the Covid-19 pandemic and the Russia–Ukraine war has been found to have a significant influence on major foreign exchange markets, which has implications for international trade and finance globally (Hung 2024).

There is mixed empirical evidence with regard to the positive and negative cause-and-effect relationship between international trade, financial development and sectoral dynamics. Table 1 lists the relevant empirical studies linking financial development and international trade. There are a limited number of studies that have examined the relationship between financial development and international trade, specifically for BRICS countries. Mukherjee et al. (2021) examined the role of financial liberalisation in bringing about financial development in EMEs, including BRICS. Their study captured four dimensions of financial development, namely depth, efficiency, stability and competition. The authors found that the liberalisation of capital markets had a positive impact on financial depth and competition. By contrast, the liberalisation of financial institutions from government interference was found to have a positive impact on financial stability. Their study also found that factors such as economic growth, political stability, government effectiveness and regulatory quality also had a crucial role to play in enhancing the financial development of EMEs, including BRICS. Financial development is found to have a positive impact on the economic growth of BRICS countries (Rani–Kumar 2018, Guru–Yadav 2019, Wait et al. 2017). The relationship between financial development, trade openness in financial services and economic growth for BRICS economies is unique (Khatun–Bist 2019). Campos et al. (2023) empirically proved that trade flows become complementary in a country with low levels of financial development, such as Brazil, when variations in financial development are a crucial determinant of comparative advantage. Other country-specific studies for Russia (Shakib et al. 2023; Lee et al. 2023), China (Zhang et al. 2015), South Africa (Ho–Iyke 2021, Salahuddin–Gow 2016) and India (Arora–Mukherjee 2019, Thomas 2016, Yang et al. 2020) have provided interesting insights about the relationship between financial development and international trade.

Table 1

Empirical studies on financial development and international trade

Study	Methodology	Country	Findings
Sare et al. (2019)	Pooled mean group – ARDL model	46 African countries for 36 years	Financial development does not significantly affect international trade, both in the long run and the short run. Service sector value additions dampened the adverse impact of financial development on trade.
Caporale et al. (2022)	Pooled mean group – ARDL model and GMM	CEEC-6 countries of the European Union for 22 years	Financial development has a positive and significant direct impact on exports and trade openness in the long run. Manufacturing sector value additions were found to be stronger than agriculture.
Mukherjee et al. (2021)	Panel data regressions – fixed and random effects models	EMEs, including BRICS; 22 years	Greater capital account openness was found to contribute positively to financial depth and stability. Trade openness improves the financial sector efficiency of emerging economies.
Rani–Kumar (2018)	Pedroni panel co-integration, FMOLS, dynamic OLS	BRICS	Presence of a long-run equilibrium relationship found between financial development, trade openness, foreign direct investment (FDI) inflows and economic growth of BRICS.
Guru–Yadav (2019)	System GMM	BRICS	Banking sector development and stock market development indicators positively influence the economic growth prospects of the BRICS.
Wait et al. (2017)	System GMM	BRICS	Private credit and financial depth were significant contributors to the higher growth rates of the BRICS.
Khatun–Bist (2019)	Pedroni panel co-integration, dynamic OLS, fully modified OLS	BRICS	The development of stock markets, bond markets and the insurance sector is crucial if BRICS wants to reap the full benefits of trade openness in financial services.
Campos et al. (2023)	Logistic smooth transition model	Brazil	Financial development has a mixed, time-varying impact on economic growth in Brazil, which depends to a great extent on the trade openness threshold.
Shakib et al. (2023)	Method of moments quantile regression	Russia	Financial development drove export diversification in Russia, especially for regions with higher business potential.
Lee et al. (2023)	OLS regression, VAR Granger causality test	Russia	Service trade partnerships with Asian countries have been found to exert a positive impact on Russia's economic growth.
Zhang et al. (2015)	Dynamic GMM	China	Trade openness and financial openness were found to exert a significant influence on financial development in China.

(Table continues on the next page.)

Continued.)

Study	Methodology	Country	Findings
Ho–Iyke (2021)	Pooled mean group, dynamic fixed effects model	Sub-Saharan Africa, inclusive of South Africa	Trade openness is found to be detrimental to financial development in middle-income countries in sub-Saharan Africa.
Salahuddin–Gow (2016)	Time series – ARDL model, bound testing model for co-integration, DOLS	South Africa	Financial development, trade openness, internet usage and economic growth have been found to be co-integrated in South Africa.
Arora–Mukherjee (2019)	Time series – ARDL model, bound testing for co-integration	India	Financial development exerts a significant positive impact on manufacturing exports, manufacturing imports and the manufacturing trade balance for India.
Thomas (2016)	Time series – ARDL model, bound testing for co-integration	India	India's service imports exhibit significant price and income competitiveness, but its service exports only possess significant income competitiveness in the long run.
Yang et al. (2020)	Dynamic bivariate probit model	India	Firms engaged in traditional services relied on banking as their source of financing, whereas firms engaged in modern services relied more on equity markets to support their exporting decisions.

Based on the review of literature that has been conducted, we find that there are only limited number of existing studies (Sare et al. 2019, Caporale et al. 2022) that have examined the impact of financial development on international trade via the transmission channel of sectoral value additions. There is a dearth of studies on this research question for the BRICS countries in particular. Our study aims to fill this research gap by examining the direct and indirect sectoral effects of financial development on international trade for the BRICS countries. Our study investigates whether the sector matters in terms of hampering or facilitating the impact of financial development on international trade. With BRICS countries being fast-growing economies and strategic stakeholders in the international trade and finance arena globally, it becomes relevant to study how the transmission channel of value added arising from the agriculture, industry and service sectors impacts the relationship between international trade and financial development for this economic bloc.

Data and methodology

This study examines the impact of financial development on international trade via sectoral value additions by constructing a panel dataset of the five BRICS countries for the time period from 1990 to 2020. The study period covers the transition of

BRICS economies to economic liberalisation and globalisation. International trade, the dependent variable for our study, is being measured using two proxies: trade openness (Kim et al. 2011, Menyah et al. 2014, Yucel 2009) and trade balance (Hur et al. 2006, Beck 2002). Consistent with the theoretical framework provided by Beck (2002), we specify the empirical model by also incorporating a few explanatory variables obtained from recent literature. The major explanatory variables of interest are financial development, the value added from the agriculture, industry and service sectors and the interaction terms of financial development with each of these sectoral value addition variables. Following Sare et al. (2019) and Caporale et al. (2022), the other independent variables included in the regression estimation are real GDP per capita, FDI inflows and a dummy variable to capture the 2008 global financial crisis.

Financial development is measured using the broad-based index of financial development constructed by the IMF. The IMF index encompasses the depth, access and efficiency aspects of both financial institutions and the financial markets. Table A1 in the Appendix sheds light on the different building blocks used for constructing the IMF index of financial development. A robustness check is also conducted by taking another standard proxy of financial development used in the literature (e.g. Beck 2002, Hur et al. 2006, Menyah et al. 2014, Kim et al. 2011), namely domestic credit to the private sector as a percentage of GDP. All of the other independent variables for this study are sourced from the World Development Indicators, published by the World Bank. Detailed information on variable descriptions and data sources used for all variables entering the empirical model is documented in Table A2 in the Appendix.

Estimation technique

Our study resorts to dynamic panel data analysis to estimate the impact of financial development on international trade via the transmission channel of sectoral value additions. Examining cross-correlations across nations is the initial diagnostic step for selecting further econometric procedures. Cross-country dependence is the possible dependence that occurs in error terms between countries due to economic shocks or other unobserved factors. Ignoring cross-country dependence may produce biased and inconsistent estimators and present spurious results. To address this problem in panel data analysis, our study employs a cross-sectional dependence (CD) test developed by Pesaran (2015). Macro-economic variables may follow a unit root process when the time dimension of a panel dataset is quite lengthy. Therefore, it is relevant to check for the order of integration of the variables entering the regression estimation. Our study relies on two new tests for stationarity: the second-generation unit root tests, CIPS (Pesaran 2007) and CADF (Pesaran et al. 2008). These two tests can deal with CD and heterogeneity in the panel dataset. Disregarding cross-sectional dependency, heterogeneity and other non-linearities in the data-generating process will affect the stability of the parameters. The selection of tests is purely based on their superiority in dealing with economic and financial variables. Before moving on

to dynamic panel data estimation, we also need to first check for the presence of a co-integrating relationship among the variables of interest.

To check for the presence of co-integration, our study performed a panel co-integration test given by Pedroni (2004) as well as a second-generation co-integration test given by Westerlund (2007). The latter test is a structural dynamic-based statistic that allows for a high degree of heterogeneity and cross-sectional dependency. The Pedroni co-integration test is residual-based and controls for country size and heterogeneity across panel parts. Pedroni co-integration comprises seven co-integration tests: the first four of these are panel co-integration, and the last three are group mean panel co-integration statistics. The Westerlund co-integration test comprises four test statistics: two are panel statistics, and the rest of the two are group mean statistics.

A panel autoregressive distributed lag (ARDL) model is employed in this study to ascertain the nature of long-run relationships and short-run dynamics. This technique of panel data analysis is preferred over others since it is suited for giving short-run and long-run estimates for small samples, especially if the number of cross-sectional units (N) is less than the number of time series units (T). This makes the panel ARDL approach suitable for our study. The panel ARDL approach is more suitable when the variables entering the regression model are of mixed order of integration, i.e. I(0) and I(1). Our study uses a maximum likelihood-based pooled mean group (PMG) approach (Pesaran et al. 1999) in the panel ARDL framework. The PMG estimator offers the optimal, reliable alternative for the efficient dynamic specification of the model in such a way that it assumes homogeneity in long-run relationships and allows for short-run heterogeneity subject to country-specific characteristics. Therefore, PMG is an appropriate estimation technique to apply in the case of the BRICS trade bloc, which exhibits common demographic and economic characteristics along with country-specific advantages. The PMG gives better estimates as it combines both averaging and pooling of estimates. The method also enables us to select an appropriate lag structure to avoid the problem of endogeneity (Attard 2019).

Four separate empirical models are specified and estimated using different proxies of financial development and international trade.

$$TO_{i,t} = \varrho_{i,1} FIN_{i,t} + \mu_{i,1} LGDP_{i,t} + \mu_{i,2} FDI_{i,t} + \varepsilon_{i,t} \quad (1)$$

$$TO_{i,t} = \varrho_{i,1} DCPS_{i,t} + \mu_{i,1} LGDP_{i,t} + \mu_{i,2} FDI_{i,t} + \varepsilon_{i,t} \quad (2)$$

$$TB_{i,t} = \varrho_{i,1} FIN_{i,t} + \mu_{i,1} LGDP_{i,t} + \mu_{i,2} FDI_{i,t} + \varepsilon_{i,t} \quad (3)$$

$$TB_{i,t} = \varrho_{i,1} DCPS_{i,t} + \mu_{i,1} LGDP_{i,t} + \mu_{i,2} FDI_{i,t} + \varepsilon_{i,t} \quad (4)$$

where $i = 1, 2, 3, \ldots, 5$ and $t = 1, 2, 3, \ldots, 41$.

Equations (1) to (4) capture the direct impact of financial development on international trade. The dependent variable TO denotes trade openness[1], and TB denotes trade balance[2]. The main independent variable of interest, FIN, denotes the financial development index developed by the IMF, and its proxy, DCPS, denotes

[1] Trade openness = (export + import) as % of GDP.

[2] Trade balance = (export – import) as % of GDP.

domestic credit to the private sector as a percentage of GDP. The other two control variables in the four models, LGDP and FDI, denote real GDP per capita and net foreign direct investment inflows respectively.

Equations (5) to (8) capture the indirect impact of financial development on international trade via the transmission channel of sectoral value additions. In addition to the variables mentioned in Equations (1) to (4), the variables AGR, IND and SER represent sectoral value additions arising from the agriculture, industry and service sectors, respectively. The indirect effect is being captured through the interactive terms FIN * AGR, FIN * IND and FIN * SER in Equations (5) and (6). For robustness checks, the interactive terms of the sectoral value-added variables along with DCPS have been included in Equations (7) and (8).

$$TO_{i,t} = \varrho_{i,1}\,FIN * AGR_{i,t} + \varrho_{i,2}\,FIN * IND_{i,t} + \varrho_{i,3}\,FIN * SER_{i,t} + \mu_{i,1}\,LGDP_{i,t} + \mu_{i,2}\,FDI_{i,t} + \varepsilon_{i,t} \quad (5)$$

$$TO_{i,t} = \varrho_{i,1}\,DCPS * AGR_{i,t} + \varrho_{i,2}\,DCPS * IND_{i,t} + \varrho_{i,3}\,DCPS * SER_{i,t} + \mu_{i,1}\,LGDP_{i,t} + \mu_{i,2}\,FDI_{i,t} + \varepsilon_{i,t} \quad (6)$$

$$TB_{i,t} = \varrho_{i,1}\,FIN * AGR_{i,t} + \varrho_{i,2}\,FIN * IND_{i,t} + \varrho_{i,3}\,FIN * SER_{i,t} + \mu_{i,1}\,LGDP_{i,t} + \mu_{i,2}\,FDI_{i,t} + \varepsilon_{i,t} \quad (7)$$

$$TB_{i,t} = \varrho_{i,1}\,DCPS * AGR_{i,t} + \varrho_{i,2}\,DCPS * IND_{i,t} + \varrho_{i,3}\,DCPS * SER_{i,t} + \mu_{i,1}\,LGDP_{i,t} + \mu_{i,2}\,FDI_{i,t} + \varepsilon_{i,t} \quad (8)$$

Our study uses a system-dynamic PMG model that has been successful in enabling parameter heterogeneity. Dynamic panel data analysis includes a lagged value of the dependent variable as one of the independent variables in the model.

The dynamic panel PMG models with trade openness as the dependent variable are given below in Equations (9) to (12).

$$\Delta TO_{i,t} = \sum_{i=1}^{m-1}(\Pi_{i,1}\,\Delta TO_{i,t-i}) + \sum_{i=0}^{n-1}(\Omega_i\,\Delta FIN_{i,t-i} + \theta_{i,1}\Delta LGDP_{t-i} + \theta_{i,2}\Delta FDI_{t-i}) + \eta_i[TO_{i,t-i} - \{\varphi_{i,t} + \varpi_{i,1}\,FIN_{i,t-i} + £_{i,1}LGDP_{t-i} + £_{i,2}FDI_{t-i} + \}] + \varepsilon_{i,t} \quad (9)$$

$$\Delta TO_{i,t} = \sum_{i=1}^{m-1}(\Pi_{i,1}\,\Delta TO_{i,t-i}) + \sum_{i=0}^{n-1}(\Omega_i\,\Delta DCPS_{i,t-i} + \theta_{i,1}\Delta LGDP_{t-i} + \theta_{i,2}\Delta FDI_{t-i}) + \eta_i[TO_{i,t-i} - \{\varphi_{i,t} + \varpi_{i,t}\,DCPS_{i,t-i} + £_{i,1}LGDP_{t-i} + £_{i,2}FDI_{t-i}\}] + \varepsilon_{i,t} \quad (10)$$

$$\Delta TO_{i,t} = \sum_{i=1}^{m-1}(\Pi_{i,1}\,\Delta TO_{i,t-i}) + \sum_{i=0}^{n-1}(\Omega_{i,1}\,\Delta FIN * AGR_{i,t-i} + \Omega_{i,2}\,\Delta FIN * IND_{i,t-i} + \Omega_{i,3}\,\Delta FIN * SER_{i,t-i} + \theta_{i,1}\Delta LGDP_{t-i} + \theta_{i,2}\Delta FDI_{t-i}) + \eta_i[TO_{i,t-i} - \{\varphi_{i,t} + \varpi_{i,1}\,FIN * AGR_{i,t-i} + \varpi_{i,2}FIN * IND_{i,t-i} + \varpi_{i,3}\,FIN * SER_{i,t-i} + £_{i,1}LGDP_{t-i} + £_{i,2}FDI_{t-i}\}] + \varepsilon_{i,t} \quad (11)$$

$$\Delta TO_{i,t} = \sum_{i=1}^{m-1}(\Pi_{i,1}\,\Delta TO_{i,t-i}) + \sum_{i=0}^{n-1}(\Omega_{i,1}\,\Delta DCPS * AGR_{i,t-i} + \Omega_{i,2}\,\Delta DCPS * IND_{i,t-i} + \Omega_{i,3}\,\Delta DCPS * SER_{i,t-i} + \theta_{i,1}\Delta LGDP_{t-i} + \theta_{i,2}\Delta FDI_{t-i}) + \eta_i[TO_{i,t-i} - \{\varphi_{i,t} + \varpi_{i,1}\,DCPS * AGR_{i,t-i} + \varpi_{i,2}DCPS * IND_{i,t-i} + \varpi_{i,3}\,DCPS * SER_{i,t-i} + £_{i,1}LGDP_{t-i} + £_{i,2}FDI_{t-i}\}] + \varepsilon_{i,t} \quad (12)$$

Here, $\pi_{i,1}$ are the short-run coefficients associated with the lagged value of international trade, and $\Omega_{i,k}$ and $\theta_{i,j}$ are the coefficients capturing financial development and other independent variables, respectively. Long-run coefficients are denoted as $\varpi_{i,k}$ and $£_{i,k}$. The coefficient of the error correction term, which reflects the speed of adjustment to attain long-run equilibrium, is denoted by η_i. The above PMG estimators allow short-run parameters to vary within the group of samples while maintaining the equality of long-run coefficients across samples. The estimation

exercise reflected in Equations (9) to (12) is also conducted by taking the trade balance as a dependent variable.

Empirical results and discussion

We start the empirical analysis by initially presenting the summary statistics and the correlation matrix for the dependent and independent variables used for the regression estimation. Table 2 reports descriptive statistics, which shed light on the measures of central tendency, variance, skewness and kurtosis of the data being analysed. Our study makes the necessary transformation of the macro-economic variables into percentages and natural logarithms, wherever required. The mean value added arising from the service sector is found to exceed that of industry and agriculture by a significant margin for all the BRICS countries taken together.

Table 2

Summary statistics

Variables	Mean	Median	Max.	Min.	Standard deviation	Skewness	Kurtosis
TO	40.58	42.00	110.5	15.15	14.97	0.54	4.56
TB	1.09	1.06	1.83	0.72	0.20	0.73	3.57
FIN	0.46	0.45	0.67	0.21	0.10	0.08	2.24
DCPS	75.06	60.21	182.8	16.83	41.08	0.42	1.96
FDI	2.02	1.75	6.18	−0.06	1.47	0.59	2.45
GDP	5169	5726	10358	528.8	2933	−0.15	1.81
AGR	9.32	5.87	27.66	1.92	7.31	0.97	2.70
IND	31.28	29.21	47.55	17.70	8.11	0.65	2.34
SER	51.71	53.12	73.33	32.38	9.30	−0.25	2.08

The correlation matrix of the variables and CD test results for CD in the panel dataset for the time period from 1990 to 2020 is presented in Table 3. The correlation matrix indicates a high degree of negative correlation between the value added from agriculture and the real GDP per capita of BRICS countries. The CD test results confirm the presence of CD in the data. This could be because of the many socio-economic characteristics shared by the BRICS countries.

Table 3

Correlation matrix and CD test

Variable	TO	TB	FIN	DCPS	FDI	LGDP	AGR	IND	SER
TO	1								
TB	0.42	1							
FIN	0.26	0.01	1						
DCPS	0.15	−0.07	0.39	1					
FDI	−0.002	0.008	0.24	0.18	1				
LGDP	0.22	0.38	0.55	0.21	0.14	1			
AGR	−0.32	−0.31	−0.5	−0.23	−0.04	−0.91	1		
IND	0.24	0.35	−0.31	0.27	0.19	−0.12	0.28	1	
SER	0.05	−0.02	0.48	0.24	−0.13	0.69	−0.83	−0.63	1
CD test	6.21**	−0.14	13.7**	8.25**	4.01***	15.91**	14.19**	5.89**	8.25**

Note: ** and *** represent 5% and 1% levels of significance, respectively.

The next step involves testing the stationarity properties of the variables entering the regression estimation. Our study uses second-generation panel unit root tests, as these consider errors due to CD. We employ CIPS and CADF (Pesaran 2007, Pesaran et al. 2008), and results are reported in Table 4. The test results indicate that the variables are integrated in mixed order, i.e. a mix of I(0) and I(1).

Table 4

Unit root tests

Variables	Without trend		With trend	
	level	first difference	level	first difference
	CIPS			
TO	−2.38*	−5.01*	−2.58	−5.11*
TB	−2.57*	−4.81	−2.23	−5.05*
FIN	−2.13	−5.11*	−2.32	−4.99*
DCPS	−1.78	−5.005*	−1.48	−4.66
FDI	−2.7*	−5.34*	−3.07*	−5.39
LGDP	−3.06*	−2.41*	−2.41	−2.84*
AGR	−3.31*	−5.40*	−3.69*	−5.53*
IND	−1.86	−4.01*	−1.77	−4.77*
SER	−2.76*	−4.43*	−2.39	−4.60*
	CADF			
TO	−2.36	−2.22	−2.75*	−2.06
TB	−2.47*	−2.84*	−2.22	−3.18*
FIN	−2.41	−3.07*	−2.48	−2.94*
DCPS	−1.95	−2.63*	−1.86	−3.19*
FDI	−2.43	−3.81*	−3.33*	−3.81*
LGDP	−2.69*	−2.44	−3.26*	−2.59
AGR	−2.87*	−3.75*	−3.13*	−3.74*
IND	−1.92	−2.86*	−1.84	−3.45*
SER	−2.44	−2.90*	−2.26	−3.28*

* Level of significance.

After examining the stationarity properties, we proceed to check for the presence of a co-integration relationship among the dependent and independent variables. Notably, the estimation techniques conducted are reliable even in the presence of cross-sectional dependency. Table 5 illustrates the results of the Pedroni (2004) and Westerlund (2007) panel co-integration tests. Here, lag length and leads are selected based on the Akaike information criterion, and we specify the maximum length as 3. The results of both the first-generation and second-generation test statistics (Pedroni 2004, Westerlund 2007) are consistent with the literature. A co-integration relationship has been established between the variables at different levels of statistical significance. Separate test statistics are reported for both trade openness and trade balance as dependent variables, using two different indicators of financial development. The coefficients and p-values related to the equations examining the direct and indirect effects of financial development on international trade are separated using brackets. Values within the brackets denote the indirect effect of financial development on international trade with the same indicators.

Table 5

Panel co-integration test

Approach	Test statistics	TO_FIN		TO_DCPS	
		z-value	p-value	z-value	p-value
Westerlund	Gt	−2.203** (−3.428***)	0.014 (0.000)	−3.064*** (−3.219***)	0.001 (0.001)
	Ga	2.492 (3.364)	0.994 (1.000)	2.273 (3.269)	0.989 (1.000)
	Pt	−6.203*** (−3.946***)	0.000 (0.000)	−7.751*** (−6.487***)	0.000 (0.000)
	Pa	1.294 (2.266)	0.902 (0.988)	1.288 (2.333)	0.901 (0.990)
Pedroni	Panel-v	−0.059 (0.544)	0.692 (0.325)	−0.604 (0.852)	0.730 (0.759)
	Panel-rho	−0.967 (0.121)	0.104 (0.802)	0.429 (−0.002)	0.772 (0.773)
	Panel-t	−3.089*** (−2.265)	0.005 (0.226)	−1.111** (−2.517**)	0.020 (0.010)
	Panel-ADF	−3.098** (−0.340)	0.018 (0.744)	1.301 (0.308*)	0.116 (0.098)
	Group-rho	0.022 (0.925)	0.833 (0.913)	0.951 (0.772)	0.951 (0.931)
	Group-t	−2.726*** (−2.958***)	0.003 (0.008)	−1.523*** (−2.775***)	0.004 (0.000)
	Group-ADF	−1.477 (0.101)	0.177 (0.432)	0.409 (1.008)	0.193 (0.188)

(Table continues on the next page.)

Continued.)

Approach	Test statistics	TB_FIN		TB_DCPS	
		z-value	p-value	z-value	p-value
Westerlund	Gt	0.813 (1.808)	0.792 (0.965)	0.718 (−0.580)	0.764 (0.281)
	Ga	3.027 (3.862)	0.999 (1.000)	2.713 (3.603)	0.997 (1.000)
	Pt	−1.234** (−1.86**)	0.042 (0.043)	−1.365** (−1.843**)	0.045 (0.034)
	Pa	2.122 (2.821)	0.983 (0.998)	1.442 (2.719)	0.925 (0.997)
Pedroni	Panel-v	−0.201 (0.15)	0.486 (0.370)	0.12 (0.401)	0.688 (0.33)
	Panel-rho	0.966 (1.14)	0.515 (0.800)	0.44 (0.647)	0.586 (0.87)
	Panel-t	−0.017* (−0.66)	0.044 (0.366)	−0.44 (−1.23)	0.196 (0.42)
	Panel-ADF	0.496*** (−1.34*)	0.005 (0.067)	−0.29*** (−1.44**)	0.005 (0.04)
	Group-rho	1.97 (1.86**)	0.817 (0.032)	1.27 (1.44)	0.773 (0.34)
	Group-t	0.697 (−0.64)	0.190 (0.411)	0.020 (−1.09)	0.201 (0.36)
	Group-ADF	0.319*** (−0.14)	0.002 (0.226)	−1.32*** (0.644)	0.003 (0.16)

Note: *, ** and *** denote the statistical significance at the 10%, 5% and 1% levels, respectively.

Based on the Pedroni co-integration test results, with trade openness as the dependent variable and for both the financial development indicators, three out of seven statistics (panel-t, panel-ADF and group-t) reject the null hypothesis of zero co-integration. When the trade balance is obtained as the dependent variable, the Pedroni test indicates the presence of a strong co-integration relationship between the variables. For robustness checks, our study used a second-generation co-integration test. Westerlund co-integration test results indicate that two test statistics (Gt and Pt) are significant when we take trade openness as a dependent variable. However, when we take trade balance as a dependent variable, one (Pt) out of four statistics indicates the presence of co-integration. This holds true for both the financial development indicators. Both tests point towards the presence of co-integration among the variables of interest.

Subsequently, our study proceeds to estimate the short-run and long-run direct effects of financial development on international trade, the findings of which are displayed in Table 6. For this purpose, we devise four separate model specifications for different proxies of international trade (trade openness and trade balance) and

financial development (FIN created by the IMF and domestic credit to the private sector). The study relies on PMG-based ARDL models specified in Equations (9) to (12) to estimate the short-run and long-run parameters.

Table 6

Direct effect of financial development (FinDev) on trade: PMG results

Variables	Trade openness		Trade balance	
	FIN	DCPS	FIN	DCPS
Short-run coefficients				
FinDev	−0.105 (0.238)	0.197 (0.408)	0.486** (0.046)	−0.352* (0.093)
LGDP	0.032** (0.046)	0.054 (0.711)	−0.601 (0.190)	−0.608 (0.162)
FDI	0.014** (0.014)	0.016** (0.017)	−0.019** (0.031)	−0.013* (0.090)
Long-run coefficients				
FinDev	0.373** (0.017)	0.045 (0.591)	0.191* (0.085)	−0.147 (0.273)
LGDP	−0.221** (0.015)	−0.094 (0.132)	−0.033 (0.280)	−0.004 (0.921)
FDI	0.028** (0.048)	0.051** (0.011)	0.011 (0.516)	0.005 (0.759)
ECT	−0.325** (0.0443)	−0.278* (0.0541)	−0.411*** (0.000)	−0.388*** (0.000)
Constant	0.725* (0.0741)	0.412* (0.087)	0.609*** (0.000)	0.474*** (0.000)
Goodness of fit R^2	0.67	0.76	0.79	0.87
Normality test Jarque Bera	1.22	2.13	0.98	0.75

Note: *significance at 10%, **significance at 5% and ***significance at 1% level (p-values in brackets).

The estimation results in Table 6 indicate that financial development (measured using the IMF index denoted as FIN) has a statistically significant impact on trade openness and trade balance in the long run. However, another proxy used to measure financial development, namely domestic credit to the private sector as a share of GDP (DCPS), is not found to have a significant impact on both measures of international trade. When we examine the short-run dynamics, it is found that financial development, irrespective of the proxy used, has an insignificant effect on trade openness. However, the short-run impact of financial development on trade balance is found to be significant. Interestingly, the IMF's measure of financial development shows a positive impact on trade balance, whereas domestic credit to the private sector shows a negative impact. Insignificant results and a negative sign for the proxy, DCPS, indicate that a broad-based approach pertaining to financial development needs to be formulated to accelerate international trade. Insignificant results for trade openness in the short run could be due to financial volatility and economic shocks affecting different countries differently. The negative and statistically significant error

correction term in all four model specifications reinforces the presence of co-integration among these macro-economic variables. In the present study, 41% of the short-run deviation from the long-run equilibrium path gets corrected in the model, including trade balance, FIN and other control variables. By contrast, the corrections from the long-run equilibrium path are found to be lower at 33% in the case of the model, including trade openness, FIN and other control variables. A similar trend is also witnessed with regard to short-run corrections when DCPS is obtained as a proxy for financial development.

While examining the impact of control variables on international trade in Table 6, the estimation results reveal that real GDP per capita and FDI are crucial determinants of international trade. Per-capita income is found to have a positive and significant impact on trade in the short run when financial development is measured using the IMF index and international trade is measured using trade openness. However, per-capita income is found to exert a negative and significant impact on trade openness in the long run. Such contrasting results between the short run and long run could be due to transitory income shocks, which affect international trade positively, whereas changes in permanent income, such as demand and supply shocks, are key factors influencing trade balance that may cause insignificant, negative or positive associations (Kim 1996). FDI is found to have a positive effect on trade openness, irrespective of the measure of financial development, and it is also statistically significant in both the short run and long run. The same is not found to hold true when the trade balance is obtained as the dependent variable. While enabling country heterogeneity, cross-sectional short-run estimates of BRICS countries indicate that the IMF index of financial development positively affects trade openness for Brazil and South Africa and trade balance for Brazil, Russia, China and India. In addition, another proxy, domestic credit to the private sector, is found to enhance trade openness for Brazil, India and Russia and the trade balance for China, India and Russia.

Table 7 showcases the indirect effect of financial development on international trade for the BRICS countries via the transmission channel of sectoral value additions arising from agriculture, industry and services. Here again, we find that the error correction term is negative and statistically significant in all four model specifications, establishing the presence of co-integration among the variables of interest. The long-run coefficients of the interaction term between financial development and agriculture value added are found to have a negative and significant impact on international trade, except for the model specification inclusive of trade openness and the IMF index, which turned out to be insignificant. The interaction term between financial development and industry value added exerts a significant and positive impact on international trade in the long run when the IMF index of financial development is obtained as a proxy. The impact of the IMF index of financial development on international trade via the transmission channel of service sector

value added is found to be positive and insignificant for trade openness but negative and significant for trade balance. In contrast, when domestic credit to the private sector is obtained as a proxy for financial development, interaction with service sector value added is found to have a positive and significant impact on the international trade performance of BRICS countries. In the short run, the transmission channels pertaining to sectoral value additions from agriculture and services are found to be negative or insignificant compared to industry value added for most of the model specifications. The error correction terms are found to be negative and statistically significant for all four model specifications in Table 7, reinforcing the presence of co-integration between financial development, international trade and other control variables entering the four models.

Table 7

Indirect effect of FinDev on trade: PMG estimation results

Variables	Trade openness		Trade balance	
	FIN	DCPS	FIN	DCPS
Short-run coefficients				
FinDev * AGR	−0.048 (0.319)	−0.011 (0.361)	0.032 (0.443)	0.061* (0.082)
FinDev * IND	0.168* (0.077)	0.014** (0.051)	0.008 (0.824)	0.002* (0.074)
FinDev * SER	−0.006 (0.606)	−0.002 (0.357)	0.001 (0.800)	−0.018* (0.054)
FDI	0.001 (0.732)	0.009* (0.071)	−0.015* (0.080)	−0.014 (0.145)
LGDP	0.220* (0.0.08)	−0.066 (0.377)	−0.919 (0.143)	0.595 (0.182)
Long-run coefficients				
FinDev * AGR	−0.057 (0.237)	−0.062*** (0.007)	−0.151*** (0.003)	−0.047*** (0.005)
FinDev * IND	0.041*** (0.004)	−0.004 (0.251)	0.088*** (0.000)	−0.045*** (0.000)
FinDev * SER	0.010 (0.824)	0.005*** (0.000)	−0.007*** (0.009)	0.054*** (0.000)
FDI	0.028*** (0.001)	0.009 (0.167)	−0.018 (0.152)	−0.031*** (0.003)
LGDP	0.189* (0.077)	−0.060 (0.426)	−0.627*** (0.000)	0.161*** (0.004)
ECT	−0.201** (0.027)	−0.347** (0.043)	−0.324*** (0.007)	−0.288*** (0.009)
Constant	−0.160** (0.039)	0.365* (0.074)	0.905** (0.041)	0.040 (0.339)
Goodness of fit R^2	0.76	0.87	0.68	0.65
Normality test Jarque Bera	1.33	2.12	1.43	1.23

Note: *significance at 10%, **significance at 5% and ***significance at 1% level (p-values in brackets).

While examining the role of control variables in the model specifications showcased in Table 7, it was found that growth in per-capita income and FDI are only weakly significant determinants of international trade in the short run. In the long run, FDI is found to exert a strongly significant and positive impact on trade openness but a negative and insignificant impact on trade balance when the IMF index is obtained as a proxy for financial development. Growth in per-capita income is found to have a weakly significant and positive impact on trade openness but a negative and strongly significant impact on trade balance when the IMF index is obtained as a proxy for financial development. The cross-sectional short-run coefficients tell a slightly different story compared to Table 6 while enabling country heterogeneity. South Africa, India and China showcase the positive role of the interaction between agriculture value added and financial development in enhancing international trade. The interaction between industrial sector value added and financial development is found to be prominent in Brazil and Russia. The service sector value added–financial development nexus is found to have a significant impact on international trade for India and China.

The findings of our study, which focuses on the indirect impact of financial development on international trade for BRICS countries via the transmission channel of sectoral value additions, are primarily in consonance with the findings of Sare et al. (2019) for African countries and Caporale et al. (2022) for CEEC-6 countries. Sare et al. (2019) found value added emanating from the service sector to have contributed significantly in its mediating role and the industrial sector to a lesser extent while studying the impact of financial development on trade openness in Africa in the long run. Caporale et al. (2022) found that in the long run, the interaction effect between financial development and sectoral value added on trade openness was stronger in manufacturing than in agriculture for the Central and Eastern European countries.

Additionally, the causal link between financial development and trade openness is tested in the presence of co-integration. A panel Granger causality test (Dumitrescu–Hurlin 2012) is conducted to ascertain possible directions of causality between different measures of financial development (FIN and DCPS) and trade openness for BRICS countries. The results of the panel Granger causality test are reported in Table 8.

Table 8

Panel Granger causality test results

Null hypothesis	W-stat	Z-bar stat	Probability
FIN does not Granger cause TO	4.47	3.22	0.043
TO does not Granger cause FIN	5.13	2.11	0.032
DCPS does not Granger cause TO	3.11	2.43	0.047
TO does not Granger cause DCPS	1.22	−0.21	0.341

It is clear from Table 8 that both measures of financial development Granger cause trade openness for the BRICS countries at the 5% level of statistical

significance. When we examine the direction of reverse causality, it is found that trade openness does Granger cause financial development as proxied by the IMF index. However, trade openness is not found to Granger cause financial development, which is proxied by domestic credit to the private sector as a share of GDP. Hence, we cannot conclude unambiguously about the presence of bi-directional causality between financial development and trade openness for the BRICS countries. The causality test results thus underline the crucial role of financial development in propelling international trade of BRICS countries.

Conclusions and policy implications

Our study examines the impact of financial development on international trade via the transmission channel of sectoral value additions for the BRICS countries during the time period from 1990 to 2020. The study employs the PMG approach of the panel ARDL model to check for the presence of co-integration and estimate the short-run and long-run relationships among the variables of interest. There is a dearth of studies focusing on the BRICS countries that have estimated the direct effect as well as the indirect effect of financial development on international trade via sectoral value added from agriculture, industry and services. Our study has filled this research gap in the literature pertaining to this powerful economic bloc. This study measures financial development using the recently constructed IMF broad-based financial development index, and international trade is measured using trade openness. For robustness checks, proxies such as domestic credit to the private sector as a share of GDP and trade balance are utilised in this study. FDI inflows and real per-capita GDP are included as key control variables in the econometric estimations.

While analysing the direct effect of financial development on international trade for BRICS countries, it was found that the impact on both trade openness and trade balance is positive and significant in the long run. While analysing the indirect effect of financial development on international trade for BRICS countries via sectoral value additions, the interaction between the IMF index and industrial sectoral value added is found to have a positive and significant impact on trade openness as well as trade balance in the long run. In the case of service sector value added and financial development interaction, the impact on trade openness is found to be positive but insignificant, whereas in the case of agriculture value added, the impact is found to be negative and insignificant in the long run for BRICS countries. The impact of growth in per-capita income and FDI inflows on trade openness is found to be positive and significant for BRICS countries in the long run while estimating the impact of FIN on trade openness via the transmission channel of sectoral value additions. The presence of co-integration among international trade, financial development and sectoral value-added interactions, as well as the control variables, is found to hold in the case of the BRICS countries and is robust to the different proxies used in our

study. While estimating the indirect effect of financial development on trade, we observe that the signs and significance levels of the long-run coefficients for the proxies used for robustness checks, namely domestic credit to the private sector and trade balance, were often not found to be in consonance with the IMF index of financial development and trade openness. A possible explanation for the divergence in the findings between the different proxies of financial development could be that domestic credit to the private sector covers only one of the dimensions of the depth of financial institution development in a country. The IMF index of financial development encompasses a whole range of other dimensions relating to the depth, access and efficiency of financial institutions and financial markets, thus holding its superiority over other indicators.

Since financial development has a positive and significant direct impact on international trade, policies for enhancing the access, efficiency and depth of financial markets and financial institutions should be the top priority for BRICS countries, as they aim to become bigger players in the international trade arena. Targeted policy interventions for increasing the value additions emanating from the industry and service sectors will prove helpful in strengthening the indirect positive effect of financial development on the international trade of BRICS countries. India is a world leader in services, and China is a world leader in manufacturing. The sharing of technical know-how and spill-over effects in industry and services between the BRICS member countries would be helpful in strengthening the transmission channel of the sectoral effects of financial development on trade. Our empirical results also indicate that it is better for BRICS countries to diversify away from agriculture if they want to boost their international trade performance. Since all of the BRICS countries have still not attained developed country status, focusing on agriculture and allied activities could have adverse effects on their terms of trade, as evident from the Prebisch Singer thesis. Policies for boosting FDI inflows into the BRICS countries will prove helpful in accelerating their international trade as well, with empirical results throwing light on the highly complementary relationship between FDI and trade for this economic bloc. Boosting further international trade within the member countries of the BRICS by identifying sources of comparative advantage within industry and services and sharing the best regulatory practices for financial markets and institutions will go a long way in transforming them into economic powerhouses.

Each of the BRICS countries is characterised by the presence of a large informal sector. During the pre-pandemic year of 2019, informal sector units as a share of the total economy stood at 69.1% for Brazil, 97.9% for Russia, 93.7% for India, 74.7% for China and 79.2% for South Africa (ILO 2020). Greater trade volumes have resulted in greater informality in BRICS countries (Khanna 2021). Higher levels of financial development have been found to reduce the size of the informal economy in sub-Saharan Africa, including South Africa (Njangang et al. 2020). Economies that experience structural transformation manifested through a falling share of agriculture

in output are expected to have lower levels of informality since agriculture normally has the highest share of informal sector units as well as informal employment compared to industry and service sectors. Although BRICS countries have witnessed a common trend of declining shares of agriculture in GDP for many decades, all of them have registered a high share of informal sector units in the total economy even after excluding agriculture (Mehrotra 2021). There is a lot of scope for south–south cooperation among BRICS nations in their transition from informality to formality. However, BRICS countries should take a guarded approach while adopting policy measures for strengthening the interaction channel between financial development and sectoral value additions on trade openness, given its positive as well as negative repercussions on the large informal sector of these economies.

The export baskets of Brazil and Russia are predominantly composed of primary commodities such as agricultural goods, mining, minerals and oil. Even then, financial development is found to have a positive effect on Brazilian and Russian trade performance (Campos et al. 2023, Shakib et al. 2023). This implies that financial development plays a crucial role in accelerating international trade, even for countries that are primarily primary product exporters. Access to finance is identified as an obstacle adversely affecting the performance of small and medium enterprises in BRICS countries (Noshad et al 2019). Medium small and micro-enterprises (MSMEs) in BRICS countries also face a lot of other hurdles that prevent them from participating and flourishing in international trade and global value chains, such as cumbersome rules and procedures, an unpredictable regulatory environment and information asymmetry. In 2019, during the annual round table of BRICS countries, the member governments reviewed issues pertaining to access to finance and formalisation of MSMEs and brought about greater integration of MSMEs in the regional and global value chains of BRICS (Government of South Africa 2020). Such inter-governmental cooperation among BRICS nations is a step in the right direction and should be further strengthened in our pursuit of an inclusive trade policy.

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Appendix

Table A1

IMF financial development index

The financial development index (FIN) is a combined index of the financial institutional index and the financial market index.

The financial institutional index is an aggregate of sub-indices:

- The financial institutions depth index is a composite measure of variables: private sector credit (% of GDP), pension fund assets (% of GDP), mutual fund assets (% GDP), insurance premiums and life and non-life (% of GDP).
- The financial institutions sccess index is a composite measure of variables: bank branches per 100,000 adults and ATMs per 100,000 adults.
- The financial institutions efficiency index is a composite measure of variables: net interest margin, lending deposit spread, non-interest income to total income, overhead costs to total assets and return on assets and return on equity.

The financial markets index is an aggregate of sub-indices:

- The financial markets depth index is a composite measure of variables: stock market capitalisation to GDP, the stock traded to GDP, international debt securities of the government to GDP, total debt securities of financial corporations to GDP and total debt securities of non-financial corporations to GDP.
- The financial markets access index is a composite measure of variables: percent of market capitalisation outside of the top 10 largest companies and the total number of issuers of debt (domestic and external, non-financial and financial corporations).
- The financial markets efficiency index is a measure of variable stock market turnover ratio (stocks traded to capitalisation).

Source: IMF (2023).

Table A2

List of variables and data sources

Indicator	Abbreviation	Source
Trade openness as a share of GDP	TO	WDI
Trade balance as a share of GDP	TB	WDI
Financial development index	FIN	IMF
Domestic credit to the private sector as a share of GDP	DCPS	WDI
GDP per capita (constant 2015 US $)	GDP	WDI
Foreign direct investment, net inflow (as a share of GDP)	FDI	WDI
Agriculture, forestry and fishing value added (% of GDP)	AGR	WDI
Industry (including construction), value added (% of GDP)	IND	WDI
Services, value added (% of GDP)	SER	WDI

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