

IS DIGITALISATION A CATALYST FOR BRICS COUNTRIES' EXPORTS? AN EMPIRICAL ANALYSIS

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ABSTRACT

Digitalisation is a key catalyst which transforms international trade by enhancing efficiency, reducing costs, expanding market access and unlocking new opportunities, significantly boosting export performance. Understanding this interplay is essential for Brazil, Russia, India, China and South Africa (BRICS) countries, major players in global trade. This study examines the digitalisation-exports relationship in BRICS, specifically how Information and Communication Technology (ICT) catalyses exports. Using a combination of panel and country-specific autoregressive distributed lag (ARDL) models, this method captures country heterogeneity and both short-term and long-term dynamics. Panel autoregressive distributed lag identifies common BRICS trends, while country-specific autoregressive distributed lag highlights distinctive country effects, strengthening the analysis. Results show that, in the short term, Information and Communication Technology's effect on exports varies across models. However, in the long term, Information and Communication Technology consistently exerts a statistically significant effect. Findings emphasise digitalisation's pivotal role in enhancing BRICS exports, particularly long term. Yet, effectiveness differs across countries. Disparities in digital infrastructure, digital literacy and institutional quality suggest digitalisation alone is insufficient. Addressing these challenges enables BRICS to leverage digitalisation and strengthen their position as prominent emerging export countries. This study contributes to the digital economy discourse with empirical evidence-based policy implications.

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1. INTRODUCTION

The global trade landscape is undergoing rapid transformation driven by the advancement of digital technologies. As digital technologies continue to develop, their integration into various sectors, from manufacturing to financial services, is reshaping traditional trade patterns (*Ahmedov, 2020*). Digitalisation, encompassing technologies like information and communication technology (ICT), E-commerce, automation, the Internet of Things (IoT), and data analytics, fundamentally reshapes production, consumption, supply chains and global trade dynamics (*Ciuriak, 2020; Ozcan, 2018*). By enhancing efficiency, reducing costs, facilitating cross-border transactions and expanding market access, digitalisation holds significant potential to boost countries' exports, particularly in developing economies (*Hu et al., 2024; Zare & Persaud, 2024*).

As prominent players in the global economy, Brazil, Russia, India, China and South Africa (BRICS) countries are actively engaged in this digital revolution. These nations have experienced substantial digital adoption, fuelled by advancements in ICT and increasing internet penetration (*Li, Pogodin & Vasilyeva, 2022*). For instance, China has emerged as a global leader in E-commerce, with companies like Alibaba and Tencent at the forefront of digital trade and innovation. India has experienced rapid growth in its information technology and software services sector, driven by initiatives such as Digital India (*Fan, 2021*). Brazil and Russia have also made significant improvements in digitalising their economic sectors, particularly in areas like digital banking and online retail. South Africa, despite facing infrastructural challenges, is expanding its digital services and mobile connectivity (*BRICS Digital Economy Report 2022, 2022*). Digital technologies empower businesses within these countries to expand their reach globally, connect with international partners and streamline operations, potentially enhancing their export competitiveness and market access (*AL-Khatib, 2023; Ezell & Koester, 2023*).

Exports are a vital tool for economic development, driving economic growth, generating foreign exchange and creating employment, particularly in developing countries (*Balassa, 1989; Fugazza, 2004*). In the context of the BRICS countries, digitalisation can enhance export competitiveness and expand access to markets through exposure to the global market (*Martins & Yang, 2009*). Moreover, robust export performance can attract foreign direct investment (FDI), as investors often seek to capitalise on the export potential of developing markets (*Islam, 2022*) this study aims to investigate the relationship between FDI inflows and export performance in Bangladesh using annual time series data for the period of 1995 to 2020. The empirical analysis is performed employing Johansen cointegration

approach and Vector Error Correction Mechanism (VECM). While extensive research (*Ahmedov, 2020; Freund & Weinhold, 2000; Nath & Liu, 2017; Ozcan, 2018; Wang & Choi, 2018*), explores digitalisation's broad implications for trade, there is a notable gap in empirically isolating its specific effects on exports, especially within emerging economies like those of the BRICS bloc. Given their diverse economic conditions and varying levels of digital adoption, these countries represent a compelling case for investigating the potential of digitalisation serving as a catalyst for their exports.

Therefore, this study examines the digitalisation-exports relationship within the BRICS context. This analysis is particularly relevant due to the evolving impact of digital technologies on global trade dynamics and provides insights for policymakers aiming to leverage digitalisation to boost exports, particularly in developing countries. The research is motivated by the potentially varied effects of digitalisation across different national contexts due to differences in infrastructure and institutions (*Demin, Mikhaylova & Pyankova, 2023; Saggi, 2002, p. 192*), and the limited specific study on this relationship within BRICS, despite their rapid digital transformation (*Li, Pogodin & Vasilyeva, 2022*).

The rest of the paper is structured as follows: Section 2 reviews the literature, outlining the theoretical framework and the analysis of empirical studies. Section 3 details the data and methodology. Section 4 presents the results and their interpretations. Section 5 concludes and provides policy implications.

2. LITERATURE REVIEW

2.1 Export patterns in BRICS

As major players in international trade, the BRICS countries collectively account for over 18% of global trade (imports and exports) (*UNCTADstat, 2023*). This substantial trade volume underscores their growing influence as both producers and consumers, highlighting their importance as key trading partners across various regions. Figure 1 below illustrates a comparative insight into the BRICS countries' total trade (2008 compared to 2021). China's total trade has experienced substantial growth, significantly outpacing its BRICS partners. While India, Russia, and Brazil have also experienced growth, South Africa remains the smallest trade contributor within the group (*Iqbal & Yadav, 2022*). These trends accentuate the varying trade capacities within the BRICS group and their collective influence on the global trade dynamics (*Nayyar, 2020*).

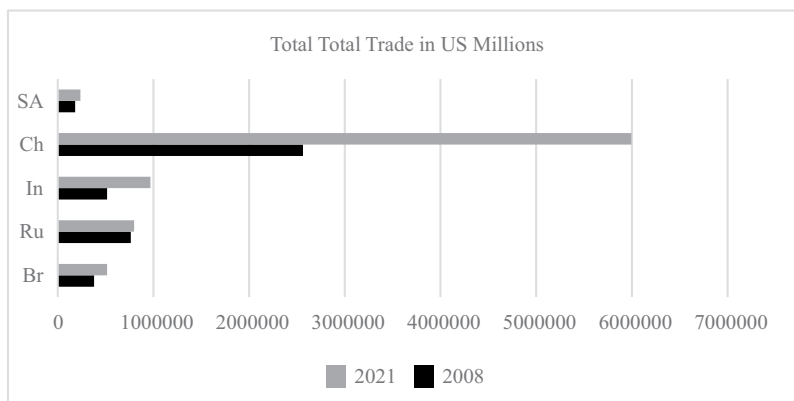


Figure 1. Trade dynamics of BRICS countries: comparative insights (2008 vs. 2021)

Source: Authors' analysis based on data from (UNCTADstat, 2023).

Exports are often influenced by various factors, including foreign demand, commodity prices, and exchange rates. However, the relative importance of these factors varies across countries. In the BRICS countries' context, Brazil's exports are heavily dependent on foreign demand for commodities, whereas China's exports are more diversified and less susceptible to commodity price fluctuations. Russia's exports are influenced by the real effective exchange rate, foreign demand, and commodity prices. India's export performance is similarly linked to the real effective exchange rate and commodity prices, while South Africa's performance is primarily driven by foreign demand (*Hooijmaaijers, 2021*). In addition, Russia and Brazil have traditionally focused on natural resources such as agriculture and mining, while India and China have excelled in manufactured and processed commodities (*Yarygina et al., 2020*). Furthermore, tariffs, quotas and other trade barriers can also significantly impact export performance (*Li, Pogodin & Vasilyeva, 2022*).

The increasing adoption of digital technologies seems to be transforming the trade patterns of BRICS countries. For instance, E-commerce and digital services and payments facilitate cross-border trade and reduce transaction costs (*Barykin et al., 2021*). Figure 2 below illustrates the growing export volume trends of the BRICS countries over selected years. BRICS countries have different export patterns. For instance, China's dominance in exports is evident, with its share rising from just over 50% in 2000 to 74% in 2020. The different economic conditions and challenges faced by these countries highlight the complexity of their exports and the multidimensional nature of their economic relations.

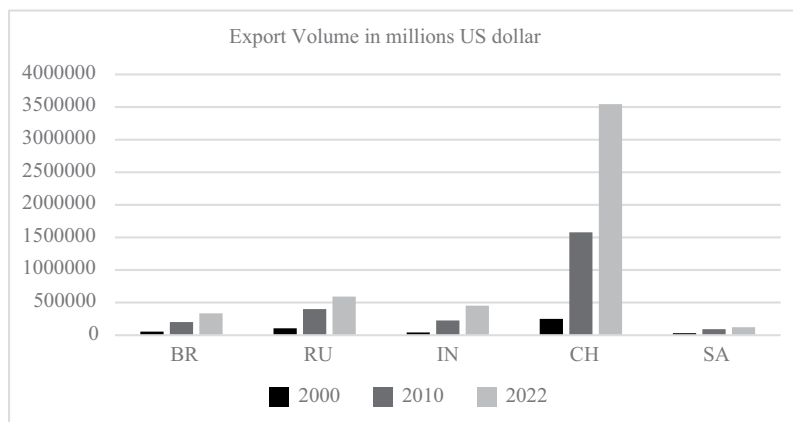


Figure 2. Export volume of BRICS countries over time (2000, 2010 and 2022)

Source: Authors' analysis based on data from ([UNCTADstat, 2023](#)).

2.2 Advancements of digitalisation in BRICS countries

Collectively, the BRICS countries account for approximately 30% of global exports of information and communication technology (ICT) products, but only 11% of the global exports of digitally deliverable services (*BRICS Trade in Services Report, 2022*). Despite China and India's growing prominence as global players in digitally deliverable services, the BRICS countries remain primarily focused on manufacturing or assembling, positioning them at the lower value-added end of the ICT goods value chain (*BRICS Digital Economy Report, 2022*). This discrepancy stresses the urge for these countries to rise to higher value-added segments within the digital technology sector to fully capitalise on the opportunities presented by digital technologies. Figure 3 below shows the increase in internet users between 2008 and 2021 across BRICS countries. The figure shows substantial growth in connectivity, with Russia and Brazil leading in 2021. Significant growth in internet usage is observed in India and South Africa, driven by the widespread availability of affordable smartphones and mobile data plans. But while South Africa and India are showing significant growth, they still lag in digital connectivity. These disparities in internet penetration are critical to understanding each country's capacity to fully engage in the digital economy. Overall, this increased connectivity in BRICS countries has spurred greater participation in E-commerce and online services. Nonetheless, notable disparities in internet penetration rates persist.

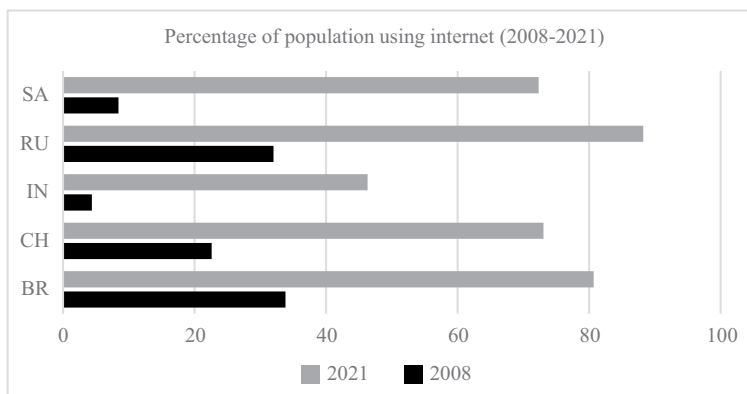


Figure 3. Growth of internet penetration in BRICS countries (2008 vs. 2021)

Source: Authors' analysis based on data from ([World Development Indicators | DataBank, 2024](#)).

The growth of the internet penetration in BRICS countries reflects their growing digital infrastructure. For example, Brazil, Russia, and South Africa are investing in enhancing their digital infrastructure, including broadband and 5G technologies, to support faster internet speeds and broader connectivity. China, in particular, is making substantial strides in 5G technology, positioning itself as a leader in digital infrastructure (*BRICS Digital Economy Report 2022, 2022*). Additionally, initiatives aimed at improving digital literacy such as the Digital India Program and the Digital Saksharta Abhiyan (DISHA) initiative in India, and National Electronic Media Institute of South Africa (NEMISA) under the South Africa's Digital Economy Mission Plan (DEMP) in South Africa, are being implemented to cultivate a workforce capable of effectively utilising digital technologies. These investments are crucial for driving digital transformation, with China setting the pace in both scale and innovation (*Ignatov, 2020*) but at the same time it deepens global inequality and impacts the growth of countries of the global South. The role of global governance institutions such as the BRICS grouping of Brazil, Russia, India, China and South Africa — the main representative of developing countries in global governance — in the promotion of digital growth has not yet been fully explored. There is also some ambiguity concerning the development level of the digital economy in particular countries. In the context of Russia's third BRICS presidency in 2020, issues of digital development in BRICS have become particularly relevant. The author analyzes current indicators of digital development in the BRICS countries, drawing on several existing methodologies, ratings, and decisions made by BRICS on issues of digital growth and levels of compliance, and makes recommendations for the further development of BRICS' digital agenda. According to data provided by the Organisation for Economic Co-operation and Development (OECD).

Moreover, the adoption of digital banking and payment platforms is on the rise across BRICS countries, with India's Unified Payments Interface (UPI) and China's QR code-based transactions leading the way, and with the E-commerce growth, particularly in China and India. Brazil has also seen substantial increases in online shopping activities. There is also a growing emphasis on Artificial Intelligence (AI) use, data analytics and machine learning across BRICS countries, with substantial investments in smart technologies and automation across various sectors, including healthcare, finance and manufacturing (*Li, Pogodin & Vasilyeva, 2022*). These platforms are significantly increasing financial inclusion. However, the extent to which digital services are available and accessible to citizens and businesses depends on the varying level of digital infrastructure development in each BRICS countries. Figure 4 below displays the ICT infrastructure development index for 2022 for each BRICS country. China and Russia are leading in ICT development. Meanwhile, India, despite its advancements, still requires further development to match the progress of its BRICS. These differences in digital development levels highlight the varying capacities of BRICS countries to harness digital technologies effectively.

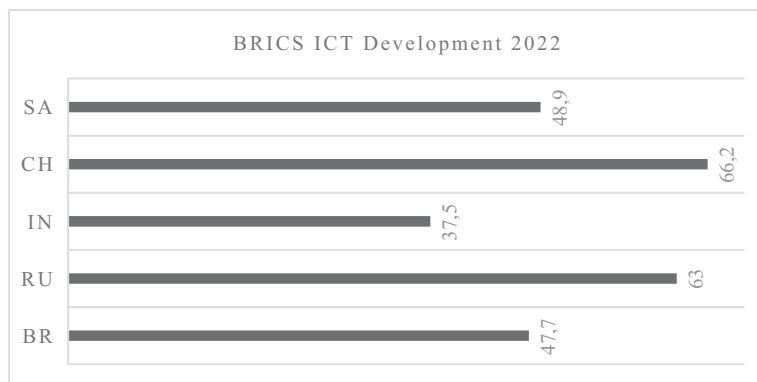


Figure 4. ICT development index across BRICS countries in 2022

Source: Authors' analysis based on data from (*UNCTADStat, 2023*).

Overall, digitalisation trends in BRICS countries reveal diverse adoption levels, shaped by unique challenges and opportunities. Variations stem from disparities in digital infrastructure, ICT penetration and digital literacy, reflected in indicators like internet connectivity, ICT development and digital skills (*BRICS Digital Economy Report, 2022*). In addition, factors such as technology investments, regulatory frameworks and access to digital services influence each country's digital progress, affecting their global competitiveness and highlighting the need for tailored digital transformation strategies.

2.3 Conceptual and analytical framework

Economic theories provide valuable insights into how advancements in technology, innovation and human capital contribute to economic growth and international trade. Consequently, the analysis of the digitalisation-exports relationship can be understood through the framework of economic trade theories that explain the effects of digital technologies on international trade. This analysis involves the application of economic theories, including the Endogenous Growth theory (*Romer, 2012; Romer, 1990*) and New Trade theory (*Krugman, 1979*). These two theoretical frameworks underline the importance of digitalisation in modern trade, especially for emerging economies striving to enhance their export capacity (*Nham, Bao & Ha, 2023, p. 1043*).

According to the Endogenous Growth theory, technological advancements such as digital infrastructure drive improvements in productivity, which in turn expand trade capacity by lowering production and transaction costs (*Romer, 2012, pp. 102–103*). This theory suggests that investments in ICT facilitate faster communication and resource optimisation, which are crucial for expanding export markets. Additionally, leveraging digital technologies can enable businesses to improve operational efficiency, facilitate better communication and optimise the allocation of resources, thereby increasing international trade and fostering economic development (*Nham, Bao & Ha, 2023*). On another hand, the New Trade theory highlights the role of increasing returns to scale and network effects in international trade (*Krugman, 1979*). Like the Endogenous Growth theory, the New Trade theory focuses on endogenous factors including: the role of technology, increasing returns to scale, knowledge spillovers and human capital (*Chandra, 2022, pp. 221–249*). However, while this theory highlights the advantages of economies of scale, it often assumes ideal market conditions that may not hold in the real world. For instance, for BRICS countries, factors such as market imperfections, infrastructural deficiencies and regulatory hurdles can obstruct the realisation of these benefits (*Geng et al., 2024*).

Therefore, in the BRICS countries context, digital technologies can enhance productivity by reducing transaction costs, improving logistics and enabling firms to reach broader markets (*Ignatov, 2020*). While digitalisation can mitigate some of the trade barriers by reducing transaction costs and enhancing market access, the extent of its effectiveness may vary across different economic contexts (*Banga & Kozul-Wright, 2018*). For instance, in the New Trade theory, a skilled workforce is essential for enhancing a country's competitive advantage in producing high-tech goods for export. This is because high-tech industries often require specialised knowledge and skills, which can drive innovation and

productivity (*Oyelaran-Oyeyinka & Lal, 2005*). Furthermore, the adoption of E-commerce platforms like eBay, Alibaba and Amazon not only significantly increased global trade volumes but also increased the market opportunities, especially for small and medium enterprises (SMEs) (*Lendle et al., 2016*). Countries, thus with a more skilled labour force, are better positioned to leverage digital tools and platforms to compete in these sectors and to engage in export activities effectively (*Banga & Kozul-Wright, 2018*). As BRICS countries continue to increase their digital technologies, they are better positioned to exploit these network effects, particularly in export-oriented sectors.

2.4 Insights from empirical studies

Empirical studies investigating the relationship between digitalisation and trade encompass various strands, including the adoption of the internet and ICT infrastructure (*Añón Higón & Bonvin, 2024; DeStefano & Timmis, 2024*), E-commerce and the role of digital platforms (*Dethine, Enjolras & Monticolo, 2020; Lendle et al., 2016*), digital services (*Azar & Ciabuschi, 2017; Liu & Nath, 2013; Nath & Liu, 2017; Yin & Choi, 2024*), regulatory impacts, and integration into global value chains (*Baldwin, 2017*). These diverse strands illustrate multifaceted relationships and provide a comprehensive understanding of how digitalisation influences trade and, more specifically, exports.

These empirical studies reveal a spectrum of findings. Using the gravity model in the G20 countries, *Yin and Choi (2024)* found that digitalisation is more likely to have a positive impact on exports, especially service exports (*Yin & Choi, 2024*). This study is relevant as it emphasises the impact of digitalisation, specifically on exports. *Abendin, Pingfang and Nkukporu (2022)* used the augmented gravity model to capture the effect of digitalisation on bilateral trade in the Economic Community of West African States (ECOWAS). Their findings reveal a significant positive effect of digitalisation on trade in the region (*Abendin et al., 2022*). This study highlights the overall positive impact of digitalisation on trade. *Wang and Choi (2018)* found that ICT has a more pronounced positive effect on exports than imports within BRICS countries using the gravity model on the panel data from the 2000 to 2016 (*Wang & Choi, 2018*). This study is most relevant as it is on BRICS countries and highlights the positive expected findings. *Ozcan (2018)* employed an augmented panel gravity model to investigate the influence of information and communication technologies (ICT) on international trade between Turkey and its trading partners. The findings reveal that ICT exerts a positive and significant impact on both Turkish import and export volumes.

Using a dynamic gravity model on panel data, [Rodriguez-Crespo, Marco and Billon \(2018\)](#) found that the impact of internet use, mobile phones and broadband on bilateral trade flows is greater for the exporter than for the importer. However, the authors emphasised that these impacts vary depending on the type of technology ([Rodriguez-Crespo, Marco & Billon, 2018](#)). In Contrast, [Ozcan \(2018\)](#) observes that ICT has a quantitatively greater effect on imports than on exports ([Ozcan, 2018](#)). But [Liu and Nath \(2013\)](#) observed that countries with better ICT infrastructure experience higher trade volumes, using fixed effects models of exports and imports with ICT as the main explanatory variable of interest. They highlighted the critical role of digital infrastructure in modern trade dynamics. Once again, the authors accentuated that the trade-enhancing effect of ICT depends more on its effective use than on the mere presence of ICT infrastructure ([Liu & Nath, 2013](#)). Therefore, based on the above theoretical and empirical literature, this study states the following hypothesis: Null hypothesis: *there is no statistically significant relationship between ICT and exports in BRICS countries*. Alternative hypothesis: *there is a statistically significant relationship between ICT and exports in BRICS countries*.

3. DATA AND METHODOLOGY

This study employs a panel data model and a country-specific autoregressive distributed lag (ARDL) model to examine the short-term and long-term effects of digitalisation on exports in BRICS countries from 2000 to 2022. To distinguish between short-term and long-term effects within the ARDL framework, we concentrate on the coefficients of the lagged differences of the variables to elucidate short-term dynamics. These coefficients signify the immediate effects of variations in the independent variables. In contrast, long-term relationships are represented by the coefficients of the lagged levels of the variables, which denote the equilibrium relationship anticipated to exist in the long-term ([Pesaran & Shin, 1999](#)).

The panel ARDL model captures the general dynamics of ICT and other variables' effects on exports across BRICS countries. This approach helps to identify predominant patterns and shared characteristics in the BRICS bloc, allowing for a broad understanding of the factors driving exports in the block and for broader policy implications at a regional level. Given the differences in economic structures, levels of digital infrastructure and trade policies among the BRICS countries, the country-specific ARDL model assesses how ICT affects export in each country differently. This dual approach provides a deeper understanding of country-level variations, informing tailored policy interventions. It also

strengthens the analysis by addressing both the commonalities and differences in how digitalisation impacts exports across BRICS, making the research more robust and policy-relevant.

3.1 Data and sources

Export data and the ICT development index were acquired from the World Development Indicators (WDI) and United Nations Conference on Trade and Development (UNCTAD) databases, respectively. Control variables were sourced from the WDI, UNCTAD and Federal Reserve Economic Data (FRED). Exports (dependent variable) were measured in constant US dollars. The ICT development index (independent variable) included fixed-line and mobile phone penetration, internet usage and secure server availability. To isolate the effect of ICT on exports, control variables included GDP, private sector, exchange rates, inflation, tariffs, human capital and institutional quality. The variables, including human capital, institutional quality, private sector and ICT, are compound indices of the overall productivity capacity index (UNCTADStat, 2023).

Table 1: Summary of Variables, Descriptions and Data Sources

Variables	Description	Sources
ICT	Estimates the accessibility and integration of communication systems within the population. It includes fixed line and mobile phone users, internet accessibility and server security	UNCTAD
Human capital	Captures the education, skills and health conditions possessed by the population, and the overall research and development integration in the texture of society through the number of researchers and expenditure on research activities.	UNCTAD
Institutions	Measures political stability and efficiency through regulatory quality, effectiveness, success in fighting criminality, corruption and terrorism, and safeguarding of citizens' freedom of expression and association.	UNCTAD
Private sector	Defined by the ease of cross-border trade, which includes time and monetary costs to export and import, and the support to business in terms of domestic credit, velocity of contract enforcement and time required to start a business.	UNCTAD
GDP	Gross Domestic Product is used to control for economic size.	WDI
Exchange rate	To account for the relative value of currencies.	UNCTAD and FRED
Inflation	Percentage change in cost to the average consumer	WDI
Tariffs	Tariff rate applied to all products subjected to all traded goods	WDI

Sources: (FRED, n.d.; UNCTADStat, 2023; World Development Indicators | DataBank, 2024).

3.2 Model specification

The ARDL model was selected for its flexibility in accommodating variables with mixed orders of integration (I(0) and I(1)), and its ability to capture both short-term and long-term dynamics in the variables (*Engle & Granger, 1987; Pesaran & Shin, 1999*). This makes it particularly suited to both time series and panel datasets, where economic variables may exhibit different integration properties (*Bardi & Hfaiedh, 2021*).

Four panel models were developed to examine the relationship between ICT and export volume while controlling for other relevant variables: Model 1 includes ICT, Human capital and Private sector development; Model 2 includes ICT, GDP and Inflation; Model 3 includes ICT and Institutional quality and Model 4 focuses on ICT, Exchange rate and Tariffs. In addition to the panel models, individual ARDL models were developed for each BRICS country to account for country-specific dynamics. The country-specific models follow a similar ARDL structure, including all variables. We applied the Levin, Lin & Chu and Im, Pesaran and Shin tests to ensure that the variables were either I(0) or I(1), confirming that none were integrated at I(2). To ensure the validity of our results and to confirm the existence of a long-run relationship, we conducted a Bounds Test with F-statistics.

The general specification of the ARDL short and long run (in bold characters) model for $t = 1, 2, \dots, T$, periods and $i = 1, 2, \dots, N$ group is specified as follows:

$$\begin{aligned} \Delta \log(EXPORTS_{it}) = & \alpha_i + \sum_{j=1}^p \beta_{ij} \Delta \log(EXPORTS_{i,t-j}) + \sum_{j=0}^q \gamma_{ij} \Delta \log(ICT_{i,t-j}) \\ & + \sum_{j=0}^r \delta_{ij} \Delta \log(CONTROL_{i,t-j}) + \phi_i (\log(EXPORTS_{i,t-1}) \\ & - \theta_i \log(ICT_{i,t-1}) - \psi \log(CONTROL_{i,t-1}) + \varepsilon_{it} \end{aligned}$$

α_i is the country-specific intercept; $\Delta \log(EXP_{it})$ is the first difference of the dependent variable (exports); β_{ij} , γ_{ij} , δ_{ij} are the short-run coefficients; ϕ_i is the error correction term that adjusts to the long-run equilibrium; and $\log(DIG_{it})$ and $\log(CONTROL_{it})$ are logarithms of digitalisation indicators and control variables, respectively. The Error Correction Term (ECT) in the cointegration model measures how quickly deviations from the long-run equilibrium are corrected. A significant speed of adjustment suggests that the dependent variable responds strongly to changes in the independent variables. For example, the ECT captures the speed at which exports adjust to changes in ICT. The ECT is expected to have a negative sign and be statistically significant. A negative and significant ECT confirms that the system corrects deviations from the long-run equilibrium

in a predictable way (Engle & Granger, 1987; Pesaran & Shin, 1999). Below are the estimation techniques with exports as the dependent variable in all four equations.

Model 1 (ICT, Human capital, Private sector development):

$$\begin{aligned}\Delta \log(EXPORTS_{it}) = & \alpha_i + \sum_{j=1}^p \beta_{ij} \Delta \log(EXPORTS_{i,t-j}) + \sum_{j=0}^q \gamma_{ij} \Delta \log(ICT_{i,t-j}) \\ & + \sum_{j=0}^q \mu_{ij} \Delta \log(HC_{i,t-j}) + \sum_{j=0}^q \nu_{ij} \Delta \log(PRIVATESECT_{i,t-j}) \\ & + \phi_i (\log(EXPORTS_{i,t-1}) + \theta_i \log(ICT_{i,t-1}) + \psi \log(HC_{i,t-1}) \\ & + \psi \log(PRIVATESECT_{i,t-1})) + \varepsilon_{it}\end{aligned}$$

Model 2 (ICT, GDP, Inflation):

$$\begin{aligned}\Delta \log(EXPORTS_{it}) = & \alpha_i + \sum_{j=1}^p \beta_{ij} \Delta \log(EXPORTS_{i,t-j}) + \sum_{j=0}^q \gamma_{ij} \Delta \log(ICT_{i,t-j}) \\ & + \sum_{j=0}^q \mu_{ij} \Delta \log(GDP_{i,t-j}) + \sum_{j=0}^q \nu_{ij} \Delta \log(INFL_{i,t-j}) \\ & + \phi_i (\log(EXPORTS_{i,t-1}) + \theta_i \log(ICT_{i,t-1}) + \psi \log(GDP_{i,t-1}) \\ & + \psi \log(INFL_{i,t-1})) + \varepsilon_{it}\end{aligned}$$

Model 3 (ICT, Institutions):

$$\begin{aligned}\Delta \log(EXPORTS_{it}) = & \alpha_i + \sum_{j=1}^p \beta_{ij} \Delta \log(EXPORTS_{i,t-j}) + \sum_{j=0}^q \gamma_{ij} \Delta \log(ICT_{i,t-j}) \\ & + \sum_{j=0}^q \mu_{ij} \Delta \log(INSTITUTIONS_{i,t-j}) + \phi_i \log(EXPORTS_{i,t-1}) \\ & + \theta_i \log(ICT_{i,t-1}) + \psi \log(INSTITUTIONS_{i,t-1}) + \varepsilon_{it}\end{aligned}$$

Model 4 (ICT, Exchange rate and Tariffs):

$$\begin{aligned}\Delta \log(EXPORTS_{it}) = & \alpha_i + \sum_{j=1}^p \beta_{ij} \Delta \log(EXPORTS_{i,t-j}) + \sum_{j=0}^q \gamma_{ij} \Delta \log(ICT_{i,t-j}) \\ & + \sum_{j=0}^q \mu_{ij} \Delta \log(EXCH_R_{i,t-j}) + \sum_{j=0}^q \nu_{ij} \Delta \log(TARIFFS_{i,t-j}) \\ & + \phi_i \log(EXPORTS_{i,t-1}) + \theta_i \log(ICT_{i,t-1}) + \psi \log(EXCH_R_{i,t-1}) \\ & + \psi \log(TARIFFS_{i,t-1}) + \varepsilon_{it}\end{aligned}$$

4. RESULTS AND DISCUSSIONS

4.1 Unit Root Tests

Table 2 below presents the stationary test result. The Levin, Lin & Chu Test confirmed that the variables were stationary at $I(0)$ (stationary at their level) and $I(1)$ (integrated of order 1), which supported the use of the ARDL model.

Table 2: Result of Unit Root Analysis via Levin, Lin & Chu Test

Variables	Probability	Integrated order
LEXPORTS	0.0000***	I (0)
LICT	0.0000***	I (0)
D(LHC)	0.0025***	I (1)
D(LPRIVATESECT)	0.0000***	I (1)
D(LINSTITUTIONS)	0.0000***	I (1)
INFL	0.0013***	I (0)
D(LEXCH_R)	0.0000***	I (1)
D(GDP)	0.0000***	I (1)
TARIFFS	0.0001***	I (0)

Note: * significant at 10% level, ** significant at 5% level and *** significant at 1% level.

Source: Authors' analysis.

4.2 Panel ARDL results and discussion

Table 3 below presents the (short-run and long-run) estimation results from the panel ARDL model. The results indicated a statistically significant and positive relationship between ICT and exports in BRICS countries in both the short run and long run, except for model 2, which only showed statistical significance in the long run. In model 2, ICT had a statistically significant and positive relationship with exports in the long run at the 1% level, but it was statistically insignificant and positive in the short run. This implies the lag in realising improvements from digital infrastructure, as ICT infrastructure projects typically take time to become fully operational, leading to delayed influence on trade flows. The significant short-run gains in exports in other models likely reflect the rapid uptake of digital technologies and E-commerce platforms, which can quickly facilitate trade by reducing transaction costs and improving global market access. This suggests that investments in digital infrastructure are crucial across both time horizons. Overall, these findings suggest that digitalisation plays a critical role in enhancing export performance, which is consistent with previous empirical studies like (*Liu & Nath, 2013; Rodriguez-Crespo et al., 2018; Wang & Choi, 2018; Yin & Choi, 2024*) that find that ICT has a positive effect on exports. The error correction term (ECM) was statistically significant across all models.

For instance, the coefficients in Model 1 were -0.3208 and -0.0815 in Model 4, significant at the 1% level ($p=0.0018$ and $p=0.0223$, respectively). The ECM results suggest a relatively fast adjustment process from any deviations from long-run equilibrium.

Table 3: Panel ARDL short-run and long-run estimations

SHORT-RUN (MEAN-GROUP)						
MODELS	COINTEQ (ECM)		VARIABLES			
	Coefficient	Prob.		Coefficient	Prob.	
Model 1	-0.3208	0.0018**	D(LICT)	1.0450	0.0957*	
			D(LHC)	-9.605060	0.0621*	
			D(LPRIVATESECT)	0.832368	0.3977	
Model 2	-0.1393	0.0407**	D(LICT)	0.070059	0.9069	
			D(GDP)	0.017882	0.0064***	
			D(INFL)	-0.001795	0.8455	
Model 3	-0.1192	0.0548**	D(LICT)	1.2280	0.0000***	
Model 4	-0.0815	0.0223**	D(LICT)	0.837426	0.0000***	
			D(LEXCH_R)	-1.126824	0.0000***	
			D(LTARIFFS)	0.040153	0.8503	
LONG-RUN (POOLED)						
MODELS	VARIABLES		Coefficient			Prob.
Model 1	LICT		2.061717			0.0000***
	LHC		-1.465710			0.0000***
	LPRIVATESECT		-1.356958			0.0000***
Model 2	LICT		1.942462			0.0000***
	GDP		0.154894			0.0000***
	INFL		0.082354			0.0009***
Model 3	LICT		1.126552			0.0000***
	LINSTITUTIONS		1.335899			0.3206
Model 4	LICT		0.857749			0.0842*
	LEXCH_R		1.447625			0.0027***
	LTARIFFS		-0.946107			0.1821

Note: * significant at 10% level, ** significant at 5% level and *** significant at 1% level.

Source: Authors' calculation

Among the other variables in the analysis, only GDP had a statistically significant and positive relationship with exports in both the short and long run at the 1% level of significance. Notably, these results of GDP suggest that short-term and long-term changes in economic growth have an immediate effect on exports, reinforcing that economic growth contributes to export capacity, as highlighted by various scholars (*Bhattacharya & Bhattacharya, 2016; Palamalai, 2016; Ramakgasha, Gidi & Thaba, 2023*).

The negative and statistically significant exchange rate suggests that a weak currency constrains exports in the short run but boosts exports in the long run by making goods more affordable in international markets. It was counterintuitive

that human capital investment has a negative relationship with exports, as one would expect that human capital in the form of skills should contribute towards export promotion. However, this finding suggests a possibility of skill mismatch, implying inefficiencies or mismatches in skills despite digital technologies advancements in BRICS countries, as the skills provided are not relevant to the export sectors. In BRICS countries, where exports are often dominated by manufacturing and natural resource industries, excessive investment in skills not directly relevant to those sectors might lead to inefficiencies. In addition, in BRICS countries, highly skilled workers may emigrate to countries with higher wages, reducing the positive impact of human capital investment on the economy. The negative relationship between human capital investment and exports in BRICS countries could also be due to several structural and economic dynamics, such as sectoral mismatches, resource dependency and institutional factors (*Becker, 1964; Lucas, 1988*). These factors might prevent human capital from translating into improved export performance.

The positive and statistically significant coefficient of inflation in the long run may also seem counterintuitive, as the result implies that high inflation weakens the currency, which boosts exports. But countries rich in natural resources often export goods that exhibit relatively inelastic demand in global markets. For instance, Brazil, known for its agricultural exports, and Russia, a major energy exporter, may experience domestic inflation. However, due to the inelastic global demand for these commodities, their exports can continue to grow despite higher domestic inflation. This phenomenon can create a long-term positive relationship between inflation and exports. In BRICS countries, this result of the relationship between inflation and exports reflects underlying economic dynamics such as industrialisation, export diversification and global commodity price trends. These factors can ultimately enhance export performance despite inflationary pressures (*Arezki & Brückner, 2011*). Finally, the statistically insignificant relationship between tariffs and exports could be attributed to a variety of factors, including the resilience and adaptability of exporters, global value chain integration, trade agreements, non-tariff barriers and offsetting effects in production costs and export competitiveness. These factors can dilute the impact of tariffs on exports, especially in complex economies like those of the BRICS countries.

4.3 Country-specific ARDL results and discussion

Tables 4 to 8 below present the country-specific ARDL results. Here, we only focused on interpreting and discussing the ICT relationship result estimations for exports for each of the BRICS countries. Overall, the country-specific ARDL results indicate variations in the role of ICT in supporting exports across the

BRICS nations. In China (Table 7) and Russia (Table 5), ICT shows a statistically significant positive relationship with exports, an unexpected statistically significant negative relationship in Brazil (Table 4), while demonstrating a delayed impact in India (Table 6) and minimal relevance in South Africa (Table 8). These varied outcomes reflect how each country's distinct economic structure, sectoral composition and stage of ICT adoption interact with digitalisation's influence on export dynamics. The error correction terms were statistically significant, indicating a rapid adjustment to long-run equilibrium.

Table 4: Brazil's ARDL short-run and long-run estimations

Dependent Variable: LEXPORTS						
Method: ARDL						
Automatic-lag linear regressors (1 max. lags): LICT LHC LINSTITUTIONS LPRIVATESECT						
GDP EXCH_R INFL TARRIFS						
Model selection method: Akaike info criterion (AIC)						
Selected model: ARDL(1,1,0,0,1,0,0,0,0)						
Variable	Coefficient	Std. Error	t-Statistic	Prob.		
LEXPORTS(-1)	0.513349	0.095218	5.391324	0.0003		
LICT	-1.060038	0.482925	-2.195036	0.0529**		
LICT(-1)	0.826209	0.395475	2.089156	0.0632*		
LHC	-1.626538	1.165307	-1.395803	0.1930		
LINSTITUTIONS	-2.551503	0.925638	-2.756481	0.0203**		
LPRIVATESECT	2.033313	0.931377	2.183125	0.0540**		
LPRIVATESECT(-1)	1.641819	0.668021	2.457737	0.0338**		
GDP	0.046800	0.007361	6.357914	0.0001***		
EXCH_R	-0.065639	0.042025	-1.561886	0.1494		
INFL	0.030690	0.007575	4.051373	0.0023**		
TARIFFS	-0.085190	0.036834	-2.312794	0.0433**		
C	10.85143	5.094650	2.129966	0.0590		
Error Correction Test						
Variable	Coefficient	Std. Error	t-Statistic	Prob.		
COINTEQ*	-0.486651	0.030260	-16.08243	0.0000***		
D(LICT)	-1.060038	0.184953	-5.731379	0.0000***		
D(LPRIVATESECT)	2.033313	0.363398	5.595279	0.0000***		
Bounds Test						
Null hypothesis: No levels relationship						
Test Statistic	Value					
F-statistic	13.612864					
	10%		5%		1%	
Sample Size	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
30	-1.000	-1.000	-1.000	-1.000	-1.000	-1.000
Asymptotic	1.850	2.850	2.110	3.150	2.620	3.770

Note: * significant at 10% level, ** significant at 5% level and *** significant at 1% level.

Source: Authors' calculation.

To confirm the presence of a long-run relationship (cointegration) among the variables in each country-specific ARDL model, the Bounds Test was conducted. The Null Hypothesis for this test is “No level relationship”. The test statistic (F-statistic) is compared against critical values to assess statistical significance. The Bounds Test F-statistic results for Brazil (13.61), Russia (12.87), India (3.76) and China (17.72) suggest evidence of a long-run relationship among the variables in the model at a 10% critical value for Brazil, Russia, India and China. Therefore, we rejected the null hypothesis and confirmed there is level relationship between ICT and exports in the BRICS countries above.

The results in Table 4 above for Brazil exhibited a statistically significant negative relationship between ICT and exports, the short run (1% significance level). However, a positive and statistically significant relationship was observed between lagged ICT and long-run exports at the 10% significance level. The short-run negative relationship between concurrent ICT and exports indicates that, contrary to expectations, ICT does not immediately stimulate Brazil's exports. This finding is particularly relevant for Brazil, as noted, Brazil's primary sectors are agriculture and mining, which may not fully capitalise on digital tools or ICT investments in the short run (*McFadden et al., 2022, pp. 9, 20, 25, 32–34; Oyelami, Sofoluwe & Ajeigbe, 2022*). Given the slower adoption rates of digitalisation in the agricultural sector, it suggests that significant time and targeted application of ICT are required to observe measurable improvements in exports. Moreover, agricultural exports may rely more on other factors, such as climate, trade policies and commodity demand, than on ICT directly. The positive impact of lagged ICT on long-run exports implies that past ICT investments or improvements have a delayed, positive effect on exports. This time lag may be attributed to the time required for firms to adapt digital tools to their specific production processes, particularly in traditional sectors like agriculture. It indicates that while current digitalisation development may not immediately translate to export growth, prior investments in digital infrastructure or technologies could yield export-related benefits over time (*Tadesse & Badiane, 2018*). This nuanced relationship implies that for Brazil, strategic and tailored digitalisation initiatives may need to account for sector-specific requirements and lagged effects of ICT adoption to maximise exports' long-term growth.

Tables 5 and 6 below display ARDL results for Russia and India, respectively. The results for Russia in Table 5 showed that ICT had a statistically significant positive relationship with exports at the 5% significance level in the long run. This implies that Russia's ICT infrastructure and investment are effectively enhancing exports. Russia's export composition includes a significant portion of energy and heavy industrial products, where ICT could enhance processes

such as logistics, supply chain management and quality control (*Feiguine & Solovjova, 2014*). The infrastructure developed within ICT might also streamline complex export procedures, from compliance to international communication, aiding export effectiveness.

Table 5: Russia's ARDL short-run and long-run estimations

Dependent Variable: LEXPORTS

Method: ARDL

Automatic-lag linear regressors (1 max. lags): LICT LHC LINSTITUTIONS

LPRIVATESECT GDP LEX_R LINFL TARRIFS

Model selection method: Akaike info criterion (AIC)

Selected model: ARDL(1,0,0,1,1,0,0,0,0)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LEXPORTS(-1)	-0.140791	0.270353	-0.520766	0.6139
LICT	0.764838	0.278064	2.750583	0.0205**
LHC	2.661791	2.663937	0.999194	0.3413
LINSTITUTIONS	-0.468985	1.143778	-0.410032	0.6904
LINSTITUTIONS(-1)	-1.999373	1.200221	-1.665837	0.1267
LPRIVATESECT	1.592876	1.581020	1.007499	0.3375
LPRIVATESECT(-1)	2.716190	1.702608	1.595311	0.1417
GDP	0.016602	0.009814	1.691709	0.1216
LEX_R	-0.583772	0.252012	-2.316440	0.0430**
LINFL	0.128913	0.100268	1.285690	0.2275
TARIFFS	0.023091	0.009457	2.441676	0.0347**
C	-4.626263	7.809464	-0.592392	0.5667

Error Correction Test

Automatic-lag linear regressors (1 max. lags): LICT LHC LINSTITUTIONS

LPRIVATESECT GDP LEX_R LINFL TARRIFS

Model selection method: Akaike info criterion (AIC)

Selected model: ARDL (1,0,0,1,1,0,0,0,0)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
COINTEQ*	-1.140791	0.072947	-15.63864	0.0000***
D(LINSTITUTIONS)	-0.468985	0.478440	-0.980238	0.3393
D(LPRIVATESECT)	1.592876	0.328923	4.842707	0.0001***

Bounds Test

Null hypothesis: No levels relationship

Test Statistic Value

F-statistic 12.871958

	10%		5%		1%	
Sample Size	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
30	-1.000	-1.000	-1.000	-1.000	-1.000	-1.000
Asymptotic	1.850	2.850	2.110	3.150	2.620	3.770

Note: * significant at 10% level, ** significant at 5% level and *** significant at 1% level.

Source: Authors' analysis.

The results for India in Table 6 showed that ICT had mixed impacts on exports. The ICT and exports relationship only became statistically significant and positive in the long term after lagging ICT at a 10% level. This suggests that digitalisation might take time to positively impact exports in India. The delayed positive effect of ICT on exports in India suggests that while ICT investments do contribute positively to exports, the results take time to manifest. This lag might indicate that ICT initiatives in India are initially focused on developing infrastructure or enabling sectors indirectly linked to exports. Moreover, India's economy relies heavily on services exports (e.g., IT and software services), which are naturally aligned with ICT advancements. However, in the manufacturing and agriculture sectors, the adoption of ICT may take longer to yield visible results, as shown for Brazil. Additionally, India's ICT sector investments might need to mature and integrate better with export-related activities, leading to the observed time lag (*BRICS Trade in Services Report, 2022*).

Table 6: India's ARDL short-run and long-run estimations

Dependent Variable: LEXPORTS				
Method: ARDL				
Automatic-lag linear regressors (1 max. lags): LICT LHC LINSTITUTIONS LPRIVATESECT GDP EXCH_R INFL TARRIFS				
Model selection method: Akaike info criterion (AIC)				
Selected model: ARDL(1,1,0,0,1,0,0,0,1)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LEXPORTS(-1)	0.228448	0.298773	0.764621	0.4641
LICT	-0.383852	1.035287	-0.370769	0.7194
LICT(-1)	1.930579	0.964296	2.002061	0.0763*
LHC	3.792977	2.060140	1.841126	0.0987*
LINSTITUTIONS	-2.922411	3.148599	-0.928163	0.3775
LINSTITUTIONS(-1)	3.628506	2.768285	1.310742	0.2224
LPRIVATESECT	-0.207899	2.353683	-0.088329	0.9315
GDP	0.021771	0.008719	2.496946	0.0340**
INFL	0.005824	0.024248	0.240167	0.8156
LEXCH_R	-2.313551	0.517763	-4.468361	0.0016***
TARIFFS	-0.004816	0.013828	-0.348300	0.7356
TARIFFS(-1)	0.020997	0.012991	1.616230	0.1405
C	-1.569542	9.018618	-0.174034	0.8657
Error Correction Test				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
COINTEQ*	-0.771552	0.088989	-8.670208	0.0000***
D(INSTITUTIONS)	2.922411	0.852162	-3.429408	0.0030***

Bounds Test						
Null hypothesis: No level relationship						
Test Statistic	Value					
F-statistic	3.758626					
	10%		5%		1%	
Sample Size	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
30	-1.000	-1.000	-1.000	-1.000	-1.000	-1.000
Asymptotic	1.850	2.850	2.110	3.150	2.620	3.770

Note: * significant at 10% level, ** significant at 5% level and *** significant at 1% level.

Source: Authors' analysis.

In Table 7 below, the results show that in China, ICT exhibits a statistically significant and positive relationship with exports at the 5% level in the long run. The positive and significant impact of ICT on exports underscores that digitalisation is directly enhancing China's export performance. This alignment indicates that China's export economy, which spans a broad range of goods including electronics, machinery and textiles, is highly compatible with the benefits that ICT provides. China's emphasis on digitalisation, smart manufacturing and e-commerce has likely allowed for rapid ICT adoption across its export sectors.

Table 7: China's ARDL short-run and long-run estimations

Dependent Variable: LEXPORTS				
Method: ARDL				
Automatic-lag linear regressors (1 max. lags): LICT LHC LINSTITUTIONS LPRIVATESECT GDP EXCH_R INFL TARRIFS				
Model selection method: Akaike info criterion (AIC)				
Selected model: ARDL(1,0,1,1,1,0,0,1,0)				
Variables	Coefficient	Std. Error	t-Statistic	Prob.
LEXPORTS(-1)	0.174250	0.116266	1.498718	0.1723
LICT	1.082189	0.342348	3.161074	0.0134**
LHC	-1.393979	2.344757	-0.594509	0.5686
LHC(-1)	5.492890	2.029244	2.706866	0.0268**
LINSTITUTIONS	-2.431860	0.932292	-2.608474	0.0312**
LINSTITUTIONS(-1)	-0.756468	0.590315	-1.281466	0.2359
LPRIVATESECT	0.701549	0.622655	1.126705	0.2925
LPRIVATESECT(-1)	-1.393935	0.799108	-1.744365	0.1193
GDP	0.011089	0.008673	1.278608	0.2369
TARRIFS	0.036275	0.017384	2.086715	0.0704*
INFL	0.018526	0.007152	2.590316	0.0321**
EXCH_R	-0.198102	0.096183	-2.059638	0.0734*
EXCH_R(-1)	0.292542	0.106952	2.735248	0.0256**
C	5.598956	2.645828	2.116145	0.0672

Error Correction Test						
Variable	Coefficient		Std. Error		t-Statistic	Prob.
COINTEQ*	-0.825750		0.042548		-19.40760	0.0000***
D(LHC)	-1.393979		0.513295		-2.715749	0.0147**
D(LINSTITUTIONS)	-2.431860		0.268269		-9.065016	0.0000***
D(LPRIVATESECT)	0.701549		0.304324		2.305271	0.0340**
D(EXCH_R)	-0.198102		0.023015		-8.607377	0.0000***
Bounds Test						
Null hypothesis: No levels relationship						
Test Statistic	Value					
F-statistic	17.724942					
	10%		5%		1%	
Sample Size	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
30	-1.000	-1.000	-1.000	-1.000	-1.000	-1.000
Asymptotic	1.850	2.850	2.110	3.150	2.620	3.770

Note: * significant at 10% level, ** significant at 5% level and *** significant at 1% level.

Source: Authors' analysis.

Table 8: South Africa's ARDL short-run and long-run estimations

Dependent Variable: LEXPORTS				
Method: ARDL				
Automatic-lag linear regressors (1 max. lags): LICT LHC LINSTITUTIONS LPRIVATESECT				
GDP EXCH_R INFL TARRIFS				
Model selection method: Akaike info criterion (AIC)				
Selected model: ARDL(1,1,1,1,1,1,0,1,1)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LEXPORTS(-1)	-0.171898	0.554842	-0.309815	0.7692
LICT	-0.373697	1.125031	-0.332166	0.7532
LICT(-1)	0.863665	1.041208	0.829483	0.4446
LHC	1.995710	9.312787	0.214298	0.8388
LHC(-1)	-8.831214	8.684240	-1.016924	0.3558
LINSTITUTIONS	-5.776736	2.627844	-2.198279	0.0793*
LINSTITUTIONS(-1)	-5.054271	3.866821	-1.307087	0.2481
LPRIVATESECTOR	-0.291148	3.210304	-0.090692	0.9313
LPRIVATESECTOR(-1)	4.754227	4.233074	1.123115	0.3124
GDP	-0.052744	0.051044	-1.033318	0.3488
GDP(-1)	-0.065487	0.023133	-2.830873	0.0366**
EXCH_R	-0.087971	0.047679	-1.845072	0.1243
INFL	0.034235	0.037857	0.904307	0.4073
INFL(-1)	-0.076829	0.046801	-1.641621	0.1616
TARRIFS	0.061042	0.077712	0.785485	0.4677
TARRIFS(-1)	-0.231007	0.166329	-1.388854	0.2236
C	65.29742	23.36734	2.794388	0.0382

Error Correction Test						
Variable	Coefficient	Std. Error	t-Statistic	Prob.		
COINTEQ*	-1.171898	0.152184	-7.700527	0.0000***		
D(LINSTITUTIONS)	-5.776736	0.865771	-6.672358	0.0000***		
D(GDP)	-0.052744	0.011854	-4.449388	0.0006***		
D(INFL)	0.034235	0.009404	3.640406	0.0027***		
Bounds Test						
Null hypothesis: No levels relationship						
Test Statistic	Value					
F-statistic	2.117790					
	10%		5%		1%	
Sample Size	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
30	-1.000	-1.000	-1.000	-1.000	-1.000	-1.000
Asymptotic	1.850	2.850	2.110	3.150	2.620	3.770

Note: * significant at 10% level, ** significant at 5% level and *** significant at 1% level.

Source: Authors' analysis.

In Table 8 above, the results of South Africa (SA) show that both current and lagged ICT had a statistically insignificant relationship with SA's exports. This insignificant relationship between ICT and exports suggests that digitalisation adoption is not translated into export performance. This implies that either ICT adoption in export-related sectors is limited, or that ICT initiatives are not well-aligned with the needs of the export sector. This can be attributed to several factors, including the relatively low adoption of advanced ICT across different sectors, varying levels of infrastructure development and the influence of other more dominant economic factors (*Gono, Harindranath & Berna Özcan, 2016*). SA's exports are largely resource-based, such as mining and agriculture, which traditionally benefit less from digitalisation compared to the manufacturing or services sectors. Moreover, infrastructural and economic challenges in ICT adoption across industries may limit the export benefits of ICT, as the technology may not yet be sufficiently developed or applied to enhance resource-based exports. Additionally, challenges such as skills shortages, economic disparities and market saturation can contribute to the disconnect between ICT development and export performance (*Van Der Walt et al., 2016*).

Overall, key findings indicate that digitalisation serves as a crucial long-term catalyst for BRICS exports. However, its effects vary significantly across these prominent economies. Recognising these country-specific differences is essential for implementing effective strategies.

5. CONCLUSIONS AND POLICY IMPLICATIONS

This study examined the relationship between digitalisation and exports in BRICS countries from 2000 to 2022, using panel and country-specific ARDL models to capture both common and specific country dynamics between digitalisation and exports. This dual approach provided a comprehensive framework for understanding the varied effects of digitalisation on exports and offered insights for policymakers. The panel ARDL approach helped to identify primary patterns and shared characteristics within the BRICS bloc, allowing for broader policy implications at a regional level. Meanwhile, the country-specific ARDL approach provided a deeper understanding of country-level variations, informing tailored policy interventions.

Key findings indicated a mixed short-run impact of Information and Communication Technology (ICT) on exports across different model specifications. However, overall, in the long run, ICT consistently showed a statistically significant positive effect on export across BRICS countries. Importantly, the effect of digitalisation acting as a catalyst in these countries varies significantly by country, with empirical results showing the strongest gains in China. These findings underscore that while digital infrastructure is a vital component, maximising the trade benefits of digitalisation necessitates complementary policies focused on enhancing human capital and institutional quality. Despite existing challenges such as varying levels of digital maturity within the group, digitalisation broadly acts as a catalyst for BRICS exports by improving trade efficiency and facilitating digital trade. The country-specific results emphasise the necessity of tailored policy approaches. For instance, Brazil could prioritise investments in ICT infrastructure and institutional reforms, while China might focus on consolidating digital trade networks and managing exchange rate volatility. Based on the findings, key policy implications for BRICS countries include:

- Prioritising investment in and development of ICT infrastructure, enhancing internet connectivity and promoting ICT adoption in export-oriented sectors.
- Focusing on human capital development through improved digital literacy and aligning educational outcomes with the demands of the digital economy.
- Implementing targeted interventions to better align specific economic sectors with export growth strategies.
- Streamlining the regulatory environment to reduce trade barriers and enable businesses to leverage digital technologies effectively for export expansion.

By addressing these areas, BRICS countries can harness the full potential of digitalisation to enhance exports and contribute to sustained economic growth. The process of digitalisation presents a significant opportunity for enhancing export growth for BRICS. However, it is not a panacea. Our findings have provided direct, evidence-driven guidance for policymakers, emphasising the importance of investing in digital infrastructure alongside essential complementary elements such as skill development and institutional frameworks to effectively unlock export capabilities.

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Conflict of interest

The authors declare there is no conflict of interest.

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ДА ЛИ ЈЕ ДИГИТАЛИЗАЦИЈА КАТАЛИЗАТОР ИЗВОЗА ЗЕМАЉА БРИКС-А: ЕМПИРИЈСКА АНАЛИЗА

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САЖЕТАК

Дигитализација представља кључни катализатор трансформације међународне трговине кроз унапређење ефикасности, смањење трошкова, проширење приступа тржишту и отварањем нових могућности, чиме се значајно побољшава извозна ефикасност. Разумијевање ове међузависности од суштинског је значаја за земље чланице БРИКС-а – Бразил, Русију, Индију, Кину и Јужноафричку Републику – које имају важну улогу у глобалној трговини. Ово истраживање испитује однос између дигитализације и извоза у оквиру БРИКС-а, с посебним фокусом на то како информационе и комуникационе технологије (ИКТ) дјелују као катализатор извоза. Коришћењем комбинације панел модела и модела ауторегресивне дистрибуционе заостале структуре (АРДЛ) по земљама, методологија омогућава обухватан увид у хетерогеност међу земљама и у динамику краткорочних и дугорочних ефеката. Панел АРДЛ модел идентификује заједничке трендове у оквиру БРИКС-а, док модели по земљама издвајају специфичне националне ефекте, чиме се додатно оснажује анализа. Резултати показују да у кратком року ефекат ИКТ-а на извоз варира у зависности од коришћеног модела, док у дугом року ИКТ досљедно показује статистички значајан утицај. Налази указују на кључну улогу дигитализације у унапређењу извоза земаља БРИКС-а, нарочито дугорочно. Ипак, степен дјелотворности разликује се међу земљама. Разлике у дигиталној инфраструктури, дигиталној писмености и институционалном квалитету сугеришу да дигитализација сама по себи није довољна. Превазилажење ових изазова омогућило би земљама БРИКС-а да у потпуности искористе потенцијал дигитализације и ојачају своју позицију као значајни извозници у настајању. Ово истраживање доприноси дискурсу о дигиталној економији кроз емпиријски засноване препоруке за обликовање политика.

Кључне ријечи: дигитализација, извоз, БРИКС, глобална трговина, ИКТ, усвајање технологије, АРДЛ.