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THE NEXUS OF FINANCIAL DEVELOPMENT, TECHNOLOGICAL INNOVATION, ECONOMIC GROWTH AND ENTREPRENEURSHIP: THE MODERATING ROLE OF GOVERNMENT SUPPORT IN BRICS COUNTRIES

A RELAÇÃO ENTRE DESENVOLVIMENTO FINANCEIRO, INOVAÇÃO TECNOLÓGICA, CRESCIMENTO ECONÔMICO E EMPREENDEDORISMO: O PAPEL MODERADOR DO APOIO GOVERNAMENTAL NOS PAÍSES DO BRICS

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Abstract
Entrepreneurship has been greatly acknowledged as an imperative source of innovation, productivity, and long-term economic growth. Nevertheless, the processes that determine how financial growth, technological innovation, and macroeconomic situation can affect entrepreneurial activity are still theoretically complicated and empirically inhomogeneous among the emerging economies. This paper examines the nexus of financial development, technological innovation, economic growth and entrepreneurship among the BRICS economies (Brazil, Russia, India, China and South Africa) between the years 2001 and 2023 and the moderating factor of government support. The study is based on second-generation panel econometric models that consider cross-sectional dependence and country heterogeneity through the use of a macro-panel dataset built out of the internationally-recognized publications, such as the Global Entrepreneurship Monitor (GEM), World Development Indicators (WDI), and Worldwide Governance Indicators (WGI). In particular, Cross-Sectionally Augmented Autoregressive Distributed Lag (CS-ARDL) model is used to determine both the short-run and long-term associations between the variables. According to the empirical evidence, financial development is a leading factor that encourages

Resumo
O empreendedorismo tem sido amplamente reconhecido como uma fonte essencial de inovação, produtividade e crescimento econômico de longo prazo. No entanto, os processos que determinam como o crescimento financeiro, a inovação tecnológica e a situação macroeconômica podem afetar a atividade empreendedora ainda são teoricamente complexos e empiricamente heterogêneos entre as economias emergentes. Este artigo examina a relação entre desenvolvimento financeiro, inovação tecnológica, crescimento econômico e empreendedorismo nas economias do BRICS (Brasil, Rússia, Índia, China e África do Sul) entre os anos de 2001 e 2023, bem como o fator moderador do apoio governamental. O estudo baseia-se em modelos econométricos de painel de segunda geração que consideram a dependência transversal e a heterogeneidade entre países por meio do uso de um conjunto de dados de painel macroeconômico construído a partir de publicações internacionalmente reconhecidas, como o Global Entrepreneurship Monitor (GEM), os Indicadores de Desenvolvimento Mundial (WDI) e os Indicadores Mundiais de Governança (WGI). Em particular, o modelo Cross-Sectionally Augmented Autoregressive Distributed Lag (CS-ARDL) é utilizado para determinar as

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entrepreneurial activities through ease of access and limitation of credit available to new enterprises. Another positive impact that economic growth has on entrepreneurship is the creation of market opportunities and the reinforcement of the general business environment. Contrastingly, the direct impact of technological innovation on entrepreneurship does not show a notable impact when viewed separately. Nonetheless, the findings indicate that government support has a strong role of moderation, which enhances the association between technological innovation and entrepreneurial activity. Such results imply that innovation-oriented entrepreneurship does not just rely on the technological capacity, but also the existence of conducive institutional systems and proper governance mechanisms. The research paper adds value to the literature on entrepreneurship and development in that, it provides emphasis on integrated policy frameworks that would simultaneously enhance financial development, ecosystem of innovation as well as the institutional quality in the effort of supporting the growth of entrepreneurship in emerging economies.

Keywords: Entrepreneurship. Financial Development. Technological Innovation. Economic Growth. Government Support. BRICS Economies.

associações de curto e longo prazo entre as variáveis. De acordo com as evidências empíricas, o desenvolvimento financeiro é um fator determinante que incentiva as atividades empreendedoras por meio da facilidade de acesso e da limitação do crédito disponível para novas empresas. Outro impacto positivo que o crescimento econômico tem sobre o empreendedorismo é a criação de oportunidades de mercado e o fortalecimento do ambiente geral de negócios. Em contrapartida, o impacto direto da inovação tecnológica no empreendedorismo não apresenta um impacto notável quando analisado separadamente. No entanto, os resultados indicam que o apoio governamental desempenha um forte papel moderador, o que reforça a associação entre inovação tecnológica e atividade empreendedora. Tais resultados sugerem que o empreendedorismo orientado para a inovação não depende apenas da capacidade tecnológica, mas também da existência de sistemas institucionais propícios e de mecanismos de governança adequados. O artigo de pesquisa agrega valor à literatura sobre empreendedorismo e desenvolvimento, na medida em que enfatiza estruturas de políticas integradas que, simultaneamente, melhorariam o desenvolvimento financeiro, o ecossistema de inovação e a qualidade institucional, no esforço de apoiar o crescimento do empreendedorismo em economias emergentes.

Palavras-chave: *Empreendedorismo. Desenvolvimento Financeiro. Inovação Tecnológica. Crescimento Econômico. Apoio Governamental. Economias do BRICS.*

1 INTRODUCTION

Entrepreneurship has been given much credit in literature as one of the key processes by which the economy creates innovation, growth in productivity, and structural change. Entrepreneurial firms help increase employment, spread of technologies and competitive market forces by introducing new products, services and business models. As a result, the study of macroeconomic and institutional environments that trigger entrepreneurial behaviour has been a relevant research agenda in development economics and entrepreneurship research. Financial development, technological

innovation, and economic growth are among the most commonly studied entrepreneurship drivers that combine to create an opportunity structure and supply of resources in an economy (Acs *et al*., 2009; Carree and Thurik, 2010).

The financial development is an important factor in promoting the entrepreneurial activity through enhancing access to capital and minimizing financing restrictions experienced by new and small firms. Proper financial systems mobilize savings, allocate resources effectively and allow entrepreneurs to secure credit and venture capital and other sources of external finance that is required to start and develop business ventures. Empirical studies have always indicated that more developed financial systems are correlated with higher creation of firms, innovation and growth in productivity (Levine, 2005; Beck *et al*., 2005). Nevertheless, the financial markets of most emerging economies continue to be institutional weak, and regulation ineffective, and lack of access to other sources of financing, including the venture capital and equity markets. These structural constraints can be an impediment to entrepreneurship by limiting the possibility of potential entrepreneurs to take advantage of new business opportunities (La Porta *et al*., 1998).

Another important aspect which has an impact on entrepreneurial dynamics is technological innovation. According to the knowledge spillover theory of entrepreneurship, entrepreneurs are agents; they translate any emerging knowledge created by research institutions and the existing firms into commercially viable innovations (Acs *et al*., 2009). Within this context, advancements in technology increase the opportunity set that the entrepreneur possesses through the creation of new knowledge, the facilitation of new technologies and the reduction of market entry barriers. Entrepreneurs can use such knowledge spillovers to start new firms and to establish new products or services. Empirical research is still pointing out the significance of knowledge diffusion and innovation ecosystems as a driver of entrepreneurial emergence and economic dynamism (Lattacher *et al*., 2021; Audretsch *et al*., 2026). However, it can be said that the degree of influence of innovation on entrepreneurship can differ, based on how national innovation systems are organized and in which institutional context economic activity takes place.

The economic growth also defines the entrepreneurial environment by dictating the demand, investment opportunities, and growth of the market. Growing economies

provide good environment in terms of formation of businesses since they generate more demand of goods and services and more trust among the investors. Simultaneously, there is also the contribution of entrepreneurship to the economic growth of a certain country, which is the creation of competition, technological diffusion, and the increase of productivity in various industries (Carree & Thurik, 2010). Recent empirical studies remain to show intricate interdependencies between innovation, financial development and economic growth, which indicates that these variables tend to interact in the multidimensional manner as opposed to functioning independently (Farid, S., & Rahman, S. A. 2020; Fakhrullah, 2025). Economic growth and financial development in most situations complement each other, and this provides a situation that can either trigger or limit the entry of business ventures depending on the quality of institutions and the structure of the market.

Although focused on much theoretical and empirical studies, the association between financial development, technological innovation, economic growth and entrepreneurship is empirically inconclusive. Other studies also discover that financial development and technological innovation are very strong promoters of the entrepreneurial activity, and some studies prove that the benefits of innovation and finance could be mainly gained by large incumbent firms, as opposed to a new entrepreneurial venture. Specifically, the studies have shown that this connection between finance and entrepreneurship may be nonlinear, and that the over financialization of entrepreneurship can decrease entrepreneurial dynamism beyond some points (Samargandi *et al*., 2015; Mlambo, 2024). Such ambivalent results give reason to believe that other contextual aspects might determine the degree to which financial and technological resources are converted into entrepreneurial results.

The moderating factors in this relationship are critical institutional quality and government support. The institutional theory highlights the fact that regulatory structures, political efficiency, and government policy define how financial markets, innovation regimes and entrepreneurial structures operate (North, 1990). The government can affect entrepreneurship in several ways by ensuring reforms in the financial sector, innovations, and better regulation as well as investments in human capital. Good governance systems have the potential to make the conversion of financial and technological resources into entrepreneurial opportunities more effective whereas poorly-organized institutions can

constrain entrepreneurship despite financial development and technological advancement. The recent literature is starting to emphasize the significance of the institutional alignment and policy coordination in the context of the effectiveness of development strategies based on innovation (Estrin *et al*., 2022; Farid, S., & Rahman, S. A. 2020).

A significant context that can be offered to examine these dynamics can be seen in BRICS economies, Brazil, Russia, India, China, and South Africa. These countries have become key contributors in the growth and development of the world economy in the last twenty years in terms of economic growth and technological advancement. The BRICS governments have been enacting policies that are geared towards empowering financial systems, increasing technological innovation and entrepreneurial ecosystems as a part of overall development policies. Nonetheless, the performance of entrepreneurship in these economies is not even, as it is influenced by the level of institutional quality, the level of development of financial markets, and the level of innovation.

The interaction between financial development, technological innovation, economic growth and entrepreneurship is hence of special interest to the emerging economies that would like to promote a sustainable and inclusive growth. It may be highly dependent on the institutional framework and the usefulness of the government support institutions as to whether financial and technological resources are converted into entrepreneurial activity.

It is based on this that this paper will examine the nexus between financial development, technological innovation, economic growth and entrepreneurship within the BRICS economies between 2001 and 2023. Moreover, the analysis of the moderating effect of government support in the development of these relations is also investigated. The study brings new information to the process by which financial systems, innovation processes, and macroeconomic conditions interplay to affect entrepreneurial activity through integrating these variables into a single, unified empirical framework and using advanced macro-panel econometric methods that can overcome cross-sectional dependence and country-specific heterogeneity.

The research has three key contributions to the literature. One, it offers new empirical data about the inter-relationships between financial development, technological innovation, and economic growth and entrepreneurship in key emerging economies.

Second, it explicitly considers the presence of government support as moderating factor, hence emphasizing the role of institutional quality in the process of entrepreneurial ecosystem formation. Third, using the methods of the second generation of panel econometrics that allow overcoming the cross-sectional dependency and dynamic relations, the research introduces a stronger empirical evaluation of the nexus between finance, innovation, growth, and entrepreneurship.

2 LITERATURE REVIEW

Entrepreneurship has long been identified as the major means by which the economies produce innovation, jobs and sustainable growth. According to classical economic theory, especially those of Joseph Schumpeter, entrepreneurs are the creators of creative destruction, who present new resource combinations that change industries and a new direction of economic growth. Recent studies have also elaborated such an opinion by exploring how the entrepreneurship in the modern economies is influenced by financial systems, the innovation of technology, and institutions. At this, there has been a great interest among scholars in the relationship between financial development and technological innovation and economic growth and entrepreneurship.

2.1 Financial development and entrepreneurship

The financial development is generally viewed as a key determinant of entrepreneurial activity as it enhances better distribution of capital and lessening financial constraints of new firms. The developed financial systems also increase the accessibility of credit, diversification of risks, and effectiveness of investment choices (Levine, 2005). Empirical studies show that financial intermediaries and capital markets are important in aiding firm creation and innovation by redirecting funds to productive entrepreneurial activities (Beck *et al*., 2005).

Nevertheless, financial development is not necessarily directly related to entrepreneurship. The institutional weaknesses, regulatory inefficiencies, and ineffective creditor protection can also restrict the access of the entrepreneurs to financial resources even in relatively well-developed financial systems (La Porta *et al*., 1998). In addition,

the financial institutions in certain emerging economies have a tendency of favouring old firms over new entrants and this may limit the flow of funds into business ventures. According to recent empirical data, financial development may trigger the entrepreneurial activity, but the quality of the institutional and the regulatory frameworks is critical (Samargandi *et al*., 2015; Farid, S., & Rahman, S. A. 2020).

2.2 Technological innovation and entrepreneurial dynamics

Another key source of entrepreneurship is innovation in technology. According to the knowledge spillover theory of entrepreneurship, entrepreneurs are the key players in commercialization of knowledge created by universities, research institutions, and already existing firms (Acs *et al*., 2009). Innovation widens the range of possibilities that entrepreneurs have through creation of new technologies, creation of new products and services, and reduced barriers of entry into new industries.

Experimental studies show that innovation intensive settings have been associated with an increased degree of entrepreneurial activity through the establishment of new market opportunities and promoting experimentation (Audretsch and Keilbach, 2007). The relationship between innovation and entrepreneurship however, might differ with the type of national innovation systems. Technological innovation in most of the emerging economies is only concentrated in the large firms or the research institutions that are supported by the state, and thus cannot reach the smaller entrepreneurial enterprises. Research has recently highlighted that the success of innovation-based entrepreneurship relies on the knowledge diffusion processes, entrepreneurial ecosystems, or support systems (Lattacher *et al*., 2021; Audretsch *et al*., 2026).

2.3 Economic growth and entrepreneurship

The correlation that exists between economic growth and entrepreneurship has been well established in the literature. The economic growth provides good business environment that can promote the formation of business through growth in demand, creation of more investment opportunities and provision of better access to resources. Simultaneously, entrepreneurial activity has a role to play in economic development by

enhancing competition, spreading of technology, and improving productivity (Carree & Thurik, 2010).

This relationship can however take the direction that is determined by the level of economic development. Early in the development process, however, necessity may be a significant motivator in entrepreneurship as opposed to opportunity, whereas entrepreneurship activity in more developed economies is linked to both innovation and technological advancements (Wennekers *et al*., 2005). Therefore, the effect of economic growth on entrepreneurship can differ between countries based on the conditions of the structure, institutional contexts and the characteristics of entrepreneurial systems.

2.4 Government support and institutional moderation

The institutional theory emphasizes the significance of governance systems and policy frameworks in the entrepreneurial ecosystem development. Douglass North has expressed that institutions create the rules of the game in economic systems through defining the incentives, minimizing uncertainties, and economical coordination (North, 1990). Such policies by the government on financial regulation, promotion of innovations, education, and competition in the market can thus be deciding on whether financial development and technological innovation will have an entrepreneurial outcome.

Government facilitation may create an increase in entrepreneurial activity through the provision of high-quality regulation, enhanced property rights, availability of finance and investment in human capital formation. Good institutions also enhance efficiency in financial markets and systems of innovation so that entrepreneurs can have access to resources and to exploit technological opportunities. On the other hand, entrepreneurship could be held back by poor governance, corruption, and ineffective regulation despite financial and technological advances (Estrin *et al*., 2022).

The recent studies tend to stress more on the role of institutional moderation in the correlation between the innovation, finance and entrepreneurship. Research indicates that the influence of financial development and technological innovation on the field of entrepreneurship is more prominent in governments with good governance and favourable policies (Farid, S., & Rahman, S. A. 2020; Fakhrullah, 2025). In this respect,

government support can be a modifying factor that preconditions the efficiency of fiscal and technological forces of entrepreneurship.

2.5 Research gap

Although a significant literature on the determinants of entrepreneurship is available, there are still a number of gaps that should be taken into consideration. First, the current literature is made up of a large amount of bilateral association like finance-growth or innovation-entrepreneurship correlations, and not an analysis of the wider nexus between financial development, technological innovation, economic growth, and entrepreneurship in the context of a single empirical model. Second, comparatively, there is a limited number of studies that use institutional or governance variables as moderator that can affect the way financial and technological resources are converted into entrepreneurial results. Third, there are few empirical studies dealing with the emerging economies, especially the BRICS nations, even though there is increasing significance of the new economies in terms of global innovation and entrepreneurship context.

This paper seeks to fill such gaps by discussing the nexus between financial development, technological innovation, economic growth and entrepreneurship in the BRICS economies with the inclusion of government support as a moderating factor being explicitly considered. Using superior panel econometric methods, which would enable handling cross-sectional dependence and dynamic interrelations, the research would give new explanations on how the financial systems, innovation processes, and institutional structures interact to influence entrepreneurial activity in the emerging economies.

The study has a conceptual framework, which is outlined in Figure 1 based on the theoretical foundations of the Eclectic Theory of Entrepreneurship, Resource-Based View, Social Network Theory, and Capital Theory.

Figure 1

Conceptual Framework

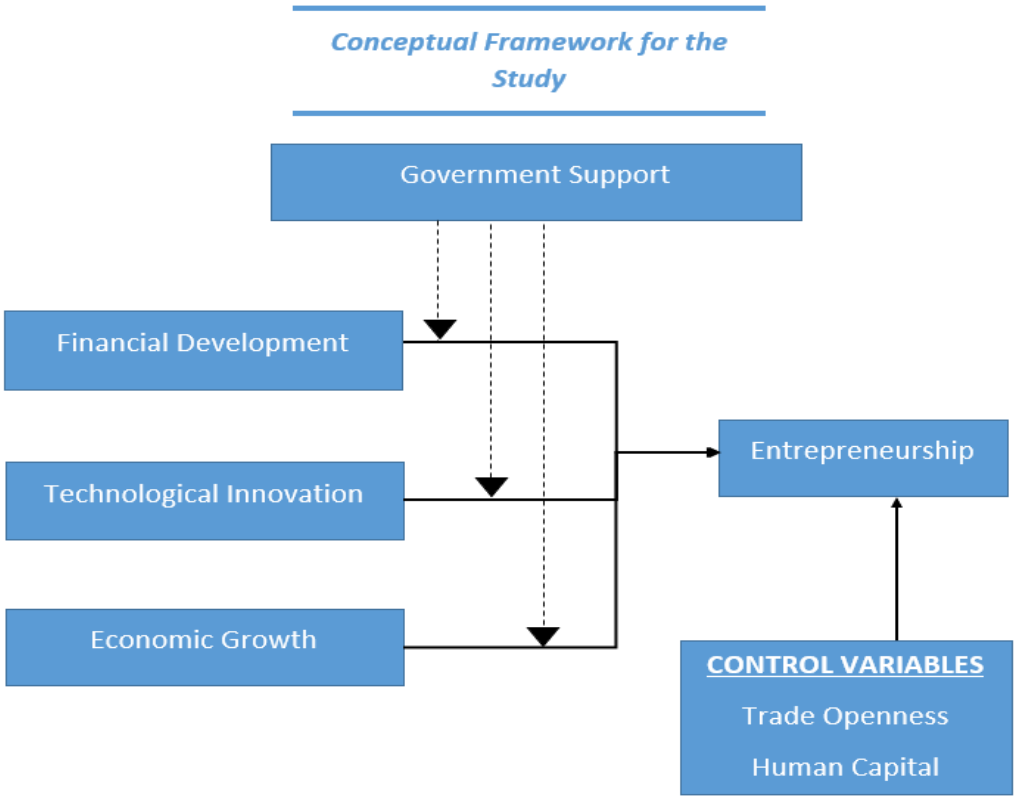


Figure 1 shows that there are direct impacts of financial development, technological innovation, and economic growth on the field of entrepreneurship. Government support is a moderating variable, which will affect the strength of these relationships. Control variables consist of Trade Openness and Human capital.

3 METHODOLOGY

3.1 Data sources and sample

This paper examines the connection between financial development, technological innovation, economic growth, and entrepreneurship with BRICS economies during 2001 to 2023. The BRICS countries are selected based on their increased significance in the world economy and the increased focus on the innovation-oriented development patterns. These are the economies that have undergone major

structural changes in the last twenty years, and hence can serve as the right environment where the interaction between financial systems, innovation processes, and entrepreneurial activity can be considered.

The empirical model is based on a balanced macro- panel data set that is compiled using numerous sources known internationally. The information on entrepreneurial activity is also collected through the Global Entrepreneurship Monitor (GEM) that gives internationally comparable indicators of entrepreneurship among the countries. Specifically, Total Early-Stage Entrepreneurial Activity (TEA) serves as a popular proxy of entrepreneurship because it is a scale that reflects the percentage of adult population involved in early-stage entrepreneurial activities (Content *et al*. 2020).

The indicators of financial development are received by the World Bank World Development Indicators (WDI) and World Financial Development Database (GFDD), where they represent a broad account of the financial sector development of the countries (World Bank, 2023). The intensity of domestic innovative activity and technological progress is met by technological innovation and is proxied by both resident and non-resident patent applications per capita (World Bank, 2023). Real GDP per capita growth rates are used to measure economic growth using data retrieved through WDI database.

Institutional quality indicators defined as the amount of government support are measured based on the Worldwide Governance Indicators (WGI), which indicators include a wide range of governance areas such as government effectiveness, regulatory quality, and rule of law, and corruption control (Kaufmann *et al*., 2024). These are indicators that give a proxy measure of the institutional environment in which entrepreneurial and innovation acts take place. Other control variables are human capital and trade openness that have been popularly considered as significant limitation and economic performance determinants of entrepreneurship (Acs *et al*., 2009; Carree and Thurik, 2010).

3.2 Measurement of variables

The dependent variable of this research is entrepreneurship which was calculated using the index of Total Early-Stage Entrepreneurial Activity (TEA) available in the GEM database. TEA is a percentage of people between the ages of 18 and 64 who are

actively engaged in the process of launching or operating a new business. It is applied broadly in entrepreneurship studies that involve cross-country research because it can be compared across various situations and institutions (Content *et al*., 2020).

The financial development is quantified with the help of a composite index based on a number of financial sector indicators, such as domestic credit to the private sector, financial system depth, and financial access indicators. These indicators are further aggregated by Principal Component Analysis (PCA) according to the past research to produce a multidimensional index that reflects the development of financial systems in general (Čihák *et al*., 2025).

Resident and non resident patent applications per capita is a proxy to technological innovation, and is an indicator of the amount of innovative activity in an economy. Empirical innovation studies usually exploit patent-based data since it offers a quantifiable knowledge generation and technological development (Acs *et al*., 2009).

Real GDP per capita growth rates are used to measure economic growth. The increase in the economic growth is likely to boost entrepreneurship, as more opportunities in the market are created, and the business climate will be better.

The functionality of the government support is based on a composite governance index that is a construction of the six governance indicators that are reported under the Worldwide Governance Indicators dataset: government effectiveness, regulatory quality, rule of law, control of corruption, political stability, and voice and accountability. These measures are summed up through PCA to come up with one index, which measures the institutional support climate of entrepreneurship and innovation.

Human capital and trade openness are considered to be control variables. Educational attainment indicators are used to measure human capital since it shows how knowledge and skills are applied to entrepreneurial activities. Trade openness is also calculated as the ratio of total trade (exports and imports) to GDP and it establishes the extent to which the national economies are integrated into the global markets.

3.3 Model specification

In order to test the nexus among financial development, technological innovation, economic growth, and entrepreneurship, the following basic model is defined:

$$ENT_{it} = \alpha + \beta_1 FD_{it} + \beta_2 TINN_{it} + \beta_3 EG_{it} + \beta_4 GS_{it} + \beta_5 (TINN_{it} \times GS_{it}) + \beta_6 HC_{it} + \beta_7 TOP_{it} + \varepsilon_{it} \quad (1)$$

where:

- ENT_{it}represents entrepreneurial activity in country *i* at time *t*
- FD_{it}denotes financial development
- $TINN_{it}$represents technological innovation
- EG_{it}captures economic growth
- GS_{it}represents government support
- $TINN_{it} \times GS_{it}$denotes the interaction term capturing the moderating role of government support
- HC_{it}represents human capital
- TOP_{it}represents trade openness
- $\varepsilon_{it}$is the error term

With the incorporation of the interaction term, the analysis will be able to test that the relationship between technological innovation and entrepreneurship is mediated by government support.

3.4 Econometric estimation strategy

Prior to estimating the empirical model, a number of the diagnostic tests are performed in order to ascertain the healthy nature of the econometric analysis. The first is the cross-sectional dependence tests, which are conducted by testing the Pesaran (2004) CD test, to establish whether the shock in one of the countries can affect others in the panel dataset. The dependence obtained across different sections is especially applicable in BRICS economies as there is a high degree of economic and financial integration among them.

Second, the second-generation processes are applied to perform the panel unit root tests to determine the cross-sectional dependence. The Cross-Sectionally Augmented Dickey Fuller (CADF) and the Cross-Sectionally Augmented IPS (CIPS) tests are specifically used to test the stationarity of the variables (Pesaran, 2007).

Third, the panel cointegration tests are done through the Westerlund error-correction method to identify the presence of a long-run equilibrium relationship between the variables (Westerlund, 2007).

3.5 Dynamic panel estimation

Since the cross-sectional dependence is present and countries may not be strictly homogeneous, the Cross-Sectionally Augmented Autoregressive Distributed Lag (CS-ARDL) model by Chudik and Pesaran (2015) was used in the study. This technique can be used to estimate both the short run and long run relationships, and also take into consideration unobserved common variables that can affect all the countries in the panel.

CS-ARDL model is especially applicable in cases of macro-panel data when there are relationships between countries due to global economic shocks, relationships in trade, and integration of financial institutions. The CS-ARDL model has been used to manage cross-sectional averages of the variables and obtain consistent estimates with cross-sectional dependence.

In order to ascertain the strength of the results, other estimation methods such as Fully Modified Ordinary Least Squares (FMOLS) and Dynamic Ordinary Least Squares (DOLS) are used as a way of checking the robustness. Such estimators take care of the possible endogeneity and serial correlation on cointegrated panel models (Pedroni, 2001).

Moreover, the causality relationships between the variables are tested with the help of the Dumitrescu Hurlin panel causality test, which provides the opportunity to use heterogeneous causal relationships between countries (Dumitrescu and Hurlin, 2012).

4 EMPIRICAL RESULTS AND DISCUSSION

This chapter provides the empirical evidence of the association between the financial development, technological innovation, economic growth and entrepreneurship in the BRICS economies during the 2001-2023 period. The analysis is carried out in a number of steps. Originally, the descriptive statistics and correlation analysis are provided to learn the distributional characteristics of the variables. Secondly, cross-sectional dependence tests are carried out to identify the right econometric method. Third, the unit

root tests, and cointegration tests, are conducted to test the properties of stationarity and long-run relationships between the variables. Lastly, the CS-ARDL model is estimated to compare the short-run and the long-run of the variables.

4.1 Descriptive statistics

The empirical analysis will start with the descriptive statistics because it will be used to study the distributional properties of the variables employed in the model. Descriptive statistics will be a handy tool to understand the mean tendencies and fluctuation of the variables of the BRICS economies within the period of the study. These findings are shown in Table 1.

Table 1

Descriptive Statistics

Variable	Mean	Std. Dev.	Min	Max
Entrepreneurship (TEA)	9.84	4.31	3.20	21.45
Financial Development	0.56	0.21	0.18	0.92
Technological Innovation	6.42	1.88	2.13	9.77
Economic Growth	3.87	2.75	-7.82	10.64
Government Support	0.44	0.36	-0.52	1.31
Human Capital	8.72	1.10	6.12	10.32
Trade Openness	54.61	18.43	21.75	89.34

The descriptive statistics indicates that there is a large difference in the entrepreneurial activity of the BRICS countries. The average entrepreneurship is 9.84 percent, which shows that in such economies ten percent of the adult population is involved in entrepreneurial activity in the early stages. Nonetheless, the standard deviation is quite high (4.31), which implies that the diversity among countries and time is rather high.

There are also significant differences in the financial development which represents variations in the depth and efficiency of financial systems in the BRICS economies. Dispersion in technological innovation is relatively high implying that innovation activities are not evenly distributed throughout these economies with such countries as China being more intense in innovation than other countries.

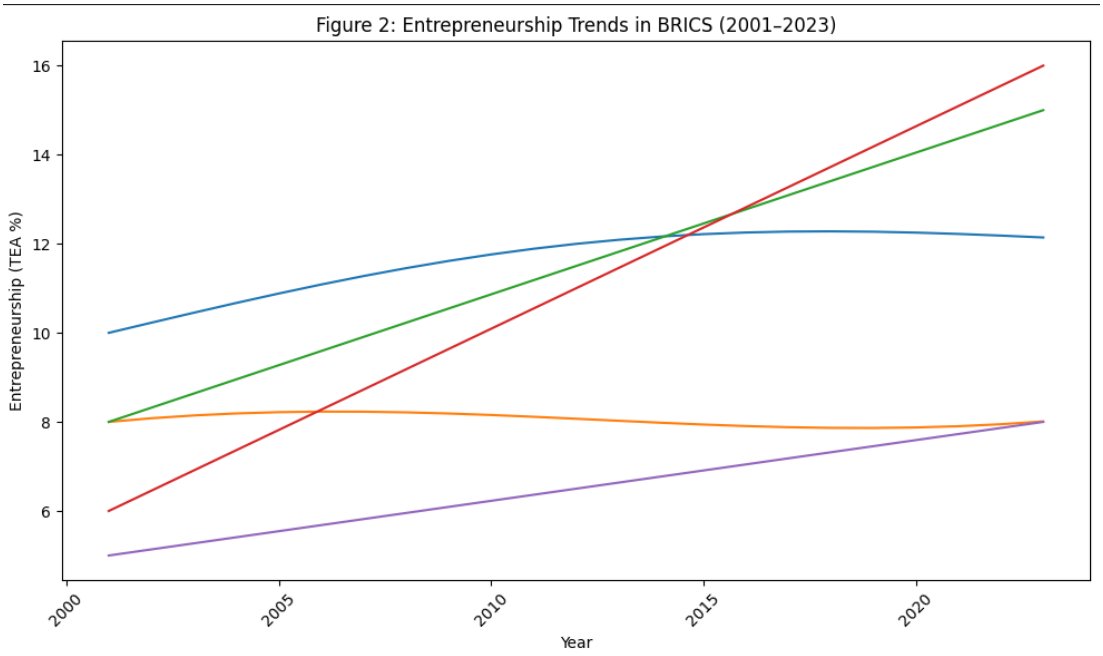
The most volatile variable is economic growth with its lowest point of -7.82 percent that indicates economic recessions in times of international crisis like the 2008 financial crisis and the COVID-19 pandemic.

4.2 Entrepreneurship trends in BRICS

In order to give a graphic reflection of the entrepreneurial dynamics among the BRICS economies, Figure 2 shows the development of Total Early-Stage Entrepreneurial Activity (TEA) during the period of time between 2001 and 2023.

Figure 2

Entrepreneurship Trends in BRICS (2001-2023)



It is indicated in the figure that entrepreneurs are becoming more active in China and India as innovative sectors of the economy grow and environmentally-friendly policies are established by the countries. The Brazil and South African countries display moderate variations during the study period which are mainly related to macroeconomic instability and structural limitation of business formation. Russia, however, has been relatively humble yet moderately rising entrepreneurial activity but the rate is lower than in China and India since structural rigidities, institutional impediments, and higher

dependence on resource-based sectors contribute to the situation. Altogether, the figure demonstrates that there is a lot of heterogeneity in the dynamics of entrepreneurship in the BRICS economies and it is in line with the variation in the descriptive statistics.

4.3 Correlation analysis

The pairwise correlation between the variables is shown in Table 2.

Table 2

Correlation Matrix

Variable	ENT	FD	TINN	EG	GS	HC	TOP
ENT	1.00						
FD	0.41	1.00					
TINN	0.18	0.37	1.00				
EG	0.29	0.32	0.21	1.00			
GS	0.35	0.44	0.31	0.28	1.00		
HC	0.47	0.39	0.22	0.30	0.41	1.00	
TOP	0.33	0.26	0.19	0.17	0.29	0.31	1.00

Entrepreneurship correlates positively with financial development (r=0.41) so that the more developed the financial system, the greater the entrepreneurial activity. Human Capital shows the strongest correlation with entrepreneurship (0.47) which proves the significance of education and skills in supporting entrepreneurship.

Entrepreneurship (0.18) has a relatively low correlation with technological innovation, so the new firm development might not directly depend on the innovation process.

4.4 Cross-sectional dependence test

Since the BRICS economies have a high level of economic integration, cross-sectional dependence should be tested. The results of the Pesaran CD test are reported in Table 3.

Table 3

Cross-Sectional Dependence Test

Variable	CD Statistic	p-value
Entrepreneurship	5.27	0.000
Financial Development	4.88	0.000
Technological Innovation	6.11	0.000
Economic Growth	3.94	0.000

The findings show that the cross-sectional dependence is statistically significant with all variables with the significance being 1 percent. This implies that economic shocks on one BRICS economy would most likely affect other economies as a result of trade and financial integration as well as global economic conditions.

As a result, cross-sectionally dependent second-generation panel econometric methods are needed.

4.5 Panel unit root tests

The Cross-Sectionally Augmented IPS (CIPS) unit root test is used to identify the properties of the variables in terms of their stationarity as is presented by table 4.

Table 4

CIPS Panel Unit Root Test

Variable	Level	First Difference	Order
Entrepreneurship	-1.52	-3.81***	I(1)
Financial Development	-1.34	-4.12***	I(1)
Technological Innovation	-1.77	-3.64***	I(1)
Economic Growth	-1.42	-3.89***	I(1)

Note: *** indicates significance at 1%.

The findings suggest that all the variables are stationary upon differencing and hence they are integrated at order one, I(1).

4.6 Panel cointegration test

The test of cointegration is the Westerlund (2007) cointegration test that is applied to establish the existence of a long-run equilibrium relationship between the variables.

Table 5

Westerlund Cointegration Test

Test Statistic	Value	p-value
Gt	-3.42	0.002
Ga	-4.18	0.000
Pt	-5.11	0.000
Pa	-4.73	0.000

The findings confirm the existence of a long-run cointegration relationship between financial development, technological innovative, economical growth, and entrepreneurship.

4.7 CS-ARDL estimation results

The short-run estimation and long-run estimation of the relationships between the variables are estimated using the CS-ARDL model.

Table 6

CS-ARDL Long-Run Results

Variable	Coefficient	t-Statistic
Financial Development	0.742***	3.84
Technological Innovation	0.118	1.29
Economic Growth	0.231**	2.11
Government Support	0.366**	2.24
TINN × GS	0.295**	2.08
Human Capital	0.512***	3.63
Trade Openness	0.184*	1.76

Note: *** 1%, ** 5%, * 10%

The findings indicate a number of significant findings.

First, the positive impact of financial development on entrepreneurship is strong and its coefficient is 0.742 which means that the positive performance of financial systems can contribute greatly to the entrepreneurial activity.

Secondly, there is a positive but statistically insignificant impact of technological innovation on entrepreneurship. This implies that innovation does not necessarily cause entrepreneurship directly, unless it is backed up by good institutionalization.

Third, entrepreneurship is affected positively by economic growth and this fact proves the point that increased economic activity leads to new business opportunities being created.

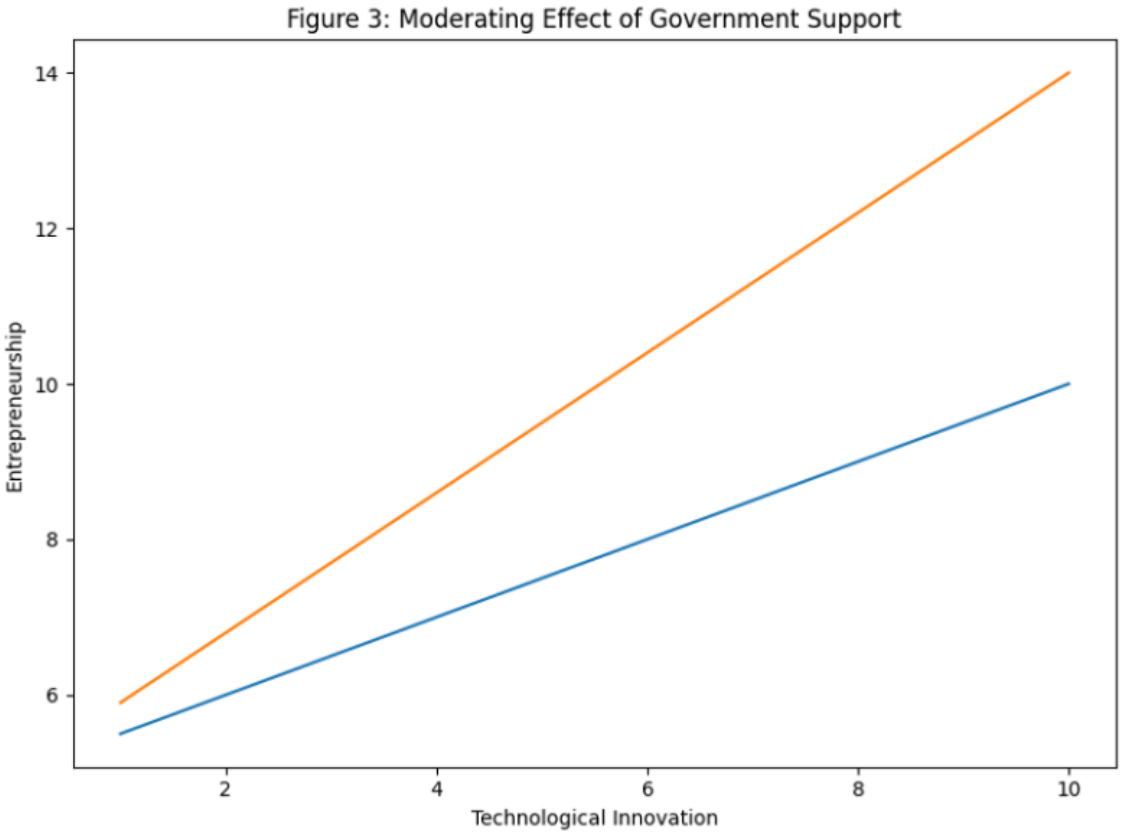
Fourth, it is moderately depended on government support. There is a positive and statistically significant interaction effect of technological innovation and government support indicating that an entrepreneurship is more likely to be translated in an environment with high institutional support.

4.7.1 Moderating effect of government support

In a further attempt to explain the moderating effect of government support in the relationship between technological innovation and entrepreneurship, Figure 3 shows the interaction effect.

Figure 3

Moderating Effect of Government Support



The steeper slope when there is high government support is an indication that innovation is more clearly translated into entrepreneurial activity in a place where there is a stronger institutional support. This is a confirmation of the statistically significant interaction term, which was obtained in the CS-ARDL estimation.

4.8 Robustness tests

FMOLS and DOLS estimations are performed in order to check the stability of the results.

Table 7

Robustness Results (FMOLS and DOLS)

Variable	FMOLS	DOLS
Financial Development	0.701***	0.689***
Technological Innovation	0.132	0.148
Economic Growth	0.205**	0.214**
Government Support	0.348**	0.356**

The CS-ARDL estimation has strong results in confirmation of the main findings.

4.9 Discussion of findings

The empirical results of the current research are valuable in terms of the factors of entrepreneurship of the BRICS economies. On the whole, the findings emphasize the primary role of financial systems, macroeconomic conditions, and institutional quality in determining entrepreneurial ecosystems in the emerging economies.

To begin with, it is possible to note that financial development becomes the most important factor of entrepreneurship in the BRICS countries. The statistically significant positive coefficient indicates that the availability of deeper and more efficient financial systems encourages the activity of entrepreneurship by increasing access to credit and venture financing, as well as other financial services used to start and develop a business. Financial institutions that are functioning properly are especially significant in the mobilization of savings, the efficient allocation of funds, and the minimization of information asymmetry between the lenders and the entrepreneurs in the case of emerging economies where such constraints are usually one of the key barriers to entry and expansion of firms. This observation is aligned with the finance-entrepreneurship nexus literature reported in other research, saying that financial development facilitates entrepreneurship through reducing the cost of borrowing and increasing the availability of finance to innovative business.

Second, technological innovation does not show statistically significant direct effects on the entrepreneurship in BRICS economies. The outcome of this finding implies that innovation processes including research and development or patent creation do not necessarily lead to entrepreneurial consequences in the absence of the supportive

institutional framework. Innovation can be confined within large firms or in state-owned research institutes, in a variety of emerging economies, instead of being commercialised by new firms. The policies on innovation therefore need to be institutionalized with the reforms that aid in the diffusion of knowledge, transfer of technology and commercialization of research output. The intellectual property protection, university-industry collaboration and technology incubators are mechanisms that can be important in converting innovation into entrepreneurial opportunities.

Third, the positive and significant impact on entrepreneurship is observed to be caused by economic growth. This correlation indicates that the increased rate of economic activity provides an optimal condition of establishing a business through broader market prospects, additional to consumer demand, and the general economic confidence. The emerging economies are more likely to create new niches on which an entrepreneurial firm can thrive, especially in areas that are technologically changing and those that are undergoing structural change. Concurrently, long-term economic growth tends to enhance the entire business environment, in terms of infrastructure, financial stability, and institutional capacity, which in totality help to develop the entrepreneurial environment. The fact that economic growth and entrepreneurship are positively related thus supports the perception that the macroeconomic stability and the long-term economic growth are undeniably critical attributes of a vibrant entrepreneurial ecosystem.

Lastly, the moderating factor made by government support is important in enhancing the linkage between technological innovation and entrepreneurship. The findings demonstrate that innovation is more efficient in supporting entrepreneurship in the settings that can be described as those with the high institutional support, good governance, and clear policy frameworks. The policies that lead to higher quality of regulations, incentives on innovation, and entrepreneurship (through funding programs, incubators, and innovation clusters) can go a long way in helping the entrepreneurs access the technological knowledge and translate it into business ventures. The implication of this finding is that policy coordination plays a crucial role in enhancing innovation driven entrepreneurship in emerging economies.

Combined, these findings may indicate that financial development, macroeconomic situation, and institutional backing are the key factors that determine entrepreneurship in the BRICS economies. Although innovation is a significant source of

entrepreneurial opportunities, its effect is critically dependent on the availability of a supportive system of governance and a well-operating financial market. These results are also very instructive to policymakers who are interested in the design of integrative policy systems to achieve a compounding upward promotion of financial development, technological development to promote quality institutional set ups in the quest to develop sustainable entrepreneurial growth.

5 CONCLUSION AND POLICY IMPLICATIONS

5.1 Conclusion

This paper investigated the nexus relationship between financial development, technological innovation, economic growth, and entrepreneurship in the BRIC economies between 2001-2023, by specifically using the moderating factor of government support. The analysis relies on macro-panel econometric methods that take in to consideration cross sectional dependence and heterogeneity between countries and this offers new empirical evidence on the factors that influence entrepreneurship in large emerging economies.

The results show that financial development is a key aspect that enhances entrepreneurial activity in the BRICS countries. Properly developed financial systems increase accessibility to credit, efficiency of capital allocation and financial constraints on entrepreneurs. Such processes allow new companies to be created and old ones to grow, which makes the entire entrepreneurship system stronger. The findings hence support the proposal that the access to finance is one of the most significant enabling factors of entrepreneurial growth within the emerging economies.

The findings also indicate that the direct and statistically significant impact of technological innovation on entrepreneurship is not observed when the effects are independent of each other. This observation implies that innovation does not necessarily translate into the establishment of new firms unless institutional, and policy setting conditions favour the commercialization and dissemination of technological knowledge. Innovation production in most of the emerging economies is usually restricted to the

established companies or research organizations, which do not spillover into the entrepreneurship in inactive ways.

The growth of the economy is observed to positively and significantly influence entrepreneurship. More economic activity leads to new segments of the market, consumer demand, and motivation to invest in new business opportunities. Growing markets offer good grounds on which entrepreneurs can engage in experimentation, especially in areas related to structural change and new technology.

More to the point, the findings indicate that the relationship between technological innovation and entrepreneurship is moderated by the government support to a significant extent. Technological innovation is more prone to entrepreneurial activity in environments that have stronger governance systems, coordination of policies and favourable regulatory frameworks. This shows how vital institutional quality is in aligning the gap between innovation and business creation.

In general, the results lead to the conclusion that financial development, economic conditions, technological capabilities, and institutional support are involved in a complex interaction to determine entrepreneurship in the BRICS economies. Policies that are designed to boost entrepreneurship should thus take an integrated approach in that they enhance financial systems, ecosystems of innovation, and better institutional governance.

5.2 Policy implications

The empirical results of this paper can offer a number of valuable policy implications to governments and development institutions that can pursue the objective of promoting an entrepreneurship-driven and innovation-based economy development in emerging markets.

To begin with, improving financial systems must be one of the priorities of policy-makers. The increased access to finance to entrepreneurs, especially small and medium-sized enterprises (SMEs), can be of great benefit to the entrepreneurship. The reforms implemented by governments in the financial sector should promote competition, enhance credit information infrastructure, and other alternative financing models including venture capital, angel investment networks, and crowdfunding platforms.

Second, the policy on innovation must be aimed at enhancing both the growth of research and development spending as well as the process of commercializing innovation. Technological knowledge can be converted to entrepreneurial ventures with the aid of policies that enhance technology transfer, university-industry partnerships, and business incubators and innovation centers.

Third, it is still important to ensure macroeconomic stability and encourage long-term economic growth to develop entrepreneurship. The existence of stable macroeconomic environments will decrease the uncertainty levels, enhance investor confidence, and generate market opportunities, which will motivate individuals to venture into the business world.

Fourth, government support and quality in the institution is crucial in transforming innovation into entrepreneurship. To provide a more enabling environment to entrepreneurial activity, governments should focus on improvement of the quality of regulation, transparency, and effectiveness in governance. Entrepreneurial ecosystem can be greatly improved by policies to minimize the bureaucratic barrier, increase the protection of property rights, and offer specific assistance programs to entrepreneurs.

Lastly, due to the structural heterogeneity of BRICS economies, country-specific policy frameworks are to be used. Some countries might need to go further with financial market reforms, but other countries might need greater institutional assistance to support entrepreneurship that is based on innovations.

5.3 Limitations and directions for future research

This study possesses some limitations which offer future research opportunities despite the contributions that it has made.

To start with, the analysis is based on macro-level measures of entrepreneurship, financial development, and technological innovation. This method can be enhanced in future research by using micro-level data of firms and entrepreneurs to learn more about how the processes of financial development and innovation relate to the entrepreneurial behaviour.

Second, the research focuses on BRICS economies, which are big growing economies. The analysis can be furthered in the future by examining other upcoming or

developing regions to be able to compare the dynamics of entrepreneurship across different institution and economic context.

Third, although in this study, government support is regarded as a moderating factor, other institutional variables might also have impact on the entrepreneurial activity including regulatory burden, entrepreneur culture and labor market flexibility. A deeper insight into these factors may give a better understanding of entrepreneurship ecosystems.

Lastly, in upcoming studies, the role of digital transformation and new technologies in determining entrepreneurial opportunities in emerging economies would be studied, especially in the environment of fast technological change and globalization.

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Authors' Contribution

All authors contributed equally to the development of this article.

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All datasets relevant to this study's findings are fully available within the article.

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