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Does Government Support Moderate the Innovation–Entrepreneurship Nexus? Evidence from BRICS Economies

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Abstract
Though there is considerable state investment in innovation in emerging economies, the results of the entrepreneurship are still skewed, and it is in doubt as to whether the technological innovation necessarily results in the entrepreneurial dynamism. The paper will test the hypothesis of whether government support is a moderating factor in the relationship between technological innovation and entrepreneurship in BRICS economies (Brazil, Russia, India, China, and South Africa) between the years 2001-2023. Based on the theory of institutional and entrepreneurial ecosystems, the research contributes to the literature in that it models government support as a conditioning strategy and not a direct agent in determining entrepreneurship. The analysis is conducted using a dynamic Cross-Sectionally Augmented Autoregressive Distributed Lag (CS-ARDL) framework, which takes into consideration cross-sectional dependency, heterogeneous response of countries and dynamic adjustment. Total Early-Stage Entrepreneurial Activity is used as an indicator of entrepreneurship, resident patent applications scaled by population as an indicator of technological innovation and a composite governance index based on PCA is used as an indicator of government support. Control variables are economic growth and human capital. The results indicate that there were three important findings. To begin with, there is a weakly negative and statistically insignificant direct impact on entrepreneurship by technological innovation, which indicates that innovation in itself is not always considered to be a key driving force of entrepreneurship in BRICS economies. Second, the government aid has a positive direct impact on entrepreneurship that is strong. Third, and most importantly technological innovation-government support interaction is negative and statistically significant that implies that government support systematically restructures the innovation-entrepreneurship nexus. In the marginal effects test, innovation exhibits a weak positive or zero association with the level of government support, but the association increases to negative as level of government support increases, suggesting that with high level of government support, there is a diversion of innovation towards existing channels dominated by the incumbent that are highly formalised and restrict entry of entrepreneurs. The study has theoretical significance through its ability to illustrate the non-neutral nature of government support in conditioning the entrepreneurial payoff of innovation, empirical significance through its provision of sound dynamic results with the help of second-generation panel techniques, and practical importance through its focus on the necessity of entrepreneur-involving policies on innovation. On the whole, the results can be

used to come up with new knowledge on why innovation-based development policies might fail to result in the development of widespread entrepreneurship in developing countries.

Keywords: *Technological innovation, Entrepreneurship, BRICS, Government support, Institutional moderation, CS-ARDL.*

1. Introduction

Entrepreneurship is well known as a driving force to structural change and is considered as a means of job generation as well as long-term economic stability especially in emerging and middle-income economies. This acknowledgment has grown more acute during the last few years as governments face declining growth rates, increasing unemployment rates and the fact that they must shift their development models being factor led to innovation led. In this scenario, the BRICS economies, Brazil, Russia, India, China, and South Africa have put entrepreneurship and technological innovation at central focus in national development policies (Acs et al., 2023; UNCTAD, 2025). Governments in these nations have increased government investment in research and development (R&D), digital infrastructure, and digital ecosystems, and usually under the belief that entrepreneurial activity and inclusive growth will be in response to innovation. However, it still happens that the results of entrepreneurship in BRICS economies are not even despite the attempts, which leads to central questions of whether technological innovation is necessarily converted into entrepreneurial dynamism.

In theory, innovation in technology should lead to entrepreneurship through lowering the cost of production, creating new business opportunities, and increasing the spaces of new firms to enter (Schumpeter, 1934; Acs et al., 2023). The empirical data of developed economies has been widely supportive of this opinion by demonstrating that innovation-intensive environments, with high levels of knowledge spillovers and competitive marketplaces, are likely to produce dynamic entrepreneurial ecosystems. Evidence on emerging economies is, however, much less convincing. Empirical evidence provides increased speculation that innovation in innovation in a developing and middle-income setting is frequently concentrated among big firms, state-owned enterprises, and state research institutions, and rarely transferred to small and new ventures (Arocena and Sutz, 2002; Cirera and Maloney, 2017). In these places, the technological innovation can increase the capital requirements, competency levels or regulatory complexity hence incurring more entry barriers to an entrepreneurship than reducing them.

This tension brings out a major unresolved debate in the literature that is whether innovation in emerging economies operates as an enabling factor to entrepreneurship or, rather, it supports structural dualism, favouring incumbents and capital-intensive production. Although there are positive studies which demonstrate positive correlations between innovation and entrepreneurial activity some studies have documented weak, negative, or context-specific impacts when institutional constraints and market structure are taken into consideration (Estrin, Korosteleva, and Mickiewicz, 2013; Dutta and Sobel, 2018). These mixed results indicate that innovation is not enough to describe the outcome of entrepreneurship and that institutional and policy environment are very important conditions.

Government support is one of the most significant institutional factors that determine the relationship between innovation and entrepreneurship. Governments can manipulate the direction of innovation, as well as access of innovation to entrepreneurs, through R&D subsidies, innovation grants, industrial policy, public procurement and regulatory regimes. Theoretically, these interventions should be able to rectify market failures, ease financial and capability limits, and make entrepreneurship more involved in innovation-led development (Rodrik, 2008; Mazzucato, 2018). Nonetheless, the assistance of government can also create distortions. Under weak-governance or institutional-capacity-misaligned settings, the political favors associated

with public support might be skewed towards politically connected firms or large incumbents or the formal sector actors, effectively crushing out small and opportunity-driven entrepreneurs (Arocena & Sutz, 2002; Acemoglu et al., 2019).

Although the government intervention has been central in the innovation policy, the empirical studies have given little focus on the moderating role of government in the innovation-entrepreneurship nexus. The majority of the studies consider the government support as a direct indicator of entrepreneurship or a control variable implicitly assuming that the intervention by the government has a consistent positive impact on the entrepreneurial performance. There is a much-limited literature that directly measures the hypothesis on whether government support moderates the relationship between technological innovation and entrepreneurial activity, at least in emerging economies. In addition, a significant portion of the current facts is based on the idea of the static panel models which do not consider the cross-sectional dependence, heterogeneous country reactions, and dynamic characteristics of adjustment processes that are particularly pronounced in the BRICS landscape involving the tight integration of economies in terms of trade, finance, and technological cycles (Pesaran, 2006; Chudik and Pesaran, 2015).

The present research attempts to fill these gaps by discussing the moderating role of government support to the correlation between technological innovation and entrepreneurship in BRICS economies during the years 2001–2023. The study is methodologically based on a dynamic Cross-Sectionally Augmented Autoregressive Distributed Lag (CS-ARDL) model that explicitly adjusts for common shocks that are not observed, the cross-sectional dependence, and non-homogenous slope coefficients across countries (Chudik and Pesaran, 2015). Substantively, technological innovation is considered to be the key explanatory variable and the government support is also modelled only as a moderator and not as a mere control. The control variables consist of economic growth and human capital to explain the macroeconomic conditions and the absorptive capacity effects that have independent effects on entrepreneurial activity.

The research has three significant contributions. First, it offers substantial dynamic evidence of the innovation-entrepreneurship relationship in BRICS economies demonstrating that technological innovation is not necessarily what would produce entrepreneurial dynamism. Second, it contributes to the literature by directly modelling the government support as a moderating force, proving that the intervention of the state does not unconditionally but transforms the innovation/entrepreneurship nexus. Third, it presents policy-relevant ideas on the reasons of why innovation-based development policies might not generate inclusive entrepreneurial performance in situations where government support is inappropriate to the entrepreneurial systems.

2. Literature Review

2.1 Theoretical Foundations

The connection between technological innovation and entrepreneurship is imbedded in a variety of theories that are complementary, most prominently Schumpeterian innovation theory, endogenous growth theory, and institutional and ecosystems entrepreneur and entrepreneurship approaches. Schumpeter (1934) theorised about entrepreneurs, who creatively destroy new resource combinations, technologies and forms of organisations. In this context, innovation is a product of entrepreneurial action as well as a product that leads to the formation of new firms. Further developments in endogenous growth theory made further formalisation to this connection, focusing on knowledge accumulation, innovation and human capital as the drivers of long run growth, and entrepreneurship as a transmission mechanism where new knowledge is monetised (Romer, 1990; Aghion and Howitt, 1992).

Nevertheless, these theoretical schools were mostly developed within the environment of developed market economies with competitive markets, good property rights and developed financial markets. Their forecasts are not as clear when it comes to emerging economies. The development and middle-income countries have innovation systems that tend to be highly fragmented, loosely linked to domestic companies and controlled by large public or multinational actors (Arocena and Sutz, 2002; Cirera and Maloney, 2017). When this happens, innovation may not be a sign that there is general opportunity of entrepreneurship. Rather, innovation can also intensify the level of technological complexity, capital intensity and skills such that small and new firms are restricted in their entry.

Another valuable approach to these divergences is the institutional theory. Institutions refer to the formal and informal guidelines which influence economic behaviour to make decisions on how resources will be distributed, how risks will be distributed and who will have access to the activities involving innovation (North, 1990; Acemoglu et al., 2019). The entrepreneurial ecosystem view is based on this observation by highlighting that entrepreneurship arises through the interaction of firms, institutions, policies, human capital and innovation systems (Acs et al., 2023). In this perspective, technological innovation can affect entrepreneurship not by itself, but it can impact it by institutional arrangements that will facilitate or limit the participation of entrepreneurship.

The government support takes the centre-stage in this institutional architecture. The innovation systems can be influenced by the public intervention which can guide the resources, provide incentives, and define the regulatory environments. More importantly, the aspect of government support can not only be a direct determinant of entrepreneurship, but also a moderating factor that preconditions the influence of innovation on the outcomes of entrepreneurship. The given theoretical understanding inspires the current research to focus on moderation, not the direct effects.

2.2 Government Support and Entrepreneurship

Government support has been traditionally considered to be a policy that can be employed to promote entrepreneurship by correcting market failures of finance, information asymmetries and externalities. The entry obstacles and entrepreneurial abilities may be amplified by means of public policies like R&D subsidies, innovation grants, business incubation programmes, and regulatory reforms (Rodrik, 2008; Mazzucato, 2018). In certain settings, empirical research results suggest that specific government assistance enhances entrepreneurial performance, especially where institutions are well-established and policies are well-enforced.

But there exists a body of literature that points at the possible negative aspects of government action. Weakly governed institutional setting with policy capture, or weak institutional capacity may strongly favour politically-connected companies or capital-intensive incumbents, which disrupts competition and reduces inclusiveness in the process of entrepreneurship (Arocena and Sutz, 2002; Acemoglu et al., 2019). These interventions could reinforce performance of the innovation on the aggregate level but undermine the connection between innovation and entrepreneur participation.

In the case of emerging economies, this divorce means that the government support cannot have essentially positive impact on entrepreneurship. Rather, it is a matter of what policies are designed, intended to accomplish, and how it is incorporated into wider entrepreneurial systems. This ambiguity is what encourages the use of government support as not a direct determinant of entrepreneurship but as a situational force that alters other relationships within the system.

2.3 Government Support as a Moderator of the Innovation–Entrepreneurship Nexus

The last theoretical and empirical research is becoming more and more aware of the fact that institutions and policies are moderators, which change the magnitude and shape of the relationships between economic variables but not act alone (Acs et al., 2023). Government assistance can enhance, dampen, or even overturn the implication of technological innovation on entrepreneurial activity in the context of innovation and entrepreneurship.

Firstly, the government support can be effective in enhancing diffusion of innovation by reducing entry barriers, enhancing access to finance, and enhancing the human capital thus enabling the entrepreneurs to capitalize on the new technology. However, when support systems favor large firms or formal systems of innovation, they can crowd out innovation based on experimentation by an entrepreneur. Innovation-entrepreneurship linkage may be undermined by government assistance in such situations, despite the expansion of innovation.

There is limited empirical data of this moderating role, especially in the cases of emerging economies and macro-panels. The majority of the available literature analyzes both innovation and support by the government alone and, thus, there is a significant gap in the literature that explains how government intervention redefines the nexus of innovation and entrepreneurship throughout history. This gap is particularly topical to the BRICS economies where the governments are actively involved in the innovation policy and industrial strategy (UNCTAD, 2025).

On account of such considerations, the study follows the following hypothesis:

H1: Government support moderates the relationship between technological innovation and entrepreneurship.

2.5 Control Variables: Economic Growth and Human Capital

Control variables entail economic development and human capital because they have been established to have close relationships with entrepreneurship. Economic growth has the capacity of boosting entrepreneurship by increasing market size and demand, and it can be linked to capital-intensive or state-oriented sectors that create little entrepreneurship spillovers (Carree et al., 2007). Human capital increases absorptive capacity, which allows entrepreneurs to discover and take advantage of opportunities in innovation, although the atmosphere of institutional environment can be different (Lucas, 1988; Estrin et al., 2013). By controlling these factors, it is possible to isolate the conditional effect of innovation and government support on entrepreneurship using the analysis.

2.6 Contribution and Positioning of the Study

This paper contributes to more subtle insights about entrepreneurship in the emerging economies by incorporating the theory of innovation, institutional viewpoints and entrepreneurial ecosystem models. Its major contribution is that it explicitly models the government support as moderating variable in the innovation-entrepreneurship relationship on a dynamic empirical basis, which consider cross-sectional dependence, and heterogeneous country responses. By so doing, the research transcends naive suppositions of automatic spillovers of innovation to entrepreneurship and provides policy-informed implications of the role of state intervention on the entrepreneurial performance in BRICS economies.

3. Methodology

3.1 Research Design and Empirical Strategy

The research design used in this study is a quantitative, macro-panel research design to find out whether the relationship between technological innovation and entrepreneurship in BRICS economies over the timeframe of 2001 - 2023 is moderated by government support. The reason why a panel structure is chosen is to take advantage of both the time-series and cross-sectional

difference between the entrepreneurship, innovation as well as institutional conditions among the countries, and to manage the unobserved heterogeneity and dynamic adjustment mechanisms.

The major methodological problem of this research is based on 3 characteristics of the macro-panel data of emerging economies that are well documented. To begin with, BRICS nations are vulnerable to universal shocks including financial crisis, technological waves, as well as geopolitical shocks that cause cross-sectional dependence. Second, the relation between innovation and entrepreneurship is probably not homogeneous between countries and indicates variations in the quality of the institutions, level of development, and policy regimes. Third, the process of entrepreneurship is dynamically persistent, which means that history has an impact on the present levels of entrepreneurship.

The common panel estimators like pooled OLS, fixed effects or random effects fail in dealing with these characteristics jointly, as they presume cross-sectional independence, homogeneity of slope and non-dynamism in relationships. In order to circumvent these deficiencies and match the empirical approach to the goals of the study, the analysis uses the Common Correlated Effects Autoregressive Distributed Lag (CS-ARDL) estimator with long-run cointegration estimators (FMOLS and DOLS) to ensure their robustness.

3.2 Variables and Data Sources

The analysis is informed by the fact that the relationship between technological innovation and the entrepreneurship activity in the BRICS countries of Brazil, Russia, India, China, and South Africa is based on the time frame 2001-2023, which is further broken down into the post-2000 booming period, the global financial crisis of 2008, and the post-pandemic period.

Entrepreneurship (ENT_{it}): Total Early-Stage Entrepreneurial Activity (TEA) is a measure of the percentage of adults involved in nascent or new business activity. This indicator is constructed on the basis of Global Entrepreneurship Monitor (GEM) database. Technological innovation ($TINN_{it}$) is calculated using patent applications by residents that is composed of the World Bank World Development Indicators (WDI) and scaled by population to adapt to the variations between countries. This summarises how far the economies are producing new knowledge, which can be put into use.

The environment that is supportive of innovation and entrepreneurship comes to be known as Government Support (GS_{it}). It is obtained by means of a composite governance index which is built on the six Worldwide Governance Indicators: government effectiveness, regulatory quality, rule of law, control of corruption, political stability, and voice and accountability. The Principal Component Analysis (PCA) is the method of construction of the single governance indicator.

Two control variables are put into play. Economic growth (EG): proxy represented by the real GDP per capita (constant 2015 US$) of the World Development Indicators (WDI) of the World Bank and then converted by the natural logarithm to enhance readability and decrease heteroscedasticity. The UNDP Education Index is the measure of human capital (HC_{it}) which is the foundation of abilities that can lead to innovation and entrepreneurship. These control variables are able to capture the structural features that are capable of influencing the technological transfer as well as entrepreneurship.

Table 1: presents the definitions, measurement, and data sources of all variables used in the empirical analysis.

Variable	Code	Measurement/Proxy	Source
Entrepreneurship	ENT	Total Early-Stage Entrepreneurial Activity (%)	GEM
Technological Innovation	TINN	Patent applications by residents (per population)	WDI
Government Support	GS	Composite governance index (PCA-based)	WDI
Economic Growth	EG	GDP per capita (constant 2015 US$; log-transformed)	WDI
Human Capital	HC	Education Index	UNDP

Source: Authors' compilation.

3.3 Model Specification

The empirical model of the baseline is a relationship between entrepreneurship and technological innovation, government support, and their interaction factor and a combination of control variables:

$$ENT_{it} = \alpha_i + \beta_1 TINN_{it} + \beta_2 GS_{it} + \beta_3 (TINN_{it} \times GS_{it}) + \beta_4 EG_{it} + \beta_5 HC_{it} + \varepsilon_{it}$$

where ENT_{it} denotes entrepreneurship at time t and country i, $TINN_{it}$ captures the technological innovation, GS itrepresents government support and $TINN_{it} \times GS_{it}$ is the interaction term that represents the moderating factor of government support. Control variables are economic growth (EG_{it}) and human capital (HC_{it}). Time-invariant heterogeneity is captured by country-specific fixed effects (α_i).

The model is developed as lagged entrepreneurship to obtain dynamic adjustment and persistence in entrepreneurial activity:

$$ENT_{it} = \alpha_i + \phi ENT_{i,t-1} + \sum_{k=0}^{p} \theta_k X_{i,t-k} + \varepsilon_{it}$$

where X_{it} contains innovation, government support, the term of interaction, and controls.

3.4 Econometric Justification

The CS-ARDL estimator was originally created through the Common Correlated Effects (CCE) framework, which is especially appropriate to the aims of the given study due to a number of reasons.

Initially, CS-ARDL directly uses cross-sectional dependence by including cross-sectional averages of the dependent and independent variables in the regression. This takes into account the unobserved similarities like the global trends in technology or other international effects of policies which at the same time will be considered in all BRICS countries. Such reliance may be overlooked resulting in biased and unreliable estimates which has been the weakness of the previous research on innovation and entrepreneurship.

Second, CS-ARDL can assume heterogenous slope coefficients that is, the impact of innovation and government support on entrepreneurship should be allowed to vary across countries. This is an important characteristic in BRICS context, in which institutional settings and policy performance differ significantly. The estimator manages to evade the limiting homogeneous effects assumption of the pooled estimators by estimating country-specific effects, which are then averaged.

Third, the ARDL model can support mixed integration orders and allows estimating both the short-run dynamics and long-term relation in the same framework. This is especially relevant

considering the fact that entrepreneurship, innovation and institutional variables tend to develop gradually and can be characterized by varying levels of permanence.

Above all, the study provides a direct solution to the main research gap of the study: the fact that the existing empirical research did not consider the simultaneous influence of dynamic adjustment, cross-sectional dependence, and institutional moderation in the analysis of the innovation-entrepreneurship nexus in emerging economies.

3.5 Moderation Analysis

The study clearly represents government support as a moderator by introducing the interaction term of technological innovation and government support, instead of treating it as a simple control variable. This method enables the test to examine whether the support of the government conditions the influence of innovation on entrepreneurship as observed in the institutional and entrepreneurial ecosystem theories.

The statistical significance and the sign value of the interaction term are the direct indicators of whether government support enhances, decreases or inverses the interaction between the innovation and the entrepreneurship. This moderation structure can be viewed as both conceptual and empirical improvement of the previous research approaches that are preoccupied only with the direct effects.

3.6 Long-Run Robustness: FMOLS and DOLS

In order to strengthen the strength of the long-run results, the research supplements the CS-ARDL results with Fully Modified Ordinary Least Squares (FMOLS) and Dynamic Ordinary Least Squares (DOLS) estimates of panel cointegrated systems. These estimators help to rectify the endogeneity and serial correlation under cointegration in the existence of cointegration and offer alternative long-run elasticity estimates.

Although FMOLS and DOLS do not treat cross-sectional dependence or slope heterogeneity exhaustively, the fact that they include them is a reference point to show how the conclusions would have differed had more sophisticated dynamic and cross-sectionally enhanced procedures have been used. This analogy justifies the validity of the empirical findings and highlights the need of the CS-ARDL framework.

3.7 Data and Estimation Procedure

The panel includes the annual data of the five BRICS economies during 2001-2023. All variables are converted into natural logarithms where feasible to stabilise variance and make coefficient interpretation as elasticities. The estimation is done on a sequential basis with the initial step being the estimations of static models that are to be compared to the other model estimations that are CS-ARDL as the desirable model and the final estimations being FMOLS and DOLS that are to be tested to establish whether the models are robust in the long-run.

3.8 Alignment with Research Objectives

The adopted methodological procedure perfectly fits the objectives of the study in three major aspects. First, it allows a stringent evaluation of the innovation entrepreneurship relationship in the circumstances of the global interdependence. Second, it directly examines the moderating effect of government support, which outlines one of the key gaps in the literature. Third, it presents policy-motivated information by separating short run dynamics and long run structural impacts.

Using the CS-ARDL model, the research will step beyond the traditional panel designs and provide empirically sound evidence on the effects of government support on the innovation-entrepreneurship nexus in BRICS economies.

4. Results and Discussion

4.1 Descriptive Statistics

Table 2 provides the descriptive statistics of entrepreneurship, technological innovation, government support, economic growth, and human capital of the BRICS economies during the 20012023 period, with 115 country-years observation of five countries.

Entrepreneurship (ENT) has high dispersion, its mean of 10.92 with a standard deviation of 5.01 with a range of 2.47 to 24.01. It is noteworthy that the between-country variation (SD = 4.38) is higher than the within-country one (SD = 3.11), which suggests that the structure and institutional differences between countries affect the entrepreneurship outcomes primarily and not a short-term variation. This tendency gives preliminary empirical evidence of the application of heterogeneous panel estimators that do not assume the homogeneity of slopes.

Technological innovation (TINN) is a more stable parameter with a mean of 10.61 and a standard deviation of 1.49. Nonetheless, its cross-country (SD = 1.56) but not within-country (SD = 0.53) variation is significantly higher, which indicates that there are still cross-national disparities in innovation capacity. This creates an implication that the BRICS economy trajectories of innovation are path dependent and rooted in national innovation systems, which augment the idea that innovation might not necessarily be automatically expressed in entrepreneurial activity.

The volatility of the variables is the greatest when dealing with government support (GS). Its mean is almost zero (0.016) although the standard deviation is large (1.01) and the values range between -2.84 and 2.75. The difference in the country is relatively high (SD = 0.61) which indicates changing policy priorities, fiscal conditions, and institutional reforms with time. This volatility can also bring about uncertainty to the entrepreneur; it is because the government support is a moderator and not a direct determinant of the outcome.

The comparison in the dispersion is relatively small in economic growth (EG) and human capital (HC). There is not much fluctuation in economic growth within and between countries and human capital fluctuates least as it is a slow-moving variable. These features are the reasons why they should be included as the control variables because they are not likely to expedite short run changes in the entrepreneurial activity.

All in all, three important implications can be made out of the descriptive evidence. First, there is strong cross-country heterogeneity in the entrepreneurship and innovation that justifies the use of heterogeneous and cross-sectionally augmented estimators. Second, the variability of the government support induces the explicit treatment as a moderating variable. Third, the heterogeneous dynamics of the variables reveal that the traditional panel model cannot be used, which supports the necessity of a dynamic model. These revelations offer a good empirical basis to the next CS-ARDL analysis that explores the ways in which the government support conditions the innovation- entrepreneurship nexus in BRICS economies.

Table 2. Descriptive Statistics

Variable	Overall Mean	Overall SD	Between SD	Within SD	Min	Max	N	Countries	Years
Entrepreneurship (ENT)	10.922	5.012	4.376	3.109	2.470	24.010	115	5	23
Technological Innovation (TINN)	10.610	1.495	1.555	0.531	8.736	14.249	115	5	23
Government Support (GS)	0.016	1.011	0.900	0.606	−2.841	2.751	115	5	23
Economic Growth (EG)	8.528	0.746	0.767	0.287	6.657	9.407	115	5	23
Human Capital (HC)	0.701	0.082	0.078	0.043	0.496	0.845	115	5	23

Notes: Overall SD captures total variability across the panel. Between SD reflects variation across countries, while Within SD captures time-series variation within countries.

4.2 Correlation Analysis

Table 3 indicates the pairwise correlations between the key variables. Generally, the correlation structure indicates moderate relationships and it does not bring up the issue of serious multicollinearity.

Entrepreneurship (ENT) is negatively associated with technological innovation (TINN) (0.132), meaning that the greater the degree of innovation, the weakly correlated with entrepreneurial activity in the BRICS economies is. This low relationship gives preliminary conative shine to the thesis that innovation is not necessarily accompanied by entrepreneurship.

There is a weak negative correlation between government support (GS) and entrepreneurship (-0.052), which implies that seen as a support mechanism, the public one might not directly trigger entrepreneurship. It is more importantly, GS is highly negatively associated with technological innovation (−0.679), which suggests that all-enhanced government action can be accompanied by reduced innovation in the market or by the individuals. This trend supports the view that the government support should be modulated and not additive.

There is a low correlation between economic growth (EG) and entrepreneurship (−0.049), which confirms that it is a control variable and not a driving force of entrepreneurial dynamics. There is also a low level of correlation of human capital (HC) with entrepreneurship (−0.151), indicating its slowness and low short-run effect on entrepreneurial performance.

The positive relationship between economic growth and human capital (0.894) is theoretically appropriate, and accumulation of skills and educational levels provide the foundations of the long-term growth paths. Although such a high correlation is worthy of consideration, there is no significant potential of multicollinearity since they are used as control variables in dynamic specifications.

In general, the findings of the correlation indicate that complex linear correlations cannot describe entrepreneurship in BRICS economies. The weak direct relationships and strong connection between institutional and structural variables give just the additional reason why the dynamic CS-ARDL framework should be taken and why the explicit modelling of the government support as a moderator in the innovation-entrepreneurship nexus should be taken.

Table 2. Pairwise Correlation Matrix

Variables	ENT	TINN	GS	EG	HC
ENT	1.000				
TINN	0.132	1.000			
GS	−0.052	−0.679	1.000		
EG	−0.049	0.149	0.097	1.000	
HC	−0.151	0.186	−0.175	0.894	1.000

Notes: ENT = Entrepreneurship; TINN = Technological Innovation; GS = Government Support; EG = Economic Growth; HC = Human Capital. Number of observations = 115.

4.3 Cross-Sectional Dependence Tests

The findings of the cross-sectional dependence (CD) test conducted by Pesaran (2004) on the variables in the analysis are published in Table 4. The findings indicate that the dependence on technological innovation, economic growth, and human capital are strong and statistically significant across the cross-section due to the large CD statistics and p-values which are below the mark of 1% significance level. This result implies that common global shocks and spillovers, including global technology diffusion, coordinated macroeconomic cycles, and similar policy and institutional patterns among the BRICS economies contribute a lot to these variables.

However, the same cannot be said of entrepreneurship and government support which do not show statistically significant cross-sectional dependence implying that the performance of entrepreneurship and the processes of government support are country-specific and prone to depend on the local institutional settings, but not on worldwide common factors. This distinction is also confirmed by the mean correlation coefficients where economic growth and human capital exhibit the highest rates of cross-country co-movement whereas entrepreneurship exhibits quite low average rates of cross-country correlation.

On the whole, the assumptions made by the first-generation panel estimators cannot be applied in the context of the strong dependence in cross section of major explanatory variables. These findings are thus good empirical support to the application of second-generation panel methods namely the CS-ARDL and DCCE-MG estimators that directly incorporate the unobserved common factors, heterogeneous dynamics, and cross-country spillovers in the BRICS case.

Table 4: Pesaran (2004) Cross-Sectional Dependence Test Results

Variable	CD Statistic	p-value	Mean Correlation	Mean Absolute Correlation
Entrepreneurship (ENT)	0.38	0.702	0.025	0.450
Technological Innovation (TINN)	9.13	0.000***	0.602	0.602
Government Support (GS)	0.54	0.588	0.036	0.447
Economic Growth (EG)	13.08	0.000***	0.862	0.862
Human Capital (HC)	14.86	0.000***	0.980	0.980

Notes: *The null hypothesis is cross-sectional independence. The CD statistic follows an asymptotic standard normal distribution. *** denotes significance at the 1% level. The panel consists of 5 countries observed over 2001–2023 (115 observations).*

4.4 Panel Unit Root Tests

The findings of the Pesaran (2007) Cross-sectionally Augmented IPS (CIPS) unit root tests are reported in Table 5 and the tests clearly take into consideration the cross-sectional dependence identified in the foregoing section. The findings show that there is a mixed sequencing of integration among variables. The level of entrepreneurship, government support, and human capital is not changing, as their CIPS statistics are above the 5% critical value in absolute terms.

Conversely, technological innovation and economic growth do not reject the null hypothesis of non-stationarity at the traditional level of significance meaning that they are integrated of order one.

This combination of I(0) and I(1) variables confirms that there is no higher-order integration problem in the panel and confirms the application of the CS-ARDL model which is specially designed to deal with mixed integration orders in the conditions of cross-sectional dependence and heterogeneous dynamics. These findings also support the need to go beyond first-generation panel estimators because the common factor and non-stationarity would be overlooked, and would be biased and inconsistent inference in the BRICS scenario.

Table 5: Panel Unit Root Tests (Pesaran CIPS)

Variable	CIPS Statistic	10% CV	5% CV	1% CV	Order of Integration
Entrepreneurship (ENT)	−2.834	−2.21	−2.33	−2.57	I(0)
Technological Innovation (TINN)	−2.094	−2.21	−2.33	−2.57	I(1)
Government Support (GS)	−2.409	−2.21	−2.33	−2.57	I(0)
Economic Growth (EG)	−1.828	−2.21	−2.33	−2.57	I(1)
Human Capital (HC)	−2.508	−2.21	−2.33	−2.57	I(0)

Notes: Pesaran (2007) CIPS test with constant, maximum lag = 1, and one cross-sectional augmentation lag. The null hypothesis is a homogeneous unit root. Rejection occurs when the CIPS statistic is smaller (more negative) than the critical value. Panel consists of 5 BRICS countries over 2001–2023.

4.5 Westerlund (2007) ECM-Based Panel Cointegration Test

The relationship between entrepreneurship, technological innovation, government support, economic growth and human capital at long-run equilibrium is investigated with the help of Westerlund (2007) error-correction-based panel cointegration test. According to Table 6, the robust bootstrap p-value of 5% rejects the null hypothesis of no cointegration with the group-mean short-run statistic (Gt). It demonstrates that at least one of the BRICS countries has a statistically significant error-correction mechanism meaning the presence of cointegration among a group of panel members.

Conversely, the other statistics, Ga, Pt, and Pa do not reject the null hypothesis with the consideration of robust p-values. The implication of those findings is that cointegration might be true in individual countries but there is no empirical strong basis to suggest that there is a homogeneous long-run equilibrium relationship between the BRICS economies. The mixed characteristics of the results point to the huge cross-country heterogeneity in the long-run dynamics of the relationship between innovation, government support and entrepreneurial activity.

It is interesting to note that this has been correlated with the institutional and structural disparities of BRICS economies, where the systems of innovation, the policy frameworks and entrepreneurship eco-systems of the countries differ considerably. The results also support the application of the dynamic heterogeneous panel estimators that permit adjustment processes in the country-specific way and do not presuppose a shared long-run relation.

Table 6. Westerlund (2007) ECM-Based Panel Cointegration Test

Statistic	Test Type	Test Value	Z-Statistic	Asymptotic p-value	Robust p-value
Gt	Group-mean (short-run)	−3.927	−3.470	0.000	**0.013**
Ga	Group-mean (long-run)	−5.209	2.261	0.988	0.488
Pt	Panel (short-run)	−6.138	−1.232	0.109	0.055
Pa	Panel (long-run)	−3.906	1.593	0.944	0.650

Notes: The null hypothesis is no cointegration. Robust p-values are obtained via bootstrap to account for cross-sectional dependence. Rejection of the null implies the existence of an error-correction mechanism.

4.6 CS-ARDL Dynamic Panel Estimates

The CS-ARDL (DCCE-MG) estimates of the BRICS panel are reported in table 7, which explicitly models the government support as a moderator of the relationship between innovation and entrepreneurship and controlling the economic growth and human capital. The value of the residual statistic of cross-sectional dependence is insignificant (CD = 0.32, p = 0.7499), which makes the assumption that the CCE augmentation is effective in absorbing common shocks and cross-country spillovers more convincing. The important finding is that interaction term TINNxGS is negative and statistically significant (β = -5.354, p = 0.001), which means that the system of governmental support conditions the relationship between technological innovation and entrepreneurial activity in a systematic way. In particular, since margins of innovation on entrepreneurship is ∂ENT/∂TINN = 0 +0.3·GS, the higher the government support, the 0.3Gs is the negativity of the net impact of innovation (or the less positive). In line with this, technological innovation has a weakly negative impact on it (β = -7.411, p = 0.089), so that in the absence of supportive and inclusive channels of transmission innovation development in BRICS economies could be skewed to large corporations, state-oriented organizations, or capital-intensive industries, which could increase entry barriers and crowd out other smaller entrepreneurial projects. In comparison, the government support comes in with strong positive direct relation with entrepreneurship (= 55.700, p = 0.002), meaning that the state capacity and pro-business policy environments can increase the overall level of entrepreneurship; but its negative interaction suggests that the government support can also guide the innovation into formalised or incumbent-friendly directions instead of diffusing entrepreneurship throughout. Economic growth has no significance as micro control (p = 0.814), which proves its importance as a macro control and not the driver of entrepreneurship in the dynamic, cross-sectionally enhanced environment. The negative significant value of human capital is 5% (0.049, -105.009) that considering its inability to move quickly and the cross-country persistence of the effect could be a structural composition effect (e.g. skilled labour in wage work and large organisations instead of necessity or young entrepreneurship). Lastly, the coefficient on lagged entrepreneurship is found to be negative and significant (= -0.208, p = 0.036), which suggests that there is an adjustment reversion behaviour of high rates of entrepreneurship: an abnormally high rate of entrepreneurship will be followed by a moderating change in the following periods.

Table 7. CS-ARDL (DCCE-MG) estimates

Variables	Coef.	Std. Err.	z-stat	p-value	95% CI
Technological innovation (TINN)	-7.411*	4.360	-1.70	0.089	[-15.956, 1.134]
Government support (GS)	55.700***	17.862	3.12	0.002	[20.691, 90.708]
TINN × GS	-5.354***	1.641	-3.26	0.001	[-8.570, -2.137]
Economic growth (EG)	-3.625	15.373	-0.24	0.814	[-33.755, 26.505]
Human capital (HC)	-105.009**	53.346	-1.97	0.049	[-209.565, -0.454]
Lagged entrepreneurship (L.ENT)	-0.208**	0.099	-2.09	0.036	[-0.402, -0.013]

Model fit: $R^2 = 0.64$; R^2 (MG) = 0.63; Root MSE = 1.96

*Significance: *** p<0.01, ** p<0.05, * p<0.10*

4.7 Moderating Role of Government Support

Figure 1 explains the marginal impact of the technological innovation on entrepreneurship in the presence of different levels of government assistance. The graph represents a very negative-sloping marginal effects curve, which implies that the effect of innovation on entrepreneurship gradually reduces as the government support rises.

When government support is low, marginal impact of technological innovation on entrepreneurship is weakly positive or almost null, moreover, indicating that innovation in comparatively market-oriented or relatively less interventionist setting is at least mildly helpful to entrepreneurial activity or at least not damaging. This is in the classical Schumpeterian arguments that innovation creates new firms by discovering and diffusing opportunities.

Nevertheless, there is monotonic decreasing marginal effect with an increase in the amount of government support and finally at high levels of government support the effect becomes monotonically negative. This means that as the interventions are high, the further innovation is linked with reduced entrepreneurial activity. The high negative gradient proves that the government support does not co-exist with the innovation but changes its entrepreneurial returns in essence.

This trend has an economic implication indicating that deep state intervention can shift innovation towards capital-intensive, state-consistent or incumbent-dominated operations at the cost of new and small-scale entrepreneurs. High support regimes can then lead to innovation becoming more centralized, more bureaucratized or more controlled by large corporations and state-owned corporations, increasing entry barriers and undermining the dynamism of grassroots entrepreneurship.

Figure 1: Moderating effect of government Support

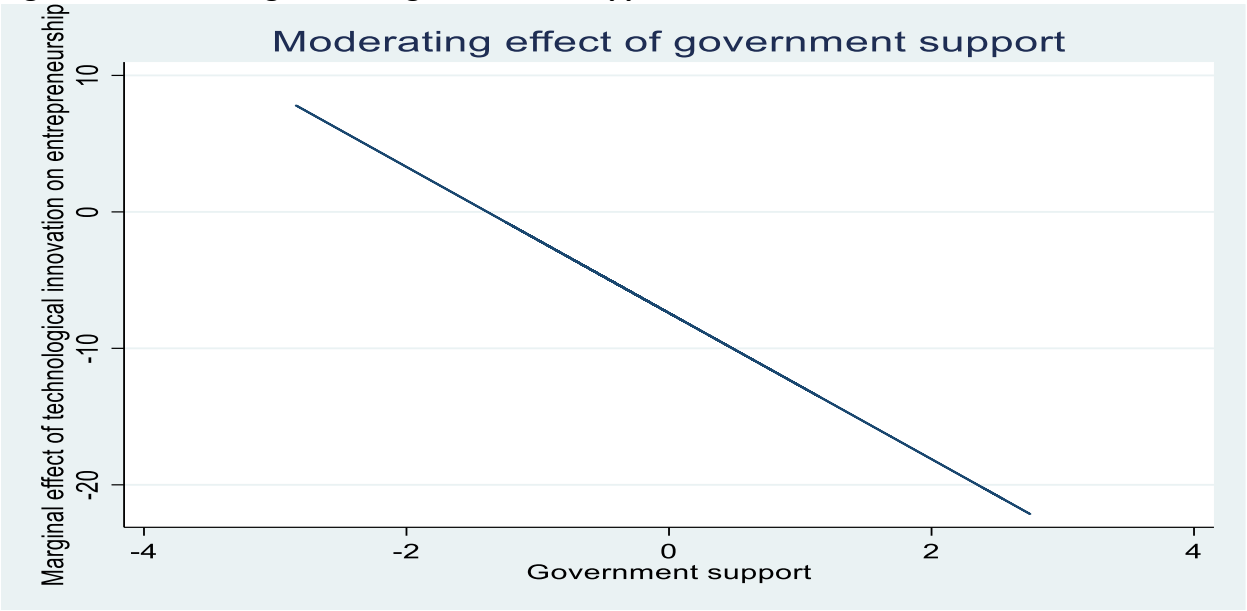


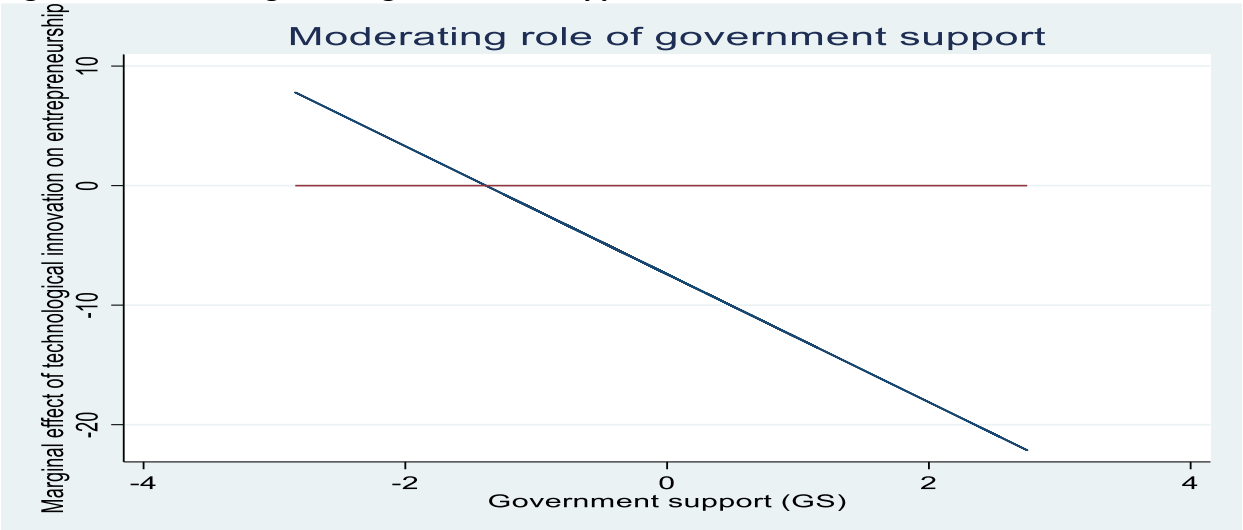
Figure 2 takes the analysis a step further by explicitly comparison of the marginal effect of technological innovation to the zero-effect reference line to provide the opportunity to determine economic and statistical significance across the levels of government support.

The figure depicts that the marginal effect of innovation to lower levels of government support is either above or near the zero, which implies that innovation does not substantially affect entrepreneurship but may contribute to it. But as the government support is increased the marginal effect crosses the zero line and exceeds it into an increasingly negative value, that is, it is negative at the higher levels of government support.

This crossroad is crucial: it is a point at which the government assistance becomes a bottleneck of the entrepreneurial vehicle. As far as the present stage, further innovation under high government support, decreases the entrepreneurial activity instead of rising it.

The continued nature of the negative marginal effect at increased levels of support confirms the CS-ARDL result of negative and statistically significant interaction term (TINN × GS). Notably, this correlation remains significant even when the economic growth, human capital, cross-sectional dependence and slope heterogeneity across BRICS economies are taken into consideration, which implies that the moderating effect is structural as opposed to being spurious.

Figure 2: Moderating role of government Support



Combined, Figures 1 and 2 give both good visual and empirical proof that government support is conditioning, rather than neutral, in the innovation-entrepreneurship relationship. Although the government support has a direct positive impact on the entrepreneurship, it negatively interacts with the technological innovation, which means that there is a trade-off between the promotion of innovations and the spread of entrepreneurship.

These results indicate that innovation-focused state assistance in BRICS economies can potentially inadvertently crowd out new entrants into an industry when it is excessively centralized, firm-favored or compliance-intensive. The innovation policy, where a scale, formalization, or strategic sector is given priority without some clearly defined tools on how to incorporate SME and startup may undermine the entrepreneurial process where innovation is tapped and translated into broad-based economic dynamism.

In general, the numbers support one major conclusion of the study: the government support can increase innovation capacity, but at the same time can undermine its entrepreneurial payoff unless the support instrument is explicitly geared towards being entrepreneur-inclusive, competition-friendly, and newcomer-accessible.

5. Conclusion

This paper investigated the existence of a moderating role of government support on the correlation between technological innovation and entrepreneurship within the BRICS economies of 2001 2023 through a dynamic CS-ARDL model, which accounted the cross-sectional dependence, slope heterogeneity, and adjustment dynamics. The results convey a clear and policy-appropriate message the innovativeness does not necessarily lead to entrepreneurial dynamism of the emerging economies, and institutional organization of government assistance is one of the most significant conditioning factors.

Three results stand out. First, technological innovation has a weak and only marginally significant direct relationship with entrepreneurship, and indicates that innovation in BRICS is not always diffusing by way of entrepreneurial entry and the formation of new ventures. Second, the positive direct impact of government support on entrepreneurship is high, which means that the overall increase of entrepreneurial involvement can be achieved through the increase of the governance capacity and the favorable policy conditions. Third, and most importantly, the relationship between government support and technological innovation is negative and statistically significant, which validates the fact that government support transforms the nexus of innovation and entrepreneurship, and does not make it stronger across board.

This finding is supported by the marginal effects analysis. Innovation is weakly (or even non-significantly) positively correlated with entrepreneurship at low levels of government support, but at higher levels of government support, the marginal effect of innovation is decreasing monotonically, and is even more negative. This trend suggests that in the high-support environment, innovation is becoming more and more formalised, incumbent-oriented, or state-aligned in the way that it does not lead to a broad-based entry and diffusion of entrepreneurship.

The general response to this evidence, is that there is a trade off where government support can directly stimulate entrepreneurship, but at the same time undermine the entrepreneurial returns to innovation once the support mechanisms favor incumbents, impose excessive compliance costs, or concentrate innovation in large organisations.

To conclude, government support in BRICS economies is not objective. It is able to instigate entrepreneurship as well as modify the manner in which innovation is translated to entrepreneurial results. The strategies of development based on innovation thus necessitate not just greater assistance, but also more effectively designed assistance, which is clearly outlined so as to allow entrepreneurial involvement into the innovation systems.

6. Policy Recommendations

The BRICS economies must have their support on government support diverted away on simply increasing the innovation capacity to ensuring that the innovation spreads to the entrepreneurial activity. Although the overall level of entrepreneurship can be increased with the help of the state, the data indicate that the level of correct or excessively centralised support can undermine the degree to which the process of innovation causes the formation of new firms. The policy on innovation should then be formulated with a clear consideration of inclusion of the entrepreneurial nature as opposed to scale or incumbency only.

Firstly, there is need to make innovation support programmes more accessible to startups and SMEs. This is necessitated by more transparent and explicit eligibility criteria, specific funding cycles to early-stage ventures, and formulas that focus on market experimentation and new firm involvement as opposed to the size of firms or political nearness. This would minimize takeover by incumbents and enhance the entrepreneurship of innovation.

Second, governments ought to reduce administrative and compliance burdens of government support. Streamlined application procedures, electronic delivery procedures and proportional reporting requirements would reduce entry barriers of small and new businesses so that the unintended effect of government assistance is to lock out entrepreneurs with limited administrative scale.

Third, the policy on innovation needs to be more directly related with creating markets among the entrepreneurs. Early demand of entrepreneurial innovations can be established through public procurement, innovation challenges and pilot programmes so that startups can scale and commercialise new technologies as opposed to using subsidies alone.

Fourth, competition policy should be provided to support innovation. Anthropology measures are needed to guard against market concentration, open standards as well as ensuring fair competition in order to ensure that the innovation system is not captured by the incumbents but also to ensure that space is available to allow new entrants.

Lastly, the policy should be context sensitive and constantly reviewed. Considering institutional heterogeneity among the BRICS economies, the governments need to customize instruments of support to local ecosystems and monitor whether the support of innovation funding is expanding the entrepreneurial base or aiding the continuation of advantage.

7. Directions for Future Research

This research can be improved in a number of significant ways in future research. To determine whether government support has different impacts on entrepreneurship of different types, first, entrepreneurship must be disaggregated into opportunity-driven, necessity-driven, and high-growth entrepreneurship. Second, aspects of innovation can be improved through differentiating between R&D intensity, quality of patents, digital innovation, and green or mission-oriented technologies so that a more nuanced picture of what types of innovation lead to entrepreneurial activity can be developed.

Third, the government support must be disaggregated onto particular policy tools, i.e. R&D subsidies, tax breaks, government procurement, and incubation programmes, to determine which tools enhance or undermine the innovation-entrepreneurship relationship. Fourth, future research would need to test formally for non-linearities and thresholds in order to determine the point of government support where the aid turns entrepreneur-enabling to entrepreneur-constraining.

Lastly, the country-specific and firm-level would assist in revealing the micro-level processes of how government support influences the innovation diffusion and entry of entrepreneurship,

extending the framework to other areas of the emerging economies would test the generalisability of the BRICS evidence.

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