A Comparative Analysis of Responsible Innovation Governance: Mapping Policy Instruments - across the BRICS Spectrum

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Abstract

The Responsible Innovation Governance (RIG) focuses mainly on Western-centric context creating a gap in understanding its application across diverse political economies. This study compares Responsible Innovation (RI) governance across BRICS (Brazil, Russia, India, China, and South Africa) and studies how each country's governance style affect and impact RI policy tools. To study we have developed and used multi-level analytical framework to map key RI principles such as anticipation, reflexivity, inclusion, responsiveness, and deliberation with Science, Technology, and Innovation (STI) policies. The study also examined how these policies are interacting with contextual moderators and the impact on outcomes. The study results clearly found the differences across the BRICS: Brazil and India use networked based economic systems with broad, but uneven integration of RI; China and Russia with state led economic system focus on anticipation and responsiveness but missed reflexivity and inclusion; South Africa uses market based approach. The study found that there is no single model for RI governance. Our study results suggest that our multi level analytical RIG model does not fit all, and an individual governance framework should be adopted for each country's institutions.

Keywords: Responsible Innovation (RI), Innovation Governance, BRICS, Comparative Policy Analysis, Science, Technology, and Innovation (STI) Policy, Governance Indicators

Introduction

Responsible Innovation (RI) is a multi-dimensional, interdisciplinary framework that aims to integrate ethical, societal, and governance concerns in the innovation processes, balancing future-oriented responsibility through continuous stakeholder engagement, digital adaptations, and continuous methodological innovations to address challenges such as adaptability, ethical considerations, and ethical dilemmas in emerging technologies and diversity and inclusion (Zhao et al., 2023) (Schroeder & Ladikas, 2015) (Wiarda et al., 2021) (Maines et al., 2020). RI is a systematic approach to anticipate risks and align innovation with societal values, emphasizing anticipation, reflexivity, inclusion, and responsiveness (Zhao et al., 2023; Jirotka et al., 2017).

The governance of transformative technologies requires building an effective innovation ecosystem. But the governance of transformative technologies itself presents a fundamental challenge, steering towards benefits to society while mitigating risks. As the challenge is framed by the dual nature of technologies, General Purposive Technologies (GPTs) are characterized by widespread intrinsic potential for improvement and mutual innovation across sectors (Bresnahan & Trajtenberg, 1995). In contrast, Mission Oriented Technologies (MOT) refers to innovations purposefully developed to tackle societal challenges, such as climate change, green energy technologies, sustainable urban development, and public health. These technologies often require long-term stable policy commitment (Mazzucato, 2018). Transformative governance identifies different strategies at the different stages of the ecosystem's evolution. In the emergence stage, policies should promote diversity and connectivity. During the expansion stage, governance should promote standardization and data accessibility. In the maturity stage, measures to ensure governance benefits, reduce switching costs, and maintain institutional stability to nurture innovation and system soundness (Könnölä et al., 2021).

Responsible innovation emphasizes anticipation, reflexivity, inclusion and responsiveness (Stilgoe et al., 2013). The strategic coupling of BRICS industrialization and infrastructure systems with responsible innovation paths require Integration of these four dimensions into governance of large scale infrastructural projects. The BRICS bloc has a different political and economic structure, which induces responsible innovation not only considered as ethical but also considered as a strategic decision in aligning with Sustainable Development Goals (SDGs).

Responsible Research and Innovation (RRI) should be more responsible and adaptable. It should be considered as a way for stakeholders to work together and respond to each other, expecting research and innovation outcomes that address the major challenges (von Schomberg, 2013). European Commission as a policy approach led RRI by practice in the form of themes like public engagement, open access, science education, gender equality, and ethics, RI aims in-depth systematic, and institutional transformation, whereas RRI is often criticized as lacks balance in bringing the real transformation due to its fragmented approach (Owen & Pansera, 2019).

The BRICS bloc (Brazil, Russia, India, China, and South Africa) occupies significant contrary position in the contemporary global economy. BRICS industrialization and infrastructure systems are shaped by challenging global trade environment and macroeconomic uncertainties. According to the United Nations' World Economic Situation and Prospects 2025 (United Nations, 2025), the updated aggregate growth forecast for developing economies remains at 4.1% for both 2025 and 2026. China's growth has been revised upward to 4.9%; India is projected to grow by 6.3%; Russia's growth is expected to slow sharply to 1.1%; Brazil with growth forecast at 2.2%; and South Africa remains at 1%. The report also highlights that infrastructure development among the BRICS is complicated by global trade tensions and shifting supply chains. In this disintegrated global landscape BRICS economies may struggle to enhance industrial competitiveness and achieve sustainable development goals.

In spite of this confluence of relevance, a significant research gap persists. The majority of RI policy models are with western-centric principles, assuming governance mechanisms characterized by democratic norms, well established civil society as performers, and certain state-market relationships. There is a lack of comparative and empirical studies on how RI is understood, practiced, and managed in the different political and economic systems of major emerging economies. Specifically, there is a lack of systematic understanding of how clearly core RI principles are integrated in national policy documents outside the Western context, the mix of policy instruments implemented in governance, and how different national governance styles translate RI into practice. As this gap is both empirical and theoretical, due to this policy makers and scholars have limited understanding of different ways Responsible Innovation Governance (RIG) present around the world. Our current study addresses the gap by asking ourselves "*How do BRICS differ in their governance mechanism to RI and how their National governance styles influence in the application of policy instrument*". To answer this question, we compare BRICS commitments mapping RI Meta-principles, their policy mix structures, and quantitative measures of governance and innovation. Following objectives of the study will address our major research question.

1.   To map and compare how BRICS addressing RI Meta-principles within their respective National STI policies.

2.   To examine the policy-mix architecture (level, mode and type) and usage of instruments for RI governance in the country.

3.   To explore how governance factors such as Research and Development (R&D) spending, Global Innovation Index (GII), and World Governance Indicators (WGI) relate to different RI governance methods and results including Voice and Accountability (VA).

4.   To develop a typology of RI governance style within the BRICS spectrum showing how governance structure relate to policy choices and innovation outcomes.

This research makes two contributions. First, by offering a detailed evidence based discussion of RIG in non-Western context. Second, we introduce and apply multi-level framework that connects governance structures to policy instrument choices, providing a model for future comparative studies in innovation governance. The comparative analysis of BRICS holds significance in three areas. First, from a theoretical perspective, it expands Western theoretical contexts of RI by evaluating its relevance and adaptability within various governance ecosystems. Second, empirically, it presents mapping RIG policy instruments across BRICS. Third, practically, it provides evidence based insights for national policy makers and global institutions to promote inclusive and effective governance.

Literature Review

Early Foundations:

The earlier foundations of RI can be traced to earlier frameworks that addressed the relationship between technology and society, including Technology Assessment (TA), Constructive Technology Assessment (CTA), and Science and Technology Studies (STS) (Schot & Rip, 1997; Guston & Sarewitz, 2002). TA gained importance in 1970's, as it attempts systematically evaluate the impact of new technologies on society, though critics often consider this as philosophical nature with limited capacity to influence innovation paths (van Est & Brom, 2012).

In shaping technological development CTA evolved beyond traditional TA by endorsing early intervention in the innovation process with broader stakeholder participation (Schot & Rip, 1997). The European Commission's Science and Society Action Plan 2001 policy context, based on various initiatives on ethics, science, and technology, provided impetus through systematic approaches to govern emerging technologies. Through this policy context, European countries intended to maintain competitiveness globally, foster scientific progress, guide innovation to a socially desirable population, bringing the science policies closer to the public, and create demand for frameworks to foster innovation (European Commission, 2001).

Emergence of Responsible Innovation

In the late 2000's concept of 'Responsible Innovation' largely appeared in academic and policy related documents. (von Schomberg, 2013) provided a comprehensive definition characterizes responsible research innovation as a transparent and interactive process where innovators and societal actors are "mutually responsive" to ensure the sustainability, societal desirability, and ethical accessibility of innovation with a goal to effectively integrate scientific and technological innovations into society. (Owen et al., 2013) advanced the theoretical developments of responsible innovation and proposes that responsible innovation requires a foresighted governance model including four integrated dimensions instead of depending only on philosophical risk assessment. (Stilgoe et al., 2013) four dimensional framework became foundation for responsible innovation practice. According to their framework responsible innovation requires anticipation in governance, reflexivity on the parts of innovators and institutions, inclusion for innovation legitimacy, and responsiveness of political economy and stakeholders concerns.

Institutional Adoption and Policy Integration

RI gained significant importance, particularly in European Science and Innovation Policy. The European Commission incorporated RI as a cross-cutting policy in Horizon 2020, a research and innovation funding program. The RRI is integrated into Horizon 2020 with the objective of fostering sustainable research and innovation (Tabarés et al., 2022). Despite implementation challenges, this unique policy experiment influenced to develop new framework, Horizon Europe (2021-2027), to boost the European Union (EU) competitiveness and growth. (Kumpf and Jhunjhunwala, 2023) emphasized that adoption requires building institutional capabilities in order to ensure that a method or technology is used responsibly and appropriately throughout the organization.

The main barrier to the adoption of RI by the rational firms is the perceived trade-off between the profit motive and social responsibility. The economic approach of RI certification label aligns with the profit motive with social objective. This approach can turn RI from a cost center to profit maximizing strategy through competitive advantage (Lukovics et al., 2023). (Stahl, 2022) emphasized that policy integration should be flexible beyond a top-down approach regulation to include adaptive governance mechanisms, knowledge building mechanisms, and stakeholder engagement.

Responsible Innovation Frameworks

To promote creativity and opportunities for innovation and science which are acceptable to society. The United Kingdom (UK) adopted the RRI framework proposed by Owen et al. (2013), popularly known as AREA framework. The framework consists of Anticipate, Reflect, Engage, and Action. This four dimensional framework overlaps with Stilgoe et al. (2013), where action is replaced with responsiveness.

The AREA framework has provided the structure for implementing RRI by encouraging foresighted governance of science. Stilgoe et al. (2013), ARIR (Anticipation, Reflexivity, Inclusion and Responsiveness) framework has achieved widespread recognition among scholars and practitioners. This framework has provided a structured approach to integrate responsibility within the governance mechanism for science and innovation. In the framework *anticipation* involves

considering future risks, unexplored issues, and applications. *Reflexivity* is a condition where institutions and researchers examine their own activities, commitments, assumptions and demands openness and stewardship within the culture of science. *Inclusion* highlights the inclusion and engagement of diverse stakeholders in the deliberation process that shapes innovation paths. *Responsiveness* encompasses the capacity to change or adopt research directions and governance mechanisms in the light of new knowledge, emerging perspectives, and societal views.

Von Schomberg(2013), outcomes oriented approach conceptualized RI as process aimed at achieving the right impacts, which are defined by society desirable, innovations which are sustainable and acceptable. Additionally, the approach views RI as a interactive process between societal actors and innovators. von Schomberg (2013), argues that RI must be judged based on the innovations which are addressing the challenges faced by the society and contributing for the sustainable development. The European Commission promoted RRI through policy activities, under the programs such as 'Science and Society', 'Science in Society', and 'Science with and for Society'. The European Commission's RRI framework comprises of six keys: engagement, gender equality, science education, ethics, and open access. This framework reflected the priority of the institutions translate RI into transformational policy domains like funding programs (Quinn, 2012).

Research Methods

The major objective of our research is to study, analyze, and compare the RIG across the BRICS Nations. To study we employed a qualitative case study design, strengthened by descriptive quantitative indicators. This design is apt, as we treat the five BRICS Nations as distinct yet comparable of emerging economies context, steering towards technological transformation.

Data Collection

Using a purposive sampling strategy, data were collected from official National policy documents related to Science, Innovation, and Technology. The documents are related to Science, Technology, and Innovation (STI) policies, development plans, ethical guidelines, governance frameworks, open government partnerships, executive statements, and Government reports. Analyzed qualitative documents are presented in the country specific tables (Refer to tables 1 to 5). Quantitative data was collected from the World Bank to study R&D expenditure as a percentage of GDP, aggregate scores of Worldwide Governance Indicators (WGI) to study the governance context, and Global Innovation Index (GII) rankings from the World Intellectual Property Organization (WIPO) to study the innovation performance. Quantitative data from the International databases are key to studying the contextual moderators (L4) and outcomes (L5).

Data Analysis

A structured qualitative content analysis was conducted on the various policy documents of the BRICS related to STI policies. Quantitative data were analyzed using descriptive analysis. For L1 analysis, a binary coding system (presence = 1 and absence = 0) for all five defined responsible innovation principles. From the policy document, we have identified verbatim phrases indicating each principle (refer to tables 1 to 5). Binary code '1' was assigned if evidence of principle is found. For L2 based on the documents, individual counties governance system was analyzed based on the dimensions governance level, coordination mode, and governance type. The governance level is coded as local (1), regional (2), and global/networked (3) based on the International engagement of the BRICS. Coordination mode is classified as hierarchy (top-down approach/state led), network, or market, based on the governance mechanism for fostering innovation. Governance type is coded as '0' for monocentric and '1' for polycentric.

For L3 analysis, each country policy instrument from the official documents is catalogued for diversity (L3_div), scored on a scale of 1 to 3 based on the instrument type used (regulatory, economic, and informational/organizational). Novelty (L3_novel) scored on a scale of 1 to 5 if RI is adopted for the purpose of innovation governance approaches. For intensity (L3_intensity) a proxy metric is calculated as diversity score * novelty score / total possible score (3 * 5 = 15) to measure the instrumental mix. For L4 and L5 analysis, quantitative data for Research and Development (R&D) expenditure percentage to the GDP, GII rankings, and WGI Scores were compiled into comparative tables and descriptive statistics to analyze the patterns.

Conceptual Framework

To systematically analyze and compare Responsible Innovation Governance (RIG) across the BRICS spectrum, we have developed and applied an original multi-level conceptual framework (Refer figure 01), conceptualized as interdependent system comprising five analytical levels: (L1) RIG Meta Governance principles evaluate the indirect commitments to RI principles (Anticipation, Reflexivity, Inclusion, Responsiveness, and Deliberation); (L2) Policy-mix architecture is a structural level. Here in this level we study and analyze design of the governance mechanism level (Local/Regional/Global), mode (hierarchy / network / market), and type of economy (monocentric / polycentric); (L3) Policy instrument, as operational level we study the governance mechanism related to regulatory, RI labels, economic, software, and RI tools used and their innovation outputs (diversity, novelty, and intensity); (L4) Contextual moderators, as a National context level studied and analyzed National inputs like Research and Development (R&D) expenditure, World Governance Indicators (WGI), and Global Innovation Index (GII); (L5) Outcome and Effectiveness level considered as the impact level to study on participatory governance by considering the voice and accountability score. The framework proposes that governance style (revealed in the level L1 & L2) mediates the selection of the policy instruments (L3), interacting with contextual moderators (L4) to produce unique responsible innovation and outcomes (L3 & L5).
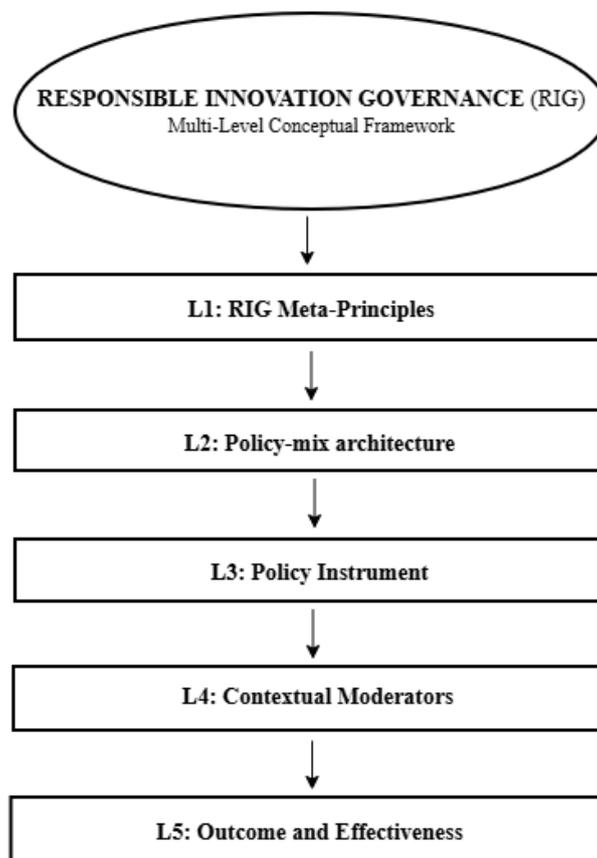
Figure 01: Research framework

Results

Table 01: Showing RIG Meta principles analysis for Brazil country

RI Principles	Key Verbatim Phrases	Source Document(s)
Anticipation	long-term policy for Scientific Technology and Innovation (STI); strategic technologies; competitiveness; sovereignty; environmental responsibility	National Strategy for Science Technology and Innovation (Ministério da Ciência, Tecnologia e Inovação (MCTI), 2025)

Reflexivity	Open science through Open Government Partnership (OGP); OGP as a path to organize; innovation diplomacy	Brazil's Open Government Journey, November 2024(The Independent Reporting Mechanism (IRM), 2024)
Inclusion	inclusive process; science for social development; benefits for local, and indigenous communities	National Strategy for Science Technology and Innovation (Ministério da Ciência, Tecnologia e Inovação (MCTI), 2025)
Responsiveness	responsible exploration; benefit for all countries, people, and future generations; long-tem sustainability	-UNOOSA 2024 Statement (Santos, 2024); -Voluntary National Review. 2024 (General Secretariat of the Presidency of the Republic, 2024).
Deliberation	citizen participation in debate, collaboration, contribution; intercultural dialogue for policy and community engagement	-UNESCO Country Strategy 2025-2027(UNESCO, 2025). -Brazil's 6th National Action Plan (Comptroller General of the Union, Brasilia, 2024).

Source: Authors compilation

Table 02: Showing RIG Meta principles analysis for Russian Federation

RI Principles	Key Verbatim Phrases	Source Document(s)
Anticipation	long-term forecast; great challenges; adaptation measures;	Executive Order of the Presidents of the Russian Federation on the Scientific and Technological Development Strategy of the Russian Federation (The Scientific and Technological Development Strategy of the Russian Federation , 2024)
Reflexivity	protecting human rights; ensuring security; technological sovereignty; formation of ethical standards;	National Strategy for the Development of Artificial Intelligence(Regulations.ai, 2025)
Inclusion	NA	
Responsiveness	prevent the unauthorized transfer of scientific results outside of the country; coordinating the participation;	Federal Law On Science and State Policy in Science and Technology (President of Russia, 2025).
Deliberation	NA	

Source: Authors compilation

Table 03: Showing RIG Meta principles analysis for India

RI Principles	Key Verbatim Phrases	Source Document(s)
Anticipation	Forward looking strategies; risk governance; equal opportunity; long-term missions; adaptive regulatory; anticipatory governance;	Draft 5th National Science, Technology and Innovation Policy (Government of India, Ministry of Science & Technology, 2020)
Reflexivity	Participatory, inclusive, and evidence-based policy; adaptation; decentralized; revisiting; reorienting;	Background Note National Science, Technology and Innovation Policy 2020 (Government of India, Office of the Principal Scientific Adviser, NITI Analog, & Department of Science and Technology., 2020)

Inclusion	Principle of inclusivity; non-discrimination; inclusive of all stakeholders;	Responsible AI –Approach Document for India (NITI Ayog, 2021)
Responsiveness	Dynamic policy; periodic review; feedback; adaptation;	Draft 5th National Science, Technology, and Innovation Policy for public consultation (PIB , 2021)
Deliberation	Apex level multi-stakeholder engagement; focused deliberations;	Responsible AI –Approach Document for India (NITI Ayog, 2021b)

Source: Authors compilation

Table 04: Showing RIG Meta principles analysis for China

RI Principles	Key Verbatim Phrases	Source Document(s)
Anticipation	Technical and design focused anticipation; institutional mechanisms; risk management;	Position Paper on Strengthening Ethical Governance of Artificial Intelligence (AI) (Ministry of Foreign Affairs, People's Republic of China, 2022)
Reflexivity	NA	
Inclusion	NA	
Responsiveness	Follow up review; Re-Examination; Checklist Management; Emergency review procedures;	(Trial) Measures for Science and Technology Ethics Reviews, (Chinese Ministry of Science and Technology , 2023)
Deliberation	Platforms for scientific and technological cooperation; open digital governance system;	Global AI Governance Plan (Permanent Mission of the People's Republic of China to the UN, 2025)

Source: Authors compilation

Table 05: Showing RIG Meta principles analysis for South Africa

RI Principles	Key Verbatim Phrases	Source Document(s)
Anticipation	Anticipate and plan for change; regular foresight exercises; environmental scanning; looking for the future; preparing for change;	White Paper on Science, Technology and Innovation, 2019 (Department of Science and Technology, Republic of South Africa, 2019).
Reflexivity	Responsible research and innovation; enabling innovation environment;	STI Decadal Plan 2022-2032 (Department of Science, Technology and Innovation, Republic of South Africa, 2024).
Inclusion	Inclusive economic development; help achieve individual and collective goals; benefit of the people of South Africa; participating in outreach activities;	Official Guide to South Africa 2020-21 (Department of Science and Innovation, 2021).
Responsiveness	To ensure an open, responsive and diverse knowledge system; relevance and acceptability of STI to society; engagement of all societal sectors; responsive to wide range of stakeholders;	White Paper on Science, Technology and Innovation, 2019 (Department of Science and Technology, Republic of South Africa, 2019).
Deliberation	NA	

Source: Authors compilation

Table 06: Showing analysis of RIG L1 Meta-Principles across BRICS

Country	L1_Anti	L1_Ref	L1_Incl	L1_Resp	L1_Deli	L1_Sum
Brazil	1	1	1	1	1	5
Russia	1	1	0	1	0	3
India	1	1	1	1	1	5
China	1	0	0	1	1	3
South Africa	1	1	1	1	0	4

Note: The presence of RIG principle is indicated as 1 and absence as 0

Source: Authors

The analysis of RIG L1 Meta-Principles across BRICS reveals three different RIG mechanisms. From the table 06, Brazil and India have a comprehensive governance system with the presence of all five principles, indicating a strong institutional environment balancing anticipation, reflexivity, inclusion, responsiveness, and deliberation. Whereas Russia and China exhibit state led governance mechanisms, but different in their absence principles: Russia lacks inclusive and deliberation principles, and China lack reflexivity and inclusion principles. In the state-centric governance mechanism, legality is claimed through the results and authority. South Africa represents a hybrid governance mechanism, only missing the deliberation principle. From the table 06, it is observed that all the BRICS Nations have anticipatory and responsive mechanisms in their governance indicate future orientation and adaptability.   As observed from the table 06 variations in reflexivity, inclusion, and deliberation principles across the BRICS Nations indicate that differences exist due to their polyarchy, liberal democracy, pluralist democratic, and state-led governance systems. These foundational governance mechanisms shape how the Nations innovate. Countries like Brazil and India with well-established participatory governance mechanisms produce a wide variety of new ideas and distribute power across many groups. Countries like Russia and China, where state-led systems tend to focus, control, and direct innovation through a centralized approach.

Table 07: Showing analysis of L2 Policy-mix architecture across BRICS

Country	L2_gov_ lev	L2_dom_mod	L2_gov_type
Brazil	3	network	1
Russia	2	hierarchy	0
India	3	network	1
China	2	hierarchy	0
South Africa	3	market	1

[Note: L2_gov_lev: 1 = local; 2 = Regional; 3 = global/networked;

L2_gov_type: 0 = Monocentric; 1 = Polycentric;]

Source: Authors

The table 07 shows that the analysis of the L2 policy mix architecture across the BRICS uncovered two different innovation governance mechanisms. Brazil, India, and South Africa exhibit a polycentric type of governance mechanism operating at the global/networked level, with dominant coordination through network or market based modes. This kind of governance mechanism indicates multifaceted, multidimensional engagement that is decentralized, participatory, and adaptive, conducive to distributed and diverse forms of innovation. In contrast, Russia and China exhibit a monocentric type of governance mechanism anchored at the regional level, coordinated hierarchically. The policy-mix architecture reflects a state centric, top down approach in terms of architecture in which policy direction is concentrated and vertically

integrated, steering innovation along more focused, state prioritized pathways. The type of governance highlights how the participants, stakeholders, mechanisms, and national innovation systems are established by basic governance structures.

Table 08: Showing L3 Policy Instrument analysis across BRICS

Country	L3_div	L3_novel	L3_intensity
Brazil	3	5	0.19
Russia	2	2	0.07
India	3	4	0.13
China	2	3	0.05
South Africa	3	4	0.15

Source: Authors calculations

The table 08 discovers, with reference to the governance architecture, different innovation performance profiles across the BRICS. From the table 08, it is evident that, across BRICS only three countries (Brazil, India, and South Africa) demonstrated high innovation diversity, novelty, and intensity. All three countries have polycentric, network, or market based governance mechanisms that promote different, adaptive and intense innovation across the various sectors. The variance is observed in the countries Russia and China due to their hierarchical, state led governance mechanism. Through the table it is found that economies with polycentric governance mechanisms resulted in more diverse and intense innovation outcomes, while economies with monocentric governance mechanism channels innovation into more focused, but less novel, and with less intense innovation.

Table 09: Showing L4 Contextual Moderators – R&D expenditure (% of GDP)

Country Name	Year							
	2015	2016	2017	2018	2019	2020	2021	2022
Brazil	1.37	1.29	1.12	1.17	1.21	1.15	**	**
India	0.69	0.67	0.67	0.66	0.66	0.65	**	**
Russian Federation	1.10	1.10	1.11	0.99	1.04	1.09	0.96	0.93
China	2.06	2.10	2.12	2.14	2.24	2.41	2.43	2.56
South Africa	0.73	0.75	0.76	0.69	0.61	0.60	0.62	0.62

Source: World Bank   Note: * * Non availability of data due to COVID

From the table 09, Research and Development (R&D) expenditure as a percentage of GDP reveals two distinct trends across the BRICS Nations. China has demonstrated consistency in its investment in R&D, increasing from 2.06% in 2015 to 2.56% in 2022. This consistency in China reflects their commitment towards sustainability as a core principle in their development. The consistent increase in R&D expenditure is not a market driven behavior, it is embedded in National policy and directing investment in strategic sectors is possible because of state-led governance mechanisms. Except for China, the remaining BRICS countries exhibit stagnant and declining trend.

It is evident from the table 09 that Brazil, India, Russia, and South Africa show inconsistent patterns without sustained growth, post 2018 decline reflects the Nation's structural and fiscal constraints, being a networked type of governance mechanism. Compared to other BRICS Nations, India has low and stable investment expenditure on R&D (0.65-0.69%). Russia's gradually declining expenditure, from 1.10% to 0.93%, reflects how economic conditions corrode innovation capabilities of a country.

Table 10: Showing analysis of L4 Contextual Moderators – GII Rank

Country Name	Year				
	2024	2023	2022	2021	2020
Brazil	50	49	54	57	62
India	39	40	40	46	48
Russian Federation	59	51	47	48	47
China	11	12	11	12	14
South Africa	69	59	61	61	60

Source: Compiled from World Intellectual Property Organization (WIPO)

The GII rankings from 2020 to 2024 (Refer to table 10) reveal three different performance trends among BRICS. China's high intensity of directed investments in strategic sectors helped maintain its consistent performance in the GII, ranking in the top 15 throughout the period. The path of China aligns with growing R&D intensity and reflects state led directed innovation model. India shows remarkable performance, improving from 48th to 39th rank as a steady advancing innovator despite low R&D expenditure; networked governance mechanisms fuelled the greater innovation efficiency and impact. Due to the structural constraints, Brazil and South Africa exhibit moderate and volatile progress despite a polycentric type of governance mechanism. Despite stable R&D intensity, observed a sharp decline in the performance of Russia, underscoring the vulnerability of the hierarchical governance mechanisms during economic shocks, which may underscore the innovation system's performance.

Table 11: Showing analysis of L4 Contextual Moderators – WGI

Country	Governance Indicators					
	Voice and Accountability	Political Stability	Government Effectiveness	Regulatory Quality	Rule of Law	Control of Corruption
Brazil	59.79	58.11	47.91	51.61	49.49	39.52
Russian Federation	36.56	54.02	47.84	43.30	39.71	31.24
India	55.59	53.25	58.17	52.88	55.16	41.87
China	28.59	62.00	62.71	53.80	47.52	49.29
South Africa	66.94	55.77	50.27	54.62	57.48	45.93

Source: Authors compilation from World Bank Governance Indicators (2020-2024)

The table 11 provides the average scores of governance indicators across the BRICS for the period 2020-2024. These indicators help understand the governance context in which RI policies are developed and implemented. It is evident from the table 11 that South Africa has the highest scores in Voice and Accountability (VA) (66.94) and the Government effectiveness score (50.27) reveals a strong governance mechanism for public participation and the performance of the public sector. This type of governance eases the integration of RI polices with transparency based on societal needs. On the contrary, China, despite having the highest score in Government Effectiveness (62.71), the lowest score in VA (28.59), exhibits the importance given to efficiency than Government Effectiveness, which will have an impact on legitimacy and public acceptance of RI policies. India's highest scores can be observed in the Government Effectiveness (58.17) and in VA (55.59), performing moderately. India should address the lower scores in Regulatory Quality (52.88) and Control of Corruption (41.87) to ensure the integrity and consistency of RI policies. Brazil's high performance scores in VA (59.79) and Political Stability (58.11) suggest that potential to develop and enforce RI policies effectively. On the other hand, Russia shows the lowest score in VA (36.56) and Control of Corruption (31.24), which will obstruct the development of robust RI policies and Implementation.

Overall, among the BRICS diverse governance indicators observed, these indicators influence the design, adoption, and impact of RI policies. Among the BRICS challenges of each country differ, with reference to the table, we would like to suggest that the RIG framework should be tailored from the perspective of respective countries governance strengths and ensure the RI policies are legitimate in meeting the requirements of societal needs.

Table 12: Showing L5 Effectiveness and Outcome: VA Scores

Country	2020	2021	2022	2023	2024
Brazil	59.8	58.2	57.38	61.2	62.4
Russian Federation	41	39.5	36.46	33.9	32
India	57.8	55.2	55.13	54.4	55.5
China	29.9	28.6	28.55	28	27.9
South Africa	65.7	68.1	66.73	66.7	67.5

Source: World Bank (www.govindicators.org)

The table 12 presents the VA score for the period 2020-2024. The VA indicator gathers the opinion about the degree to which people can choose their Government. From the table 12, it is evident that among the BRICS, South Africa registered the highest scores throughout the period, due to their institutional governance mechanism for public participation and freedom of expression. Brazil's VA score declined in the period 2020 to 2022, due to political instability, which surpassed the growth and corrected in the years 2023 and 2024 due to its democratic strength. Whereas India is performing above the global median (50) due to the recent policy shifts affecting civic space.

Over the five year period, Russia's VA score has declined from 41 to 32, which is most striking among the BRICS due to their state led governance mechanism. China's score remain stable at a low level, with low fluctuation aligns with a unique governance mechanism that gives more importance to state authority over liberal notions of VA. These trends demonstrate how economic development, political systems, and institutional mechanisms are closely linked. The changes in the trends are influenced by respective countries policies and governance mechanisms.

Discussion

The analysis results reveal that RIG varies across the BRICS countries, due to their different governance mechanisms. Brazil and India adopted the majority of the RIG principle due to their polycentric and network based governance approach. Their higher scores in VA helped in creating a more participatory and flexible innovation environment. Whereas China and Russia use state-led, hierarchical governance mechanisms focused on anticipation and responsiveness, but often lack reflexivity and inclusion principles. This means that, in the centralized governance mechanism, able to maintain strong investment in R&D and support achieving technological goals, as evident in China's improved innovation ranking. It may also reduce the diversity and societal acceptance of innovation outcomes. South Africa represents a combined approach with participatory and market-led governance mechanisms but still struggles to convert deliberation into consistent policy.

As observed from the results across the BRICS, there exists a difference in governance due to how much countries are spending on R&D, their innovation results, and the quality of their institutions. China's state-led governance mechanism has led to steady growth in R&D and innovation, but a low score in VA raises concerns about whether these innovations are acceptable to society and, in terms of ethics, over time. In contrast with less R&D spending, India shown impressive growth in the GII due to network based governance mechanism supported by inclusive and flexible innovation, though issues like corruption and regulation remain. Brazil and South Africa, with participatory governance mechanisms, have seen unstable innovation results as polycentric economic models are sensitive to economic and political changes. Overall, the country's style of governance mechanism is key in choosing and using RIG tools, influencing how innovation is managed, and whose perspectives are included.

Conclusion

This study substantiates that RIG across the BRICS is not the same due to individual countries political and economic systems. From the analysis, it is evident that countries like Brazil and India tend to have more flexible and inclusive governance mechanisms as their economic models are polycentric and networked. As China and Russia use state-led governance mechanisms, this approach has limited various stakeholders in adopting innovation to meet their specific goals and strategies. Though South Africa has a combination of two governance approaches, innovation is limited by structural challenges. The results suggest that our model RIG does not fit all, and an individual governance framework should be adopted for each country's institutions. The study confirms our main argument national governance style measured by L1 and L2, strongly acting as a powerful mediators in determining policy instrument mix (L3) in turn interacts with contextual moderators (L4) to create different innovation paths and societal results (L5). Policy makers, institutions, and scholars should comprehend that responsible innovation works best when ethical principles are supported by strong governance mechanisms. Across the BRICS countries with polycentric systems, they should focus on reliable funding and stable institutions, while countries with state-led systems should focus on flexible and inclusive processes to build trust and legitimacy within society.

Theoretical Implications

This research has made several contributions to innovation and governance studies. The study found that the main RI frameworks (Stilgoe et al., 2013; von Schomberg, 2013), were mostly developed based on the European context, as the features are universal can be considered in emerging economies context, as evident in our study for example Chinese policy documents show little reflexivity and inclusion. To study the RIG our developed analytical multi-level framework to study the innovation governance offers to study comparative policy studies. From the study we found that it is harder to rely on standard ways of measuring innovation success. For example China's state-led model does well with the inputs such as R&D spending and its outcome in GII ranking. However, its low score in VA raises the question, 'how effective and sustainable this approach is for society?' So here in this case we suggest while assessing RIG traditional innovation indicators to be considered as it measures the effectiveness of legitimacy and public trust. This example suggest for reconceptualizing one of the RI principles 'effectiveness'.

Policy Implications

This research will provide actionable insights for policy makers within the BRICS spectrum. For polycentric economic systems (Brazil, India, and South Africa) stabilize the innovation system by creating long-term commitments for strategic RI missions and require anti corruption measures to build investor confidence and public trust in governance framework. For State led hierarchical economic systems (China and Russia) create well structured ways for stakeholders to participate in the technological assessments, discussions, and society represented panels. Instead of adapting EU context RI models, develop RI tool kit that matches with respective nations governance style which drives the innovation governance progress.

Limitations and future research

Since the analysis is primarily based on 'by law' or 'for law' policy statements, we may not fully capture the implementation of policies. Using binary coding of complex principles helps with comparison but also simplifies delicate policy discussions. In the conceptual framework, the established relationship between L2 and L3 is limited by the qualitative and cross sectional nature of the study. Although policy documents, reports, and executive statements were selected through extensive research, the selection may not be comprehensive. As we have done cross-sectional analysis, to trace the evolution of RIG style over the period, longitudinal studies are needed. Future research should focus more on how these policy statements are put into practice, their long term impact, and how they vary across sectors, instead of studying already stated policies.

In summary, as BRICS influence direction of technology in the 21st century, the question of *how* they innovate is just as important as *what* they innovate. As we find through our research, that there is no single path to RI. Instead, it is a complex and shaped by nation's governance choices. Globally, technological competition is growing; the BRICS experience can help by showing how emerging economies balance innovation and governance fairly.

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