5 GOVERNANCE, DIGITAL TRANSFORMATION, AND THE GIG ECONOMY: EVIDENCE FROM BRICS COUNTRIES

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Abstract

The interaction between digital transformation, governance quality, and infrastructure development has become increasingly central to understanding the structural foundations and sustainability of modern Gig economies. This paper analyzes the relationships among technological innovation (Tech), infrastructure (Infra), governance (Gov), and digital transformation (Dtrans), and the growth of the Gig economy (Gig) in BRICS countries (2016 to 2024). The study employs the Pooled Mean Group (PMG) estimator as the baseline method and the Common Correlated Effects Mean Group (CCEMG) estimator for robustness, to analyze the combined effect of Infra and Tech with Gov and Dtran on online labor markets (Gig). Results show that there is a negative impact of interaction between Tec and Infa (-0.696) and Global connectivity (Globcon) (-0.949), but literacy (3.182) and Dtrans (0.665) have a positive influence on the Gig in the long term. Similarly, the governance-digital transformation interaction (-0.799) and infrastructure (-1.493) are producing negative impacts, but financial development (1.955) and corporate activity (0.134) have positive impacts on the Gig. These results suggest that human capital and access to digital processes increase the growth of the Gig economy. However, structural and institutional interactions can create inefficiencies. Policymakers should prioritize strengthening digital inclusion and human capital while reforming governance–infrastructure complementarities to minimize institutional inefficiencies and fully realize the growth potential of the Gig economy.

Keywords: *Gig Economy; Technological Advancement; Digital Transformation; Governance frameworks; Infrastructure Development*

JEL Classification: *J23, J24, L86, O33, O38, F63*

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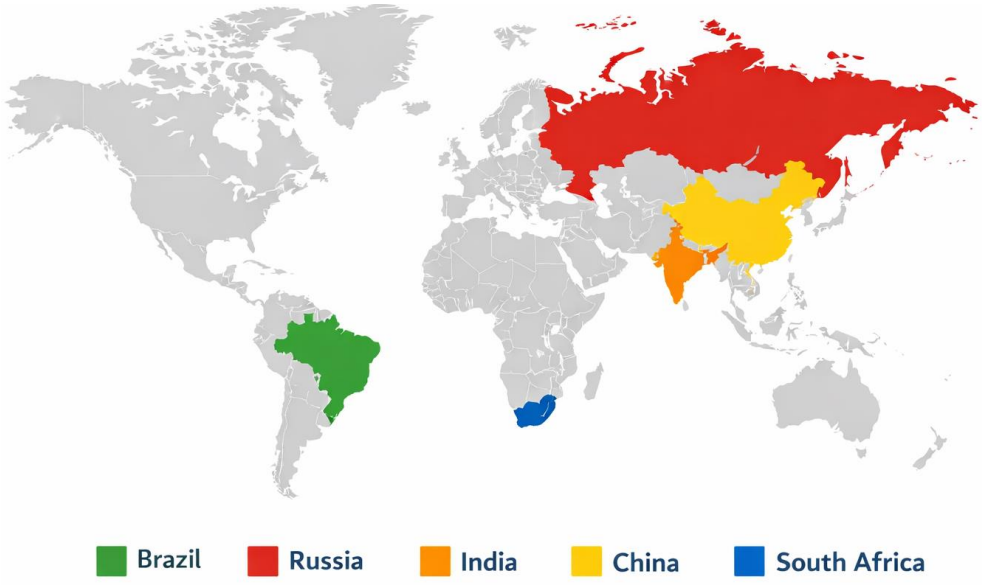
1. Introduction

The gig economy (Gig) has become a revolutionary force in global labor markets and is changing labor and economic structures. The Gig, defined as short-term, flexible work solutions facilitated through digital platforms, has become prominent across diverse economies, especially in emerging economies such as the BRICS nations (Brazil, Russia, India, China, and South Africa) (Sharma and Sharma, 2025). Gig work in these countries is analyzed in the context of rapidly growing economies with diverse institutional frameworks and varying stages of technological and infrastructural development. According to Braesemann et al. (2022), digital platforms have played a pivotal role in fueling Gig work, while Sundararajan (2017) highlights the disruptive impact of technological innovation on traditional labor markets. This creates an interesting setting to examine the interactions between technology and Gig.

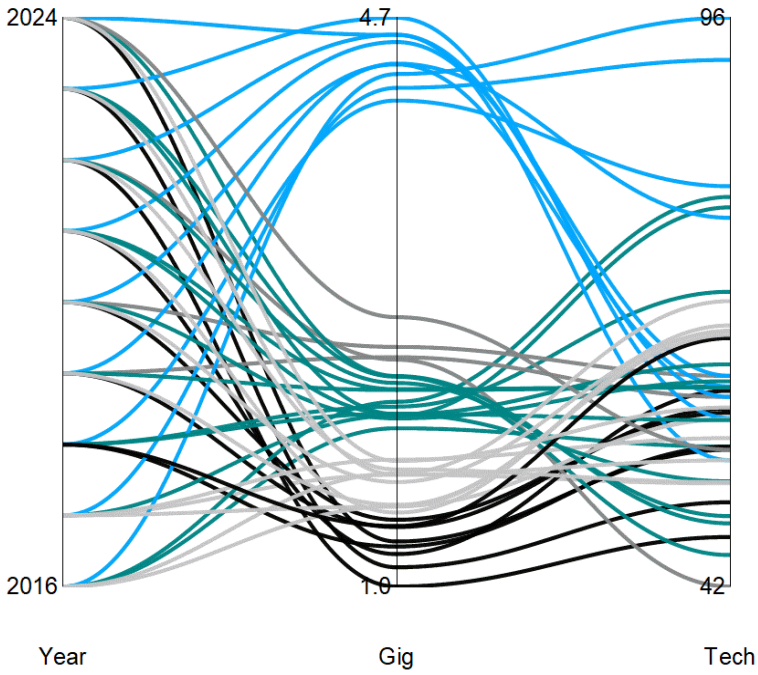
Gig is playing a vital role in labor engagement and ultimately in economic growth. Innovation (Tech) and digital transformation (Dtrans) are now considered vital determinants of sustainable growth across sectors (Yangjin *et al.,* 2026; Hongbin *et al.,* 2026). In this regard, digital platforms are shaping today's labor market, enabling temporary hires and freelance work in the Gig Economy (Himani Srihita *et al.,* 2025). Zhu et al. (2023) also validated the role of regional digitalization in the growth of Gig opportunities. In this regard, the role of institutional quality and governance (Gov) framework is also important. Achieving the ultimate benefits of Gig depends on the quality of institutions and Gov mechanisms that enable Gig workers to have fair working conditions (Adams-Prassl, 2022; Singh *et al.,* 2023). The BRICS countries represent more than 3 billion people, and the stated theme is highly relevant to these nations (Rani *et al.,* 2025). A graphical representation of the BRICS countries, along with their geographical distribution in Figure 1, shows that all the countries together play a significant role in the global economy.

Figure 1: Visual map of BRICS



Central to this study is the exploration of factors that drive Gig, focusing on two key dimensions. How Tech and infrastructure (Infra) contribute to the creation of Gig work, and how Gov and institutional quality affect Gig work. Previous work has highlighted the role of Infra and Dtrans in developing potential for flexible work arrangements (Liu *et al.,* 2023). Gao and Zhu (2026) recently explored digital Infra as a vital enabler of Gig work. In contrast, Devyatkova et al. (2023) focused on the interaction of Infra and innovation (Tchinf) for the establishment of economic resilience. In addition, Joshi (2023) analyzed how institutional quality affects the extent to which Tech impacts employment outcomes. In parallel, as proposed by Hoff (2021), the Gov of the Gig is important in shaping the success of policies that support or regulate the Gig. The present study formulated two models to explore the determinants of Gig across BRICS nations, including Dtrans, Gov, Infra, and institutional synergies. A graph showing the Tech relationship with Gig for BRICS nations is given in Figure 2.

Figure 2: Visual representation of main variables trends



Source: Author's Construction

Figure 2 shows the progression of Gig from 2016 to 2024 and its link with Tech. The left axis represents the years, the right axis the Tech values, and the gradient shows the magnitude of Tech. It graphically shows how the Gig grows yearly in response to improvements in Tec. Over this period, line density and complexity have steadily increased, and an intensified interaction between Gig dynamics and technological progress is emerging. For instance, by 2024, the interaction between Gig and Tech becomes stronger and more closely linked, suggesting a growing reliance on Tech for Gig's growth.

Considering the stated theme, the present study analyzes the relationships among Tech, Infra, Gov, and Dtrans in the growth of Gig in BRICS countries (2016 to 2024). The specific research objectives of the study are as follows:

- *To evaluate the interactive impact of Infra and Tech on the Gig*
- *To investigate the collaborating influence of Gov and Dtrans on the Gig*

This study makes a comprehensive contribution to the emerging literature on Gig determinants. This is done by developing an integrated analytical framework that combines Dtrans, Gov, Infra, and Tech across BRICS economies over the period 2016–2024. Prior studies largely focus on developed economies, but the present work addresses a critical gap by examining emerging markets characterized by diverse institutional structures, varying Gov quality, and rapid technological change. The study introduces two interaction terms: Tchinf (innovation × infrastructure) and Govdt (governance × digital transformation). These are taken to capture the interconnected and complementary roles of Tech and institutional factors in shaping Gig work, thereby extending earlier work that considered these dimensions in isolation. Using a panel dataset spanning nearly a decade and employing advanced econometric techniques, the research captures both temporal and regional dynamics, enabling a more robust analysis of causality and long-term trends. Furthermore, by incorporating macroeconomic and structural variables such as Globcon, income levels, and corporate activity, the study provides a holistic understanding of the drivers of Gig expansion. Overall, it not only advances academic discourse by emphasizing the synergy between Tech and institutional quality but also offers evidence-based, policy-relevant insights for fostering a sustainable and inclusive Gig in BRICS countries.

After the introduction, this study is structured as follows. A literature review of previous research on the determinants of the Gig is presented in Section 2. An overview of the data, variables, econometric models, and empirical strategy used is provided in Section 3, and the findings are presented in Section 4. Finally, Section 5 concludes the study and recommends policy actions, presenting future research directions.

2. Literature Review

2.1 Theoretical Literature Review

This study is based on theories of labor market economics, institutional economics, and technological innovation. Gig presents a decentralized, more adaptable and flexible, short-term work arrangement that is sometimes platform-mediated rather than traditional labor-market models with standard employment contracts. This transformation follows Schumpeter's theory of economic development (Schumpeter, 1961), in which Tech replaces the existing order and opens new industries. Digital transformation and Tech have both contributed to removing barriers to labor market entry and increasing Globcon across BRICS nations. Sundararajan (2017) argues that the onset of these shifts is enabled by digital platforms that integrate individuals and businesses into a dynamic, tech-driven ecosystem. Moreover, the technologically and infrastructurally diverse nature of the BRICS landscapes underscores the importance of BRICS as a case for studying the determinants of the Gig.

To complement this perspective, the institutional economics perspective considers how Gov and 'financial development' (Fdev) shape the regulatory and operational environments of the Gig. According to North (1990), institutions contain the ‘rules of the game’ that shape which technologies, as well as economic activities, are adopted and regulated by society. De Stefano (2015) shows that Gov frameworks and the quality of institutions are critical to either encourage or discourage the growth of Gig work. The effects of these frameworks on the scalability and sustainability of platform work arrangements are direct. Additionally, the study incorporates terms of interaction between institutional and technology factors, including the innovation * infrastructure

(Tchinf) and governance * digital transformation (Govdt). The dynamic capabilities theory (Teece *et al.,* 1997) resonates with this approach in its assumption that business organizations must adapt to the volatile, rapidly changing economic landscape and, as a result, be tech-driven.

The comprehensive understanding of how Tech advances and institutional quality conditions Gig growth in the BRICS context is grounded in these theoretical underpinnings. On the one hand, the BRICS nations present a unique mix of economic and institutional diversities. On the other hand, with a shared focus on Dtrans and Infra development. All of the above nations share a fertile ground for analyzing the drivers of Gig work. This paper situates the study within the academic debates on digital labor markets, the institutional economics theoretical lens, and the economic development framework, thereby providing policy-relevant insights for developing a sustainable and inclusive Gig.

2.2 Empirical Literature

2.2.1. Impact of Innovation and Infrastructure on Gig

A rapid technological development, however, has facilitated growth on both the supply and demand sides (Bergek and Norrman, 2015; Khurshid *et al.,* 2026). Technological innovation is now considered mandatory for long-term sustainable outcomes in industries (Khan *et al.,* 2026; Liu *et al.,* 2026). He et al. (2024) emphasized that technological advancements, especially digital platforms, are fundamentally changing the structure of traditional labor markets, and tech-driven ecosystems are broadening global gig-based employment. The relationship between Infra and Tech with the Gig has been extensively studied, with findings highlighting their transformative roles in shaping flexible labor markets. Studies in the early stages, such as Graham et al. (2017), focused on the role of the Gig and digital labor as a strategy to create jobs. In particular, the foundational Infra, including internet connectivity to enable the growth of the Gig in Sub-Saharan Africa and Southeast Asia, establishes a positive relationship between digital Infra and on-demand labor opportunities.

Technological advancements are a key driver of the Gig, reshaping traditional labor structures and creating new avenues for flexible work. Kraus et al. (2023) highlight that the emergence of Industry 5.0—characterized by automation, cyber-physical systems, and digital platforms—has transformed economic relations and accelerated the development of Gig-based work through smart industry and service ecosystems. Similarly, Himani Srihita et al. (2025) emphasize the central role of digital platforms in enabling freelance and on-demand employment, noting that technological progress has expanded flexible work opportunities while also shaping worker experiences and labor market dynamics. Furthermore, Gao and Zhu (2026) demonstrate that participation in the Gig enhances Tech, particularly in emerging economies, by allowing firms and entrepreneurs to access specialized skills and resources. These findings suggest that Infra plays a critical role in enabling the Gig, given its strong and reciprocal relationship with Tech.

2.2.2. Impact of Governance and Digital Transformation on Gig

Governance and institutional quality are necessary determinants for achieving sustainable outcomes and achieving the required outcomes (Khan *et al.,* 2025; Khurshid *et al.,* 2025). Gov and Dtrans in the Gig form an indispensable relationship, as implied by many studies that call for strong Gov frameworks to confront emerging challenges in this new work system. As Lampinen et al. (2018) argued, algorithmic control tends to favor the platform owners. However, worker-led platform cooperatives can change that dynamic by altering the nature of ownership. Governments giving workers control over algorithms can lead to a fairer work experience, greater transparency, and a more democratic, accountable Gig. Similarly, Bunders and De Moor (2024) argued that Gov is essential for developing Gig in Europe and that platform cooperatives based on worker ownership represent an alternative to the investor-driven platforms.

Nanda et al. (2025) emphasize that the increasing reliance on algorithmic systems in Gig platforms raises concerns about bias, transparency, and accountability, highlighting the need for

robust data governance frameworks to ensure fairness and trust among workers, consumers, and platforms. Gov and Dtrans in the Gig thus form an indispensable relationship, as many studies call for robust institutional frameworks to address emerging challenges in this evolving work system. Together, these studies demonstrate that effective Gov is critical for ensuring that Dtrans in the Gig remains equitable and sustainable, enabling a more balanced, transparent and accountable system while mitigating power imbalances and supporting long-term growth.

2.3 Literature Gap

Although there is a growing literature on the Gig, this study tries to fill important gaps. Existing research has lacked analysis of the interactive impact of Infra and Tech on Gig work, as most research has focused on individual elements such as Tech improvements or regulation. Moreover, prior literature largely overlooks cross-country heterogeneity, particularly in emerging economies such as BRICS, where differences in institutional quality and digital readiness may lead to divergent Gig outcomes. In addition, existing studies are predominantly micro-level and fail to incorporate macroeconomic and structural determinants such as financial development, income levels, and corporate activity. Also, the potential for nonlinear or adverse interactions among key variables remains underexplored, as most studies assume uniformly positive relationships. Additionally, the role that worker-led cooperatives play in Dtrans in the Gig remains underinvestigated. In developing regions and across various regulatory environments, how these two factors collaboratively affect the sustainability and fairness of Gig work is not well understood. Filling this gap and, more broadly, examining the drivers of growth and equity in the Gig, this study focuses on the interaction between Gov and Dtrans. Lastly, the study employed a recent and appropriate econometric strategy, with robustness tests, to obtain reliable estimates that can guide policymakers.

3. Data and Methods

3.1 Data Details

Based on data covering the period from 2016 to 2024, the study offers a comprehensive analysis of recent developments in the Gig, Gov, and Dtrans. The data sources used (Table 1) include official websites, databases, and relevant indexes to ensure reliability and relevance. BRICS countries (Brazil, Russia, India, China, and South Africa) were selected for this study because of their economic diversity, strategic importance, and active participation in Dtrans, all of which make them highly relevant to the Gig. Table 1 shows the details of the considered variables with sources

Table 1: Description of variables

Variables	Symbols	Source
Gig economy	*Gig*	Online labor index[4]
Global connectivity	*Globcon*	Liner shipping connectivity index[5]
Per capita income	*PI*	GDP per capita growth (annual %)[6]
Listed public corporations	*Corp*	Number of New Limited Liability Companies[7]

[4] http://onlinelabourobservatory.org/

[5] unctadstat.unctad.org

[6] https://data.worldbank.org/

[7] https://data.worldbank.org/

Innovations	*Tech*	Global Innovation Index[8]
Infrastructure	*Infra*	Planning and logistics Index score 1-5[9]
Governance	*Gov*	Government Effectiveness
Financial development	*Fdev*	Domestic credit to the private sector by banks
Literacy rate	*Ltrc*	School enrollment
Digital transformation	*Dtrans*	Mobile subscribers per 100 inhabitants
Innovation*infrastructure	*Tchinf*	-
Governance*digital transformation	*Govdt*	-

3.2 Empirical Modeling

This study develops an empirical model to examine the multifaceted relationship among key factors affecting the Gig. The first model combines Infra elements such as Tchinf and Globcon with socio-economic factors such as Per capita income (PI), Literacy rate (Ltrc) and Dtrans to examine the synergism between them and Gig. Equation 1 shows the first model of the present study:

$$Gig_{it} = Tchinf_{it} + Globcon_{it} + PI_{it} + Ltrc_{it} + Dtrans_{it} + ü_{it} \quad (1)$$

The second empirical model explores the connection between Gov and financial structures (Govdt, Financial development-Fdev, Infra, Corp and Tech) to determine how the Gig will evolve. The two models seek to uncover how these variables, individually or interactively, affect Gig dynamics and sustainability across different regions, providing a framework for a systemic analysis of the sector's transformation. Equation 2 presents the said empirical model:

$$Gig_{it} = Govdt_{it} + Fdev_{it} + Infra_{it} + Corp_{it} + Tech_{it} + ü_{it} \quad (2)$$

where "*i*" represents a BRICS country (e.g., Brazil, China, Russia etc.) and "*t*" indicates Year (e.g., 2016... 2024).

3.3 Empirical Strategy

The estimation strategy adopted in this study uses advanced econometric techniques to improve the robustness of the findings. An overview of the dataset is provided via descriptive statistics and a correlation matrix to infer variable interrelations, which guide further analysis. The Breusch–Pagan LM test is used to account for cross-sectional dependence and detect dependence across cross-sectional units in panel data, thereby helping avoid biased estimation (Breusch and Pagan, 1980). The CIPS panel unit root test (Pesaran, 2007) is conducted on the data to account for heterogeneity and cross-sectional dependence and assess the unit root properties of the data, capturing both I(0) and I(1) processes.

The Westerlund cointegration test (Westerlund, 2007) is used to analyze cointegration among variables, accounting for cross-sectional dependence and providing robust inference on long-run equilibrium relationships. The Pooled Mean Group (PMG) (Pesaran *et al.,* 1999) is used to estimate dynamic relationships, as this estimator is well suited for a heterogeneous panel with

[8] https://www.globalinnovationindex.org

[9] http://foodsecurityindex.eiu.com/

both short- and long-term dynamics. Furthermore, as a robustness test, the Common Correlated Effects Mean Group (CCEMG) estimator is used to establish the stability of the results obtained with the PMG estimator.

Other than that, the panel causality test of Dumitrescu and Hurlin (2012) is employed for directional causality analysis among variables, while accounting for cross-sectional dependencies. The all-encompassing approach guarantees a reliable, context-inclusive outcome for the findings, which may be referred to as the characteristic of panel data. The outcomes obtained with this appropriate empirical strategy are reliable and can help policymakers achieve the required objectives through Gig.

4. Results and Discussion

4.1 Preliminary Testing Outcomes

Table 2 shows the descriptive statistics of the outcomes. The descriptive statistics indicate moderate variation across variables, with Gig showing a mean of 2.39 and reasonable dispersion, suggesting heterogeneous platform activity across countries. Core explanatory variables such as Globcon, Tech, Gov, and Dtrans exhibit relatively stable distributions (low standard errors), whereas Corp and Fdev show greater variability. Then, the CSD for each variable is also displayed in Table 2, indicating the extent to which the data series of the same variable across different countries in the panel are correlated. With high CSD values across all variables, the study suggests that the data from the BRICS economies are not independent of one another, as is common in panel data analysis of countries with interlinked economies. For example, the CSD value of 'Globcon' (52.072) implies a very strong cross-sectional dependence. The use of a second-generation unit root test, such as the CIPS test, is therefore justified by cross-sectional dependence. Further, the CIPS results in Table 2 reveal that all variables are non-stationary at the level but stationary at first difference (I(1))**.** As the variables do not exhibit cross-section dependence in the first difference at the level I(1) this supports the use of Westerlund's cointegration test and the PMG estimator for this work (Saleem *et al.,* 2025).

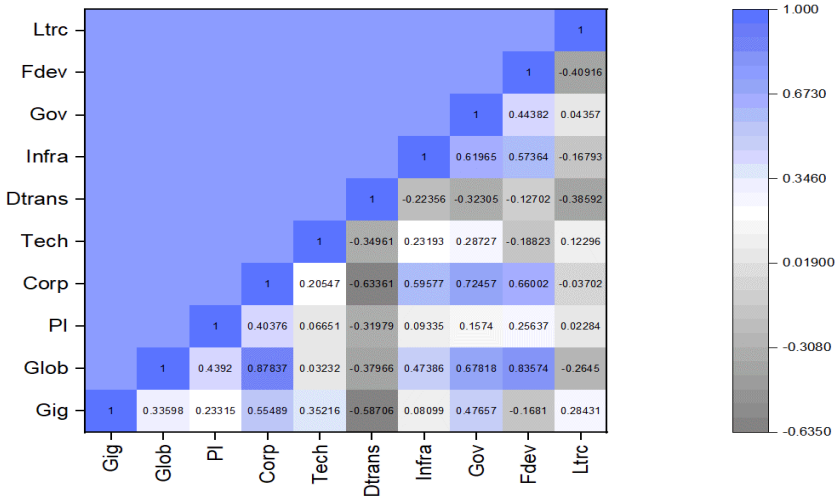
Table 2: Descriptive statistics, Unit root and CSD outcomes

Variable	Mean	SE	Min	Max	CIPS I(0)	CIPS-I(1)	CSD
Gig	2.39	1.11	1.00	4.70	-1.49	-5.67***	22.84**
Globcon	5.47	0.83	4.60	7.14	-0.24	-6.01***	52.07***
PI	2.31	0.54	0.00	2.86	-1.84	-5.58***	46.10***
Corp	6.75	1.50	5.24	9.45	-1.31	-5.85***	53.38***
Tech	4.10	0.17	3.74	4.56	-1.08	-5.82***	47.76***
Dtrans	4.78	0.27	4.29	5.11	-1.80	-5.65***	50.96***
Infra	1.16	0.11	0.94	1.33	-1.46	-5.71***	64.60***
Gov	4.13	0.22	3.50	4.46	-1.42	-5.69***	46.61***
Fdev	4.28	0.46	3.89	5.31	-1.52	-5.9***	52.51***
Ltrc	4.63	0.05	4.54	4.77	-0.74	-6.03***	37.67***

*Notes: CIPS -2.07 -2.19 -2.41 denotes 10% 5% 1%, ***, **, * p < .01, 0.05, and 0.10 and I(0) is at level and I(1) is at 1st difference, CSD indicates Breusch-Pagan LM test and SE stands for standard errors*

The correlation outcomes in Figure 3, highlight the relationships between various determinants of the Gig and associated variables. Listed public corporations (Corp) show the strongest positive correlation with Gig (0.55), suggesting that their presence is highly correlated with Gig growth, perhaps owing to greater corporate demand for flexible labor. On the other hand, Gov and Globcon also reveal positive associations with Gig activities (both fairly high: Gov (0.48) and Globcon (0.34)). On the contrary, Dtrans reveals a very strong negative linkage with Gig (-0.59), indicating possible disruptions to the traditional Gig's structure through reconfiguration of the labor ecosystem or automation. Correlations are weak, indicating little direct relationship between the Gig and Infra (0.08) and per capita income (0.23). Globcon is highly correlated with other variables, Corp (0.88) and Fdev (0.84), indicating its centrality to the systems of economic interconnectedness. Strong financial development and/or high global integration may also explain the negative correlation between Ltrc and other variables, including Globcon (-0.26) and Fdev (-0.41). However, this effect may result from uneven disparities in literacy across regions. In general, the outcomes show that all the variables are associated with the Gig in BRICS countries.

Figure 3: Correlation outcomes



Source: Author's Construction

The Westerlund cointegration test results for both models in the analysis provide strong evidence of a long-run relationship among the variables in the BRICS economies. The results are given in Table 3. For model-1, the variance ratio statistic is 1.3762, and the p-value is 0.0844. The p-value is marginally above the conventional 0.05 threshold and provides marginal evidence of cointegration at the 10% level of significance. This implies that, for Model-1, there is evidence to suggest that the variables in the model have a long-term equilibrium relationship. The presence of Cointegration suggests that although each variable may be non-stationary on its own, they share a common long-run trend and move together. Also, the results of model-2 show a variance ratio statistic of 1.3000 and a p-value of 0.0968. Again, as in Model-1, the p-value for Model-2 is greater than 5%, and thus provides evidence of cointegration at the 10% significance level. As shown in this result, there is a long-term relationship between these variables in the model. This shows that the two models exhibit cointegration, further indicating that we have sufficient evidence of long-run equilibrium relationships between the variables.

Table 3: Westerlund cointegration

		Statistics	P-value
Model-1	Variance ratio	1.3762	0.0844
Model-2	Variance ratio	1.3000	0.0968

4.2 PMG and CCEMG Outcomes

Table 4 shows the outcomes of PMG and the robustness test CCEMG for both models. It is evident that in Model 1, an increase in Tech and Infra interaction negatively affects the Gig; the coefficient is negative and highly significant (p = 0.000) with a value of Tchinf (-0.696). It could mean that increasingly advanced Infra leads to decreasing demand for Gig-based employment from functions better integrated with traditional employment systems, or because of greater automation. The result is consistent with Barlybaev et al. (2022) and Van Doorn et al. (2023), which demonstrate that improvements in Infra can reduce Gig work as workers are gradually assimilated into the formal labor market. For Globcon, our coefficient is negative (-0.949) and statistically significant (p = 0.000), suggesting diminishing returns on the Gig from greater Globcon. Because more opportunities may come with increased exposure to competition, globalized digital platforms could represent the negative relationship. Similar results are discussed by Espitia et al. (2022), who argue that digital platforms' intense connectivity worldwide raises job competition and, accordingly, lowers Gig work. Further, the study finds that PI is negatively correlated (-0.084, significant at p = 0.000), meaning that Gig work could decline with rising per capita income.

A higher income, meanwhile, allows for more opportunities to have a stable job, lessening the need for alternative forms of income like Gig work. Rising incomes lead to a decreased incentive for individuals to take jobs on online labor platforms, as studied by Wu et al. (2024). As their wages increase, they tend to move toward more steady, traditional forms of work. The coefficient for Ltrc is positive (3.182) and significant (p = 0.000), indicating that as literacy rates increase Gig work also tends to increase. That may explain why better-educated people are more likely to take part in the Gig. They are better able to understand and interact with digital platforms and perform tasks that require greater skill. This aligns with Orth (2024), who show that literacy rates and educational levels play a significant role in gig participation. It is also clear that the estimated coefficient Dtrans (0.665) is positive, indicating that the higher the level of Dtrans, the higher the Gig activity. This finding is consistent with Nadeem et al. (2024), who argue that Gig is flourishing as digital platforms grow and become more accessible to people, creating more opportunities for workers.

For Model 2, a negative, significant (p = 0.000) coefficient for Govdt (-0.799) indicates that higher Gov in the Dtrans space decreases the Gig. Moreover, stronger digital Gov may enable regulatory force or oversight that makes it harder for Gig workers to succeed. Also a positive and highly significant coefficient (1.955, p = 0.000) for Fdev suggests that financial systems with greater official market depth support the growth of the Gig. Better financial services can help Gig workers manage their money more effectively and offer them better investment options. Allon et al. (2023) present evidence that financial development is a fundamental factor that paves the way for the growth of the Gig. The coefficient for Infra is negative (-1.493) and significant (p= 0.000), suggesting that better Infra development may also reduce Gig work, perhaps by reducing reliance on Gig work as its role as a replacement for formal jobs diminishes as more become available. Banik and Padalkar (2021) found that a lower dependence on Gig employment may occur in traditional sectors if existing Infra can support them. Furthermore, Corp shows a significant and positive coefficient, indicating that having more listed public corporations is associated with more Gig economic activity. One reason may be that large firms usually deliver Gig opportunities through outsourcing and digital platforms. Tan et al. (2021) also report similar results that large

firms are increasingly relying on Gig workers. Similarly, the coefficient for Tech is negative but statistically insignificant, suggesting that as Tech advances, people may need less Gig employment, as jobs that would normally be outsourced to Gig workers might be automated. This observation also holds because Bunjak et al. (2021) found that automation in other sectors could lead to a decline in Gig work.

The results obtained from the CCEMG estimator are largely consistent with the baseline PMG findings. So they are reinforcing the robustness and validity of the empirical analysis. In Model 1, the key variables, including Globcon, PI, Ltrc and Dtrans, retain similar signs and comparable magnitudes across both estimators, indicating stability in long-run relationships despite controlling for cross-sectional dependence. Likewise, in the extended specification, variables such as Fdev and Corp remain positive and statistically significant; Infra and the interaction term Govdt continue to exhibit negative effects, consistent with PMG estimates. Although minor differences in coefficient size and significance levels are observed, the overall directional consistency across PMG and CCEMG suggests that model-specific biases do not drive the findings. This is enhancing confidence in the reliability and generalizability of the results.

Table 4: Empirical outcomes of PMG and CCEMG estimators

	Variables	PMG		CCEMG	
		Co-ef	SE	Co-ef	SE
Model-1	Tchinf	-0.70***	0.11	-0.26	0.11
	Globcon	-0.95***	0.22	-0.8	0.25
	PI	-0.08***	0.01	-0.09	0.01
	Ltrc	3.18***	0.83	3.68	1.58
	Dtrans	0.67**	0.26	0.71	0.25
	__ec	0.40***	0.1		
	Tchinf	0.39	0.25		
	Globcon	0.13	0.41		
	PI	-0.25***	0.06		
	Ltrc	-0.95	1.84		
	Dtrans	1.60***	0.35		
Model-2	Govdt	-0.80***	0.19	-0.08**	0.05
	Fdev	1.96***	0.39	2.70***	0.31
	Infra	-1.50***	0.39	-2.71*	1.36
	Corp	0.13***	0.04	0.11***	0.03
	Tech	-0.21*	0.12	-0.10**	0.28
	__ec	0.26**	0.08		
	Govdt	1.84	0.34		
	Fdev	3.72***	0.98		
	Infra	3.94*	2.25		
	Corp	1.00**	0.41		
	Tech	0.14	0.18		

*Notes: Note: ***, **, * p < .01, 0.05, and 0.10, Gig is dependent variable in models 1 and 2, SE stands for standard errors and Co-ef stands for coefficient value*

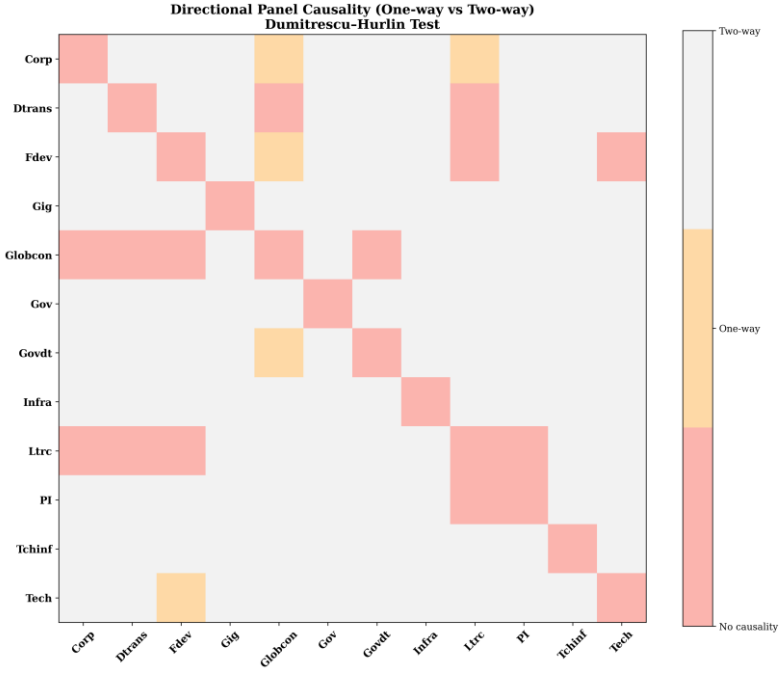
Generally, the findings align closely with the study's objective of examining how technological, institutional, and structural factors jointly define the Gig in BRICS economies. The variables Dtrans and ltrc emerge as key drivers of GIG expansion; the negative effects of Infra, Globcon, and Gov-related interactions suggest that structural maturation and institutional strengthening may shift labour away from Gig-based arrangements toward more formal employment systems.

This indicates that the Gig economy in developing contexts is not solely driven by Tech, but is critically conditioned by the quality of Gov and the stage of economic development. This highlights the importance of balanced policy design to harness synergies without creating institutional inefficiencies.

4.3 Causality Outcomes

The Dumitrescu-Hurlin causality outcomes are shown in Table A (See Appendix) and also visually depicted in Figure 4. The results from the Dumitrescu-Hurlin panel show that the variables exhibit many dynamic, unidirectional, and bidirectional causalities. The Gig and key institutional and digital drivers, such as Gov, Govdt, Globcon, Fdev, Dtrans, Corp, Infra, Tchinf, Tech, Ltrc and PI, have a bidirectional causal relationship, indicating a strong causal nexus between the growth of the Gig and its facilitating environment. It is worth noting that the mutual relationships between Gov and Dtrans, and Govdt and Gig, point to the synergetic nature of the quality of Gov and Dtrans in enhancing the resilience of the Gig. Financial development and Infra also show reciprocal relationships with the terms of interaction between the Dtrans and Gov, highlighting their complementary roles in supporting the development of digital labor markets. Moreover, there is a strong causal connection among Tech, Infra, and corporate dynamics, which implies that an integrated ecosystem is the backbone of the Gig's growth. In general, the results allow us to conclude that there are systemic feedback mechanisms that strengthen institutional, Tech, and economic forces in the formation of the Gig.

Figure 4: Causality directions



Source: Author's Construction

5. Conclusion and Policy Implications

This study highlights how technology, infrastructure, governance and digital transformation all come together to place the BRICS nations on the periphery of the Gig. Empirical results show that Infra and Tech development are synergistic in supporting the Gig by enabling flexible labor markets, increasing access to opportunities, and fostering Tech. Furthermore, Gov and Dtrans influence each other, as shown here, to help address inefficiencies at the systemic level and improve accountability on digital labor platforms. These insights highlight the complexity of the Gig's growth dynamics, which goes beyond technological progress to robust institutional and Gov frameworks.

This research has manifold policy implications. For real Gig development, governments and policymakers must invest in foundational Infra, predominantly broadband connectivity. They must also promote the development of Tech ecosystems that merge digital platforms with enabling tools to expand economic opportunities and improve worker productivity. Furthermore, while unfair power imbalances must be mitigated through strong Gov frameworks, Gig workers need fair treatment. Policymakers should incentivize worker-centric models like co-ops and create transparent, novel regulatory mechanisms that allow Tech to continue while accountability is maintained. Moreover, the governance of digital platforms can be enhanced through cross-border collaborations and harmonized policies to mitigate jurisdictional complexities. Finally, the measures, taken together, might serve to foster a more inclusive and sustainable Gig.

Despite its contributions, the study has limitations. The insights into BRICS nations are difficult to generalize to other regions with distinct socio-economic dynamics. In addition, macro-level data may ignore the nuances of country-specific issues around Gig workers. This analysis could provide a foundation for future research on Gig platforms at a micro-level or in cross-regional comparisons, to build a more comprehensive understanding of the Gig. Nonetheless, the study provides a solid foundation for future research exploring the challenges and opportunities inherent in the Gig, offering valuable insights for academics, policymakers, and stakeholders.

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Appendix:

Table A: Causality outcomes

Null Hypothesis	W-Stat.	Null Hypothesis:	W-Stat.	Null Hypothesis:	W-Stat.
Gov → Gig	0.034**	Govdt →Globcon	0.298*	PI →Fdev	0.281*
Gig →Gov	0.08**	Fdev →Govdt	0.108**	Fdev →PI	0.031**
Govdt → Gig	0.06**	Govdt →Fdev	0.114**	Corp →Dtrans	0.134*
Gig →Govdt	0.09**	Dtrans →Govdt	0.278*	Dtrans →Corp	0.172*
Globcon → Gig	0.10**	Govdt →Dtrans	0.170*	Infra →Dtrans	0.112**
Gig →Globcon	0.25*	Corp →Govdt	0.123*	Dtrans →Infra	0.027**
Fdev → Gig	0.076***	Govdt →Corp	0.134*	Tchinf →Dtrans	0.171*
Gig →Fdev	0.124*	Infra →Govdt	0.053**	Dtrans →Tchinf	0.086**
Dtrans → Gig	0.176*	Govdt →Infra	0.018**	Tech →Dtrans	0.187*
Gig →Dtrans	0.110**	Tchinf →Govdt	0.212*	Dtrans → Tech	0.096**
Corp → Gig	0.098**	Govdt →Tchinf	0.117*	Ltrc →Dtrans	0.475
Gig →Corp	0.101**	Tech →Govdt	0.248*	Dtrans →Ltrc	0.455
Infra → Gig	0.014**	Govdt → Tech	0.135*	PI →Dtrans	0.032**
Gig →Infra	0.005**	Ltrc →Govdt	0.347*	Dtrans →PI	0.035**
Tchinf → Gig	0.012**	Govdt → Ltrc	0.214*	Infra →Corp	0.026**
Gig →Tchinf	0.010**	PI →Govdt	0.041**	Corp →Infra	0.010**
Tech → Gig	0.020**	Govdt →PI	0.016**	Tchinf →Corp	0.106**
Gig → Tech	0.027**	Fdev →Globcon	0.378*	Corp →Tchinf	0.038**
Ltrc → Gig	0.110**	Globcon →Fdev	0.475	Tech →Corp	0.088**
Gig →Ltrc	0.143*	Dtrans →Globcon	0.609	Corp → Tech	0.048**
PI → Gig	0.005**	Globcon →Dtrans	0.717	Ltrc →Corp	0.585
Gig →PI	0.006**	Corp →Globcon	0.398*	Corp →Ltrc	0.202*
Govdt →Gov	0.146*	Globcon →Corp	0.445	PI →Corp	0.011**
Gov →Govdt	0.278*	Infra →Globcon	0.032**	Corp →PI	0.006**
Globcon →Gov	0.283*	Globcon →Infra	0.038**	Tchinf →Infra	0.008**
Gov →Globcon	0.163*	Tchinf →Globcon	0.060**	Infra →Tchinf	0.022**
Fdev →Gov	0.066**	Globcon →Tchinf	0.176*	Tech →Infra	0.008**
Gov →Fdev	0.058**	Tech →Globcon	0.076**	Infra → Tech	0.010**
Dtrans →Gov	0.146*	Globcon → Tech	0.204*	Ltrc →Infra	0.010**
Gov →Dtrans	0.170*	Ltrc →Globcon	0.364*	Infra →Ltrc	0.237*
Corp →Gov	0.243*	Globcon →Ltrc	0.237*	PI →Infra	0.000**
Gov →Corp	0.133*	PI →Globcon	0.077**	Infra →PI	0.000**
Infra →Gov	0.016**	Globcon →PI	0.019**	Tech →Tchinf	0.022**
Gov →Infra	0.009**	Dtrans →Fdev	0.232*	Tchinf → Tech	0.010**

Tchinf →Gov	0.234*	Fdev →Dtrans	0.185*	Ltrc →Tchinf	0.070**
Gov →Tchinf	0.154*	Corp →Fdev	0.092**	Tchinf →Ltrc	0.076**
Tech →Gov	0.245*	Fdev →Corp	0.094**	PI →Tchinf	0.025**
Gov → Tech	0.182*	Infra →Fdev	0.089**	Tchinf →PI	0.001**
Ltrc →Gov	0.396*	Fdev →Infra	0.020**	Ltrc → Tech	0.072**
Gov →Ltrc	0.100**	Tchinf →Fdev	0.036**	Tech →Ltrc	0.110**
PI →Gov	0.040**	Fdev →Tchinf	0.052**	PI → Tech	0.045**
Gov →PI	0.004**	Tech →Fdev	0.046**	Tech →PI	0.001**
Globcon →Govdt	0.452	Fdev → Tech	0.060**	PI →Ltrc	0.029**

*Note: Note: ***, **, * p < .01, 0.05, and 0.10 and → stands for "does not Granger Cause"*