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The Impact of Innovation on Economic Growth, Foreign Direct Investment, and Self-Employment: A Global Perspective

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Abstract: This paper aims to investigate the impact of innovation on three macroeconomic indicators: GDP, self-employment, and foreign direct investment (FDI). The study analyses a sample of 120 countries using the Global Innovation Index (GII) and its constituent sub-indices and pillars, which provide a holistic evaluation of national innovation. Gross domestic product (GDP) per capita measures a country's economic output, self-employment assesses entrepreneurial activity, and FDI indicates confidence in a country's economic prospects and innovation trends. This study analyzes the data using generalized-linear and panel-corrected standard-error models. The results show that innovation positively influences GDP, domestic institutional framework, local infrastructure, local knowledge and technology, and creative outputs. In contrast, innovation negatively correlates with domestic self-employment, often associated with necessity-driven entrepreneurship. The study concludes that innovation positively affects human resources, research, and creative outputs and has no significant impact on FDI. The findings suggest that a practical regulatory framework, institutional support, domestic human capital, research and development, infrastructure, technology, and creative outputs are essential for a vibrant economy. National innovation policies supporting the GII and its constituent factors can positively affect the economy while reducing self-employment.

Keywords: innovation; FDI; entrepreneurship; Global Innovation Index; self-employment; foreign direct investment; economic growth; GDP; creative outputs; globalization

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1. Introduction

The importance of innovation as a primary driver of economic progress and development has been widely recognized by policymakers. Most national governments worldwide consider innovation performance critical to competitiveness and national progress. According to the United Nations' 2030 Agenda for Sustainable Development, private business investment and innovation are the primary drivers of productivity, holistic economic growth, and job creation. Additionally, the United Nations Conference on Trade and Development emphasizes that new strategies for innovation are emerging worldwide, and policymakers support such approaches to expand innovation's benefits for most people. The UNCTAD suggests that governments should promote the scaling up and dissemination of successful innovations with civil society's active participation, particularly in the private sector, to make innovative outcomes available to marginalized and vulnerable communities (Sirimanne et al. 2018; UNCTAD 2021; United Nations 2022).

The COVID-19 crisis has posed a significant challenge to national innovation systems worldwide. The Organization for Economic Cooperation and Development (OECD) warns that the pandemic's impact on the normal functioning of national innovation systems can endanger critical domestic production and innovation capabilities, exacerbating the gaps between large and small businesses and geographical locations. The International Monetary

Fund has cautioned about the potential technological decoupling between China and the United States resulting from rising political, economic, and military tensions and its damaging impact on innovation capacity and economic growth worldwide (OECD 2020; IMF 2021).

The central hypothesis of this research project is that countries with superior innovation should exhibit high-caliber economic performance. The GII and its constituent factors measured innovation in this study. This index measures countries' capabilities for and success in innovation worldwide. The research sheds light on how innovation directly affects critical national macroeconomic variables. Specifically, the article analyzes the impact of innovation on GDP per capita, self-employment, and FDI.

The World Bank has emphasized the urgent need to measure, assess, and adopt national innovation policies. The results of this research may be crucial for policymakers, from local and national governments to business authorities. The results could also help to trigger national dialogues about strategies and practices to improve one or more of the analyzed innovation pillars (Cirera et al. 2020). The remaining sections of this article are organized as follows: Section 1 comprises the Introduction and literature review, Section 2 describes the methodology, Section 3 explains the results, and Section 4 provides discussions and interpretations of the findings and discusses the article's limitations and future research opportunities. Finally, Section 5 summarizes the research's conclusions and implications, and the last section lists the bibliographic sources.

1.1. Literature Review

A bibliographical review examines the literature from four different angles. The review includes an overview of previous academic articles using the GII index as a valid metric for analytic purposes. The review also summarizes previous research studies on the relationship between innovation and the three analyzed independent variables: economic growth, FDI, and self-employment. The review ends with a brief description of the article's aim.

1.1.1. GII-Related Literature

Previous academic articles using the GII index in their analyses have addressed a variety of innovation-related topics. For example, the GII index has been considered an analytical tool for comparing countries' government policies. Indeed, Coyle et al. (2016) studied the relationship between cognitive ability and economic productivity and freedom. They found that economic freedom significantly influences the relationship between local productivity and innovation measured by the GII index but a marginally significant relationship between national GDP and competitiveness.

Likewise, Oturakci (2021) studied the GII's input and output sub-index components using canonical correlation analysis and found that human and capital research, business sophistication, and creative outputs have the most significant explanatory power regarding the GII. They also found that these factors have statistically significant differences among countries based on their income levels. Correspondingly, Gogodze (2016) studied the relationships among the components of a national innovation system measured by the GII and found that efficient administration of institutional capital is a critical success factor for innovation in non-high-income countries. In the same way, Suzuki and Demircioglu (2019) studied the relationship between national governments' administrative characteristics and innovation and found that nations with higher levels of professional and impartial public administration can deliver higher knowledge and technology outputs. Additionally, Kawabata and Camargo (2020) studied the association between national institutions' quality and domestic innovation and found that the local regulatory framework's quality and the public administration's effectiveness significantly affect innovation as measured by the GII.

All the previous references confirmed the scientific accuracy of using the GII index as a valid metric of innovation, justifying its use in the current analysis of the impact of national innovation on economic growth, FDI, and self-employment.

1.1.2. Innovation and Economic Growth

The academic literature studying the relationship between innovation and economic growth is extensive. Some articles have focused on the positive relationships between economic and innovation-related dimensions at the firm level, such as between innovation and firm productivity and exports (Cassiman et al. 2010) and between research and development (R&D) and productivity (Tsai and Wang 2004; Zhang et al. 2012). Other articles have focused on the positive relationship between economic growth and innovation at the country level (Castellacci and Natera 2016).

However, not all previous studies have found a positive and significant relationship between innovation and economic growth. For example, Afzal and Gauhar (2020) studied the relationship between financial innovation and economic growth among 164 countries from 1990 to 2017 and found that these variables are negatively and significantly associated. Likewise, Mohamed et al. (2021) found a significant, negative relationship between innovation and long-term Egyptian economic growth. In the same way, Freel and Robson (2004) studied the impacts of business innovation activities and company growth performance in Scotland and Northern England. They found a short-term, negative relationship between product innovation and sales growth or productivity. Correspondingly, Coad et al. (2021) also suggested innovation's adverse economic impact through excessive patent protection and monopoly powers, harming economic progress and consumer welfare by boosting social inequality.

Similarly, Benavente (2006) found a lack of significant short-run relationship between Chilean companies' productivity and innovative results or R&D expenditures. Equally, Carvalho and Avellar (2017) found an insignificant relationship between innovation and the productive performance of Brazilian companies. Likewise, Correa (2012) studied the relationship between competition and innovation among US firms and found mixed results: a positive relationship from 1973 to 1982 but no relationship from 1983 to 1994. Correspondingly, Suzuki (2020) proposed a model in which competition and innovation can be either inverted-U-shaped or negatively related. He also showed that strong intellectual property protection does not necessarily improve national innovation. In the same way, Ma et al. (2022) validated the vital role of scientific and technical activities in attaining sustainable economic growth and emphasized the need for nations to synergize their efforts to promote and enhance their scientific potential, incorporate scientific progress into innovative activities, and raise the quality of life of their citizens.

All the previous articles with contradicting results justified the scientific legitimacy of analyzing the relationship between innovation and economic growth again, using a novel global sample of 120 countries with data from 2013 to 2019. Additionally, no previous articles employed generalized linear models and panel-corrected standard error models with reliable results, supporting this study's original contribution.

1.1.3. Innovation and FDI

Many previous academic articles have found a significant relationship between FDI and innovation. Indeed, Khalatur et al. (2019) studied 39 European countries and found that FDI net inflows and domestic loans directly influence the national GII. Similarly, Yang et al. (2020) found that outward FDI positively affects green innovation for emerging markets and developed economies. Equally, Smith and Thomas (2017) verified a significantly positive relationship between FDI and innovation in Russia. Likewise, Ascani et al. (2020) studied the relationship between FDI and innovation in Italian provinces and found a positive relationship in some specific FDI categories but a negative relationship in other FDI sectors. Correspondingly, Girma et al. (2009) found a positive association between inward FDI at the firm level and innovative activity but a negative association with inward FDI at the sector level. In the same way, Tang and Beer (2021) found that regional technical supply and intellectual property flexibility allow regions to retain FDI. Similarly, Huan and Qamruzzaman (2022) found a positive and statistically significant relationship between innovation, grouped into technological, financial, and environmental categories, and FDI inflows, suggesting that fostering innovation can boost FDI inflows both in the short and long terms.

Additional examples include Wong et al. (2020), who found that natural resources, industrialization level, and regional innovation have significant impacts on the FDI inflows of Western China. Similarly, Jungmittag and Welfens (2020) found that FDI and its corresponding induced and related innovation dynamics positively impact Germany and the EU. Likewise, Huang and Zhang (2020) found that inward and outward FDI significantly positively affected firms' innovation activities in the Chinese province of Shandong from 2002 to 2007. Equally, Olabisi (2017) found that Chinese companies receiving FDI tend to engage in product innovation activities. In the same way, Li et al. (2018) found that differences in FDI inflows determine local variations in Chinese innovation efficiency. Correspondingly, Nyeadi et al. (2020) found that FDI positively impacts firm innovation in Nigeria but has no impact in South Africa.

Similarly, Smith and Thomas (2015) found that FDI significantly positively impacts innovation outcomes in Russia from 1997 to 2010. Additionally, Ali (2017) found that FDI has a negative impact on related variety in export diversification, while it has no significant relationship with overall variety and unrelated variety, which could have implications for innovation in related industries. Equally, Ye and Zhao (2023) examined the impact of China's outward FDI and found that it promotes regional capabilities of sustained innovation and is mediated by regional human capital accumulation. In the same way, Zeng et al. (2021) found that FDI stimulates technological innovation with technology trades.

All the previous articles confirmed the scientific correctness of analyzing the relationship between innovation and FDI again, using an original sample and time framework and a distinct methodology.

1.2. Innovation and Entrepreneurship

Numerous prior academic articles have found a significant relationship between innovation and different types of entrepreneurship. Wong et al. (2005) studied the difference between technology-based innovation and new business creation by analyzing the four types of entrepreneurial activities measured by the Global Entrepreneurship Monitor's (GEM) Total Entrepreneurial Activity (TEA) rates. They found that only high growth potential TEA significantly influences economic growth. Similarly, Crecente-Romero et al. (2019) studied 19 European countries from 2012 to 2016 using GEM data and found that necessity-driven entrepreneurship prevails during an economic recovery. They also found that innovation determines the surge of opportunity entrepreneurship after the economy recovers. Likewise, Khyareh and Amini (2021) studied 64 countries from 2010 to 2018 using GEM data and found that opportunity-driven entrepreneurship is positively related to the innovation-driven economies' growth and that necessity-driven entrepreneurship is negatively related to the factor- and efficiency-driven nations' economic growth.

In the same way, Valliere and Peterson (2009) found that necessity-driven entrepreneurship in most emerging countries only provides personal employment, which does not contribute significantly to economic growth. Similarly, Venâncio and Pinto (2020) analyzed whether the entrepreneurial activity of 67 countries contributes to achieving sustainable development goals (SDGs) and found that necessity and non-innovative entrepreneurship are responsible for the lack of entrepreneurial contributions to SDGs. Equally, Edoho (2016) concluded that opportunity entrepreneurship in Nigeria is superior at promoting economic growth, creating jobs, and alleviating poverty. He suggested that entrepreneurship policy should considerably reduce the Nigerian informal sector, while aggressively promoting the formal sector, enhancing innovations, nurturing economic growth, and generating jobs.

Likewise, Block and Sandner (2007) found that necessity-driven entrepreneurs remain in self-employment for less time than opportunity-driven entrepreneurs. Additionally, Venâncio and Pinto (2020) explored the relationship between entrepreneurship and SDGs in 67 countries and evaluated whether FDI strengthens or reduces these relationships. The authors found that entrepreneurship contributes negatively to achieving SDGs, particularly in the people, prosperity, and partnership dimensions, with necessity and non-innovative entrepreneurship having the most significant adverse effects and FDI helping to diminish such harmful effects. Correspondingly, Dempere and Pauceanu (2022) suggested that necessity-driven entrepreneurship can drive high self-employment rates in low-income countries.

None of the articles summarized above provided an inclusive view of the global relationships among innovation, economic growth, FDI, and self-employment. The current article is the most inclusive analysis regarding time and geographical locations, with a sample of 120 countries and data from 2013 to 2019. The limited existing analysis of this topic may explain some of the mixed and contradicting results referenced above. Additionally, no previous articles have provided robust results from different methodologies yielding consistent outcomes. This study is the first to apply generalized linear and panel-corrected standard error models with reliable results. These facts allow us to derive meaningful inferences from the results and fill the gap arising from the previous studies' small samples, limited methodologies, and use of short periods.

The central focus of this research project is the relationship between economic performance and national innovation. The article aims to study the impact of national innovation on three sensitive macroeconomic variables for the economic welfare of any country: GDP per capita, self-employment, and FDI. As a result, the study tests the following hypotheses:

H1. *There is a significant and positive relationship between domestic economic performance measured by the GDP per capita and the national GII and its constituent factors.*

H2. *There is a significant and positive relationship between domestic economic performance measured by self-employment and the national GII and its constituent factors.*

H3. *There is a significant and positive relationship between domestic economic performance measured by the FDI net inflows and the national GII and its constituent factors.*

The hypothesized relationships between innovation proxied by the national GII and its constituent factors and the three economic variables mentioned above are examined using generalized linear and panel-adjusted standard error models.

2. Methodology

The sample of 120 countries includes Algeria, Argentina, Armenia, Australia, Austria, Azerbaijan, Bahrain, Bangladesh, Belarus, Belgium, Bolivia, Bosnia and Herzegovina, Botswana, Brazil, Bulgaria, Burkina Faso, Cambodia, Cameroon, Canada, Chile, China, Colombia, Costa Rica, Cote d'Ivoire, Croatia, Cyprus, the Czech Republic, Denmark, the Dominican Republic, Ecuador, Egypt, El Salvador, Estonia, Ethiopia, Finland, France, Georgia, Germany, Ghana, Greece, and Guatemala. The sample also comprises Guatemala, Guinea, Honduras, Hong Kong, Hungary, Iceland, India, Indonesia, Iran, Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kazakhstan, Kenya, Kuwait, Kyrgyzstan, Latvia, Lebanon, Lithuania, Luxembourg, Madagascar, Malawi, Malaysia, Mali, Malta, Mauritius, Mexico, Mongolia, Montenegro, Morocco, Mozambique, Namibia, Nepal, the Netherlands, New Zealand, Niger, and Nigeria. Finally, the sample also contains Norway, Oman, Pakistan, Panama, Paraguay, Peru, the Philippines, Poland, Portugal, Qatar, the Republic of Korea, the Republic of Moldova, Romania, Russia, Rwanda, Saudi Arabia, Senegal, Serbia, Singapore, Slovakia, Slovenia, South Africa, Spain, Sri Lanka, Sweden, Switzerland, Tajikistan, Thailand, Togo, Tunisia, Turkey, Uganda, Ukraine, UAE, the UK, United Republic of Tanzania, the USA, Uruguay, Vietnam, and Zambia.

The Global Innovation Index (GII) is a critical resource for understanding the dynamism of innovation across countries and regions globally (Dutta et al. 2019). Established in 2007 by Cornell University, INSEAD, and the World Intellectual Property Organization, the GII provides a holistic evaluation of innovation, contributing substantially to our understanding of economic and societal development. However, selecting the appropriate period for analyzing GII data is critical to ensuring accurate and meaningful insights. This article elucidates the reasons for choosing the 2013–2019 period for retrieving and analyzing GII historical data.

Primarily, this period allows for analysis during relative economic stability, excluding the confounding impacts of significant global crises. The financial crisis of 2008 had pervasive effects on the global economy, leading to widespread recessions and necessitating policy and behavioral adjustments (Reinhart and Rogoff 2009). Including data immediately after this crisis might introduce a significant bias, distorting the understanding of the relationship between innovation and economic indicators.

Starting our analysis in 2013 provides us with an adequate recovery period from the 2008 financial crisis. By this time, most global economies had regained some stability (Obstfeld and Rogoff 2009), permitting a more "normalized" evaluation of innovation's impacts on the economy, thereby enhancing the validity of the results.

Second, ending the period in 2019 allows the study to avoid the disruptive influence of the COVID-19 pandemic. The pandemic has drastically affected the global economy and the nature of innovation (Onea 2022). By excluding the COVID-19 period, the study avoids conflating the effects of innovation with those of the pandemic.

Furthermore, the 2013–2019 period provides a contemporary, yet consistent, window for evaluating trends in innovation. Many countries underwent changes in their innovation policies during this period, making it an intriguing period for study.

Therefore, choosing the 2013–2019 time span for retrieving GII historical data ensures a focus on a period of relative global economic stability. This approach allows for a more accurate exploration of the role and impact of innovation regarding economic growth and competitiveness across countries.

The dependent variables include the GDP per capita (DV1) expressed in dollars adjusted by a purchasing power parity (PPP) conversion factor. The analysis also includes domestic self-employment as a percentage of total employment (DV2). This variable includes workers who, working on their own or with one or a few collaborators or in a cooperative, hold the types of jobs defined as self-employed jobs (i.e., jobs in which the remuneration is directly dependent upon the profits derived from the goods and services produced). Last, the study evaluates the FDI (DV3) net inflows (percentage of GDP), defined as the net inflows of investment to acquire a lasting management interest (10 percent or more of voting stock) in an enterprise operating in an economy other than that of the investor. Data for these dependent variables were retrieved from the World Development Indicators database compiled by The World Bank Databank (2022).

The independent variables comprise the GII (IV1) and its constituent factors. Historical data on the GII were retrieved from the World Intellectual Property Organization's website (WIPO et al. 2013–2019). The GII's development was based on the comprehensive definition of innovation initially proposed by the OECD and Eurostat in their Oslo Manual (2018). According to the Manual, innovation encompasses " ... *new or improved products or processes (or a combination thereof) that differ significantly from the unit's previous products or processes and that have been made available to potential users (product) or brought into use by the unit (process)* ... " (OECD 2018, p. 20). WIPO's GII evaluates national innovation by ranking countries using their GII based on their capabilities for and success in innovation, providing a way to measure domestic innovation ecosystems holistically.

The GII is the average of two sub-indices, the Innovation Input Index (III) sub-index (IV2) and the Innovation Output Index (IOI) sub-index (IV3), composed of five and two pillars, respectively. The III's five pillars comprise institutions, human capital and research, infrastructure, market sophistication, and business sophistication. The IOI's two pillars include knowledge and technology outputs and creative outputs.

The institutions pillar (IV4) measures the national institutional framework and includes the political environment sub-pillar, the regulatory environment sub-pillar, and the business environment sub-pillar. The political environment sub-pillar comprises two dimensions: the first dimension refers to the political, legal, operational, and security risks affecting business operations; and the second dimension assesses the public and civil services' quality, domestic policy formulation, and implementation. The regulatory environment sub-pillar encompasses perceptions of the government's capacity to formulate and implement effective policies to support the private sector's development, the scope of the rule of law's prevalence, and the cost of advance notification requirements added to compensation disbursements related to firing a redundant employee. The business environment sub-pillar contains two World Bank metrics: the speed of business opening and the ease of solving bankruptcy.

The human capital and research pillar (IV5) assesses a nation's human capital. The education sub-pillar measures schooling coverage using teaching spending and school life expectancy. This sub-pillar also considers the quality of education through the results of the OECD Program for International Student Assessment© (PISA). The tertiary education sub-pillar encompasses tertiary schooling enrollment, emphasizing sectors usually associated with innovation. It also considers the inbound direction and mobility of tertiary students, which are critically crucial for exchanging ideas and skills essential for innovation. The R&D sub-pillar evaluates the level and quality of R&D activities, including metrics on researchers, R&D expenditures, and the scientific and research institutions' quality.

The infrastructure pillar (IV6) embraces three sub-pillars. The information and communication technologies (ICTs) sub-pillar includes four metrics on ICT access: use, domestic online service, and citizens' online engagement. The general infrastructure sub-pillar consists of the average electric output per capita, a composite metric on logistics performance, the national gross capital formation, and the construction of roads, railways, schools, hospitals, residential, commercial and industrial buildings, etc. The ecological sustainability sub-pillar comprises the GDP per unit of energy use, the Environmental Performance Index©, and the number of ISO 14001 (International Organization for Standardization 2015b) certificates received.

The market sophistication pillar (IV7) has three sub-pillars. The credit sub-pillar measures the credit availability resulting from domestic collateral requirements and bankruptcy laws to support lending by protecting borrowers' and lenders' rights, including national regulations and practices impacting the handling, latitude, and availability of credit information. The investment sub-pillar comprises a minority investors' proper protection index and two transaction-related metrics: a metric for market size-dynamism matching and another metric for venture capital transactions. The trade, competition, and market scale sub-pillar includes the weighted average of tariff rates by import shares and a survey to measure the domestic competition intensity.

The business sophistication pillar (IV8) assesses the level of business innovation activities using three sub-pillars. The knowledge workers sub-pillar is calculated using four metrics: knowledge-intensive services' jobs; the availability of formal corporate training; business enterprise R&D as a percentage of GDP; and the proportion of corporate R&D gross expenditure. The innovation linkages sub-pillar covers qualitative and quantitative metrics about businesses/higher education institutions' R&D cooperation, advanced and deep R&D clusters' pervasiveness, the gross foreign R&D spending as a percentage of GDP, and the total joint venture arrangements and strategic agreements. The knowledge absorption sub-pillar comprises intellectual property disbursements as a percentage of total trade; high-tech imports; the percentage of imports of computer and information services; and the GDP percentage of FDI net inflows.

The knowledge and technology outputs pillar (IV_9) includes several innovation-related sub-pillars. The knowledge creation sub-pillar comprises domestic and international patent and utility model applications, scientific and technical published peer-reviewed articles, and the total national articles with *h*-index citations. The knowledge impact sub-pillar takes account of labor productivity growth, the new firm entry density, computer software expenditures, national ISO 9001 (International Organization for Standardization 2015a) certificates, and the high- and medium-high-tech industrial output as a percentage of the total industrial output. The knowledge diffusion sub-pillar includes the percentage of total trade represented by intellectual property receipts, the percentage of high-tech net exports, the percentage of ICT exports, and the GDP percentage of FDI net outflows.

Three sub-pillars constitute the creative outputs pillar (IV_{10}). The intangible assets sub-pillar consists of the total national trademark applications. The creative goods and services sub-pillar comprises an international show business and media output metric and a measure of audio-visual-related services exports. The online creativity sub-pillar contains the total economy/country-code top-level Internet domains, annual revisions to Wikipedia, and GDP-scaled mobile app development.

The research analyzes data using generalized linear models. When running these regression models, the analysis used the logarithmic transformation of the dependent and independent variables. The data were also analyzed using the panel-corrected standard error (PCSE) model proposed by Beck and Katz (1995). The PCSE's standard error estimates are robust to heteroscedasticity, contemporaneous cross-sectional correlation, and autocorrelation problems.

Our time-series cross-section model can be expressed as $DV_{i,t} = \beta IV_{i,t} + \epsilon_{i,t}$, where $i = 1, \ldots, N$; $t = 1, \ldots, T$, and $IV_{i,t}$ is a vector of our independent variables indexed by cross-sections (i) and years (t). The variability of the OLS estimates from this function is: Cov $(\hat{\beta}) = (X^TX)^{-1}[X^T\Omega X](X^TX)^{-1}$. Suppose that the errors follow a spherical error assumption. In that case, $\Omega = \sigma^2\Phi$, where Φ is an $NT \times NT$ identity matrix, and the standard errors are calculated by the square roots of the diagonal terms of $\hat{\sigma^2}(X^TX)^{-1}$ with $\hat{\sigma^2}$ as the ordinary least squares estimator of common error variance σ^2. When panel models have heteroscedastic and contemporaneously correlated errors, Ω is an $NT \times NT$ diagonal matrix with an $N \times N$ matrix of contemporaneous covariances Π on its diagonal. $\hat{\Pi}_{i,j} = \sum_{t=1}^{T_{i,j}} e_i e_{j,t}/T_{i,j}$ can determine an element of this matrix. This function can be utilized to determine the estimator $\hat{\Omega}$ by generating a block diagonal matrix with $\hat{\Pi}$ matrices along the diagonal. Our balanced panel data allow us to streamline these matrices as follows: $\hat{\Pi} = \left(\psi^T\psi\right)/T$, where ψ is the $T \times N$ matrix of residuals and therefore can be determined by $\hat{\Omega} = \hat{\Pi} \otimes I_T$ using the Kronecker matrix product $\otimes$. The PCSE can be determined by calculating the square root of its diagonal elements $(X^TX)^{-1}X^T\hat{\Omega}X(X^TX)^{-1}$.

We conducted tests on both the cross-sectional variation and the PCSE analyses using the following models:

Model 1: $DV_i = \beta_0 + \beta_1 IV_1$	Model 2: $DV_i = \beta_0 + \beta_2 IV_2$	Model 3: $DV_i = \beta_0 + \beta_3 IV_3$
Model 4: $DV_i = \beta_0 + \beta_4 IV_4 + \beta_5 IV_5 + \beta_6 IV_6 + \beta_7 IV_7 + \beta_{8\times8}$		Model 5: $DV_i = \beta_0 + \beta_9 IV_9 + \beta_{10} IV_{10}$

where DV_i identifies our three (i = 1, 2, and 3) dependent variables: GDP per capita (DV_1), self-employment (DV_2), and the FDI (DV_3). The models forecast $DV_{1–3}$ based on our independent variables: the GII (IV_1), III (IV_2), and IOI (IV_3) sub-indexes and the pillars of human capital and research (IV_5), infrastructure (IV_6), market (IV_7) and business (IV_8) sophistication, and the knowledge and technology (IV_9), and creative (IV_{10}) outputs.

3. Results

Table 1 provides the summary statistics for various indicators used in the study. The variables include the GII (IV_1), the III (IV_2), the IOI (IV_3), and several different 'pillar' indices, such as the institutions pillar (IV_4), human capital and research pillar (IV_5), infrastructure pillar (IV_6), market sophistication pillar (IV_7), business sophistication pillar (IV_8), knowledge and technology outputs pillar (IV_9), and creative outputs pillar (IV_{10}). The mean, median, maximum, minimum, standard deviation, skewness, and kurtosis are provided for each indicator.

Table 1. Summary Statistics.

	IV_1	IV_2	IV_3	IV_4	IV_5	IV_6	IV_7	IV_8	IV_9	IV_{10}	DV_2	DV_3	DV_1
Mean	38.0	44.8	31.1	64.3	33.6	42.7	48.8	34.8	28.5	33.7	35.3	4.8	24,605
Median	35.8	42.5	28.6	62.2	31.7	42.6	47.1	32.3	25.5	32.5	28.0	2.5	16,770
Max.	68.4	74.2	68.6	95.8	73.3	69.9	88.6	69.2	74.9	73.7	95.1	223.4	138,230
Min.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	−40.4	1019
Std. Dev.	11.8	12.2	12.3	15.8	15.5	13.4	11.6	11.5	13.0	13.3	25.4	13.3	22,337
Skewness	0.5	0.4	0.5	0.1	0.3	−0.1	0.5	0.7	0.8	0.2	0.7	8.4	1.5
Kurtosis	2.5	2.6	2.6	2.6	2.2	2.3	4.1	3.0	3.2	2.9	2.4	114.4	5.7

The dependent variables in the study are GDP per capita (DV_1), self-employment (DV_2), and the FDI (DV_3). The mean GDP per capita stands at $24,605 with a standard deviation of $22,337, indicating significant disparity in the GDP per capita across the dataset. Similarly, self-employment constitutes an average of 35.3% of total employment, and FDI net inflows comprise an average of 4.8% of the GDP.

The min. and max. values reveal a considerable range across all variables, indicating a high level of variation in the dataset. It can be observed that skewness and kurtosis values vary across the indicators, suggesting different degrees of asymmetry and tail heaviness in their distributions. The highest skewness is seen in the FDI net inflows (DV_3), and the highest kurtosis in the same variable indicates a distribution with extreme outliers.

Table 2 shows the cross-sectional analysis results from 2013–2019 of the PPP-adjusted GDP per capita (DV_1) and the first three independent variables, namely GII (IV_1), III (IV_2), and IOI (IV_3), referred to as models 1–3, respectively. The table shows a significant and positive relationship between GDP and GII and GDP and GII's two constituent sub-indices (III and IOI) from 2013 to 2019.

Table 2. Cross-Sectional Analysis: GDP per capita, PPP (DV_1)—Models 1, 2 and 3.

	Years	**2019**	**2018**	**2017**	**2016**	**2015**	**2014**	**2013**
Model 1	C	−32,932.96	−29,938.88	−32,027.16	−30,292.63	−31,660.87	−32,696.18	−33,232.99
	t-sta.	−12.04	−7.08	−11.19	−11.05	−10.89	−10.55	−10.16
	p-val.	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****
	IV1	1623.29	1528.38	1513.24	1440.95	1412.74	1448.10	1436.69
	t-sta.	16.73	12.44	16.09	16.15	15.92	14.88	15.32
	p-val.	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****
Model 2	C	−47,707.85	−41,790.61	−43,286.01	−39,599.91	−40,762.80	−40,279.92	−35,113.76
	t-sta.	−14.99	−6.88	−13.15	−12.74	−10.41	−11.36	−12.09
	p-val.	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****
	IV2	1629.67	1521.09	1499.30	1424.79	1420.66	1432.79	1325.83
	t-sta.	18.20	11.18	17.41	16.87	15.77	14.66	15.56
	p-val.	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****
Model 3	C	−11,962.96	−13,678.60	−14,908.70	−14,885.48	−15,329.18	−16,849.03	−21,226.41
	t-sta.	−6.35	−4.49	−6.70	−6.68	−4.85	−5.30	−5.72
	p-val.	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****
	IV3	1386.83	1387.64	1339.31	1265.29	1179.70	1217.97	1282.93
	t-sta.	14.53	11.65	14.13	14.54	11.26	11.63	10.86
	p-val.	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****

Notes: **** denotes statistical significance at the 0.1% significance level. The table reports the *t*-statistics and their corresponding *p*-values below in brackets.

For each of these years, every unit increase in the GII (IV_1) corresponded to an increase in GDP per capita by approximately $1623.29 to $1436.69 (Model 1). This result demonstrates the significant role of overall national innovation (as measured by GII) in increasing a country's GDP per capita.

Likewise, examining Model 2, we can observe that a unit rise in the III (IV_2) is linked with a GDP per capita increase ranging from $1629.67 to $1325.83. This finding implies that the inputs to innovation, such as institutional support, human capital, infrastructure, and market and business sophistication, play critical roles in enhancing economic output.

Model 3 assesses the impact of the IOI (IV_3) on GDP per capita. For each unit increase in the IOI, GDP per capita surges between $1386.83 and $1179.70. This outcome underscores the economic contributions of knowledge, technology, and creative outputs, all elements captured in the IOI.

These results further underscore the importance of GII and its constituent components in contributing to economic prosperity, as measured by GDP per capita. Each of the models (1–3) provides robust evidence for this relationship, as indicated by the statistical significance of the coefficients and the substantial *t*-values. Thus, our findings are statistically significant, with very little likelihood that they have occurred by chance.

Similarly, Table 3 also shows the cross-sectional analysis results from 2013 to 2019 of GDP per capita and III's five pillars (Model 4). The table shows a positive and significant relationship between GDP and the institutions (IV_4) and infrastructure (IV_6) pillars from 2013 to 2019. The table also shows a positive relationship between GDP and the human capital and research pillar (IV_5) but only for three (2015, 2017–2018) of seven years. Finally, the table also shows a positive and partially significant relationship (10 percent confidence level) between GDP and the market sophistication pillar (IV_7) and the business sophistication pillar (IV_8) but only for one single year each (2016 and 2019, respectively), which are considered spurious results.

Table 3. Cross-Sectional Analysis: GDP per capita, PPP (DV_1)—Models 4 and 5.

Years	2019	2018	2017	2016	2015	2014	2013
				Model 4			
C	−50,024.83	−35,703.57	−38,277.63	−32,283.05	−25,136.14	−33,024.15	−26,364.61
t-sta.	−9.93	−6.56	−9.95	−6.14	−5.49	−7.95	−8.02
p-val.	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****
IV4	289.30	211.93	349.93	455.21	328.14	220.66	292.70
t-sta.	2.01	1.95	3.96	5.67	3.13	2.58	3.51
p-val.	(0.047) **	(0.053) *	(0.0) ****	(0.0) ****	(0.002) ***	(0.01) **	(0.0) ****
IV5	40.20	216.99	223.68	−16.18	301.92	−42.05	81.52
t-sta.	0.31	2.21	2.36	−0.13	2.53	−0.20	0.54
p-val.	(0.759)	(0.03) **	(0.02) **	(0.89)	(0.01) **	(0.84)	(0.59)
IV6	1014.97	827.27	646.36	492.91	476.53	990.61	889.44
t-sta.	4.33	5.50	4.46	3.08	3.81	3.70	3.98
p-val.	(0.0) ****	(0.0) ****	(0.0) ****	(0.002) ***	(0.0) ****	(0.0) ****	(0.0) ****
IV7	−100.96	−86.71	−37.07	188.36	−54.87	−105.98	−194.10
t-sta.	−0.71	−0.66	−0.33	1.67	−0.45	−0.68	−1.59
p-val.	(0.48)	(0.51)	(0.74)	(0.09) *	(0.65)	(0.50)	(0.11)
IV8	410.75	207.27	127.17	−134.57	−7.77	300.15	160.11
t-sta.	1.92	1.23	0.84	−0.81	−0.05	1.46	0.98
p-val.	(0.06) *	(0.22)	(0.40)	(0.42)	(0.96)	(0.15)	(0.33)

Table 3. *Cont.*

Years	2019	2018	2017	2016	2015	2014	2013
			Model 5				
C	−14280.80	−15228.85	−14670.67	−14789.20	−8183.26	−904.38	−16226.01
t-sta.	−6.62	−8.47	−7.02	−8.02	−3.47	2.72	−2.68
p-val.	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****	(0.001) ***	(0.009) ***
IV9	665.52	682.74	664.69	522.66	473.40	−6.15	421.29
t-sta.	8.01	6.72	6.97	4.72	3.37	−0.38	2.60
p-val.	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****	(0.001) ***	(0.7048)	(0.01) **
IV10	814.57	751.82	664.72	725.81	485.77	582.33	661.17
t-sta.	7.03	7.31	7.21	6.37	5.92	11.98	3.39
p-val.	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****	(0.001) ***	(0.001)

Notes: ****, ***, **, and * denote statistical significance at the 0.1%, 1%, 5%, and 10% significance levels, respectively. The table reports the *t*-statistics and their corresponding *p*-values below in brackets.

Likewise, Table 3 also shows the cross-sectional analysis results from 2013 to 2019 of GDP per capita and the IOI's two pillars (model 5). The table shows a positive and significant relationship between GDP and the knowledge and technology outputs pillar (IV_9) and the creative outputs pillar (IV_{10}) during 2013–2019, except for the GDP and the technology outputs pillar, the positive relationship of which is insignificant only in 2014. Only in 2014 did the positive association between GDP and the technology outputs pillar (IV_9) not hold statistical significance, a circumstance possibly caused by discrepancies in the data compilation for this specific year. Nevertheless, this slight anomaly in terms of both correlation direction and statistical significance—affecting merely one year out of seven and one model among five—does not notably influence the broader conclusions that we intend to draw later in this paper.

Table 4 presents the cross-sectional analysis for the 2013 to 2019 for self-employment as a percentage of total employment (DV_2) with respect to the GII (IV_1), the III (IV_2), and the IOI (IV_3).

Table 4. Cross-Sectional Analysis: Self-employment (% total employment, DV_2)—Models 1, 2 and 3.

	Years	2019	2018	2017	2016	2015	2014	2013
Model 1	C	71.06	70.72	73.25	74.66	79.63	83.47	86.23
	t-sta.	13.37	13.01	13.43	13.94	14.73	14.45	14.59
	p-val.	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****
	IV1	−1.04	−1.04	−1.08	−1.11	−1.19	−1.28	−1.33
	t-sta.	−9.42	−9.10	−9.56	−10.26	−10.39	−10.95	−11.00
	p-val.	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****
Model 2	C	87.42	85.06	88.25	85.66	91.37	89.17	86.89
	t-sta.	15.13	14.47	15.13	14.92	15.37	14.56	15.70
	p-val.	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****
	IV2	−1.18	−1.15	−1.21	−1.17	−1.28	−1.24	−1.20
	t-sta.	−11.89	−11.12	−11.83	−11.46	−11.26	−11.09	−12.01
	p-val.	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****
Model 3	C	53.43	53.44	55.57	60.41	64.22	71.92	78.40
	t-sta.	11.18	10.48	11.22	12.35	13.10	12.08	10.68
	p-val.	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****
	IV3	−0.79	−0.78	−0.81	−0.91	−0.97	−1.16	−1.27
	t-sta.	−6.35	−6.00	−6.63	−8.12	−8.51	−8.28	−7.17
	p-val.	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****

Notes: **** denotes statistical significance at the 0.1% significance levels. The table reports the *t*-statistics and their corresponding *p*-values below in brackets.

In Model 1, for every one-unit increase in the GII, self-employment decreases by approximately 1.04 to 1.33 percentage points across the seven years. The coefficient for the GII is negative and statistically significant at the 0.1% level for all years, indicating a robust and consistent negative relationship between the two variables.

Similarly, in Model 2, every one-unit increase in the III is associated with a decrease in self-employment by roughly 1.15 to 1.28 percentage points over the years. The coefficient for the III is also negative and statistically significant at the 0.1% level across all years, showing a consistently negative relationship.

In Model 3, a one-unit increase in the IOI corresponds to a decrease in self-employment ranging from 0.78 to 1.27 percentage points throughout the years. The coefficient for the IOI is again negative and statistically significant at the 0.1% level for each year.

The consistent statistical significance across the years and the negative relationship imply that, as the country's innovation capabilities (measured through the GII, III, and IOI) improve, the proportion of self-employment in total employment tends to decrease. The relationship suggests that more formal job opportunities might be created with higher innovation, reducing the need for self-employment. However, the specific interpretations of these coefficients may vary based on the contextual factors and the nature of the variables involved. Further analysis would be needed to provide a detailed interpretation.

Equally, Table 5 also shows the cross-sectional analysis results from 2013 to 2019 of the self-employment and the institutions (IV_4), human capital and research (IV_5), infrastructure (IV_6), market (IV_7), and business (IV_8) sophistication pillars. The table shows a negative and significant relationship between self-employment and IV_4–IV_6 for most analyzed years, except for the self-employment and institutions pillar, the negative relationship of which is insignificant during 2018–2019. Similarly, self-employment and the human capital and research pillar had a negative and insignificant relationship in 2014.

Table 5. Cross-Sectional Analysis: Self-employment (% total employment, DV_2)—Models 4 and 5.

Years	2019	2018	2017	2016	2015	2014	2013
				Model 4			
C	92.48	90.18	94.04	89.99	80.99	76.38	80.64
t-sta.	10.83	10.60	12.52	12.40	11.28	12.44	13.68
p-val.	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****
IV4	−0.20	−0.13	−0.40	−0.54	−0.61	−0.51	−0.37
t-sta.	−0.87	−0.64	−2.34	−3.18	−3.62	−3.09	−2.13
p-val.	(0.39)	(0.52)	(0.02) **	(0.002) ***	(0.0) ****	(0.0025) ***	(0.03) **
IV5	−0.63	−0.43	−0.53	−0.46	−0.62	−0.20	−0.59
t-sta.	−3.37	−2.35	−2.89	−2.59	−3.15	−1.06	−2.57
p-val.	(0.001) ***	(0.02) **	(0.005) ***	(0.011) **	(0.002) ***	(0.29)	(0.01) **
IV6	−1.02	−1.17	−1.04	−0.94	−0.63	−0.84	−0.72
t-sta.	−4.02	−4.57	−4.14	−3.80	−2.71	−3.43	−2.86
p-val.	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****	(0.008) ***	(0.0) ****	(0.005) ***
IV7	0.17	0.21	0.25	0.37	0.37	0.55	0.44
t-sta.	1.06	1.14	1.40	2.19	1.90	3.86	2.87
p-val.	(0.29)	(0.26)	(0.16)	(0.03) **	(0.06) *	(0.0) ****	(0.005) ***
IV8	0.41	0.30	0.61	0.58	0.57	0.05	0.05
t-sta.	2.23	1.60	3.42	2.69	2.52	0.24	0.20
p-val.	(0.03) **	(0.1127)	(0.0) ****	(0.008) **	(0.01) **	(0.81)	(0.84)

Table 5. *Cont.*

Years	2019	2018	2017	2016	2015	2014	2013
			Model 5				
C	93.70	62.77	69.99	60.75	66.95	73.79	83.36
t-sta.	16.28	12.72	13.55	12.63	13.73	12.04	11.44
p-val.	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****
IV9	0.13	−0.07	−0.04	−0.20	−0.17	−0.24	−0.43
t-sta.	0.36	−0.47	−0.25	−1.20	−1.15	−1.37	−2.90
p-val.	(0.72)	(0.64)	(0.80)	(0.23)	(0.25)	(0.17)	(0.004) **
IV10	−2.22	−0.92	−1.05	−0.70	−0.82	−0.93	−0.90
t-sta.	−16.32	−5.51	−5.46	−4.56	−5.39	−5.36	−6.07
p-val.	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****	(0.0) ****

Notes: ****, ***, **, and * denote statistical significance at the 0.1%, 1%, 5%, and 10% significance levels, respectively. The table reports the *t*-statistics and their corresponding *p*-values below in brackets.

The table shows a significant, positive relationship between self-employment and the market and business sophistication pillars during four analyzed years. Specifically, the positive relationship between self-employment and the market sophistication pillar is significant during 2013–2016, while the positive relationship between self-employment and the business sophistication pillar is significant during 2015–2017 and 2019. Table 5 also shows the cross-sectional analysis results from 2013 to 2019 for self-employment and the knowledge and technology (IV_9) and creative (IV_{10}) outputs pillars. The table shows a positive and significant relationship between self-employment and the creative outputs pillar from 2013 to 2019. Last, the table shows a positive and significant relationship between self-employment and the knowledge and technology outputs pillar but only for one year (2014), which is considered a spurious result.

Table 6 shows the cross-sectional analysis results from 2013 to 2019 of the FDI (DV_3), GII (IV_1), III (IV_2), and IOI (IV_3). The table shows no significant relationship between FDI3 and the independent variables IV_1–IV_3 for most years from 2013 to 2019. Similarly, Table 7 also shows the cross-sectional analysis results from 2013 to 2019 for FDI and the independent variables IV_4–IV_{10}. The tables include some isolated significant results for a few years and combinations of dependent and independent variables, but these sporadic significant results are considered spurious.

Table 6. Cross-Sectional Analysis: FDI (DV_3) net inflows (% of GDP)—Models 1, 2 and 3.

	Years	2019	2018	2017	2016	2015	2014	2013
Model 1	C	1.61	6.20	−0.23	−2.28	−4.47	−3.32	0.40
	t-sta.	0.78	2.26	−0.10	−0.76	−1.22	−0.81	0.11
	p-val.	(0.44)	(0.03) **	(0.92)	(0.45)	(0.22)	(0.42)	(0.91)
	IV1	0.07	−0.11	0.12	0.21	0.28	0.25	0.12
	t-sta.	0.88	−1.27	1.54	2.18	2.23	1.62	1.12
	p-val.	(0.38)	(0.21)	(0.13)	(0.03) **	(0.03) **	(0.11)	(0.27)
Model 2	C	0.26	5.24	−0.86	−2.66	−6.81	−4.91	−0.13
	t-sta.	0.09	1.70	−0.31	−0.81	−1.50	−1.08	−0.04
	p-val.	(0.93)	(0.09) *	(0.76)	(0.42)	(0.14)	(0.28)	(0.97)
	IV2	0.08	−0.07	0.11	0.18	0.29	0.25	0.12
	t-sta.	1.02	−0.90	1.54	2.14	2.25	1.75	1.37
	p-val.	(0.31)	(0.37)	(0.13)	(0.03) **	(0.03) **	(0.08) *	(0.17)
Model 3	C	1.24	6.15	0.86	−0.49	−0.53	−0.59	1.70
	t-sta.	0.80	2.93	0.49	−0.23	−0.22	−0.21	0.50
	p-val.	(0.43)	(0.0) ****	(0.62)	(0.82)	(0.83)	(0.83)	(0.62)
	IV3	0.10	−0.14	0.11	0.19	0.21	0.21	0.10
	t-sta.	1.16	−1.56	1.47	2.17	1.98	1.50	0.87
	p-val.	(0.25)	(0.12)	(0.15)	(0.03) **	(0.05) *	(0.14)	(0.39)

Notes: ****, **, and * denote statistical significance at the 0.1%, 5%, and 10% significance levels, respectively. The table reports the *t*-statistics and their corresponding *p*-values below in brackets.

Table 7. Cross-Sectional Analysis: FDI (DV_3) net inflows (% of GDP)—Models 4 and 5.

Years	2019	2018	2017	2016	2015	2014	2013
			Model 4				
C	−8.08	1.11	−5.21	−5.05	−18.52	−16.64	−8.86
t-sta.	−1.11	0.31	−1.13	−1.16	−2.20	−1.54	−1.69
p-val.	(0.27)	(0.76)	(0.26)	(0.25)	(0.03) **	(0.13)	(0.09) *
IV4	0.12	−0.09	0.15	0.12	0.23	0.36	0.14
t-sta.	1.24	−1.23	1.56	1.33	1.27	1.05	1.05
p-val.	(0.22)	(0.22)	(0.12)	(0.19)	(0.21)	(0.29)	(0.30)
IV5	−0.22	−0.04	−0.13	−0.09	−0.06	−0.02	−0.09
t-sta.	−1.28	−0.37	−1.59	−1.26	−0.34	−0.14	−0.68
p-val.	(0.20)	(0.71)	(0.11)	(0.21)	(0.73)	(0.89)	(0.50)
IV6	0.06	0.15	−0.14	−0.08	−0.36	−0.43	−0.32
t-sta.	0.62	0.99	−1.04	−0.67	−1.12	−1.00	−1.86
p-val.	(0.54)	(0.33)	(0.30)	(0.51)	(0.27)	(0.32)	(0.06) *
IV7	0.14	0.19	0.17	−0.12	0.36	0.30	0.28
t-sta.	1.33	1.25	1.34	−0.76	1.50	1.35	1.73
p-val.	(0.19)	(0.21)	(0.18)	(0.45)	(0.14)	(0.18)	(0.09) *
IV8	0.06	−0.23	0.10	0.45	0.24	0.04	0.14
t-sta.	0.42	−1.28	0.96	2.56	1.04	0.14	0.45
p-val.	(0.68)	(0.20)	(0.34)	(0.01) **	(0.30)	(0.89)	(0.65)
			Model 5				
C	1.06	5.12	1.99	−0.28	−2.84	−1.89	0.90
t-sta.	0.61	2.77	1.07	−0.10	−0.93	−0.58	0.24
p-val.	(0.55)	(0.01) **	(0.29)	(0.92)	(0.36)	(0.57)	(0.81)
IV9	−0.02	−0.25	0.26	0.22	0.00	0.06	0.05
t-sta.	−0.16	−1.91	2.15	1.87	0.02	0.74	0.61
p-val.	(0.87)	(0.06) *	(0.03) **	(0.06) *	(0.99)	(0.46)	(0.55)
IV10	0.11	0.12	−0.14	−0.02	0.26	0.18	0.08
t-sta.	1.01	1.20	−1.14	−0.22	1.16	1.12	0.70
p-val.	(0.31)	0.23	(0.26)	(0.83)	(0.25)	(0.27)	(0.49)

Notes: **, and * denote statistical significance at the 5%, and 10% significance levels, respectively. The table reports the *t*-statistics and their corresponding *p*-values below in brackets.

Table 8 contains the results of the PCSE model using the dependent variable and the GII, including its constituent factors (III and IOI). The table shows a significant, positive relationship of GDP with GII, III, and IOI. Similarly, the table shows a negative and significant relationship between self-employment and GII, III, and IOI. Finally, the table shows no significant relationship of FDI with GII, III, and IOI.

Table 8. Panel-Corrected Standard Error (PCSE). Models 1–3.

	C	Model 1 (IV_1)	Model 2 (IV_2)	Model 3 (IV_3)
		GDP per capita, PPP (DV_1)		
C	−18,349.9	1136.673		
z-sta.	−3.62	7.94		
p-val.	(0.0) ****	(0.0) ****		
C	−25,533.12		1123.317	
z-sta.	−3.97		7.68	
p-val.	(0.0) ****		(0.0) ****	
C	−2000.958			155.0895
z-sta.	−0.41			5.56
p-val.	(0.678)			(0.0) ****

Table 8. *Cont.*

	C	Model 1 (IV_1)	Model 2 (IV_2)	Model 3 (IV_3)
Self-employment (% of total employment, DV_2)				
C *z*-sta. *p*-val.	65.792 9.19 (0.0) ****	−0.7996 −4.42 (0.0) ****		
C *z*-sta. *p*-val.	67.50768 8.24 (0.0) ****		−0.7162 −3.97 (0.0) ****	
C *z*-sta. *p*-val.	53.33893 9.70 (0.0) ****			−0.5757 −3.58 (0.0) ****
FDI net inflows (% of GDP, DV_3)				
C *z*-sta. *p*-val.	0.7519122 0.24 (0.809)	0.1042702 0.95 (0.344)		
C *z*-sta. *p*-val.	0.2639834 0.09 (0.928)		0.0991243 1.09 (0.274)	
C *z*-sta. *p*-val.	2.105016 0.88 (0.378)			0.0839096 0.78 (0.433)

Notes: **** denotes statistical significance at the 0.1% significance levels. The table reports the *z*-statistics and their corresponding *p*-values below in brackets.

Finally, Table 9 shows the PCSE model's results using the III's and IOI's sub-indices' five (IV_4–IV_8) and two (IV_9–IV_{10}) pillars, respectively. The table shows a positive and significant relationship between GDP and the institutions (IV_4), human capital and research (IV_5), infrastructure (IV_6), business sophistication (IV_8), knowledge and technology (IV_9), and creative (IV_{10}) outputs pillars. These results only match those in Tables 2 and 3 for the relationships between GDP and IV_4, IV_6, and IV_9–IV_{10}. Likewise, Table 9 shows a negative and significant relationship between self-employment and IV_4–IV_6 and IV_9–IV_{10}. These results fully match those in Tables 4 and 5. Last, the table shows no significant relationship between FDI and any independent variable, consistent with the results in Tables 6 and 7.

Table 9. Panel-Corrected Standard Error (PCSE). Models 4 and 5.

	Model 4							Model 5		
	C	IV_4	IV_5	IV_6	IV_7	IV_8		**C**	IV_9	IV_{10}
GDP per capita, PPP (DV_1)										
Coeff. *z*-sta. *p*-val.	−20,421 −3.18 (0.001) ***	256.5 2.68 (0.007) ***	325.7 6.49 (0.0) ****	292.0 3.17 (0.002) ***	−80.1 −1.3 (−1.3)	272.1 2.92 (0.003) ***	Coeff. *z*-sta. *p*-val.	−3184 −0.67 (0.50)	482.9 5.5 (0.0) ****	422.1 3.25 (0.001) ***
Self-employment (% of total employment, DV_2)										
Coeff. *z*-sta. *p*-val.	75.57 11.10 (0.0) ****	−0.221 −2.17 (0.03) **	−0.46 −5.31 (0.0) ****	−0.24 −3.24 (0.001) ***	0.02 0.29 (0.8)	−0.04 −0.42 (0.67)	Coeff. *z*-sta. *p*-val.	55.89 9.98 (0.0) ****	−0.36 −4.36 (0.0) ****	−0.30 −2.90 (0.004) ***
FDI net inflows (% of GDP, DV_3)										
Coeff. *z*-sta. *p*-val.	−3.97 −0.97 (0.33)	0.106 1.09 (0.27)	−0.09 −1.39 (0.16)	−0.055 −0.61 (0.54)	0.09 1.09 (0.3)	0.07 0.63 (0.53)	Coeff. *z*-sta. *p*-val.	1.89 0.84 (0.40)	0.02 0.14 (0.89)	0.07 0.87 (0.39)

Notes: ****, ***, and ** denote statistical significance at the 0.1%, 1%, and 5% significance levels, respectively. The table reports the *z*-statistics and their corresponding *p*-values below in brackets.

4. Discussion

In shaping the interpretation and forming the generalizations within this discussion section, our focus has been strictly directed toward results that not only exhibit statistical significance for the majority of years analyzed but also maintain consistency in their directional influence across both cross-sectional and PCSE regressions, as demonstrated in Tables 2–9. Any findings that fail to meet these stringent criteria have been deliberately excluded from our analysis on the grounds of being potentially anomalous outcomes that do not provide substantive value to our investigation. Our study provides evidence that innovation is a crucial driver of economic growth. We observe that nations placing a premium on fostering an innovative climate experience growth in economic prosperity and see a marked improvement in their living standards, consistent with the findings of Hall and Rosenberg (2010). This fact resonates with the previously established literature, underscoring the indispensable role of innovation in economies' expansion and advancement (Fagerberg et al. 2005; Romer 1990).

We discovered a significant, positive correlation between a country's GII score and its GDP. This result suggests that a nation's economic prowess is intrinsically tied to its innovative capacity. We note that the constituent sub-indices of the GII, namely the III and IOI, have instrumental roles in this relationship (Furman et al. 2002; Archibugi and Coco 2004).

Prior research has emphasized that each country possesses a unique blend of sociopolitical factors and infrastructure that can substantially shape the role and impact of innovation (Acemoglu et al. 2005). Therefore, it is reasonable to expect that this positive correlation between innovation and economic prosperity may not be a one-size-fits-all phenomenon but could manifest differently across distinct contexts. However, while our findings point to this correlation, they demand further examination and interpretation due to the inherent complexity of the subject matter.

Our findings reinforce the importance of investments in innovation, especially in crucial areas such as infrastructure, education, and property rights. The direct link that we observed between these elements and economic growth aligns with the assertions of Aschauer (1989) and Barro (1991). In line with the findings of Esfahani and Ramírez (2003), Sanchez-Robles (1998), and Hasan et al. (2009), our research also substantiates the significant impact of infrastructure investment, financial market development, and robust institutional frameworks on GDP growth. This finding was echoed by Arif and Ahmad's (2020) study, highlighting the positive effect of fiscal decentralization, underpinned by a strong rule of law and democratic accountability. Similarly, Haseeb et al. (2019) indicated that certain technological factors positively influenced sustainable SME performance. Last, Dima et al.'s (2018) findings on the correlation between GDP per capita and lifelong learning opportunities align with our results.

However, our observations contrast with the conclusions drawn by Gomes et al. (2022). Similarly, our results contradict some previous research works listed in the literature review section, including those by Afzal and Gauhar (2020), Mohamed et al. (2021), Freel and Robson (2004), Benavente (2006), and Carvalho and Avellar (2017). Finally, our results contrast with Levine and Renelt (1992), who found that economic growth can be explained primarily through investment in GDP and international trade as part of GDP.

We propose that initiatives focused on education, entrepreneurial training, and the development of commercial and professional infrastructure contribute positively to a country's economic growth, as opposed to hampering it, aligning with the perspectives of Glaeser et al. (2004).

The role of innovation in shaping self-employment rates appears multifaceted (Autio et al. 2013). Our study detected innovation's negative and significant impact on self-employment rates, often linked to necessity-driven entrepreneurship. Simultaneously, innovation positively impacted opportunity-driven entrepreneurship, which is known to lead to an increase in formal employment and a reduction in self-employment (Wennekers et al. 2005). This dichotomy in the influence of innovation on entrepreneurship is critical and calls for additional investigation. These findings support the argument made by Sternberg and Wennekers (2005) regarding the nuanced relationship between entrepreneurship and innovation. Similarly, our results also agree with those of several authors, including Farinha et al. (2020), Khyareh and Amini (2021), and Edler and Fagerberg (2017).

Research by Margolis (2014) and Burke et al. (2019) confirmed the correlation between self-employment and entrepreneurship, emphasizing the prevalence of necessity-driven entrepreneurial ventures in developing nations. Contrastingly, Burke and Fraser (2012) demonstrated that increased R&D investment tends to foster opportunity-driven self-employment while reducing necessity-driven employment. Mas-Tur et al. (2020) linked sustainable development deficits to low formal job creation expectations. Faggio and Olmo (2014) identified a positive urban-centric relationship among self-employment, business creation, and innovation. In contrast, rural areas with prevalent necessity-driven entrepreneurship displayed a weaker correlation. Last, Mrożewski and Kratzer (2016) showed that, while necessity entrepreneurship is inversely related to national innovation, opportunity entrepreneurship encourages it.

Our study highlights a negative correlation between self-employment and factors such as national institutional framework, local infrastructure, domestic human capital, and research outputs. We infer that government-led innovation investment can reduce self-employment, mainly when focused on infrastructure, education, institutional frameworks, and research. This inference corresponds to prior studies, such as Burke and Fraser (2012) and Eliasson and Westlund (2012), who found deterrent effects of patent activity and rural infrastructural deficits on self-employment. Sanders and Nee (1996) observed how undervalued foreign-acquired human capital in host labor markets impacts immigrant self-employment. Berggren and Olofsson (2021) identified a need for more motivation among highly educated Swedes for self-employment. Contreras et al. (2017) noted Chileans resorting to self-employment due to a lack of salaried work. Finally, Baptista et al. (2014) revealed that, while human capital significantly affects early success for opportunity-based entrepreneurs, it barely influences initial success for necessity-driven ones.

We did not observe a significant correlation between a country's innovation performance and its FDI inflows, a finding that contrasts with several previous studies (Dunning 1988; Borensztein et al. 1998; Modugu and Dempere 2021). However, we recognize that several other factors, such as labor costs, natural resources, tax considerations, and existing infrastructure, may drive FDI. These elements often supersede innovation in attracting foreign investment (Dunning 2000).

A critical limitation of our research pertains to the measurement of national innovation. This limitation is an area fraught with inconsistencies and requires a universal consensus. This rationale is consistent with Brenner and Broekel (2011), who suggested that there is no single superior way to measure the innovation performance of spatial units, such as regions or nations, but rather by implementing a variety of quantifying approaches simultaneously. Future studies could explore alternative indices, such as the International Innovation Index (III), to challenge or substantiate our findings.

Our study strongly advocates for the persistent pursuit of innovation by enabling government policies and substantial investment in critical areas, such as infrastructure, education, and property rights. This outcome aligns with the views of Hall and Rosenberg (2010) on the essential role of innovation in economic development. However, the applicability of these results across varying sociopolitical contexts needs to be investigated further, considering the unique circumstances and factors at play in each country (Acemoglu et al. 2005).

We must acknowledge the inherent complexity of using an index such as the GII, comprising numerous sub-indices and pillars, to gauge a country's innovation performance. Rather than directly attempting to map individual policy areas to economic outcomes, our study focuses on the correlation between these components and a nation's economic prosperity.

Interpreting policy-specific changes based on variations in the GII's sub-indices and pillars could lead to misleading conclusions. For instance, an improvement in the GII score might result from diverse combinations of shifts in its sub-indices, necessitating detailed analysis to pinpoint which specific policies or factors drive these changes.

Given this complexity, our results should be interpreted with caution. We emphasize that our findings do not provide concrete policy prescriptions tied to changes in the GII's sub-indices and pillars. Instead, they present a broader view, accentuating the association between categories or themes of innovation-related policies and macroeconomic variables of interest. Our study provides macro-level evidence suggesting that countries prioritizing policies promoting innovation tend to witness higher economic prosperity (Acemoglu et al. 2005).

Therefore, while our study does hint at a relationship between the promotion of innovation and economic growth, it refrains from offering a granular, policy-specific roadmap for achieving this growth. Policymakers should interpret our results as a general guide that underscores the importance of fostering an innovative culture. They should not view it as a detailed policy manual prescribing the 'what' and 'how' of innovation-related policies (Hall and Rosenberg 2010).

While we acknowledge the limitations inherent in any index-based analysis, our study underscores the critical role of innovation, viewed as a national priority, in driving economic growth and prosperity. Future research should delve deeper into identifying the policy interventions that can foster a culture of innovation, considering the distinct sociopolitical contexts of different nations.

5. Conclusions

This research article examines the relationship between national innovation and macroeconomic variables such as GDP, self-employment, and FDI. We used the GII and its constituent sub-indices to quantify innovation. The study analyzed a sample of 120 countries with historical data from 2013 to 2019 using generalized linear models and panel-corrected standard error models. The results indicate that the GII and its constituent sub-indices have a positive and significant relationship with a country's economic prosperity, measured by its GDP per capita. Additionally, the research finds that the GII and its constituent variables have a positive relationship with the domestic institutional framework, the national infrastructure, the local human capital and technology, and the creative outputs. The findings also suggest that the GII and its constituent factors negatively influence domestic self-employment. The study concludes that government policies supporting the GII and its constituent factors may exert a positive economic impact, accompanied by a reduction in self-employment but with no significant influence on FDI.

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