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ENTREPRENEURIAL ECOSYSTEM AS A CATALYST FOR ECONOMIC GROWTH: A GLOBAL EMPIRICAL EVIDENCE USING A NOVEL COMPOSITE INDEX

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ABSTRACT

In this paper, we examine the role of entrepreneurial ecosystems in driving economic growth across 107 economies from 2011 to 2023. Our objective is to develop and validate a composite index that captures the efficiency of national entrepreneurship systems and assesses its impact on economic growth. To achieve this, we construct six entrepreneurial sub-indexes and a composite Global Entrepreneurship Monitor Index (GEMI) using a two-step approach: first, we apply an output-oriented slacks-based measure (SBM) data envelopment analysis (DEA); second, we use ordinary least squares (OLS) and fixed effects panel regressions to estimate the relationship between GEMI and GDP growth. We also conduct multiple robustness checks using GDP per capita and alternative model specifications. We find that GEMI has a robust positive impact on economic growth, consistent with the Entrepreneurship Ecosystem Theory (EET), which emphasizes the critical role of a well-rounded entrepreneurial environment. Our additional analyses reveal key patterns across income levels, regions, and stages of economic development, indicating that high-income countries benefit the most, middle-income countries experience moderate gains, and low-income countries face significant barriers. We observe that GEMI plays a more transformative role in developed economies, where synergies between financial systems, governance, and open markets amplify its effects compared to emerging economies. Regional variations reveal stronger gains in Europe and Latin America, while Sub-Saharan Africa and MENA regions remain constrained by weak infrastructure and governance. Results remain consistent across robustness checks using GDP per capita and alternative estimation techniques. Our findings offer practical implications for policymakers, international development institutions, and researchers aiming to foster entrepreneurship-led growth. We emphasize the importance of strengthening regulatory frameworks, expanding access to finance, and investing in education and infrastructure to unlock the transformative potential of entrepreneurship.

KEYWORDS: Economic Growth, Entrepreneurship Ecosystem Theory (EET), Global Entrepreneurship Monitor Index (GEMI), Data Envelopment Analysis (DEA), Emerging vs. Developed Markets

JEL CLASSIFICATION: L26, O47, C67, C43.

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INTRODUCTION

Entrepreneurship is more than just a driver of economic growth (Acs & Szerb, 2007; Smith, 2010; Herrington et al., 2010; Parker, 2020; Meyer & Meyer, 2020; Uctu & Al-Silefanee, 2024); it is a transformative force that touches lives, fosters innovation, and addresses some of society's most pressing challenges, such as unemployment, poverty, and inequality (Audretsch & Keilbach, 2004; Acs et al., 2018; Parker, 2020; Abdulai & Hussain, 2024). It is a shared journey of creating solutions, nurturing ideas, and building a collective future. At its core lies the entrepreneurial ecosystem—a dynamic network of elements including access to finance, supportive policies, education, infrastructure, and cultural norms—all working together to spark innovation and economic transformation (Spilling, 1996; Cohen, 2006; Stam

& Spigel, 2016; Spigel, 2017; Mujahid et al., 2019; Shwetzer et al., 2019; Hechavarría & Ingram, 2019; Jones & Ratten, 2021; Stam & van de Ven, 2021; Bendickson et al., 2021). These ecosystems derive from structural conditions facilitating (or hindering) the launching of new ventures and provide the framework for exploring opportunities that drive innovation, job creation, and economic growth (GEM, 2021). Yet, despite theoretical evidence from Entrepreneurial Ecosystem Theory (EET) (Isenberg, 2010), the real-world outcomes often diverge, which reflects the intricacies of ecosystem dynamics and the diverse nature of entrepreneurial contexts.

Existing research highlights the intricate relationship between entrepreneurship and economic growth, particularly in contexts where entrepreneurial ecosystems are cohesive and well-developed. Despite the theoretical evidence provided by the EET, empirical findings on its relationship with economic growth remain inconclusive. Some studies highlight a positive impact, demonstrating that well-developed ecosystems drive growth by fostering innovation and creating jobs (e.g., Salgado-Banda, 2007; Smith, 2010; Wachira, 2022; Uctu & Al-Silefanee, 2024). In contrast, other research points to negative effects, often attributing them to inefficiencies or misaligned ecosystem elements (e.g., Madzikanda & Dabuo, 2021). Still, some studies suggest no significant relationship, arguing that the impact of entrepreneurship on growth is highly contextual and shaped by factors such as the stage of economic development or institutional quality (e.g., Kim et al., 2022; Bubnovskaia et al., 2024). In less mature ecosystems, barriers such as inadequate infrastructure, weak institutions, and financial constraints can diminish or even negate the potential of entrepreneurship to catalyze growth. Here, we aim to address these inconclusive findings by providing fresh empirical insights into the relationship between entrepreneurship and economic growth at a global level, with a focus on the role of entrepreneurial ecosystems.

Moreover, most previous research is based on a micro-perspective in assessing the impact of entrepreneurship on economic growth (e.g., Salgado-Banda, 2007; Sergi et al., 2019; Kim et al., 2022; Abdinnour & Adeniji, 2023; Bubnovskaia et al., 2024). However, our research adopts a macro-oriented or country-wide perspective, employing a novel output-oriented slacks-based measure (SBM) Data Envelopment Analysis (DEA) methodology without explicit inputs to construct a novel composite index referred to as the *Global Entrepreneurship Monitor Index (GEMI)* and its six novel sub-indexes. Furthermore, the interplay between different ecosystem dimensions and their collective impact on economic growth remains underexplored, particularly in diverse contexts such as income levels, regional characteristics, and stages of economic development. Here, we underline that the gap requires a comprehensive and multidimensional approach to analyzing entrepreneurial ecosystems and their role in fostering economic growth at global level.

The current study makes several significant contributions to the existing body of knowledge on entrepreneurship and economic growth. First, it contributes to the literature by constructing a novel composite measure, GEMI, which comprehensively captures the entrepreneurial ecosystems across 107 economies from 2011 to 2023. Second, the study introduces a methodological innovation by employing an output-oriented SBM-based DEA approach without explicit inputs, which provides a balanced evaluation of ecosystem performance by ensuring that no single dimension dominates (Mahdiloo et al., 2023). Third, the research develops six entrepreneurial sub-indexes—financial, policy and regulatory, education and knowledge, infrastructure, market dynamics, and cultural and social norms – that offer a detailed and multidimensional assessment of entrepreneurial ecosystem. Fourth, it moves beyond the micro-level perspective prevalent in existing studies and adopts a macro-oriented approach to evaluate the collective impact of entrepreneurial ecosystems on economic growth, allowing for a more comprehensive understanding of how ecosystems as a whole contribute to economic outcomes. Fifth, the study addresses the heterogeneity in the entrepreneurship-growth relationship by examining how GEMI and its sub-indexes impact economic growth across different income levels, regional contexts, and stages of economic development, providing nuanced insights into the varying contributions of entrepreneurial ecosystems in developed and emerging economies. Sixth, the findings contribute to the

policy discourse by highlighting the most significant drivers of ecosystem efficiency, particularly the critical role of the policy and regulatory sub-index, offering actionable insights for policymakers to strengthen ecosystem elements. Finally, the research provides a robust empirical foundation for future studies to explore the dynamic and contextual nature of entrepreneurship's impact on economic growth, encouraging further examination of institutional, regional, and sectoral variations.

To address these contributions, we frame the study around key research questions that guide our investigation. Specifically, we ask: *How does a well-rounded entrepreneurial ecosystem influence economic growth? What are the specific contributions of individual dimensions of the ecosystem, such as access to entrepreneurial financing, supportive policies and regulations, education, infrastructure, market dynamics, and cultural norms? To what extent does access to entrepreneurial financing facilitate innovation and business growth, and how do supportive policies and regulations lower entry barriers and enhance entrepreneurial activity*? Furthermore, we explore the roles of education, infrastructure, market dynamics, and cultural norms in contributing to economic outcomes. Finally, we investigate how the GEMI-growth relationship varies across income levels, regional contexts, and stages of economic development, highlighting the distinct dynamics in developed and emerging markets.

Our main findings reveal that the GEMI has a robust and significant positive impact on economic growth globally, consistent with the EET and also resonate with the entrepreneurial ecosystem conception by Spigel (2017), Mujahid et al. (2019), Shwetzer et al. (2019), Jones and Ratten (2021), Stam and van de Ven (2021), Bendickson et al. (2021), and Khyareh & Amini, (2021). Among the six sub-indexes, we find that the policy and regulatory sub-index emerges as the most significant driver, underscoring the importance of streamlined regulations, governmental support, and reduced bureaucratic barriers in fostering entrepreneurship. However, we also find that other sub-indexes, such as financial access, education and knowledge, and infrastructure, exhibit limited or insignificant effects in certain contexts, reflecting structural and institutional inefficiencies. We further highlight heterogeneity across income levels, regions, and stages of economic development. High-income countries, with their mature ecosystems, demonstrate the strongest GEMI-growth link, primarily driven by opportunity-driven entrepreneurship. In contrast, we observe that low-income countries face significant challenges, including financial constraints, inadequate infrastructure, and weak governance, which limit entrepreneurship's contributions to growth. Regionally, we identify that Europe and Central Asia, as well as Latin America, benefit the most from entrepreneurship, while Sub-Saharan Africa and the MENA region encounter persistent barriers that constrain entrepreneurial activity. Additionally, we highlight differences in the role of entrepreneurial ecosystems in developed and emerging markets. In developed economies, we find that GEMI has a strong and significant impact on economic growth, driven by mature institutions, financial systems, and competitive markets. In emerging economies, however, we observe that the relationship is positive but weaker, reflecting structural barriers such as inadequate infrastructure, weak governance, and inconsistent policy enforcement that constrain entrepreneurship's transformative potential.

The findings of our study offer actionable insights for policymakers aiming to enhance entrepreneurial ecosystems and drive economic growth. First, we emphasize the need to streamline policy and regulatory frameworks, as the policy and regulatory sub-index emerges as the most critical growth driver. Simplifying regulations, reducing bureaucracy, and fostering government support are essential, particularly in emerging economies where weak governance, inconsistent policies, and inadequate infrastructure hinder the GEMI-growth relationship. Policymakers should bridge these gaps by ensuring policy consistency and investing in foundational infrastructure. Second, access to entrepreneurial financing is crucial for fostering innovation and business growth. Expanding credit availability, establishing venture capital funds, and promoting alternative financing, such as crowdfunding, are key interventions, especially in low-income and emerging markets. Investing in education and knowledge development by integrating entrepreneurship into curricula and promoting skills development in business management, digital literacy, and creativity is equally vital. Third, strengthening physical and technological infrastructure, such as transportation, broadband connectivity, and digital platforms, is necessary to reduce regional

disparities. While Europe and Central Asia may benefit from boosting innovation and competitiveness, Sub-Saharan Africa and MENA require foundational reforms in governance, infrastructure, and market dynamics. Additionally, fostering cultural norms that encourage entrepreneurial risk-taking and innovation through campaigns celebrating success and reducing stigma around failure is critical. We advocate for a holistic approach to strengthening all ecosystem dimensions simultaneously—finance, regulation, education, infrastructure, and market dynamics—for balanced and sustainable growth. Even high-income countries must address inefficiencies in areas like education and financial access to remain competitive. Lastly, fostering regional collaboration to share best practices, pool resources, and address shared challenges like trade barriers and digital connectivity can amplify global entrepreneurship's potential. Implementing these recommendations can strengthen ecosystems and drive inclusive, sustainable economic growth worldwide.

The remainder of the paper is structured as follows: Section 2 reviews the literature and develops hypotheses; Section 3 outlines the methodology and data; Section 4 presents the empirical analysis and findings; Section 5 provides additional analyses and robustness checks; and Section 6 concludes with key insights, contributions, and future research directions.

1 LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

Entrepreneurship serves as a fundamental driver of economic growth, flourishing within the framework of a well-established entrepreneurial ecosystem (Acs & Szerb, 2007; Smith, 2010; Herrington et al., 2010; Kuder, 2015; Durda & Ključnikov, 2019; Wachira, 2022; Uctu & Al-Silefanee, 2024). This ecosystem, conceptualized by Isenberg (2010), offers a holistic perspective on how various interconnected components collectively foster and sustain entrepreneurial activity (Theodoraki et al., 2021). Isenberg's model underscores the importance of factors such as access to finance, supportive policies, educational systems, infrastructure, market dynamics, and sociocultural norms (e.g., Cohen, 2006; Mujahid et al., 2019; Shwetzer et al., 2019; Bendickson et al., 2021). Together, these dimensions create a synergistic environment that enables entrepreneurs to thrive and significantly contribute to economic advancement. The comprehensive nature of Isenberg's entrepreneurial ecosystem theory is particularly compelling. It reveals that no single element can independently propel entrepreneurial success; rather, the interplay among these elements drives sustainable growth (Abootorabi et al., 2021). For instance, while access to capital is vital for launching new ventures, its true potential is realized when combined with regulatory support, robust infrastructure, and a culture of innovation and risk-taking. This interconnectedness equips entrepreneurs with the resilience to overcome challenges, seize emerging opportunities, and effectively mobilize resources and networks. Despite the theoretical strength of entrepreneurial ecosystem theory, empirical studies yield mixed results regarding its direct contribution to economic growth. Empirical evidence generally affirms the positive relationship between well-developed ecosystems and economic progress, attributing growth to enhanced innovation and job creation (Salgado-Banda, 2007; Smith, 2010). Conversely, some studies highlight negative outcomes, often linked to inefficiencies or mismatched ecosystem components (Madzikanda & Dabuo, 2021). Others argue that entrepreneurship's influence on growth is highly context-dependent, shaped by variables such as economic development stages and institutional robustness (Chowdhury et al., 2018; Kim et al., 2022). Stam and van de Ven (2019) emphasize the critical role of cultural and social norms in shaping entrepreneurial ecosystems. Societies that celebrate innovation, honor entrepreneurial success, and view risk-taking as an opportunity rather than a liability foster more conducive environments for entrepreneurship (Lyons et al., 2012). Networks, mentorship programs, and community support systems further enhance social capital, granting entrepreneurs easier access to knowledge, capital, and strategic alliances. Education and knowledge transfer form another pillar essential to the entrepreneurial ecosystem. Embedding entrepreneurship into academic curricula and fostering collaborations between universities and industries stimulate creativity and equip individuals with vital entrepreneurial

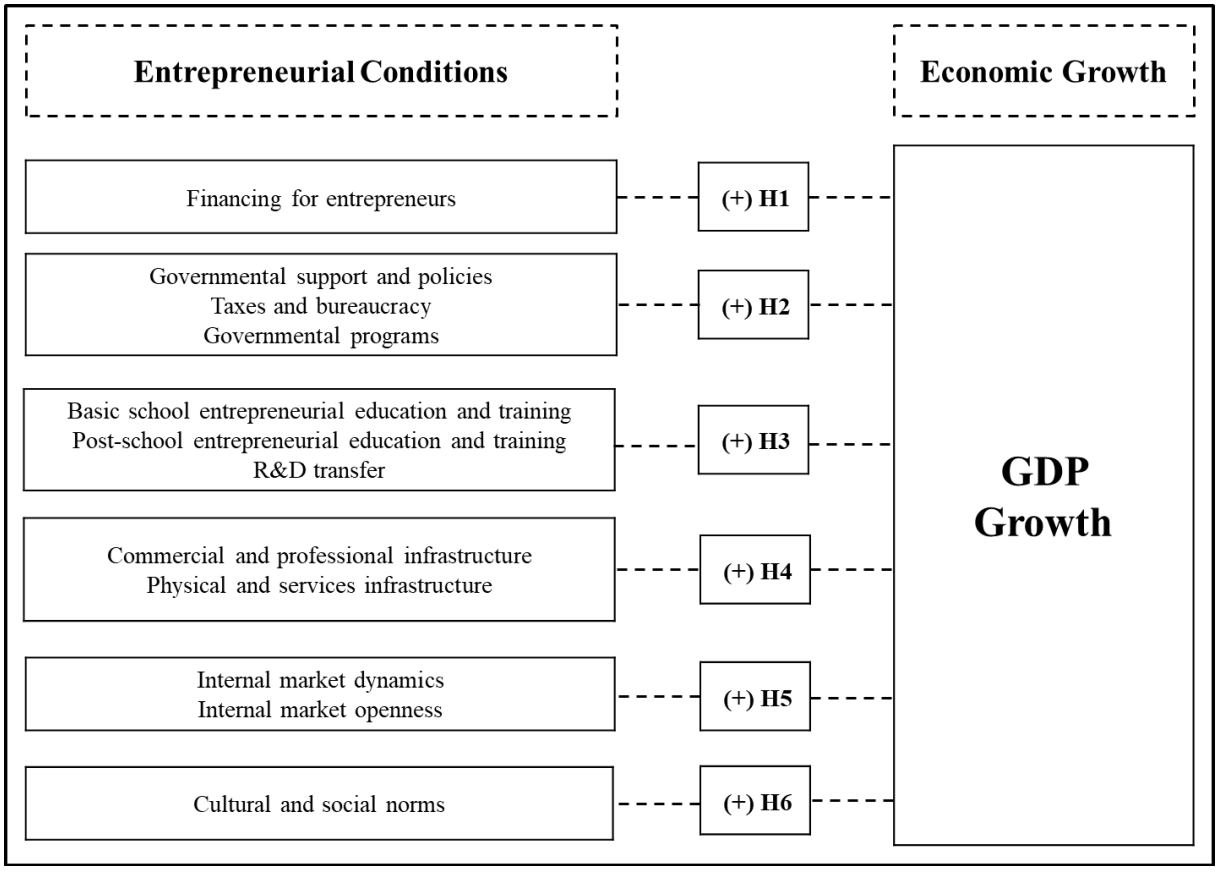
competencies (Rocha et al., 2024; Rosienkiewicz et al., 2024). Similarly, Song et al. (2020) argue that infrastructure—both physical and digital—reduces operational friction, broadens market reach, and enhances logistical efficiency, further driving entrepreneurial activity. Dynamic and competitive markets amplify entrepreneurial ecosystems by fostering technological progress, attracting investment, and dismantling barriers to entry (Bejjani, 2023; Mago, 2023). Transparent regulatory environments ensure fair competition and enable diverse market participation. Drawing from these insights, we propose the following hypothesis:

Hypothesis 1: *The entrepreneurial ecosystem exerts a positive and significant influence on economic growth.*

Access to finance remains a crucial for entrepreneurial success, directly influencing the growth and sustainability of enterprises. A diverse range of financing avenues—including venture capital, microfinance, and fintech solutions—promotes entrepreneurship by mitigating risk and fostering innovation (Kerr & Nanda, 2015; Bruton et al,. 2015; Chen et al., 2021). However, in regions with underdeveloped financial sectors, inefficient capital allocation can dilute the impact of financial access on growth (Vega-Pascual et al., 2024; Wang et al., 2021). In parallel, policy frameworks and regulatory environments significantly shape entrepreneurial ecosystems. Simplified regulatory processes, tax incentives, and government-sponsored initiatives such as incubators and accelerators lower entry barriers and facilitate business formation (Djankov et al., 2006; Audretsch et al., 2021). The effects of supportive policies are most pronounced in developed economies, where mature institutions amplify these benefits (Kubickova, 2017). Equally critical is the role of entrepreneurial education and knowledge dissemination, which cultivate innovative thinking and enhance start-up activity (Nabi et al., 2017; Fayolle, 2023). However, the tangible economic benefits of entrepreneurial education may materialize gradually, particularly in regions with underdeveloped educational infrastructures. Infrastructure further underpins entrepreneurial success by curbing operational costs and widening market access. Reliable transportation networks, digital infrastructure, and advisory services emerge as indispensable enablers (Autio et al., 2021; Isenberg, 2020). Nonetheless, infrastructure alone is insufficient to drive economic growth without complementary factors such as policy support and market accessibility. Market openness and competitiveness fuel entrepreneurship by fostering innovation, attracting capital, and advancing technology (Porter & Kramer, 2022). While dynamic markets significantly impact developed economies, structural obstacles in emerging markets often constrain entrepreneurial growth. Lastly, sociocultural norms that champion innovation and risk-taking catalyze entrepreneurial activity. Societies that valorize entrepreneurship tend to exhibit higher entrepreneurial participation and improved economic outcomes (Hofstede et al., 2018; Audretsch & Moog, 2022). Yet, cultural factors, in isolation, are insufficient drivers of growth, reinforcing the need for integrated ecosystems. Based on the reviewed literature, we propose a conceptual framework that links entrepreneurial ecosystems to economic growth through six key dimensions: finance, policy, education and knowledge, infrastructure, market dynamics, and sociocultural norms. These dimensions collectively define the Global Entrepreneurship Monitor Index (GEMI), which we hypothesize will positively influence economic growth. We also anticipate that this relationship varies across income levels and regions due to contextual differences in ecosystem maturity. Figure 1 summarizes the conceptual framework guiding this study.

- **H1a:** *Access to entrepreneurial financing has a positive but insignificant influence on economic growth.*
- **H1b:** *Supportive government policies and streamlined regulations have a positive and significant impact on economic growth.*
- **H1c:** *Entrepreneurial education and knowledge transfer have a positive but insignificant impact on economic growth.*
- **H1d:** *Development of commercial and physical infrastructure positively contributes but not significantly to economic growth.*
- **H1e:** *Open and dynamic markets have a positive but insignificant impact on economic growth.*
- **H1f:** *Cultural and social norms supportive of entrepreneurship have a positive but insignificant impact on economic growth.*

Figure 1 **Conceptual Framework**



(Source: Authors' own elaboration)

2 METHODOLOGY AND DATA

2.1 Data and Sample Construction

We construct a global unbalanced panel dataset covering 107 economies from 2011 to 2023. The sample period reflects consistent data availability and captures major global shifts, including the post-financial crisis recovery, structural transformations, and the effects of the COVID-19 pandemic. The unbalanced structure results from differences in national reporting, but panel estimation techniques—namely fixed-effects and random-effects regressions—address potential non-stationarity. Hausman test results consistently favour the fixed-effects specification. As the focus is on cross-country variation rather than time-series inference, stationarity tests are not applied. Entrepreneurial framework indicators are sourced from the Global Entrepreneurship Monitor (GEM) database, which provides internationally harmonized data on entrepreneurial financing, government support, regulatory conditions, education and R&D transfer, infrastructure, market dynamics, and cultural norms. GEM data is collected annually through standardized surveys and expert assessments, offering robust ecosystem-level insights. Macroeconomic and institutional control variables—including GDP growth, GDP per capita, trade openness, inflation, investment, population growth, and mobile cellular subscriptions—are drawn from the World Bank's World Development Indicators (WDI). Governance indicators are obtained from the Worldwide Governance Indicators (WGI), while the Financial Development Index is sourced from the International Monetary Fund (IMF). Appendix B details variable definitions and sample coverage.

2.2 Measures of Economic Growth

We measure economic growth using two main indicators: the *GDP growth rate* and the *GDP per capita growth* (Wong et al., 2005; Stel et al., 2005; Mueller, 2007; Valliere and Peterson, 2009; Lepojevic et al., 2016; Sergi et al., 2019; Stoica et al., 2020; Kim et al., 2022), which are among the most widely used measures of economic growth. The GDP growth rate is our main dependent variable as it captures the annual change in a country's overall economic output, which provides a broad view of economic growth of an economy. In contrast, we use GDP per capita as an alternative measure to check the robustness of our results, as it adjusts for population changes and offers insights into how economic growth impacts individuals. Together, these measures allow us to analyze how entrepreneurship influence economic outcomes across different countries.

2.3 Measurement and Construction of Novel Entrepreneurial Sub-indexes and Composite Index

The measurement and construction of the entrepreneurial ecosystem's composite index involve a two-step process. First, entrepreneurial sub-indexes are constructed using relevant indicators through an output-oriented SBM-based DEA without explicit input variables. Second, these sub-indexes are aggregated into a single composite index (GEMI) using the same output-oriented SBM DEA methodology, assuming a variable returns to scale regime. This approach, inspired by Mahdiloo et al. (2023), adopts a non-compensatory methodology, ensuring that each sub-index contributes meaningfully and that poor performance in one dimension cannot be fully offset by strong performance in another.

2.3.1 Step 1: Construction of Entrepreneurial Sub-indexes Using SBM DEA

Table 1 **Entrepreneurial Framework Conditions from GEM database**

Sub-indexes	Indicators	Research Articles	Sources
Financial Sub-index	Financing for entrepreneurs	Lopes et al. (2018) Borozan & Borozan (2020); and Lopes et al. (2021)	NES-GEM
Policy and Regulatory Sub-index	Governmental support and policies Taxes and bureaucracy Governmental programs		NES-GEM
Education and Knowledge Sub-index	Basic school entrepreneurial education and training Post-school entrepreneurial education and training R&D transfer		NES-GEM
Infrastructure Sub-index	Commercial and professional infrastructure Physical and services infrastructure		NES-GEM
Market Dynamics Sub-index	Internal market dynamics Internal market openness		NES-GEM
Cultural and Social Sub-index	Cultural and social norms		NES-GEM

Notes: Table 1 provides a summary of the Entrepreneurial Framework Conditions from the GEM database, highlighting the key sub-indexes and their respective indicators, which collectively measure the entrepreneurial ecosystem across various dimensions.

(Source: Authors' own elaboration)

The entrepreneurial ecosystem is captured through six sub-indexes derived from the Entrepreneurial Framework Conditions in the GEM database:

The sub-indexes are constructed by aggregating relevant indicators using an output-oriented SBM DEA without explicit input variables. The SBM model explicitly incorporates slacks (i.e., deviations from optimal performance) into the optimization process.

Mathematical Formulation

For each country o (Decision-Making Unit, DMU), the objective is to maximize the efficiency of its sub-index ($Subindex_k$), given n_k indicators associated with sub-index k.

a) Objective Function:

$$\max \ \theta_k^o \sum_{i=1}^{n_k} \frac{Indicator_{k,i}^o}{\sum_{j=1}^{J} \lambda_j \, . \, Indicator_{k,i}^j + s_{k,i}^+}$$

where: $\theta_k^o \in [0,1]$: Degree of entrepreneurship efficiency for sub-index k in country o. $Indicator_{k,i}^o$: Value of the $i-th$ indicator for country o in sub-index k. $s_{k,i}^o$: Slack variable representing underperformance in indicator i. λ_j: Intensity variable (weight for country j). J: Total number of DMUS (countries).

b) Constraints*:*

- Weighted sum of indicators for all countries should not exceed the evaluated country's performance:

$$\sum_{i=1}^{n_k} \lambda_j \, . \, Indicator_{k,i}^j + \ s_{k,i}^+ \ = \ Indicator_{k,i}^o \, , \qquad \forall_i$$

- Intensity variables ensure **variable returns to scale:**

$$\sum_{j=1}^{J} \lambda_j = 1, \qquad \lambda_j \geq 0$$

- Non-negativity for slacks

$$s_{k,i}^+ \geq 0$$

c) Efficiency score for sub-index k:

$$Subindex_k^o \ = \ \theta_k^o$$

The output-oriented SBM DEA model ensures that the efficiency score ($Subindex_k^o$) accounts for both proportional performance and slack in individual indicators. This model also ensures the sub-index scores are normalized between 0 and 1. $Subindex_k^o = 1$ indicates full entrepreneurial efficiency in sub-index k. $Subindex_k^o < 1$ reflects inefficiencies or underperformance in one or more indicators.

2.3.2 Step 2: Aggregation of Sub-indexes into the Composite Index (GEMI)

The six sub-indexes ($SubIndex_1, SubIndex_2, \ldots, SubIndex_6$) are aggregated into a single composite index (GEM_{Index}) using the same SBM DEA methodology.

Mathematical Formulation

a) Objective Function:

$$\max\ \theta^o = \frac{1}{6}\sum_{k=1}^{6} \frac{SubIndex_k^o}{\sum_{j=1}^{J} \lambda_j \,.\, SubIndex_k^j + s_k^+}$$

where: $\theta^o \in [0,1]$ is the degree of entrepreneurial efficiency (GEMI) for country o. $SubIndex_k^o$ is sub-index score for country o. $s_k^+ is$ slack variable representing underperformance in sub-index k. λ_j is intensity variable for country j.

b) Constraints:

- Weighted sum of sub-indexes for all countries should not exceed the evaluated country's sub-indexes:

$$\sum_{j=1}^{J} \lambda_j \,.\, SubIndex_k^j + s_k^+ = SubIndex_k^o\,, \qquad \forall_k$$

- Intensity variables ensure **variable returns to scale**:

$$\sum_{j=1}^{J} \lambda_j = 1, \qquad \lambda_j \geq 0$$

- Non-negativity for slacks

$$s_k^+ \geq 0$$

c) Efficiency Score for the Composite Index:

$$GEMI^O = \theta^0$$

The composite index accounts for all six sub-indexes, ensuring that no sub-index is ignored or compensated for by others. The GEMI score is normalized between 0 and 1. $GEMI^O = 1$ indicates full entrepreneurial efficiency across all sub-indexes. $GEMI^O < 1$ reflects inefficiencies in one or more sub-indexes.

2.4 Control Variables

In this study, we include several control variables to account for macroeconomic, demographic, technological, and institutional factors that influence the relationship between entrepreneurship and economic growth. The Financial Development Index (FDI) is incorporated as it reflects the efficiency, depth, and accessibility of financial markets, which are critical for channeling resources to entrepreneurial activities and fostering economic growth. Trade Openness, defined as the ratio of exports plus imports to GDP, represents a country's integration into global markets (Salgado-Banda, 2007; Kim et al., 2022). It facilitates entrepreneurship by providing access to larger markets, encouraging knowledge spillovers, and promoting innovation. Inflation, measured through the Consumer Price Index, captures macroeconomic stability, as high or volatile inflation can create uncertainty, discouraging entrepreneurial activities and investment (Salgado-Banda, 2007). The Population Growth Rate is included as a demographic indicator, influencing labor supply, consumer demand, and the scale of entrepreneurial

activities (Kim et al., 2022). Gross Capital Formation (Investment) measures the level of investment in infrastructure, technology, and fixed assets, which are essential for supporting entrepreneurship by improving productivity and reducing operational barriers (Kim et al., 2022). Mobile Cellular Subscriptions (MCS) serve as a proxy for digital connectivity, enabling digital entrepreneurship, market access, and efficient communication channels. Lastly, the Institutional Quality Index (IQI), which comprises governance indicators such as control of corruption, government effectiveness, regulatory quality, and the rule of law, reflects the overall governance environment (Méndez-Picazo et al., 2012). Strong institutions are pivotal for reducing uncertainty, enforcing contracts, and providing a supportive ecosystem for entrepreneurial ventures. These control variables collectively provide a comprehensive understanding of the external factors influencing economic growth, ensuring robust and reliable analysis in this study.

2.5 Model Specification

To empirically assess the relationship between entrepreneurship and economic growth, we specify the following econometric models, with a focus on examining each entrepreneurial sub-index separately in addition to the composite GEM index ($GEMI$). Ordinary Least Squares (OLS) is employed as the baseline estimation method.

Baseline Model

The baseline model examines the impact of the composite GEM index ($GEMI$) on economic growth, measured by GDP growth (GDP_{Growth}). The model is specified as follows:

$$GDP_{Growth_{i,t}} = \beta_0 + \beta_1 GEMI_{i,t} + \beta_2 Controls_{i,t} + \epsilon_{i,t}$$

where: $GDP_{Growth_{i,t}}$ is the annual GDP growth rate for country i in year t. $GEMI_{i,t}$ is the composite index of entrepreneurship derived using output-oriented DEA methodology. $Controls_{i,t}$ is the vector of control variables, including financial development index (FDI), Trade Openness $(Trade_{Opennes})$, Inflation $(Inflation)$, Population Growth (Pop_{Growth}), Investment $(Investment)$, Mobile Cellular Subscriptions (MCS), and Institutional Quality Index (IQI). $\epsilon_{i,t}$ is error term, capturing unobserved heterogeneity. This model provides a holistic view of how entrepreneurial ecosystems, as captured by the GEM_{Index} influence economic growth.

Sub-index Models

To better understand the contribution of individual dimensions of entrepreneurial framework conditions, we analyze each sub-index separately:

$$GDP_{Growth_{i,t}} = \beta_0 + \beta_1 Subindex_{i,t} + \beta_2 Controls_{i,t} + \epsilon_{i,t}$$

where $Subindex_{i,t}$ represents each of the six entrepreneurial sub-indexes analyzed separately: Financial Sub-index $(Fin_{Subindex})$ captures access to entrepreneurial financing; Policy and Regulatory Sub-index $(Policy_{Reg_{Subindex}})$ assesses government policies, bureaucracy, and programs, Education and Knowledge Sub-index $(EduKnow_{Subindex})$ reflects entrepreneurial education and R&D transfer; Infrastructure Sub-index $(Infra_{Subindex})$ captures commercial and physical infrastructure; Market Dynamics Sub-index $(MarkDyn_{Subindex})$ measures market openness and dynamics,; and Cultural and Social Sub-index

$(CultSoc_{Subindex})$ reflects societal norms and attitudes toward entrepreneurship. This specification ensures that each sub-index-s unique impact on economic growth is isolated, which allows for a detailed understanding of their respective contributions.

3 EMPIRICAL ANALYSES

In this section, we analyze the data through descriptive statistics, examine variable relationships via the correlation matrix, and present baseline findings on the impact of GEMI and its sub-indexes on GDP growth.

3.1 Descriptive Statistics

We observe from the summary statistics, as shown in Table 1, that the global sample reflects diverse macroeconomic, institutional, and entrepreneurial conditions. For the *dependent variables*, we note that GDP growth has a mean of 2.67% with a standard deviation (SD) of 3.58, while GDP per capita growth averages 1.82% (SD = 3.62). These averages suggest moderate global economic growth, with substantial variability as reflected in ranges from sharp declines (-18.00% and -19.63%) to high growth rates (24.62% and 23.44%). For the *entrepreneurial sub-indexes*, we find that the financial sub-index averages 0.51 (SD = 0.22), indicating moderate access to entrepreneurial financing. The policy and regulatory sub-index (mean = 0.38, SD = 0.24) and education and knowledge sub-index (mean = 0.36, SD = 0.21) reveal relatively low global scores, suggesting room for improvement in these areas. The infrastructure sub-index shows better performance (mean = 0.57, SD = 0.28), while the market dynamics sub-index (mean = 0.46, SD = 0.24) and cultural and social sub-index (mean = 0.52, SD = 0.22) indicate moderate levels of support for entrepreneurship. The *GEM Index*, with an average of 0.29 (SD = 0.20), highlights the relatively low overall efficiency of entrepreneurial ecosystems globally, with values ranging widely from 0.02 to 1.00. We also observe disparities in the control variables. The Financial Development Index (FDI) (mean = 0.50, SD = 0.23) and trade openness (mean = 88.46, SD = 61.76) suggest moderate to high levels globally, with trade openness varying widely (0.00 to 394.22). Inflation averages 5.19% (SD = 12.62), ranging from deflationary pressures (-16.46%) to high inflation (235.52%). Population growth (mean = 0.82%, SD = 1.35) varies from sharp declines (-10.93%) to rapid increases (11.58%), while investment (mean = 23.33%, SD = 7.48) reflects considerable commitment to capital formation globally. Mobile cellular subscriptions (MCS) average 110.84 per 100 people (SD = 41.00), suggesting widespread access but with disparities (0.00 to 236.49). Institutional Quality Index (IQI) (mean = 0.00, SD = 2.06) demonstrates significant differences in governance quality, ranging from -5.31 to 3.53.

Table 2 **Summary Statistics**

Variables	Count	Mean	Var	SD	Min	Max
Main Dependent Variable						
GDP Growth	723	2.67	12.82	3.58	-18.00	24.62
Alternative Dependent Variable						
GDP per capita	723	1.82	13.09	3.62	-19.63	23.44
Independent Variables						
Fin_Subindex	723	0.51	0.05	0.22	0.00	1.00
Policy_Reg_Subindex	723	0.38	0.06	0.24	0.01	1.00
EduKnow_Subindex	723	0.36	0.04	0.21	0.01	1.00
Infra_Subindex	723	0.57	0.08	0.28	0.01	1.00
MarkDyn_Subindex	723	0.46	0.06	0.24	0.01	1.00

CultSoc_Subindex	723	0.52	0.05	0.22	0.00	1.00
GEMI	723	0.29	0.04	0.20	0.02	1.00
Control Variables						
FDI	723	0.50	0.05	0.23	0.08	0.99
Trade_Openness	723	88.46	3814.63	61.76	0.00	394.22
Inflation	723	5.19	159.14	12.62	-16.46	235.52
Pop_Growth	723	0.82	1.83	1.35	-10.93	11.58
Investment	723	23.33	56.01	7.48	0.00	53.71
MCS	723	110.84	1680.91	41.00	0.00	236.49
IQI	723	0.00	4.25	2.06	-5.31	3.53

Notes: Table 2 provides a summary of the descriptive statistics for the main dependent, alternative dependent, independent, and control variables used in the analysis. The table includes key statistical measures such as the number of observations (Count), mean, variance (Var), standard deviation (SD), and the range (minimum and maximum values). For detailed variable definitions, refer to Appendix B.

(Source: Authors' own elaboration)

3.2 Pairwise Correlation Matrix

The pairwise correlation matrix in Table 2 highlights the relationships among all independent variables in our dataset, with correlation coefficients all below 0.8, effectively minimizing multicollinearity concerns in our analysis. Each entrepreneurship sub-index/composite index is analysed in a separate regression model, further reducing potential multicollinearity issues. Additionally, with a variance inflation factor (VIF) below 5 across all specifications, we can confidently conclude that multicollinearity is not a significant concern in our estimations.

Table 3 **Pairwise Correlations**

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
(1) GDP Growth	1.000														
(2) Fin_Subindex	-0.070	1.000													
	(0.059)														
(3) Policy_Reg_Subindex	0.097	0.050	1.000												
	(0.009)	(0.180)													
(4) EduKnow_Subindex	0.049	0.116	0.103	1.000											
	(0.192)	(0.002)	(0.006)												
(5) Infra_Subindex	0.009	0.129	0.070	0.075	1.000										
	(0.805)	(0.001)	(0.061)	(0.043)											
(6) MarkDyn_Subindex	0.058	-0.031	0.096	0.040	0.092	1.000									
	(0.120)	(0.407)	(0.010)	(0.283)	(0.013)										
(7) CultSoc_Subindex	0.051	0.088	0.151	0.130	0.088	0.010	1.000								
	(0.171)	(0.019)	(0.000)	(0.000)	(0.018)	(0.786)									
(8) GEMI	0.092	0.338	0.481	0.479	0.355	0.350	0.316	1.000							
	(0.013)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)								
(9) FDI	-0.127	0.105	0.148	0.078	0.079	-0.032	0.087	0.066	1.000						
	(0.001)	(0.005)	(0.000)	(0.036)	(0.034)	(0.389)	(0.019)	(0.075)							
(10) Trade_Openness	0.086	0.030	0.092	0.125	0.087	0.100	0.004	0.091	0.117	1.000					
	(0.021)	(0.421)	(0.014)	(0.001)	(0.020)	(0.007)	(0.922)	(0.014)	(0.002)						
(11) Inflation	0.012	0.009	-0.050	-0.046	-0.033	0.014	-0.074	0.000	-0.210	-0.152	1.000				
	(0.745)	(0.803)	(0.183)	(0.214)	(0.381)	(0.714)	(0.048)	(0.999)	(0.000)	(0.000)					
(12) Pop_Growth	0.124	0.026	0.075	0.015	-0.014	0.003	0.094	0.075	-0.114	-0.021	0.062	1.000			
	(0.001)	(0.478)	(0.045)	(0.681)	(0.716)	(0.941)	(0.012)	(0.045)	(0.002)	(0.570)	(0.097)				
(13) Investment	0.233	-0.028	0.040	0.055	0.061	0.073	0.107	0.024	0.050	0.126	-0.058	0.080	1.000		
	(0.000)	(0.450)	(0.279)	(0.137)	(0.100)	(0.051)	(0.004)	(0.522)	(0.176)	(0.001)	(0.120)	(0.032)			
(14) MCS	-0.011	-0.002	0.019	0.007	0.013	-0.091	-0.014	-0.068	0.125	0.126	-0.103	-0.056	0.089	1.000	
	(0.768)	(0.950)	(0.608)	(0.852)	(0.727)	(0.014)	(0.712)	(0.068)	(0.001)	(0.001)	(0.006)	(0.134)	(0.017)		
(15) IQI	-0.109	0.096	0.160	0.165	0.143	0.027	0.035	0.134	0.657	0.411	-0.278	-0.176	-0.063	0.169	1.000
	(0.003)	(0.010)	(0.000)	(0.000)	(0.000)	(0.476)	(0.344)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.091)	(0.000)	

Notes: Table 3 presents the pairwise correlations between the main dependent variable (GDP Growth), independent variables (GEMI and sub-indexes), and control variables. Correlation coefficients are provided alongside their p-values in parentheses.

(Source: Authors' own elaboration)

3.3 Results and Discussion

Our baseline findings, presented in Table 4, provide evidence on the impact of entrepreneurship on economic growth at a global level. We capture entrepreneurship using sub-indexes and a novel composite index. The sub-indexes include the financial sub-index, policy and regulatory sub-index, education and knowledge sub-index, infrastructure sub-index, market dynamics sub-index, and cultural and social sub-index. The composite index is the GEMI, estimated using an output-oriented DEA methodology. Economic growth is measured through the GDP growth rate as the main dependent variable (Sergi et al., 2019; Stoica et al., 2020; Kim et al., 2022). Our main findings reveal that the *GEMI*, a composite index of all sub-indexes, exhibits a positive and highly significant relationship with GDP growth (1.827***), supporting the first hypothesis, which is consistent with the findings of Khyareh & Amini (2021) and Gomes et al. (2023). This showcases the integral role of a well-rounded entrepreneurial ecosystem where all dimensions interact synergistically to enhance economic growth (Wennekers & Thurik, 1999; Baumol & Strom, 2007). This aligns closely with the *EET* (Isenberg, 2010), which emphasises the necessity of interconnected and mutually reinforcing elements – such as financial systems, policy frameworks, and cultural dynamics – to sustain and amplify entrepreneurship-driven economic growth. These findings also resonate with broader conceptualizations of entrepreneurial ecosystems provided by Spilling (1996), Cohen (2006), Stam and Spigel (2016), Spigel (2017), Mujahid et al. (2019), Shwetzer et al. (2019), Jones and Ratten (2021), Stam and van de Ven (2021), and Bendickson et al. (2021). As to sub-indexes, the *financial sub-index* has a negative but statistically insignificant coefficient (-0.813), suggesting inefficiencies in financial resource allocation or utilization within entrepreneurial ecosystems. The *policy and regulatory sub-index* shows a positive and statistically significant coefficient (1.721**), aligning with the *institutional theory* (North, 1990). This highlights the pivotal role of the regulative pillar—comprising government support, streamlined policies, and reduced bureaucratic barriers—in driving entrepreneurship-led growth. While the *education and knowledge sub-index* has a positive coefficient (0.852), its impact is not statistically significant, likely reflecting the lag between investments in entrepreneurial education and their long-term economic outcomes. Similarly, *the infrastructure sub-index* (0.053) and the *market dynamics sub-index* (0.323) have positive but statistically insignificant coefficients, indicating that while these dimensions are necessary for entrepreneurship, their effects on growth may depend on complementary factors such as policy support and market access. The *cultural and social sub-index*, which reflects societal norms and values, also has a positive but insignificant coefficient (0.516), emphasizing that cultural support for entrepreneurship alone is insufficient to drive significant economic growth. To sum up, the overall findings provide empirical support for entrepreneurship ecosystem theories, which clarifies how interconnected and mutually reinforcing dimensions can sustain and amplify entrepreneurship-driven economic growth.

Control variables further contextualize these findings. The FDI consistently shows a negative but insignificant coefficient (-1.161 to -1.332), suggesting that while financial development is important, its role in entrepreneurship-driven growth may be limited or even counterproductive in certain contexts. Trade openness has a positive and significant impact (0.006*), indicating that integration into global markets facilitates entrepreneurial activity by providing access to larger markets and fostering innovation. Inflation has a negative but insignificant effect (-0.002 to -0.004), reflecting limited macroeconomic instability in moderating the entrepreneurship-growth relationship. Population growth shows a positive but insignificant coefficient (0.116 to 0.160), suggesting that demographic factors may not directly influence entrepreneurship's contribution to GDP growth. Gross capital formation (investment) has a highly significant positive impact (0.100***), highlighting the critical role of investments in infrastructure, technology, and capital goods in driving growth. MCS exhibit near-zero and insignificant coefficients (-0.000 to 0.001), suggesting that while mobile connectivity is necessary for digital entrepreneurship, it may not

directly influence GDP growth. The IQI shows a positive but insignificant effect (0.113 to 0.138), indicating that while strong institutions are essential for entrepreneurial success, their direct contributions to economic growth may be mediated by other variables.

Table 4 **Entrepreneurship and Economic Growth Relationship**

	(1) GDP Growth	(2) GDP Growth	(3) GDP Growth	(4) GDP Growth	(5) GDP Growth	(6) GDP Growth	(7) GDP Growth
Fin_Subindex	-0.813						
	(0.574)						
Policy_Reg_Subindex		**1.721****					
		(0.544)					
EduKnow_Subindex			0.852				
			(0.627)				
Infra_Subindex				0.053			
				(0.456)			
MarkDyn_Subindex					0.323		
					(0.538)		
CultSoc_Subindex						0.516	
						(0.584)	
GEMI							**1.827*****
							(0.659)
FDI	-1.161	-1.332	-1.167	-1.214	-1.192	-1.255	-1.122
	(0.784)	(0.780)	(0.784)	(0.785)	(0.785)	(0.785)	(0.781)
Trade_Openness	0.006*	0.006*	0.006*	0.006*	0.006*	0.006*	0.006*
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Inflation	-0.002	-0.002	-0.003	-0.002	-0.003	-0.002	-0.004
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
Pop_Growth	0.160	0.116	0.145	0.152	0.153	0.143	0.120
	(0.099)	(0.099)	(0.099)	(0.099)	(0.099)	(0.100)	(0.100)
Investment	0.101***	0.100***	0.100***	0.102***	0.101***	0.100***	0.100***
	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)
MCS	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	0.001
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
IQI	0.138	0.128	0.122	0.134	0.132	0.136	0.113
	(0.124)	(0.123)	(0.124)	(0.124)	(0.124)	(0.124)	(0.123)
Income_Class							
2.income_Class	0.895*	0.961*	0.913*	0.901*	0.903*	0.912*	0.954*
	(0.428)	(0.426)	(0.428)	(0.429)	(0.429)	(0.429)	(0.427)
3.income_Class	2.184***	2.360***	2.240***	2.200***	2.178***	2.201***	2.308***
	(0.575)	(0.574)	(0.576)	(0.576)	(0.577)	(0.575)	(0.574)
4.income_ Class	2.096*	2.298*	2.224*	2.166*	2.172*	2.198*	2.392*
	(0.944)	(0.939)	(0.944)	(0.945)	(0.944)	(0.945)	(0.943)
Constant	0.142	-0.841	-0.591	-0.306	-0.429	-0.502	-0.908
	(0.767)	(0.726)	(0.745)	(0.750)	(0.752)	(0.753)	(0.741)
Number of obs.	721	721	721	721	721	721	721
R Squared	0.110	0.119	0.109	0.107	0.107	0.108	0.117
Adjusted R Squared	0.096	0.106	0.096	0.093	0.094	0.094	0.103
F-Statistic	7.928	8.741	7.912	7.725	7.760	7.803	8.507
p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Notes: Table 4 summarizes the regression results examining the relationship between entrepreneurship, represented by the sub-indexes and the composite GEMI, and GDP growth. The analysis employs OLS as the estimation method. Coefficients are accompanied by standard errors in parentheses, with statistical significance levels denoted by asterisks: ***, **, and * correspond to significance at the 1%, 5%, and 10% levels, respectively. For detailed variable definitions, refer to Appendix B.

(*Source:* Authors' own elaboration)

4 ADDITIONAL ANALYSES AND ROBUSTNESS CHECKS

To ensure the robustness of our findings and provide deeper insights into the relationship between entrepreneurship and economic growth, we conduct additional analyses across various dimensions. These include comparisons between developed and emerging economies, regional differences, and variations across income classifications. We also validate the consistency of results by employing GDP per capita as an alternative measure of economic growth.

4.1 Additional Analyses

4.1.1 Developed vs. Emerging Economies Analysis

Entrepreneurship has been widely recognized as a critical engine of economic growth, but its efficacy is deeply influenced by the economic and institutional context in which it operates. To better understand these dynamics, we sub-analyzed our data by dividing the sample into developed and emerging economies, leveraging the GEMI – a composite measure of entrepreneurial framework conditions (IMF classification). Our findings, summarized in Table 5, reveal distinct narratives (Sergi et al., 2019; Kim et al., 2022): while entrepreneurial ecosystems in developed economies exhibit cohesive synergies that significantly drive economic growth, emerging economies face structural and institutional barriers that constrain entrepreneurship's transformative potential.

The results reveal that the GEMI has a robust and highly significant impact on GDP growth in developed economies, highlighting the strength and effectiveness of their entrepreneurial ecosystems. In these economies, mature financial systems, strong institutional frameworks, and open, competitive markets work in harmony to create an environment where entrepreneurship not only flourishes but also drives sustained economic growth. This synergy reflects the advanced state of these economies, where the interconnected components of the entrepreneurial framework reinforce each other to amplify their collective impact. Such findings align with Sergi et al. (2019), who emphasize that institutionalization is pivotal in enhancing the effectiveness of entrepreneurial integration processes – such as clusters and innovation networks – in fostering high-quality economic growth in developed nations. Conversely, the GEMI in emerging economies exhibits a positive but only marginally significant effect on GDP growth. While this highlights the importance of entrepreneurship as a growth driver even in less mature economies, it also sheds light on the critical bottlenecks that limit its potential. Weak governance, inadequate infrastructure, inconsistent policy enforcement, and underdeveloped markets create structural barriers that constrain entrepreneurial ecosystems from fully contributing to economic progress. Addressing these challenges is essential to unlocking entrepreneurship's latent potential. This conclusion resonates with Sergi et al. (2019), who argue that emerging markets must prioritize further institutionalization to optimize entrepreneurial contributions and enhance their impact on economic growth. These findings also align with Kim et al. (2022)'s, who, in a cross-country analysis, demonstrated, that high-performing entrepreneurs significantly influence economic growth in advanced economies, while developing economies require further institutional support to harness entrepreneurship's potential.

To delve deeper, we analyzed the individual sub-indexes that comprise the GEMI. The *financial sub-index* is significant only in developed economies (coefficient = 0.001*), emphasizing the critical role of well-developed financial systems in facilitating access to capital for entrepreneurs. In

emerging economies, the lack of significance reflects the limitations of financial systems that are either inaccessible or under-resourced. Financial inclusion reforms, particularly in emerging markets, are vital to addressing this gap and fostering entrepreneurial activity. The *policy and regulatory sub-index* emerges as a critical driver of GDP growth in both contexts but with nuanced differences. In developed economies (coefficient = 1.296*), the sub-index reflects the importance of streamlined regulations and supportive governmental policies in sustaining entrepreneurship's contribution to growth. In emerging economies, while the coefficient is larger (coefficient = 1.947*), its weaker statistical significance suggests that inconsistent policy enforcement and weak institutions undermine the full impact of regulatory frameworks. This finding showcases the transformative potential of policy reforms, particularly in emerging economies, where addressing institutional weaknesses could dramatically enhance entrepreneurship's role in economic development. The *education and knowledge sub-index* demonstrates a significant impact in developed economies (coefficient = 0.211**), where advanced educational systems and R&D infrastructure are well-aligned with economic and entrepreneurial needs. This alignment fosters innovation and human capital development, both of which are essential for sustained economic growth. Conversely, the lack of significance in emerging economies highlights deficiencies in the quality, accessibility, and relevance of entrepreneurial education and knowledge transfer mechanisms. Addressing these gaps through targeted investments in education and R&D infrastructure could yield substantial dividends in these economies. Interestingly, the *infrastructure sub-index* is not significant in either context, suggesting that while infrastructure is a necessary condition for entrepreneurship, it alone does not directly translate into GDP growth. This finding implies that infrastructure must be complemented by other enabling factors, such as effective policy frameworks and market access, to amplify its impact. Similarly, the *cultural and social sub-index* shows no significant impact in either group, indicating that cultural norms, while important for fostering entrepreneurial intent, do not have a direct measurable effect on economic outcomes. The *market dynamics sub-index* exhibits a significant and positive relationship with GDP growth in developed economies (coefficient = 2.385**), highlighting the role of open and competitive markets in amplifying entrepreneurship's contribution to economic activity. However, in emerging economies, this sub-index is not significant, likely due to structural barriers such as limited market openness, monopolistic practices, and inefficient supply chains. Breaking down these barriers is essential to unlocking entrepreneurship's potential in emerging markets.

Table 5 **Entrepreneurship and Economic Growth: Developed vs. Emerging Economies**

	(1) GDP Growth	(2) GDP Growth	(3) GDP Growth	(4) GDP Growth	(5) GDP Growth	(6) GDP Growth	(7) GDP Growth	(8) GDP Growth	(9) GDP Growth	(10) GDP Growth	(11) GDP Growth	(12) GDP Growth	(13) GDP Growth	(14) GDP Growth
	Developed Economies	*Emerging Economies*	*Developed Economies*	*Emerging Economies*	*Developed Economies*	*Emerging Economies*	*Developed Economies*	*Emerging Economies*	*Developed Economies*	*Emerging Economies*	*Developed Economies*	*Emerging Economies*	*Developed Economies*	*Emerging Economies*
Fin_Subindex	**0.001***	-1.340												
	(0.915)	(0.740)												
Policy_Reg_Subindex			**1.296*****	**1.947***										
			(0.818)	**(0.723)**										
EduKnow_Subindex					**0.211****	0.926								
					(0.941)	(0.848)								
Infra_Subindex							**-0.050**	0.121						
							(0.684)	(0.606)						
MarkDyn_Subindex									**2.385****	-0.805				
									(0.837)	(0.711)				
CultSoc_Subindex											0.228	0.392		
											(0.948)	(0.754)		
GEMI													**1.732*****	**1.631***
													(0.972)	**(0.897)**
FDI	0.696	0.004	0.631	-0.305	0.720	-0.174	0.690	-0.110	1.427	0.011	0.706	-0.163	0.999	-0.236
	(1.403)	(1.166)	(1.396)	(1.161)	(1.406)	(1.168)	(1.405)	(1.169)	(1.406)	(1.172)	(1.403)	(1.172)	(1.405)	(1.166)
Trade_Openness	0.010**	0.001	0.010**	0.001	0.010**	0.001	0.010**	0.001	0.010**	0.001	0.010**	0.001	0.010**	0.001
	(0.003)	(0.004)	(0.003)	(0.004)	(0.003)	(0.004)	(0.003)	(0.004)	(0.003)	(0.004)	(0.003)	(0.004)	(0.003)	(0.004)
Inflation	0.182**	-0.004	0.174*	-0.006	0.179*	-0.006	0.181**	-0.006	0.189**	-0.005	0.179*	-0.005	0.171*	-0.007
	(0.069)	(0.011)	(0.069)	(0.011)	(0.070)	(0.011)	(0.069)	(0.011)	(0.068)	(0.011)	(0.070)	(0.011)	(0.069)	(0.011)
Pop_Growth	0.219	0.161	0.201	0.101	0.212	0.144	0.219	0.148	0.267	0.150	0.200	0.146	0.147	0.120
	(0.307)	(0.110)	(0.305)	(0.111)	(0.307)	(0.110)	(0.306)	(0.110)	(0.302)	(0.110)	(0.315)	(0.111)	(0.307)	(0.111)
Investment	0.202***	0.094***	0.204***	0.091***	0.201***	0.093***	0.202***	0.094***	0.212***	0.095***	0.200***	0.093***	0.201***	0.093***
	(0.052)	(0.020)	(0.051)	(0.020)	(0.052)	(0.020)	(0.052)	(0.020)	(0.051)	(0.020)	(0.052)	(0.020)	(0.051)	(0.020)
MCS	0.010	-0.004	0.009	-0.003	0.010	-0.003	0.010	-0.004	0.012*	-0.004	0.010	-0.004	0.010	-0.003
	(0.006)	(0.004)	(0.006)	(0.004)	(0.006)	(0.004)	(0.006)	(0.004)	(0.006)	(0.004)	(0.006)	(0.004)	(0.006)	(0.004)
IQI	-0.464	0.380*	-0.470	0.333*	-0.468	0.329	-0.463	0.344*	-0.608*	0.358*	-0.463	0.350*	-0.482*	0.320
	(0.242)	(0.168)	(0.241)	(0.166)	(0.242)	(0.168)	(0.242)	(0.167)	(0.244)	(0.167)	(0.242)	(0.168)	(0.241)	(0.167)
Constant	-4.717*	1.062	-5.166**	-0.191	-4.796**	0.089	-4.689**	0.365	-6.559***	0.751	-4.818**	0.258	-5.459**	-0.076
	(1.839)	(0.912)	(1.721)	(0.869)	(1.742)	(0.900)	(1.743)	(0.906)	(1.800)	(0.890)	(1.757)	(0.907)	(1.745)	(0.887)
Income level control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of obs.	286	435	286	435	286	435	286	435	286	435	286	435	286	435
R Squared	0.139	0.107	0.147	0.116	0.139	0.103	0.139	0.100	0.164	0.103	0.140	0.101	0.149	0.107
Adjusted R Squared	0.111	0.084	0.119	0.093	0.111	0.080	0.111	0.077	0.137	0.080	0.111	0.078	0.121	0.084
F-Statistic	4.964	4.621	5.289	5.022	4.971	4.410	4.965	4.294	6.014	4.419	4.972	4.317	5.374	4.624
p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Notes: Table 5 presents the results of the OLS regression analysis, comparing the impact of entrepreneurship on economic growth, measured using GDP growth, across developed and emerging economies. The analysis includes sub-indexes such as the financial sub-index, policy and regulatory sub-index, and others, alongside the composite GEMI. Coefficients are accompanied by standard errors in parentheses, and statistical significance levels are denoted by asterisks: ***p < 0.01, **p < 0.05, and *p < 0.1. For detailed variable definitions, refer to Appendix B.

Source: Authors' own elaboration)

4.1.2 Country Income Classification Analysis

In this section, we examine the heterogeneity in the relationship between entrepreneurship and economic growth across four income classifications: high-income, upper middle-income, lower middle-income, and low-income countries (World Bank income country classification). Broadly, our findings reveal substantial disparities in the contribution of entrepreneurial ecosystems to economic activity. The results are presented in Table 6.

The findings on GEMI and its impact on GDP growth across income groups can be explained through the lens of necessity-driven and opportunity-driven entrepreneurship. In high-income countries, GEMI demonstrates a strong positive relationship with GDP growth (1.970***), driven by opportunity-driven entrepreneurship (Hechavarria & Reynolds, 2009; Mota et al., 2019). These economies benefit from well-established entrepreneurial ecosystems, including access to funding, advanced infrastructure, and supportive policies, enabling scalable and innovative ventures that significantly drive economic activity (Gomes et al. 2023). In upper middle-income countries, GEMI has a positive but smaller impact (0.778**), reflecting mixed entrepreneurial motives. Structural challenges like bureaucratic inefficiencies and weaker institutions limit the full potential of opportunity-driven ventures, despite emerging entrepreneurial ecosystems. In lower middle-income countries, GEMI remains positive (0.701*), though significance is further reduced, as necessity-driven entrepreneurship dominates (Acs, 2006; Bosma et al., 2018; Hechavarria & Reynolds, 2009). Here, businesses are largely small-scale, subsistence-focused, and hindered by financial and institutional barriers, constraining their contribution to GDP growth. In low-income countries, GEMI is negative and insignificant (-0.021), as underdeveloped ecosystems and survival-driven entrepreneurship fail to impact GDP meaningfully (Acs et al., 2008; Mota et al., 2019).

When analyzing the sub-indexes, we observe that the *financing for entrepreneurs sub-index* plays a modest but significant role in high-income countries (0.018*), where well-developed financial markets provide stable access to funding. In contrast, this sub-index is insignificant in upper middle-income countries (1.449) and negative in low middle-income (-3.087) and low-income countries (-2.276), highlighting the persistent financial barriers hindering entrepreneurship in less developed economies. The *policy & regulatory sub-index* emerges as the most consistent and impactful driver of GDP growth across all income levels, with significant coefficients in high-income (1.186***), upper middle-income (1.558**), low middle-income (2.460*), and low-income countries (3.856), which aligns with the findings of Gomes et al. (2023). This finding showcases the critical importance of supportive government policies, streamlined bureaucracies, and effective regulatory environments in fostering entrepreneurship, especially in lower-income contexts where policy reforms can yield substantial benefits. The *education & knowledge sub-index* exhibits a modest but significant positive effect in high-income countries (0.052**), which reflects the role of entrepreneurial education and knowledge transfer in driving economic growth; however, our finding is not in line with the previous evidence found by Gomes et al. (2023) from OECD countries context. Interestingly, we find a more pronounced impact in upper middle-income countries (1.411*), where investments in education may unlock greater entrepreneurial potential. In low middle-income and low-income countries, however, the coefficients are either insignificant or negative (-3.973), suggesting that underdeveloped education systems and insufficient knowledge transfer mechanisms limit entrepreneurship's impact on growth in these regions. We also find that the *infrastructure sub-index* plays a significant role in high-income countries (0.150*), where strong infrastructure enables entrepreneurial activity. However, in upper middle-income countries, the coefficient is insignificant (0.282), and in low middle-income countries, it is negative (-1.744), pointing to significant infrastructure gaps that hinder entrepreneurship. In low-income countries, the sub-index remains insignificant (0.466), reflecting minimal infrastructure development. Similarly, the *market dynamics sub-index* is significant in driving GDP growth in high-income

(1.361**) and upper middle-income countries (2.095*), where competitive and open markets support entrepreneurship. However, the sub-index is insignificant in low middle-income (0.749) and low-income countries (-1.639), indicating that market inefficiencies act as barriers to entrepreneurial growth in these contexts. The cultural & social sub-index shows a significant positive effect in high-income countries (0.088*), highlighting the role of supportive cultural norms and social systems in fostering entrepreneurship. In upper middle-income countries, however, the coefficient is insignificant (-0.574), suggesting that cultural factors may not yet fully align to support entrepreneurship. In low middle-income countries, the coefficient is positive but insignificant (3.645), indicating potential for cultural shifts to enhance entrepreneurship. In low-income countries, the sub-index remains insignificant (0.532), reflecting the underdeveloped entrepreneurial culture and social norms in these economies.

Table 6 **Entrepreneurship and Economic Growth Across Country Income Levels**

	(1) **GDP Growth**	(2) **GDP Growth**	(3) **GDP Growth**	(4) **GDP Growth**
	High Income	**Upper Middle Income**	**Low Middle Income**	**Low Income**
Panel A: Global Entrepreneurship Monitor Index				
GEMI	**1.970*** **	**0.778** **	**0.701***	-0.021
	(0.794)	**(1.534)**	**(2.047)**	(4.021)
Constant	-1.992*	1.135	4.151	7.179
	(0.999)	(1.451)	(2.432)	(7.278)
Controls	Yes	Yes	Yes	Yes
Number of obs.	408	212	81	20
R Squared	0.121	0.121	0.064	0.648
Panel B: Financing for Entrepreneurs Sub-index				
Fin_Subindex	**0.018***	1.449	-3.087	-2.276
	(0.747)	(1.188)	(1.651)	(2.294)
Constant	-1.352	1.966	6.244*	7.189
	(1.091)	(1.461)	(2.413)	(6.621)
Controls	Yes	Yes	Yes	Yes
Number of obs.	408	212	81	20
R Squared	0.107	0.127	0.106	0.677
Panel C: Policy & Regulatory Sub-index				
Policy_Reg_Subindex	**1.186*** **	**1.558** **	**2.460***	3.856
	(0.677)	**(1.170)**	**(1.698)**	(1.959)
Constant	-1.676	0.803	3.224	s2.776
	(0.986)	(1.437)	(2.391)	(6.348)
Controls	Yes	Yes	Yes	Yes
Number of obs.	408	212	81	20
R Squared	0.114	0.128	0.089	0.740
Panel D: Education & Knowledge Sub-index				
EduKnow_Subindex	**0.052** **	**1.411***	1.845	-3.973
	(0.793)	**(1.368)**	(1.766)	(2.954)
Constant	-1.383	0.853	3.351	10.265
	(1.013)	(1.463)	(2.486)	(6.806)
Controls	Yes	Yes	Yes	Yes
Number of obs.	408	212	81	20

R Squared	0.107	0.125	0.077	0.698
Panel E : Infrastructure Sub-index				
Infra_Subindex	**0.150***	0.282	-1.744	0.466
	(0.575)	(0.947)	(1.367)	(2.034)
Constant	-1.444	1.206	5.062*	6.262
	(1.020)	(1.479)	(2.293)	(7.947)
Controls	Yes	Yes	Yes	Yes
Number of obs.	408	212	81	20
R Squared	0.107	0.121	0.084	0.650
Panel F: Market Dynamics Sub-index				
MarkDyn_Subindex	**1.361****	**2.095***	0.749	-1.639
	(0.693)	**(1.080)**	(1.675)	(1.809)
Constant	-2.153*	1.919	3.949	8.790
	(1.049)	(1.397)	(2.530)	(6.903)
Controls	Yes	Yes	Yes	Yes
Number of obs.	408	212	81	20
R Squared	0.115	0.136	0.065	0.673
Panel G: Cultural & Social Sub-index				
CultSoc_Subindex	**0.088***	-0.574	3.645	0.532
	(0.776)	(1.137)	(1.713)	(2.509)
Constant	-1.390	1.683	1.885	6.806
	(0.999)	(1.517)	(2.509)	(7.103)
Controls	Yes	Yes	Yes	Yes
Number of obs.	408	212	81	20
R Squared	0.107	0.121	0.118	0.649

Notes: Table 6 presents the results of the regression analysis examining the impact of entrepreneurship, as measured by the GEMI and its sub-indexes, on GDP growth across countries categorized by income levels (high income, upper middle income, low middle income, and low income). Each panel (Panel A to G) highlights a specific entrepreneurial sub-index alongside the composite GEM Index (GEMI), allowing for a detailed understanding of their contributions to economic growth in diverse income contexts. The analysis employs robust controls and reports statistical significance levels denoted by asterisks: ***p < 0.01, **p < 0.05, and *p < 0.1. For detailed variable definitions, refer to Appendix B.

Source: Authors' own elaboration)

4.1.3 Regional Analysis

In this section, we explore the effect of entrepreneurship on GDP growth across seven regions: East Asia & Pacific, Europe & Central Asia, North America, Middle East & North Africa, Sub-Saharan Africa, Latin America & Caribbean, and South Asia (World Bank Regional Classification). Our findings reveal significant regional disparities, which highlights the varying capacities of entrepreneurial ecosystems to contribute to economic growth. The results are presented in Table 7.

Our findings reveal that GEMI has a significant and positive relationship with GDP growth in Europe & Central Asia (1.626**) and Latin America & Caribbean (4.488**), emphasizing the importance of entrepreneurship in fostering economic activity in these regions. These findings reflect relatively stable institutions and supportive entrepreneurial ecosystems. In North America, GEMI is positive but less pronounced (0.163*), likely due to the region's already mature and highly efficient markets. Conversely, GEMI is insignificant in East Asia & Pacific, Middle East & North Africa, Sub-Saharan Africa, and South Asia, suggesting that entrepreneurship's contribution to growth in these regions is constrained by structural and institutional barriers. These findings align

broadly with those of Kim et al. (2022); however, while Kim et al. (2022) adopted a micro-level perspective, focusing on individual entrepreneurial activities, our investigation takes a macro-oriented approach.

The *financial sub-index* demonstrates significant negative effects in East Asia & Pacific (-2.652**) and Sub-Saharan Africa (-5.502*), highlighting the critical role of financial constraints in limiting entrepreneurial activities. Inefficient financial systems and limited access to funding in these regions may impede entrepreneurship's ability to drive growth. In contrast, financial systems in Europe & Central Asia exhibit a small positive but insignificant effect (0.106), suggesting some progress but room for improvement. Addressing these financial barriers is essential for unlocking entrepreneurship's potential in underperforming regions. *Policy and regulatory frameworks* emerge as consistent drivers of entrepreneurship-led growth, with significant positive effects in Europe & Central Asia (1.551**) and Latin America & Caribbean (4.095**). These results underline the importance of streamlined regulations, effective government support, and reduced bureaucratic obstacles in fostering entrepreneurship. Although the coefficients are positive in Middle East & North Africa (2.712) and Sub-Saharan Africa (3.751), their insignificance suggests that policy implementation may not yet align with entrepreneurial needs in these regions. Strengthening policy execution could amplify entrepreneurship's impact on growth. The *education & knowledge sub-index* has a significant positive impact in Sub-Saharan Africa (4.058), suggesting that investments in entrepreneurial education and knowledge transfer can substantially enhance economic growth in this region. However, this sub-index remains insignificant in all other regions, indicating a gap in aligning education systems with the demands of entrepreneurship. Expanding entrepreneurial education tailored to regional needs could improve outcomes in underperforming areas. The *infrastructure sub-index* appears to have a limited impact on entrepreneurship-led growth, with the infrastructure sub-index largely insignificant across regions. Its negative coefficient in Sub-Saharan Africa (-0.944) reflects the region's significant infrastructure gaps, which hinder economic growth. Similarly, *market dynamics* exhibit varied effects; while Europe & Central Asia benefits from a significant positive impact (2.168**), North America shows a significant negative relationship (-3.617*), possibly due to market saturation or inefficiencies. Addressing these market-specific challenges is crucial for fostering entrepreneurial activity. Finally, *cultural and social norms* demonstrate mixed effects. In East Asia & Pacific, the *cultural & social sub-index* negatively impacts growth (-2.152*), indicating that risk-averse attitudes or unsupportive societal norms may suppress entrepreneurial activities. In other regions, the sub-index is insignificant, reflecting limited cultural alignment with entrepreneurial objectives. Promoting cultural shifts that encourage risk-taking and innovation could unlock entrepreneurship's potential in regions where cultural barriers persist.

Table 7 **Regional Analysis of the Impact of Entrepreneurship on Economic Growth**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Variable	**GDP Growth**	**GDP Growth**	**GDP Growth**	**GDP Growth**	**GDP Growth**	**GDP Growth**	**GDP Growth**
	East Asia & Pacific	**Europe & Central Asia**	**North America**	**Middle East & North Africa**	**Sub-Saharan Africa**	**Latin America & Caribbean**	**South Asia**
Panel A: Global Entrepreneurship Monitor Index							
GEMI	-0.028	**1.626****	**0.163***	1.524	2.545	**4.488****	0.018
	(0.909)	(0.978)	**(1.666)**	(1.690)	(3.183)	**(1.925)**	(5.840)
Constant	3.690	-5.950***	-13.071	6.302	4.598	-0.768	121.219
	(4.380)	(1.712)	(29.909)	(3.311)	(6.359)	(1.792)	(56.143)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of obs.	76	321	22	89	53	144	16
R Squared	0.649	0.156	0.540	0.317	0.194	0.220	0.626
Panel B: Financial Sub-index							
Fin_Subindex	**-2.652****	0.106	-0.010	1.260	**-5.502***	-0.941	-8.144
	(0.757)	(0.865)	(1.490)	(1.753)	**(2.170)**	(1.661)	(10.070)
Constant	7.154	-5.311**	-13.444	6.932*	8.191	0.946	62.042
	(4.115)	(1.754)	(32.614)	(3.185)	(6.145)	(1.975)	(88.827)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of obs.	76	321	22	89	53	144	16
R Squared	0.705	0.149	0.540	0.314	0.290	0.190	0.663
Panel C: Policy & Regulatory Sub-index							
Policy_Reg_Subindex	0.289	**1.551****	0.191	2.712	3.751	**4.095****	0.977
	(0.750)	**(0.783)**	(1.621)	(1.646)	(2.234)	**(1.476)**	(4.668)
Constant	3.663	-5.947***	-12.827	5.083	3.816	-0.587	118.382
	(4.348)	(1.693)	(30.128)	(3.374)	(6.210)	(1.742)	(54.516)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of obs.	76	321	22	89	53	144	16
R Squared	0.650	0.159	0.540	0.333	0.233	0.233	0.629

Panel D: Education & Knowledge Sub-index							
EduKnow_Subindex	-0.178	-0.222	0.355	-0.585	4.058	0.821	4.235
	(0.862)	(0.928)	(1.864)	(1.834)	(2.604)	(1.791)	(4.386)
Constant	3.789	-5.163**	-10.785	7.485*	1.334	0.129	111.751
	(4.386)	(1.699)	(32.840)	(3.294)	(6.535)	(1.867)	(50.217)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of obs.	76	321	22	89	53	144	16
R Squared	0.649	0.149	0.541	0.310	0.226	0.190	0.676
Panel E : Infrastructure Sub-index							
Infra_Subindex	-0.247	-0.228	0.807	-0.112	-0.944	1.274	-3.062
	(0.648)	(0.659)	(1.108)	(1.516)	(1.861)	(1.165)	(4.734)
Constant	3.570	-5.133**	-9.885	7.258*	4.879	-0.500	120.263
	(4.357)	(1.696)	(29.379)	(3.269)	(6.446)	(1.939)	(51.195)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of obs.	76	321	22	89	53	144	16
R Squared	0.650	0.149	0.558	0.309	0.186	0.196	0.651
Panel F: Market Dynamics Sub-index							
MarkDyn_Subindex	0.611	**2.168****	-3.617*	-2.482	-2.632	-0.316	-2.979
	(0.720)	**(0.800)**	(1.314)	(1.537)	(2.200)	(1.501)	(6.646)
Constant	2.290	-6.799***	-45.721	9.622**	5.040	0.523	111.923
	(4.627)	(1.743)	(26.221)	(3.463)	(6.318)	(1.810)	(56.087)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of obs.	76	321	22	89	53	144	16
R Squared	0.653	0.169	0.709	0.332	0.208	0.189	0.638
Panel G: Cultural & Social Sub-index							
CultSoc_Subindex	-2.152*	-0.141	0.010	0.850	0.456	-1.173	15.175
	(0.914)	(0.917)	(1.397)	(1.885)	(2.255)	(1.536)	(6.666)
Constant	3.850	-5.181**	-13.558	6.560	4.089	1.032	14.097
	(4.179)	(1.714)	(29.648)	(3.473)	(6.617)	(1.920)	(60.988)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of obs.	76	321	22	89	53	144	16
R Squared	0.677	0.149	0.540	0.311	0.182	0.192	0.799

Notes: Table 7 presents the results of the regional analysis exploring the impact of entrepreneurship, as measured by the GEMI and its sub-indexes, on GDP growth across seven global regions: East Asia & Pacific, Europe & Central Asia, North America, Middle East & North Africa, Sub-Saharan Africa, Latin America & Caribbean, and South Asia. Each panel evaluates the relationship between specific entrepreneurial dimensions and economic growth, while incorporating robust controls to account for regional-specific factors. The analysis employs robust controls and reports statistical significance levels denoted by asterisks: ***p < 0.01, **p < 0.05, and *p < 0.1. For detailed variable definitions, refer to Appendix B.

Source: Authors' own elaboration)

4.2 Robustness Checks

4.2.1 GDP Per Capita as an Alternative Measure of Economic Growth

In Table 8, we confirm the robustness of the baseline results using GDP per capita as an alternative measure of economic growth (Salgado-Banda, 2007; Sergi et al., 2019; Stoica et al., 2020; Kim et al., 2022). This metric, which adjusts for population dynamics, emphasizes the consistent positive relationship between entrepreneurship and economic growth. Key sub-indexes, such as policy and regulatory dimension, remain significant contributors, highlighting the importance of governance. We find that these results remain consistent across income levels, regions, and stages of economic development, reinforcing entrepreneurship's role as a catalyst for economic development.

Table 8 **Eentrepreneurship-Growth Relationship: GDP Per Capita as an Alternative Measure**

	(1) **GDP per capita**	(2) **GDP per capita**	(3) **GDP per capita**	(4) **GDP per capita**	(5) **GDP per capita**	(6) **GDP per capita**	(7) **GDP per capita**
Fin_Subindex	-0.813						
	(0.567)						
Policy_Reg_Subindex		**1.653****					
		(0.538)					
EduKnow_Subindex			0.796				
			(0.620)				
Infra_Subindex				0.091			
				(0.451)			
MarkDyn_Subindex					0.326		
					(0.532)		
CultSoc_Subindex						0.430	
						(0.577)	
GEMI							**1.805*****
							(0.652)
FDI	-1.212	-1.379	-1.222	-1.264	-1.244	-1.300	-1.175
	(0.776)	(0.771)	(0.776)	(0.776)	(0.777)	(0.776)	(0.772)
Trade_Openness	0.005*	0.005*	0.005*	0.005*	0.005*	0.006*	0.005*
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Inflation	-0.002	-0.002	-0.002	-0.002	-0.003	-0.002	-0.004
	(0.011)	(0.010)	(0.011)	(0.011)	(0.011)	(0.011)	(0.010)
Pop_Growth	-0.811***	-0.853***	-0.825***	-0.819***	-0.818***	-0.826***	-0.850***
	(0.098)	(0.098)	(0.098)	(0.098)	(0.098)	(0.099)	(0.099)
Investment	0.102***	0.101***	0.101***	0.102***	0.102***	0.101***	0.101***
	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)
MCS	0.000	0.001	0.001	0.001	0.001	0.001	0.001
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
IQI	0.152	0.143	0.137	0.147	0.146	0.150	0.128
	(0.122)	(0.122)	(0.123)	(0.123)	(0.123)	(0.122)	(0.122)
Income_Class							
2.income_Class	0.905*	0.969*	0.923*	0.913*	0.913*	0.920*	0.964*
	(0.423)	(0.422)	(0.424)	(0.424)	(0.424)	(0.424)	(0.422)
3.income_Class	2.079***	2.248***	2.132***	2.095***	2.073***	2.096***	2.202***
	(0.569)	(0.568)	(0.570)	(0.569)	(0.570)	(0.569)	(0.568)
4.income_ Class	2.026*	2.222*	2.150*	2.099*	2.101*	2.122*	2.319*
	(0.934)	(0.929)	(0.934)	(0.935)	(0.934)	(0.934)	(0.933)

Constant	0.057	-0.904	-0.655	-0.412	-0.515	-0.550	-0.985
	(0.759)	(0.719)	(0.736)	(0.742)	(0.744)	(0.745)	(0.733)
Number of obs.	721	721	721	721	721	721	721
R Squared	0.148	0.157	0.148	0.146	0.146	0.146	0.155
Adjusted R Squared	0.135	0.144	0.134	0.132	0.133	0.133	0.142
F-Statistic	11.196	11.979	11.153	10.982	11.017	11.036	11.793
p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Notes: Table 8 presents the results of the regression analysis examining the relationship between entrepreneurship, represented by the GEMI and its sub-indexes, and GDP per capita as an alternative measure of economic growth. The analysis uses OLS regression, with coefficients followed by robust standard errors in parentheses. Statistical significance levels are denoted by asterisks: ***p < 0.01, **p < 0.05, and *p < 0.1. For detailed variable definitions, refer to Appendix B.

Source: Authors' own elaboration)

4.2.2 Fixed Effects Regression Analysis

To assess the impact of the entrepreneurial ecosystem on economic growth, we perform both fixed-effects and random-effects regressions across all model specifications. This dual approach ensures the robustness of our results by accounting for potential unobservable heterogeneity across countries. The Hausman test was conducted for each specification to determine the most appropriate econometric framework. In other words, The p-values from the Hausman tests were consistently below the 0.05 threshold, rejecting the null hypothesis that the random-effects model is appropriate. The results consistently indicate that the fixed-effects model is the most suitable for our analysis, as it effectively controls for time-invariant country-specific characteristics that could bias the estimates in a random-effects framework. Our analyses reconfirm the consistency of our baseline findings, demonstrating that the key relationships between the entrepreneurial ecosystem subindices and economic growth remain robust across model specifications. The fixed-effects regression framework allows us to isolate the within-country variations over time, providing reliable and consistent results for policy implications.

Table 9 **Entrepreneurship and Economic Growth Relationship: Fixed Effects Regression**

	(1) **GDP Growth**	(2) **GDP Growth**	(3) **GDP Growth**	(4) **GDP Growth**	(5) **GDP Growth**	(6) **GDP Growth**	(7) **GDP Growth**
Fin_Subindex	-0.347						
	(0.589)						
Policy_Reg_Subindex		**1.485****					
		(0.543)					
EduKnow_Subindex			0.473				
			(0.637)				
Infra_Subindex				0.325			
				(0.452)			
MarkDyn_Subindex					-0.007		
					(0.553)		
CultSoc_Subindex						-0.400	
						(0.649)	
GEMI							**1.850*****
							(0.661)
FDI	-12.760*	-11.618*	-12.557*	-12.776*	-12.682*	-12.570*	-12.331*
	(5.015)	(4.999)	(5.015)	(5.014)	(5.023)	(5.016)	(4.984)
Trade_Openness	0.077***	0.076***	0.076***	0.076***	0.077***	0.077***	0.074***
	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)
Inflation	0.045*	0.042*	0.044*	0.045*	0.045*	0.046*	0.041*
	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)

Pop_Growth	0.146	0.104	0.138	0.136	0.138	0.137	0.105
	(0.135)	(0.134)	(0.135)	(0.135)	(0.135)	(0.135)	(0.134)
Investment	-0.054	-0.050	-0.053	-0.056	-0.054	-0.055	-0.048
	(0.042)	(0.041)	(0.042)	(0.042)	(0.042)	(0.042)	(0.041)
MCS	0.011**	0.011**	0.012**	0.012**	0.012**	0.011**	0.012***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
IQI	0.604	0.576	0.550	0.598	0.580	0.574	0.542
	(0.595)	(0.590)	(0.595)	(0.594)	(0.594)	(0.594)	(0.590)
Income_Class							
2.income_Class	-1.398	-1.322	-1.385	-1.373	-1.384	-1.427	-1.340
	(0.825)	(0.820)	(0.825)	(0.825)	(0.825)	(0.828)	(0.820)
3.income_Class	-1.798	-1.590	-1.759	-1.820	-1.806	-1.870	-1.730
	(1.357)	(1.352)	(1.359)	(1.357)	(1.358)	(1.361)	(1.349)
4.income_ Class	-8.032	-7.204	-7.617	-8.017	-8.012	-8.233	-7.103
	(6.099)	(6.071)	(6.122)	(6.098)	(6.103)	(6.109)	(6.070)
Constant	2.918	1.567	2.426	2.602	2.692	2.902	1.978
	(2.985)	(2.970)	(2.980)	(2.961)	(2.990)	(2.980)	(2.952)
Number of obs.	721	721	721	721	721	721	721
R Squared	0.093	0.104	0.094	0.093	0.093	0.093	0.104
F-Statistic	5.635	6.348	5.655	5.652	5.600	5.638	6.386
p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Notes: Table 9 presents the results of the fixed effects (FE) regression analysis examining the relationship between entrepreneurship, represented by the GEMI and its sub-indexes, and GDP growth as the main measure of economic growth. The analysis uses FE regression, with coefficients followed by robust standard errors in parentheses. Statistical significance levels are denoted by asterisks: ***p < 0.01, **p < 0.05, and *p < 0.1. For detailed variable definitions, refer to Appendix B.

Source: Authors' own elaboration)

CONCLUSION

In this study, we conducted a comprehensive analysis of the relationship between entrepreneurial ecosystems and economic growth across 107 economies from 2011 to 2023. Using an innovative methodological approach – output-oriented SBM-based DEA without explicit inputs – we developed the GEMI and its six sub-indexes to encapsulate the multidimensional nature of entrepreneurial ecosystems. Our findings clearly show that a well-rounded entrepreneurial ecosystem, as represented by GEMI, significantly drives economic growth globally. These results provide strong empirical support for the EET, which emphasizes the importance of interconnected and synergistic dimensions – spanning finance, policy, education, infrastructure, market dynamics, and cultural norms – in fostering entrepreneurship and amplifying its impact on economic outcomes.

We identified the policy and regulatory sub-index as the most critical driver of economic growth, highlighting the importance of streamlined regulations, governmental support, and reduced bureaucratic barriers. However, other sub-indexes, at a global level, show a positive but insignificant impact on economic growth. Moreover, our findings also reveal substantial heterogeneity in the entrepreneurship-growth nexus, shaped by income levels, regional characteristics, and stages of economic development. High-income countries demonstrated the strongest GEMI-growth relationship, driven by mature ecosystems and opportunity-driven entrepreneurship. In contrast, low-income countries face structural and institutional barriers, which constrain the contributions of necessity-driven entrepreneurship to economic growth.

At a regional level, we observed that Europe & Central Asia and Latin America derive the most significant benefits from well-functioning entrepreneurial ecosystems, whereas regions such as Sub-Saharan Africa and MENA continue to face challenges that impede entrepreneurship's potential to catalyze growth.

Additionally, we found that GEMI has a more transformative effect in developed economies, where institutional synergies amplify its impact, compared to emerging economies, which struggle with structural inefficiencies.

Our findings carry important implications for policymakers. We emphasize the need for targeted interventions to enhance entrepreneurial ecosystems, including simplifying regulatory frameworks, expanding access to entrepreneurial financing, investing in education and skills development, and addressing infrastructural gaps. For emerging and low-income economies, we stress the importance of foundational reforms in governance and institutional quality to unlock entrepreneurship's latent potential. Furthermore, we advocate for fostering regional collaboration to share best practices and tackle shared challenges, which can enhance entrepreneurial activity globally.

This study is not without limitations. While our global approach provides comprehensive insights, it does not capture sector-specific variations in entrepreneurial dynamics. Additionally, our reliance on secondary data limits the exploration of micro-level drivers and informal sector activity. Future research could integrate microfoundational data or examine longitudinal ecosystem transformations, particularly in response to digitalization or climate-related disruptions.

With this research, we contribute to the literature on the entrepreneurship-growth relationship and introduce a novel framework for evaluating entrepreneurial ecosystems through GEMI. We suggest that future research could extend our work by exploring sector-specific impacts of entrepreneurship, analyzing the role of digital transformation within ecosystems, or investigating the interplay of ecosystem dimensions in different institutional and cultural contexts. Overall, we reaffirm the centrality of entrepreneurship as a catalyst for economic growth and offer actionable insights for fostering inclusive and sustainable development worldwide.

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Appendix A: Country Distribution Across the entire period 2011-2023

Country	Frequency	Country	Frequency	Country	Frequency
Algeria	3	Angola	6	Argentina	10
Armenia	1	Australia	6	Austria	6
Bangladesh	1	Barbados	5	Belarus	2
Belgium	4	Belize	2	Bolivia	1
Bosnia and Herzegovina	5	Botswana	4	Brazil	13
Bulgaria	5	Burkina Faso	4	Cameroon	3
Canada	10	Chile	13	China	10
Colombia	13	Costa Rica	2	Croatia	13
Cyprus	8	Czech Republic	2	Denmark	2
Dominican Republic	2	Ecuador	8	Egypt	9
El Salvador	3	Estonia	7	Ethiopia	1
Finland	7	France	10	Georgia	2
Germany	13	Ghana	2	Greece	13
Guatemala	12	Hong Kong	1	Hungary	9
India	12	Indonesia	9	Iran	13
Ireland	10	Israel	11	Italy	12
Jamaica	6	Japan	10	Jordan	3
Kazakhstan	7	Kuwait	2	Latvia	13
Lebanon	4	Libya	1	Lithuania	7
Luxembourg	11	Madagascar	3	Malawi	2
Malaysia	7	Mexico	13	Morocco	9
Mozambique	1	Namibia	2	Netherlands	13
Nigeria	3	North Macedonia	5	Norway	10
Oman	5	Pakistan	3	Panama	13
Paraguay	1	Peru	8	Philippines	3
Poland	13	Portugal	7	Qatar	9
Romania	7	Russia	9	Saudi Arabia	8
Senegal	2	Serbia	1	Singapore	4
Slovakia	13	Slovenia	13	South Africa	11
South Korea	12	Spain	13	Sudan	2
Suriname	2	Sweden	13	Switzerland	13
Thailand	10	Togo	2	Trinidad & Tobago	4
Tunisia	3	Turkey	8	Uganda	3
Ukraine	1	UAE	9	United Kingdom	13
United States	12	Uruguay	12	Venezuela	3
Vietnam	4	Zambia	2		

Notes: The GEM dataset contains missing values, which stem from the fact that certain countries do not consistently participate in the survey across all years. This inconsistency highlights the diverse levels of engagement and data availability among nations, potentially influenced by resource constraints, policy priorities, or shifts in national focus

Source: Authors' own elaboration)

Appendix B: Variable definitions

Variables	Abbreviations	Definitions	Data Sources
Main Dependent Variable			
GDP Growth Rate	GDP_Growth	GDP growth (annual %)	WDI by WB
Alternative Dependent Variable			
GDP per capita	GDP_Per_Capita	GDP per capita growth (annual %)	WDI by WB
Independent Variables			
Financing for Entrepreneurs Dimension	Fin_Subindex	Financing for entrepreneurs	GEM
Policy and Regulatory Dimension	Policy_Reg_Subindex	Governmental support and policies Taxes and bureaucracy Governmental programs	GEM
Education and Knowledge Dimension	EduKnow_Subindex	Governmental support and policies Taxes and bureaucracy Governmental programs Basic school entrepreneurial education and training Post school entrepreneurial education and training R&D transfer	GEM
Infrastructure Dimension	Infra_Subindex	Commercial and professional infrastructure Physical and services infrastructure	GEM
Market Dynamics Dimension	MarkDyn_Subindex	Internal market dynamics Internal market openness	GEM
Cultural and Social Dimension	CultSoc_Subindex	Cultural and social norms	GEM
Global Entrepreneurship Monitor Index	GEMI	GEM consists of the all sub-indexes which are estimated using output-oriented DEA methodology	GEM
Control Variables			
Financial Development Index	FDI	Financial Development index (FD) is a relative ranking of countries on the depth, access, and efficiency of their financial institutions and financial markets.	IMF
Trade Openness	Trade_Openness	Trade openness is defined as the ratio of exports plus imports over GDP.	WDI by WB
Consumer Price Index	Inflation	Consumer price index reflects changes in the cost to the average consumer of acquiring a basket of goods and services that may be fixed or changed at specified intervals, such as yearly.	WDI by WB
Population Growth Rate	Pop_Growth	Annual population growth rate for year t is the exponential rate of growth of midyear population from year t-1 to t, expressed as a percentage.	WDI by WB
Gross Capital Formation	Investment	Gross capital formation (formerly gross domestic investment) consists of outlays on additions to the fixed assets of the economy plus net changes in the level of inventories. Fixed assets include land improvements (fences, ditches, drains, and so on); plant, machinery, and equipment purchases; and the construction of roads, railways, and the like, including schools, offices, hospitals, private residential dwellings, and commercial and industrial buildings. Inventories are stocks of goods held by firms to meet temporary or unexpected fluctuations in production or sales, and "work in progress.	WDI by WB

Mobile Cellular Subscriptions	MCS	Mobile cellular telephone subscriptions are subscriptions to a public mobile telephone service that provide access to the PSTN using cellular technology. The indicator includes (and is split into) the number of postpaid subscriptions, and the number of active prepaid accounts (i.e. that have been used during the last three months).	WDI by WB
Institutional Quality Index	IQI	(2010)'s governance indicators which is consisted of six components: Control of Corruption, Government Effectiveness, Political Stability and Absence of Violence/Terrorism, Regulatory Quality, Rule of Law, and Voice and Accountability.	WGI by WB

Notes: Appendix A defines all variables used in the study. GDP Growth and GDP per capita are the dependent variables, sourced from the World Bank. Independent variables include GEM sub-indexes (e.g., financing, policy, infrastructure) and the GEMI, calculated using DEA. Control variables, such as Trade Openness, Inflation, and Institutional Quality, are sourced from WDI, IMF, and WGI databases.

Source: Authors' own elaboration)