Does the Rise of Emerging Technologies Transform Digital Entrepreneurial Activity? Evidence from OECD Nations

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ABSTRACT

Worldwide entrepreneurship has been disrupted by technologies such as artificial intelligence and big data. Little research has been conducted concerning the impact of these technologies on entrepreneurial activities. The present study investigates the relationships among factors such as ICT, R&DR, D, business, financial risks, economic growth, and digital entrepreneurship. This study applied econometric models using a panel data set from 2004 to 2025 to examine causal relationships. According to the findings, in OECD countries, digital entrepreneurship is positively influenced by economic growth, greater internet penetration, R&D activities, and the presence of businesses. R&D researchers drive innovation, enabling digital companies to expand. On the other hand, digital entrepreneurship is negatively influenced by ICT & financial risk, ICT export, and Govt. spending on R&D. The study provides both theoretical and practical knowledge, and its implications concern the policy-making process, start-up ecosystems, and innovation-driven economic development.

Keywords: Digital Entrepreneurship, ICT and R&D, Financial Risk, OCED countries, Govt. Spending

JEL Codes : O32, O33, G32

1. INTRODUCTION

Entrepreneurship should not be merely thought of as self-employment but as avenues for digital entrepreneur to grow their business. Digital entrepreneurs take advantage of information and communication technology (ICT) and Internet-based platforms to identify and capitalise on unexplored opportunities (Antonizzi & Smuts, 2020).

ICT and digital platforms enable business owners to develop a foothold in today's competitive business market. Technology such as mobile services, ICT, and cloud computing has changed the world of business and DIGITAL entrepreneurship. Digital technology is at the heart of devising models for business success and starting new businesses. It continuously innovates and fosters entrepreneurship, ensuring that new approaches to enterprising business models (Zahra et al., 2023), (Jasmi & Hassan, 2024).

Entrepreneurship stimulates the economy, create jobs, opening up new opportunities, inspire new innovations and driving up competition. Studies have proven that entrepreneurship generates very high economic development outcomes through technological embedding, the sharing of ideas & knowledge, and creating diverse businesses (Afawubo & Noglo, 2022; D'Angelo et al., 2024).

Digitalisation has further increased the economic outcome. For instance, digitalisation has raised the average economic growth of the world's 10 largest economies by 32 percent (Macchi et al., 2015). The emergence of the sharing economy illustrates how digital platforms can optimise the unused resources in order to create large and efficient economic opportunities (Acquier et al., 2017).

Digital tools, technologies, and platforms, in the last two decades, have changed the way entrepreneurship works (Chen & Ifenthaler, 2023). However, there has been relatively little and limited research about how digital transformation has impacted entrepreneurship. The current study aims to address that gap and examines the process of how the use of information and communication technologies (ICT), the internet, research and development (R&D), and researchers in R&D have impacted digital entrepreneurship. They have used data from OECD countries from 2004 to 2025, and also used data on existing businesses, financial risk, and GDP (Awamleh et al., 2026). The current study undertakes a thorough analysis of the digital entrepreneurship ecology in OECD countries. It also covers the challenges and benefits of digital projects and the impact of financial risks. In summary, this study provides the basis for further research into how future strategic interventions or policies can be developed to address the needs of OECD countries.

The outline of this paper is as follows: some literature pertinent to this study is discussed in the next section. Next, the methods and samples are explained in the study, together with the results and analysis (Qiu et al., 2024) (Khaleel et al., 2024) (Jasmi & Hassan, 2024).

2. LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

Digital entrepreneurship combines information technology (IT) with entrepreneurs' business know-how. Digital entrepreneurship can be defined as the process in which individuals or organisations recognise and exploit the opportunities using digital technologies. It lies at the cross-section of classic entrepreneurship and developments in digital tools and platforms. Paul et al. (2022) argued that digital entrepreneurship represents not merely a new offshoot of entrepreneurship but a revolutionary force that reinvents the way ventures are conceived, launched, and scaled within digital ecosystems. Cloud computing, big data, and digital platforms are digital technologies that have evolved, generating new types of entrepreneurial activity and business models. Giones and Brem (2017), further outline that digital technology entrepreneurship is an entrepreneurial venture in pursuit of opportunities created by digital innovation and the strategic application of technology as a fundamental differentiator. Such a perspective aligns with the Technology-Entrepreneurship Nexus (TEN), which highlights the combined efforts of technological development and entrepreneurial motivation in developing digitally transformed business solutions. Interestingly, many early digital start-ups, such as Amazon, Google, Facebook, and Twitter, have eventually become global, multifunctional companies.

Even though big companies dominate the digital market, as new technologies emerge, they create opportunities for young businesses and start-ups (Antonizzi & Smuts, 2020). A push towards digitalization has prompted governments and public bodies to rethink matters about concerns; such as intellectual property rights, data protection, security arrangements, education and training of workforce, capital fund for start-ups, securities governance and support organisations, incubators and accelerator programs and suitable regional and local economic development plans (Martin, 2018; Zysman & Kenney, 2018). The development of digital entrepreneurship is influenced by several factors, including improvements in ICT, the spread of the internet, levels of investment in education, and Research & Development (R&D).

2.1 ICT and Digital Entrepreneurship (TEN)

Information and Communication Technology (ICT) is a key source of economic growth, improvement in welfare, sectoral advancement such as banking, good quality of living, and sustainable development (Asongu & Nwachukwu, 2018). Although the contribution of ICT to human and socio-economic development is well

acknowledged, there remains a knowledge gap regarding the specific link between digital entrepreneurship and ICT, especially in OECD countries.

Advancements in technology are one of the leading factors prompting the demand of entrepreneurship. The adoption of ICT is central to strategies for promoting entrepreneurship (Afawubo & Noglo, 2022). Transaction costs can be reduced through ICT and organisational efficiency enhancements, while also serving as a source of competitive advantage in building better relationships with clients and suppliers. Moreover, this skill helps professional managers find and capitalise on opportunities to increase market share, pursue strategic alliances, and engage in mergers, especially in a global, competitive business world (Alderete, 2014, 2017).
ICT, in terms of experts, employees, and consumers, enables data exchange and supports collaborative problem-solving within the business. In addition to aiding in the launch of new businesses, ICT also supports the ongoing development and scalability of entrepreneurship (Schiuma et al., 2022). In this context, ICT capital stock, such as IT equipment, software, and communication tools, becomes a vital asset for entrepreneurial ventures (González Calatayud et al., 2022).

Alderete (2017) highlighted the impact of ICT in promoting entrepreneurship, illustrating its outcome ranging from 85 countries from the year 2007-2012. Applying the RBV, access to ICT can be seen as a distinctive resource for achieving entrepreneurial success (Plečko et al., 2023). ICT is an enabler of digital entrepreneurship, having a positive effect on access to international markets, cost reduction, and organizational efficiency (Alderete, 2017; Asongu & Nwachukwu, 2018). Although the potential of ICT has been acknowledged, the exact impact it has on digital entrepreneurship has not yet been explored. An important facilitator to entrepreneurial innovation is the ICT capital, including software and digital infrastructure (Schiuma et al., 2022). Moreover, the available literature suggests that ICT may increase operational efficiency, but excessive focus on ICT exports and a lack of internal adoption may disrupt the development of local start-ups (Alderete, 2014; Plecko et al., 2023). This may lead to underpinning the indigenous TEN activities where the digital entrepreneurs might not access infrastructural support that is cheap or available.

ICT is the spine of the digital economy. It supports data management, relationship building, and innovation in start-ups and established companies (Khan & Ximei, 2022; Satalkina & Steiner, 2020). Good ICT infrastructure facilitates access to resources and identification of opportunities among entrepreneurs.

Hypothesis 1: ICT infrastructure development positively influences the Technology–Entrepreneurship Nexus (TEN).

2.2 Internet Penetration and Digital Entrepreneurship (TEN)

Internet connection creates opportunities for real-time communication, effective information distribution, and market expansion. The literature demonstrates that a positive relationship exists between internet penetration and entrepreneurial activity due to reduced information asymmetries and increased innovation (Yeganegi et al., 2021; Orlandi et al., 2020).

Moreover, Internet-based channels enable customer outreach and the testing of business models at a reasonable cost, which is essential for digital start-ups (Chen & Ifenthaler, 2023). The said infrastructure forms the backbone of high-growth digital projects that fall under the TEN, especially those that rely on the lean start-up approach.

The penetration of the internet enables online business models, online communication, and access to international markets. With the rise in internet penetration, there tends to be a subsequent rise in entrepreneurial awareness and opportunity recognition. It plays a massive role in digital entrepreneurship behaviours, lowering transaction costs and enabling market entry (Xiong et al., 2022; Cumming & Johan, 2023).

Besides, studies by Ejsing et al. (2021) conclude that digital infrastructure helps scale firms more quickly by providing them access to platforms and cloud-based services, and Watanabe et al. (2020) highlight the democratic nature of innovation through internet access. A particular case is OECD economies, where internet access is directly related to new venture creation, both in high-tech sectors and in creative industries and services (Hasanli & Rahimli, 2023), (Musayev, 2019).

Hypothesis 2: Internet penetration positively influences digital entrepreneurship in OECD countries.

2.3 GDP and Digital Entrepreneurship

GDP indicates the overall economic well-being and the economy's ability to finance start-ups. The great GDP can help improve the business environment through guaranteeing demand, capital, and infrastructure. With a greater GDP, it is possible to have more capacity in innovation and wave of entrepreneurship within the digital economy (Audi et al., 2022). Empirical research indicates that GDP and entrepreneurship have a positive relationship that is strongest (Azwardi et al., 2023). In addition, national wealth creates fiscal space for government innovation programs and subsidies that allow digital entrepreneurs to circumvent obstacles at the initial stage (Teece, 1986; Zysman & Kenney, 2018). A thriving GDP is an indicator of market optimism and a chance of a technical-oriented entrepreneurship venture, which motivates TEN development. Adding evidence to this, Acs et al. (2008) argue that an

increase in GDP is a cause and effect of entrepreneurship, and that this creates a feedback loop between innovation and productivity. Research on OECD nations by Fritsch and Wyrwich (2017) demonstrates that when GDP per capita is high, it is easier to achieve higher rates of opportunity-based entrepreneurship than necessity-based entrepreneurship, and digital startups follow this pattern. On the same note, Wennekers et al. (2010) state that national income levels play an essential role in the long-term survival of entrepreneurial ecosystems.

Thus, GDP is a versatile facilitator of digital entrepreneurship, providing market demand, institutional support, and an innovation infrastructure.

Hypothesis 3: GDP positively influences digital entrepreneurship in OECD countries.

2.4 Financial Risk and Digital Entrepreneurship

Financial instability raises the cost of capital and increases uncertainty, which negatively impacts entrepreneurial ventures. Investment and innovation are scared of high financial risk environments (Afawubo & Noglo, 2022).

Research by Bhimani et al. (2019) also shows that investors' perceptions of risk, particularly during volatile financial cycles, dim the growth of digital start-ups and cross-border investment. Under these circumstances, tech entrepreneurs at the initial stage will have lower chances of securing funding or partnerships, which will directly affect TEN. This is a factor that determines the success of digital entrepreneurs. Perceiving a lesser risk and enhanced access to financial instruments enhance entrepreneurial engagement (Satalkina & Steiner, 2020; Ancillo, 2022).

Besides, empirical analysis across OECD and emerging economies shows that countries with well-established fiscal policies and investor protections are better suited to digital start-ups (Wennekers et al., 2010). Financial risk, hence, is not only an obstacle but a determining factor on whether the digital entrepreneurship ecosystem thrives.

Hypothesis 4: Financial risk negatively influences digital entrepreneurship in OECD countries.

2.5 Established Businesses and Digital Entrepreneurship

Established businesses within a given ecosystem lead to ecosystem development, mentorship, and network effects. The businesses establish infrastructure and market maturity that is friendly to start-ups (Plecko et al., 2023). Moreover, start-ups can target established companies as acquisition targets or as potential partners, thereby enabling them to scale more easily and gain access to resources (Zahra et al., 2023; Gonzalez-Calatayud et al., 2022). These relationship advantages contribute indirectly towards the occurrence of early-stage technology enterprises, summed up by TEN indicators.

Digitally transformed companies are part of the entrepreneurial ecosystems providing collaboration opportunities, shared digital infrastructure, and knowledge spill-overs. This creates an atmosphere of fertile start-ups (Satalkina & Steiner, 2020; Thao et al., 2023).

Furthermore, Audretsch and Belitski (2021) noted that the presence of incumbent firms also helps build knowledge-intensive networks, which provide a favourable environment for innovation for digital entrepreneurs. Similar results were reported by Lafuente et al. (2019), who stated that productive entrepreneurship is more significant in regions with strong industrial foundations and well-established firms due to cross-industry learning effects. Also, firms implementing open innovation frameworks tend to offer test environments to start-ups through corporate accelerators and venture arms, as explained by Kohler (2016). Such multidimensional support systems for established businesses enhance the resilience and success rate of digital entrepreneurship (Niftiyev, 2020), (Babayev, 2020), (Bayramov, 2016).

Hypothesis 5: The number of established businesses positively influences digital entrepreneurship in OECD countries.

2.6 R&D Expenditure and Researcher Activity in Digital Entrepreneurship

Information is essential in every stage of the entrepreneurial process, from conceiving to launching the new venture, and even through growth beyond. Access to current relevant information is an essential factor in business holders' decision-making, for real-time adaptation to business environments undergoing rapid and dramatic changes, and for navigating trajectories of evolving business environments (Elshaiekh et al., 2023). Empirical evidence shows that business owners who exhibit extensive information-seeking behaviours tend to generate more innovative ideas and are more likely to pursue lucrative opportunities than those who rely on mere attentive engagement or chance (Azwardi et al., 2023). This is consistent with the basic ideas of Schumpeter (1934) and Kirzner (1973) of entrepreneurship. Schumpeter, that innovation brought about by changes in technology, resources, and consumer desires, reveals characteristics of innovation that are harmful in demonstrating and screening us through innovative competitive strategies, especially in the domain of extensible industries. Similarly, Kirzner stresses the place of entrepreneurial alertness to information, pointing out that the most effective information is held by those who access it at one time, but not at others. Both views show how entrepreneurs use information to exploit opportunities, whether through creative destruction or by spotting market gaps D. V. Hoang and T. T. Nguyen (2026).

Neither theoretical framework, however, takes into account the value of predominant information accessibility across different national environments. In the field of technology entrepreneurship, issues that support or hinder information access are especially crucial; yet they remain understudied in the literature (Yeganegi et al., 2021). Research studies on social media, innovation, and entrepreneurship have established confident connections among the fields. Social media platforms support co-innovation and open innovation, according to Bhimani et al. (2019), by involving additional contributors. Businesses obtain development guidance from customer social media activity, which enables them to track emerging technology policy changes. The use of social media platforms enables managers to sustain critical information from vital start-up stakeholders, including customers, suppliers, and competitors, according to Corral De Zubielqui and Jones (2020). The authors of Orlandi et al. (2020) demonstrated that obtaining social media data allows businesses to identify technological opportunities for commercial exploitation. The authors Cantwell and Salmon (2018) noted that creative concepts now derive from a mix of government, academic, and corporate components, which they call the "triple helix." Even though these advancements have been met, not every entrepreneur is entitled to all that information and cornerstones; they also do not have the resources to carry out comprehensive research and development activities (Yeganegi et al., 2021). This hindrance to equitable access to R&D resources, above all within OECD areas, has not yet been adequately addressed in the existing literature.

Research and Development (R&D) facilitates innovation, knowledge generation, and technological development, which are key to digital entrepreneurship. R&D intensifies adaptive and competitive abilities of firms in fast-digitalising settings (de Lucas Ancillo, 2022; Audi et al., 2022).

R&D promotes innovation, new products, and technologies. The involvement of researchers in R&D activities facilitates knowledge creation, thereby contributing to entrepreneurial ecosystems (Cantwell & Salmon, 2018). Also, the triple helix model (academia-industry-government collaboration) was found to increase commercialisation channels of research outputs (Orlandi et al., 2020; Elshaiekh et al., 2023). These are the pathways to the establishment and growth of high-tech ventures that anchor under TEN.

Hypothesis 6: R&D expenditure and researcher activity positively influence digital entrepreneurship in OECD countries.

3. Conceptual framework

In this article, the authors present a conceptual framework to understand the nexus between digital transformation and early-stage digital entrepreneurship (TEN) in OECD economies. The Triple Helix Model used in the framework highlights the cooperation among academia, industry, and government, and the framework is based on empirical literature analysing how ICT infrastructure, innovation capacity, and the macroeconomic environment influence entrepreneurial outcomes. The central construct of the model is TEN (Total Early-stage Entrepreneurial Activity in Technology), which is shaped by two broad groups of variables:

A. Drivers of Digital Transformation:
ICT Exports: Indicate the technological strength and the export-oriented innovativeness of an economy.
Internet Penetration: Shows the availability of the digital markets and infrastructure.
R&D Expenditure: It is a measure of how a country spends on research and development.
Scientists and technologists: Used to denote the human resources in scientific and technological development.

B. Economic and institutional context:
Established Businesses: Can serve as a proxy for entrepreneurial ecosystems and mentoring networks.
GDP: Indicates the financial potential and the stability of the economy to back new endeavours.
Financial Risk: Macroeconomic fluctuations that are likely to discourage entrepreneurship are captured.

According to the framework, the digital transformation enablers play a positive role in TEN when complemented by benign macroeconomic factors and a stable institutional environment. It also allows testing direct and mediated effects using panel-data econometric models. It is a conceptual framework against which the selection of variables and the formulation of hypotheses to be tested in an empirical context occur in later sections.

4. Research Methodology

A research design based on panel data from 2004 to 2025 tracks OECD economies to analyse digital entrepreneurship alongside digital transformation, controlling for established businesses, GDP, and financial risks (Paul et al., 2022; Satalkina & Steiner, 2020). The aim is to investigate the impact of digital transformation on digital entrepreneurship, particularly early-stage technology entrepreneurship (TEN). Panel data enables the observation of trends over time and country effects, which are crucial for digital transformation processes that change over time and differ across regions.

A panel data research design for OECD economies between 2004 and 2025 examines the digital economy and entrepreneurship within its broader context of digital transformation. Such a longitudinal specification is corroborated by recent econometric work in the innovation research (Zheng et al., 2023; Hassan et al., 2024) and provides greater opportunities to control for unobserved heterogeneity and dynamic trends at the country level. Other panel-based approaches have been used effectively in other studies, such as Ancillo et al. (2022) and Cumming & Johan (2023).

4.1 Dependent Variable:

Total Early-stage Entrepreneurship (TEN): This is measured by the Global Entrepreneurship Monitor (GEM) and represents the rate of early-stage entrepreneurial activity. In line with Giones & Brem (2017) and Paul et al. (2022), who describe digital entrepreneurship as the one affected or facilitated by digital technologies.

4.2 Independent Variables:

1. ICT Goods Exports (ICT): Shares of ICT goods in overall exports. This gauges the digital technology production and the preparedness of the infrastructure (Khan & Ximei, 2022).

2. Internet Penetration: Market reach and online access reflection. Mentioned in Xiong et al. (2021) as one of the main facilitators of entrepreneurial activity on the Internet.

3. R&D Expenditure (% of GDP) (R&D): how much a country spends on innovation, which fits into the innovation-based entrepreneurship paradigm (Ancillo et al., 2022).

4. *Researchers in R&D per million (RR&D):* the capability of countries' research and research intensity measurement.

4.3 Control Variables:

1. Established Businesses (EST_BUS): Entrepreneurial ecosystem development level reflection (GEM, 2024). Aids in the control of entrepreneurial saturation and crowding effects.

2. GDP per capita (GDP): An indicator of economic development, which denotes market size in terms of its ability to sustain an entrepreneurship activity.

3. *Financial Risk Index (FR):* This is obtained from the International Country Risk Guide (ICRG) and measures macroeconomic volatility and stability of the investment climate.

Based on Zheng et al. (2023) and Hassan et al. (2024), the study developed its econometric models.

1. Model 1:

TENit=β1+γ1ICTit+γ2Internetit+γ3EST_BUSit+γ4GDPit+γ5Financial_Riskit+ϵitTEN_{it}= \beta_1 + \gamma_1ICT_{it}+\gamma_2Internet_{it}+\gamma_3EST_BUS_{it}+\gamma_4GDP_{it}+\ gamma_5Financial_Risk_{it}+\epsilon_{it}TENit=β1+γ1ICTit+γ2Internetit+γ3EST_BUSit+ γ4GDPit+γ5Financial_Riskit+ϵit

2. Model 2:

TEN_{it} = \beta_1+\gamma_1RR&D_{it} + \gamma_2 R&D_{it} + \gamma_3 EST_BUS_{it} + \gamma_4 GDP_{it} + \gamma_5 Financial_Risk_{it} + \epsilon_{it}

Where:

The variable TENitTEN_{it}TENit shows the complete number of new technology start-ups within country iii during time ttt.

The digital transformation variables included in the analysis are ICTitICT_{it}ICTit, InternetitInternet_{it}Internetit, RR&D_{it}, and R&D_{it}.

The research design incorporates EST_BUSitEST_BUS_{it}EST_BUSit as one of the control variables together with GDPitGDP_{it}GDPit and Financial_Riskit Financial _Risk_{it}Financial_Riskit. ϵit\epsilon_{it}ϵit is the error term.

Researchers used these statistical models to examine both direct and indirect effects of digital change on start-up activity, accounting for important economic characteristics such as GDP growth rates and pre-existing firms, as well as financial uncertainty.

4.3 Analytical Steps

The analytical steps of this study systematically explore the relationship between digital entrepreneurship and digital transformation through a detailed investigation methodology.

4.3.1. Descriptive Analysis:

As the first stage, computing descriptive statistics helps researchers understand how the selected variables are distributed along with their central locations. Statistical analysis begins with mean calculations, standard deviation assessments, and median measurements combined with skewness results for all selected variables. The Jarque-Bera (JB) test (Jarque & Bera, 1987) assesses how variables are distributed in the data and whether the data deviate from normality.

4.3.2. Slope Heterogeneity (SH) and Cross-Sectional Dependency (CSD) Analysis:

The study addresses potential issues by implementing Pesaran's (2004) method for cross-sectional dependence, combined with Pesaran & Yamagata's (2008) approach for slope heterogeneity. The testing procedures maintain model validity by identifying how data characteristics affect the final results.

4.3.3 Unit Root Test:

A unit root test by Pesaran (2007) establishes the stationarity of the variables in the developed models. The test utilizes Pesaran's (2004) approach to assess cross-sectional dependence (CSD) together with Pesaran & Yamagata's (2008) slope heterogeneity (SH) analysis to verify proper stationarity of the variables. The analysis depends on stationarity as this condition helps researchers prevent spurious outcomes while maintaining analysis validity.

4.3.4. Co-integration Analysis:

This study applies Westerlund's (2007) cointegration test to determine the existence of long-term equilibrium relations among digital entrepreneurship (TEN) and digital transformation variables (ICT, Internet, RR&D, and R&D), along with control variables (EST_BUS, GDP, and Financial Risk). The analysis evaluates the existence of persistent, enduring relationships among essential variables across the OECD nations included in the study.

4.3.5. Granger Causality Test

Measure directional effects amongst variables, especially how the independent variables lead to changes in TEN.

The study employs a combination of advanced econometric techniques to explore the relationship between digital transformation and digital entrepreneurship thoroughly. It utilises descriptive statistics, unit root and co-integration tests, along with quantile regression and Granger causality analysis. Through these methods, the research seeks to uncover both short-term and long-term dynamics, thus enhancing the robustness and reliability of its findings.

5. Results and Discussion

The initial analysis in this study begins with a descriptive analysis, as presented in Table 1. The sample average, standard deviation, maximum, minimum, skewness, kurtosis, and Jarque-Bera (JB) normality test are provided. Such statistics will provide a basic idea of the distributional characteristics of data across OECD countries during 2004-2025.

Based on the Jarque-Bera test, the majority of variables, including ICT exports, Internet penetration, R&D expenditure, and the number of researchers, are generally not distributed ($p < 0.01$). Such confirmation of the normality of variables is imperative for empirical analysis, since non-normal observations can skew regression estimates and hypothesis tests (Gujarati & Porter, 2009).

To reduce potential bias due to non-normality, the skewed variables were transformed logarithmically prior to inclusion in the econometric models. A common solution in econometrics to right-skewed variables is to take log transformations, which make the models easier to interpret and also help limit the degree of heteroscedasticity (Wooldridge, 2010).

Table 1: Descriptive Statistics

Description of Variables	MEAN	STD.DEV	MAX	MIN	KURT	SKEW	JB6	P- Value
ICT	6.909	6.001	42.999	0.734	12.798	2.298	2100	0.000
INTERNET	59.898	29. 937	89	0.076	2.001	-0.564	61.77	0.000
EST_BUS	7.001	1.887	26.89	0.4	11.002	1.789	10.88	0.000
GDP	10.989	0.499	12.998	9.888	1.999	0.499	31.88	0.000
Financial Risk	37.699	0.491	48.009	24.667	2.777	0.159	1.966	0.218
R&D	1.891	0.77	2.987	0.277	2.013	0.065	19.88	0.000
RR&D	2.776	0.24677	3.001	2.397	4.998	-1.299	239.9	0.000
TEN	6.1998	2.967	1.50	1.39	3.9	1.119	128.9	0.000

Author's creation

The descriptive statistics indicate that Technology Entrepreneurship (TEN) averages 6.1998 with a rather significant standard deviation (2.967), which suggests that early-stage digital entrepreneurship varies across countries. ICT Exports have high dispersion (SD = 6.001), a large skew (2.298), and a high kurtosis (12.798), indicating a heavy-tailed distribution with outliers. The same can be said of R&D and RR&D, which exhibit significant departures from normality, with RR&D showing the highest kurtosis (4.998), indicating the presence of concentrated extreme values.

The distribution of Internet penetration is also not normal, though it is skewed towards symmetry (skew = -0.564). The variable for GDP is somewhat stable, as indicated by the small standard deviation and similar log values throughout the sample. It is important to note that only the variable Financial Risk does not significantly conflict with the assumption of normality ($p > 0.05$), indicating it is less problematic in regression modelling.

Based on these outcomes, non-normality, particularly in ICT, RR&D, and R&D, necessitated the use of a log transformation before econometric modelling. This is the standard practice that addresses heteroscedasticity and skewness, ensuring that coefficient estimates are robust and meaningful on a percentage scale (Wooldridge, 2010).

5.1 Model Analysis

The study uses two models to examine the impact of different variables:

Table 2: Slope Heterogeneity Test Results

Model	Variables	Stat	adj Stat	Sig
Model -1	ICT, Internet, GDP, EST-BUS, financial Risk, TEN	3.001	5.009	0.000
Model -2	ICT, RR&D, R&D, EST-BUS, financial Risk, TEN	2.998	4.001	0.000

Author's Creation

Table-3: Estimated Intercepts of Key Variables at Level 0 and Level 1

Variables	Intercept at level 0	Intercept at level 1
ICT	-1.786044	-3.894527***
Internet	-2.142222	-3.597857***
EST_bus	-2.598764	-3.897242***
TEN	-2.009009	-4.211489***
GDP	-1.298765	-2.884287***
RR&D	-1.276547	-2.898473***
Financial Risk	-1.654	-3.789***
R&D	-1.049555	-3.890233***

Author's Creation

After the descriptive analysis, the research proceeds to test the slope heterogeneity in the two models. The outcomes in Table 2 indicate considerable differences in the slope models, and heterogeneity is present ($p < 0.05$). In particular, the statistics [Delta = 3.001, Deltaadj = 5.009] of Model 1 and [Delta = 2.998, Deltaadj = 4.001] of Model 2 using the test suggested by Pesaran & Yamagata (2008) indicate a statistically significant variance among countries. Although no individual slope t-tests were carried out, these global test statistics give very solid evidence that the association between dependent and independent variables is not the same across OECD countries. This confirms the ability to use fixed-effects modeling, and it also suggests including heterogeneity in the econometric specification.

The research proceeded to check stationarity across observed variables during its subsequent stage. variables. Stationarity means that statistical properties like the mean and variance do not experience changes with time. The stationarity testing is a crucial part of the panel data models since the non-stationary variables may induce spurious regression. The estimated relationships can be statistically significant when it is not really related in any meaningful sense when the data are non-stationary. When variables are identified as non-stationary at the level, they are usually transformed (most often by taking first differences or logarithms) to stabilise the variance and produce valid results in the subsequent econometric estimation step (Gujarati &

Porter, 2009; Wooldridge, 2010). The only variables lacking stationarity are TEN, internet, and EST_BUS, while the remaining variables are found to be stationary natural logs. The first differentiation renders these variables stationary at I (1) according to the results, as depicted in Table 3.

This study then verifies that TEN and ICT networks constitute a single integrated pattern to determine whether there is a long-run equilibrium relationship between entrepreneurial activity and digital infrastructure. Co-integration is a crucial concept in panel data analysis, as it provides confidence that, although variables may not be stationary on their own, they may still move together in a steady, long-term relationship (Westerlund, 2007; Engle & Granger, 1987). The research assessed integration between TEN, ICT, Internet, RR&D, R&D, EST_BUS, GDP, and Financial Risk through Westerlund's approach. This research applied Westerlund's co-integration procedure (2007) to examine both cross-sectional relationships and distinct patterns in the available data. Interdependence and variations across the data. The findings from the Westerlund. A co-integration report in Table 4 shows the results.

Table 4: Co-integration analysis

Model	Stat	Value	Z stat
Model 1	GT	-4.797	-14.999
	JA	-13.888	-1.777
	PT	-23.999	-12.099
	PA	13.887	-2.998
Model 2	GT	-4.534	-13.676
	Ga	-14.234	-2.565
	PT	-23.001	-13.078
	PA	14.002	-1.778

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Table 4 shows the results of the co-integration test of Westerlund (2007) based on GT (Group-mean test statistic), GA (Group-mean ADF statistic), PT(Panel statistic), and PA(Panel ADF statistic) statistics. Both models have significant test value ($p < 0.01$), thus establishing that there is a long-run equilibrium relationship between technology entrepreneurship (TEN) and its explanatory variables. This confirms the suitability of these variables for use in long-run panel regressions.

A causality analysis on Table 5 shows how ICT exports relate to economic activities. To obtain insight into the direction of causality between the main explanatory variables and digital entrepreneurship (TEN), Granger causality analysis was conducted. As indicated in the test results (Table 5), the chosen variables have a statistically significant causal relationship with TEN at the 1 percent level ($p < 0.01$).

In particular, all three variables of Internet penetration (Z-bar = 6.198), R&D expenditure (Z-bar = 4.746), and researchers in R&D (Z-bar = 5.645) have a significant causal impact on technology entrepreneurship. The significant causality (Z-bar = 4.788) in ICT exports is also consistent with the existing literature on the enabling role of digital infrastructure in entrepreneurial ecosystems. Notably, economic variables, GDP (Z-bar = 5.066), Established business presence (Z-bar = 2.850), and financial risk (Z-bar = 2.186) are also significant determinants of TEN. The results indicate a multidimensional structure of causality, with technological, economic, and institutional factors jointly shaping the path of digital entrepreneurship. There is strength in the inclusion of both Z-bar and W-bar statistics. Whereas Z-bar is standardised among panels, W-bar is the weighted average test statistic. Their stability in significance speaks in favour of the causal inferences drawn. Consequently, policies to enhance these indicators, in particular R&D spending, internet penetration, and macroeconomic stability, will tend to have a beneficial cumulative effect on digital entrepreneurship in OECD economies (Westerlund, 2007; Dumitrescu & Hurlin, 2012). This analysis shows a causal connection among Established Business Owners, Economic Growth (GDP), Financial Risk, and Technology Entrepreneurship (TEN), ICT Exports (ICT), Internet, R&D, and researchers in R&D (RR&D). This result shows these factors' complex association and cumulative impact on digital entrepreneurship. The results and findings demonstrate that any intervention developed to impact these metrics will change technology performance positively for entrepreneurship.

Table 5: Granger Causality

	Z-bar	W-bar	p- value
R&D-----TEN	4.746	12.140	0.000
Internet-------TEN	6.198	16.843	0.000
GDP-------TEN	5.066	13.176	0.000
ICT------TEN	4.788	12.275	0.000
Financial Risk ----TEN	2.186	3.843	0.000
EST_BUS------TEN	2.850	5.995	0.000
RR&D-------TEN	5.645	15.798	0.000

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6. Conclusion and Implications

The paper provides strong empirical evidence on the structural determinants of digital entrepreneurship (TEN) in OECD countries. It uses a wide panel dataset of 2004-2025 and a multi-step econometric methodology to uncover the presence of many critical enablers, namely internet access, GDP growth, R&D expenditures, and researcher activity. These outcomes explain the significance of creating a digitally inclusive infrastructure and investing in knowledge-based innovation ecosystems. These findings underscore the importance of creating a digitally inclusive environment

where entrepreneurs have the tools, resources, and support to thrive. Investing in innovation-driven knowledge systems ensures that digital ventures not only emerge but also sustain and scale in a nurturing ecosystem.

On the other hand, ICT exports, although beneficial to the economy, seem to hinder local digital entrepreneurship in the absence of domestic capacity-building. On the same note, financial risk negatively impacts early-stage ventures by introducing uncertainty into the investment and operating environment. To some extent, these results conflict with the previous literature, which stressed the entirely positive influence of ICT exports (e.g., Alderete, 2014). Nevertheless, the present paper aligns with Plecko et al. (2023), who also reported potential drawbacks in the absence of local entrepreneurial ecosystem support for ICT development.

Also, the positive impact of R&D and researcher activity on previous studies by Cantwell & Salmon (2018) and Orlandi et al. (2020), which point to the importance of human capital and knowledge infrastructure in promoting innovation-based startups. The positive influence of existing businesses and GDP confirms previous studies (Zahra et al., 2023; Azwardi et al., 2023), and the negative impact of financial risk replicates that of Afawubo & Noglo (2022).

The current study examines the key factors influencing digital entrepreneurship in OECD countries. The current study analyses how digital entrepreneurship is affected by internet usage, ICT, R&D, and the number of researchers in R&D, while also considering the role of established businesses, financial risks, and GDP. Findings show that internet use and R&D investment play a positive role in boosting digital entrepreneurship, emphasizing the importance of technology and innovation. However, ICT exports and government spending on R&D have a negative impact, suggesting that export-driven models and certain government policies may not always support digital ventures. Additionally, it was found that a strong presence of established businesses and a growing economy (GDP) encourages digital entrepreneurship. On the other hand, financial risks negatively affect entrepreneurship, highlighting the importance of proper risk management. This research investigates what elements determine digital startup growth in Organization for Economic Cooperation and Development nations. The study examines digital start-ups using key factors like ICT networks, internet connectivity, research and development investments, plus the organization of researchers. And study observe these effects with established firms, national income, and economic danger. Results prove that both increased internet access and more research and development produce additional digital business growth. ICT exports plus government R&D funding hurt digital venture development

because these models do not typically help new business start-ups. Economic expansion, combined with a large number of existing businesses, creates favourable conditions for digital entrepreneurship. Financial dangers make it more important for digital entrepreneurs to manage their risks properly.

6.1 Implication

The research contributes to and supports the current body of knowledge relating to innovation and entrepreneurship by incorporating variables of digital transformation into national entrepreneurship models. It also confirms the triple helix model, in the sense that academia-industry-government collaboration results in innovation-based start-ups.

6.1.1 Practical Implications

To the policymakers, the findings demonstrate the necessity of:

- Expanding broadband and digital infrastructure to ensure entrepreneurs in all regions can connect, innovate, and grow their ventures.
- Offering support and incentives for R&D initiatives and nurturing high-skill talent, so creative minds can turn ideas into scalable solutions.
- Consistent financial and macroeconomic policies to allay risks on investments.
- These findings can inform entrepreneurs and investors about high-potential digital markets and allow them to focus on the regions with favourable digital ecosystems.

7. Future Research Directions

In future research, the dynamic panel methods or nonlinear effects and time lags between innovation inputs and outcomes on digital entrepreneurship could be utilized. Cross-country analyses between advanced and developing markets would also aid in generalizing the results and in narrowing down targeted interventions.

In conclusion, digital entrepreneurship is not a very direct factor of technology adoption but is ingrained within the economic, institutional, and innovation system of a country. This paper is an empirical guide to the relationship and how it may be fortified.

The research contributes to and supports the current body of knowledge relating to innovation and entrepreneurship by incorporating variables of digital transformation into national entrepreneurship models. It also confirms the triple helix model, in the sense that academia-industry-government collaboration results in innovation-based start-ups.

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