Inzinerine Ekonomika-Engineering Economics, **2025, 36(4), 481–497**

The Effect of External Environment Factors and Founders' Characteristics on Digital Platform Start-up Performance. Dynamic Competition Perspective

Victor Gimenez[1], Diego Prior Jimenez[1], Asta Pundziene[2], Rima Sermontyte-Baniule[2]*

[1]*Autonomous University of Barcelona*
Plaça Cívica, 08193 Bellaterra, Barcelona, Spain
E-mail. Victor.Gimenez@uab.cat; Diego.Prior@uab.cat

[2]*Kaunas University of Technology*
Gedimino str. 50, Kaunas, LT-44029, Lithuania
*E-mail. Asta.Pundziene@ktu.lt; Rima.Sermontyte-Baniule@ktu.lt (*corresponding author)*

https://doi.org/10.5755/j01.ee.36.4.40941

Digital platform start-ups rely on technological innovations to compete with other start-ups and incumbents. Competition by innovation, so-called dynamic competition, radically changes how start-ups leverage the external environment and founders' characteristics to create superior performance. Although scholars unveiled the significant role of dynamic competition in entrepreneurial ecosystems, it is little known about how external environment factors and founders' characteristics interact under dynamic competition. This study focuses on the healthcare industry, which is a highly innovative sector where digital platform start-ups face unique challenges and opportunities. Using a sample of 235 digital platform start-ups, this study quantifies the impact of external environment factors and analyses the role of founders' characteristics through managerial effectiveness. The findings reveal that economic freedom and governance quality may negatively affect performance, while founder characteristics enhance managerial effectiveness and significantly support start-up success. This study contributes to the literature by linking digital entrepreneurship with dynamic competition and offers insights into how start-ups can strategically navigate competitive environments to achieve superior performance.

Keywords: *Digital Platform Start-Ups; Dynamic Competition; Performance; Founders' Characteristics; External Environment Factors.*

Introduction

The speed of digitization fuels innovations and, thus, the emergence of new digital ventures. Technological innovation causes broad-spectrum and dynamic competition that cuts across organizations, sectors, and markets (Petit & Teece, 2021). This innovation-driven competition for future markets is known as dynamic competition (Dynamic Competition and Public Policy, 2022), which brings about dramatically different products and services that customers enjoy and that nations require for economic growth and national security (Teece, 2023, p. 375).

However, the emergence and performance of digital platform start-ups are characterized by more than the speed of digitization (Kapoor & Klueter, 2020). In digital platform ecosystems, start-up platforms have to continuously adapt their strategies to sustain the competitive advantage (Van Alstyne *et al.,* 2016). External environment factors may affect digital platform start-up performance in multiple ways. To date, scholars have explored rivalry between incumbents and new entries, the role of intellectual property management, the effect of radical innovation on market disruption, entrepreneurial ecosystems and the financial performance of digital start-ups (Autio *et al.,* 2018; Sidak & Teece, 2009); however, the impact of environmental contingencies and the effect of founders' characteristics on digital platform start-up performance has yet to be explored. This knowledge gap is filled by examining the effects of *external environment factors and founders' characteristics on platform performance.* Furthermore, the study addresses the gap in the literature linking digital entrepreneurship with dynamic competition to explain innovation-based start-ups' superior performance and competitiveness.

This study is conducted in the healthcare industry, which is a highly regulated and innovation-intensive sector. Digital platform start-ups in healthcare must navigate complex stakeholder environments, strict regulations, and evolving technology standards (Pundziene *et al.,* 2023; Sermontyte-Baniule *et al.,* 2022). These characteristics make healthcare a particularly relevant context for examining how external environmental factors and founders' characteristics interact under conditions of dynamic competition.

To capture the effect of the external environment of digital platform start-ups, three vital indices were adopted: the Index of Economic Freedom; the Global Innovation Index; and World Bank data regarding worldwide governance quality indicators.

Similarly, to understand the influence of founders' characteristics on digital platform start-ups' performance, characteristics such as founders' serial experience and education were selected as key factors impacting a start-up's ability to achieve superior performance and competitive advantage. This is particularly relevant in digital technology sectors, where competition is primarily driven by innovation due to their dynamic and rapidly evolving nature. Founders with extensive experience and strong educational backgrounds are better equipped to navigate the complexities of the digital business landscape. Unlike traditional pipeline

businesses, digital platform start-ups require leaders who can nurture external ecosystems rather than simply managing internal resources. Founders who fail to embrace this shift may struggle to sustain platform growth, as seen in cases where top-down management styles have led to platform failures (Van Alstyne *et al.,* 2016) . The ability to scale platform-based businesses hinges on the founder's adaptability and strategic mindset, making their characteristics crucial to lead in dynamic competition.

To measure the performance of digital platform start-ups, key indicators reflecting both financial performance and traction impact were analyzed. Financial performance was assessed through valuation, representing the company's total economic value; funding, referring to the total capital raised in funding rounds; and revenue, indicating the latest known revenue generated. Traction impact was measured by the number of employees, reflecting employment generated; website users, serving as a proxy for the scope of services provided; and the number of X (formerly Twitter) followers, representing the company's social media reach. These indicators were selected for their quantifiability, entrepreneurial and competitive relevance, and ability to signal competitive advantage and the likelihood of success in dynamic competition.

The study outcomes rest on the quantitative research design and secondary data from 235 digital platform start-ups across Europe and the USA. To answer the research question and test the hypothesis, the benefit of doubt (BoD) methodology was used. As a result, this study offers a unique contribution to digital entrepreneurship and dynamic competition theory by demonstrating the significant effect of founders' characteristics on managerial effectiveness and the superior performance of digital start-ups.

Furthermore, the results demonstrate that higher levels of economic freedom and country governance have a negative effect on start-up performance and that higher levels of innovation can have a positive effect on start-up performance. Stated differently, this study supports prior research confirming that macroeconomic factors matter; however, it paves the way for a new research stream on founders' characteristics and their role in utilizing external environment assets to ensure dynamic competitive advantage and master dynamic competition. This study provides a threefold theoretical contribution to digital entrepreneurship and dynamic competition theory: first, it fills a gap by linking the digital entrepreneurship and dynamic competition literature, noting that digital platform start-ups should be considered essential actors in dynamic competition, which calls for the rethinking of start-up choices; second, the study offers novel insights into the role of economic freedom and governance quality in negatively affecting digital platform start-up performance; third, this study shows that managerial effectiveness and founders' characteristics significantly complement the start-up performance and survival of dynamic competition. To survive and lead dynamic competition, a digital platform start-up needs to carefully assess external environment factors when tailoring an innovation strategy and business model. Furthermore, founders need to have a serial founder and/or counterpart with education from one of the top 25 universities in the world.

Matching external environment factors with founders' characteristics creates a digital platform start-up dynamic competitive advantage and a greater likelihood of success in dynamic competition.

Theoretical Background

Dynamic Competition and Digital Platform Start-Up Performance: The Role of Industry Context and Innovation-Driven Growth.

Dynamic Competition

Scholars call for dynamic competition research in relation to emerging digital technology and platform start-ups (Teece, 2023). Teece (2023) and Teece and Linden (2017) argue that dynamic competition contrasts with static competition, which still dominates economics and strategic management research and has not been explicitly discussed in the entrepreneurship literature. Static competition as a dominant viewpoint does not sufficiently explain digital platform start-ups' success in VUCA (volatility, uncertainty, complexity, and ambiguity) environments; therefore, looking at dynamic competition as a process rather than an outcome can shed light on the start-up way forward in the digital innovation era. Dynamic competition is enabled by creating and commercializing new products, processes, and business models (Sidak & Teece, 2009, p. 610), whereas static competition focuses on competition in the current market and price-lowering battles (Teece, 2023). In other words, the dynamic competition perspective is very timely and in line with processes that dominate digital technology innovations and businesses; however, entrepreneurship studies have not been conducted thus far. A competitive environment in which diverse firms invest heavily in R&D, experiment with new business models, and scale new technologies to replace more established ones is a dominant logic in the digital technology development market. It is common and expected that, in an effort to maintain success, new competitors will enter industry as a result of the introduction of new technology. On the other hand, digital platform start-ups, as new entrants, need to rebound into the coopetition interplay with incumbents and other start-ups to develop their products, services and markets. Furthermore, their business models are dynamically changing while they progress with product innovation, which reflects complex interrelations between the actors of dynamic competition. A new entrant's and/or incumbent's prospects will be harmed if the firm does not adapt to shifting markets and technological landscapes. Thus, a firm's strategy plays a key role in its performance and the level of competition it offers (Van Alstyne *et al.,* 2016) .

In addition, the theory of dynamic competition recognizes that competition is a process in which entrepreneurs and entrepreneurial managers are important actors (Dillen *et al.,* 2018; Sidak & Teece, 2009). Maintaining innovation depends upon the existence of entrepreneurs and the institutional structures and public funding that support innovation; therefore, external environment factors such as country innovativeness, quality of governance, and economic freedom can affect entrepreneurial decisions in light of competition. This can be explained by the fact that for entrepreneurs, it becomes difficult to identify what makes the firm successful, specifically when the business environment

is ambiguous. As a response to an ever-changing and ambiguous environment, start-ups constantly adapt to external environment contingencies and transform internal processes. Therefore, government and policy authorities need to maintain economic diversity and a variety of organizational forms. Furthermore, being modular and connected, digital technology can erase the boundaries between industries, creating an opportunity for cross-industrial cooperation (Sidak & Teece, 2009). The latter strengthens dynamic competition in action, as innovation-based competition aims to create new markets rather than price- and output-based competition within the same markets (Vaaler & McNamara, 2010).

Although dynamic competition applies to all technological markets, the healthcare industry has unique specifics: 1) it is a highly regulated industry; 2) the healthcare industry is one of the most innovative, measured by the number of patents filed per year; and 3) the players are public and private healthcare providers (Pundziene *et al.,* 2023; Sermontyte-Baniule *et al.,* 2022) These conditions exert pressure on a platform business that engages digital technologies to facilitate transactions between diverse players (Pundziene *et al.,* 2023). The above-discussed sector specificities restrict dynamic competition in the healthcare digital platform market (Parker *et al.,* 2020). Thus, assessing a more holistic set of external environment factors and managerial efficiency impacts on healthcare platform start-up performance is essential. Next, how digital platform start-up performance can reflect dynamic competition is discussed.

Digital Platform Start-ups' Performance

The start-up "performance is measured by a variety of outcomes that also *indicate the growth potential of their firms*" and thus their competitiveness (Caliendo *et al.,* 2023). The concept of firm performance is multifaceted and can encompass aspects such as financial performance, operational efficiency, and strategic management, among others. Consequently, as the business landscape evolves with rapid digitalization, the way firms assess performance must adapt accordingly. This shift is evident in the rise of digital platform start-ups, which challenge traditional metrics and demand a fresh evaluation of what constitutes successful performance (Cennamo, 2021; Kapoor & Agarwal, 2017; Tiwana, 2015). "Digital platform firms use digital technologies and connectivity to exploit and control digitized resources that reside beyond the scope of the firm, creating value by facilitating connections" (Gawer, 2020, p. 1). Scholars argue that platforms have disrupted competition and innovation across multiple sectors and industries (Van Alstyne *et al.,* 2016).

Notably, digital platform business models have entered and disrupted multiple sectors, but certain sectors, which are characterized as highly regulated sectors, have yet to experience the disruption of digital platforms. Noteworthy examples of undisrupted markets are healthcare, energy, and education (Ozalp *et al.,* 2018). Digital platforms in highly regulated industries theoretically hold the same potential as those in any other industry. Platforms can scale quickly by deploying advanced technologies, reducing certain costs, and creating networks. In any case, highly regulated sectors impose additional barriers on digital platform firms (Parker *et al.,* 2020). Thus, a platform strategy for attracting users, allowing them to interact, and creating networks must be formulated while still adhering to governing norms. Scholars argue that industries and sectors that have to ensure societal human rights (e.g., the healthcare and education sectors) imply many more regulations and norms than other sectors do, therefore leaving less room for private firms to act and innovate (Ozalp *et al.,* 2022).

A well-performing business including platforms "will provide a custom solution that can support a price high enough to cover all costs and yield profit that is at least sufficient to support the business and its growth" (Teece & Linden, 2017, p. 5). The competitiveness of digital platforms or a performance measurement of platforms varies depending on the type of platform and its objectives (e.g., the mobility platform and the social network platform might, in essence, be led by different objectives); therefore, platforms, for example, in comparison with incumbent firms, might consider indicators such as user engagement, network effects, the user acquisition cost, the conversion rate etc. Start-up competitiveness rests on performance and is closely related to how digital platform firms will guarantee their funding options, what revenue streams will be created and what size of the market digital platform firms will capitalize on.

From an economic perspective, platform revenues depend on the selected strategy to attract customers and the ability to encourage them to connect, interact, or transact (Van Alstyne *et al.,* 2016). These metrics can provide valuable insights into the performance and growth potential of a platform and help inform business decisions, but notably, each industry and market may have its own specific metrics for measuring performance, and the relevance of some metrics may depend on context. On the basis of the earlier analysis, it is assumed that digital platform start-up superior performance reflects dynamic competition.

The Effect of External Environment Factors on Digital Platform Start-up Performance

Digitization is accelerating the pace of innovation and, thus, dynamic competition (Teece & Linden, 2017). Although multiple factors influence the pace of digitization, firm innovation and dynamic competition, the path to start-up superior performance is influenced by various external environment factors. Dynamic competition, enabled by digital technologies, has become more global, and businesses are more complex; thus, for each new digital platform start-up, it is essential to evaluate market entry conditions, as they vary across countries. In other words, different patterns of technology acceptance and diffusion exist across different countries (Sermontyte-Baniule *et al.,* 2022). Several external environment factors come into play when digital platform firms consider market entry or scaling processes. Scholars argue that digital platform firms that operate in a competitive market create a path to innovate and escape the competition (Gawer, 2020; Van Alstyne *et al.,* 2016). In contrast, digital platforms that operate in markets with raised entry barriers innovate less. Market-dominant firms might be protected from competition by diverse practices and policies, thus discouraging new entrants from

entering such markets. Thus, worldwide, industrial policy goals and jurisdictions differ across countries (Parker et al., 2020) and the institutional environment plays a crucial role in determining the nature of the entrepreneurship that prevails in an economy (Barcena-Martin *et al.,* 2021). To better understand the market landscape, digital platform start-ups can rely on key measures such as economic freedom, the innovation index, and governance quality indicators. These factors are essential for navigating dynamic competition, as they influence not only a start-up's initial market entry strategy but also its long-term growth and performance.

Economic Freedom and Entrepreneurship

The Index of Economic Freedom quantifies the extent to which an economy is characterized by a market economy, meaning that voluntary contracts can be entered into within a framework of a stable and predictable legal system, with a restricted level of government ownership, regulations, and taxation (Berggren, 2003). Thus, a country's potential for long-term growth and prosperity is dependent upon its economic structure and institutions, as the level of economic freedom affects incentives, productive effort, and the effectiveness of the resources used for any business (de Haan & Sturm, 2000). The level of economic freedom, defined by the institutional environment, can either foster or hinder the degree of entrepreneurship (Kuckertz *et al.,* 2016).

A large body of empirical data shows that greater economic freedom has a positive effect on entrepreneurial activity. For example, better economic freedom allows direct foreign investment to increase opportunity-driven entrepreneurship and decreases necessity-driven entrepreneurship (Afi *et al.,* 2022). Even small increases in economic freedom stimulate entrepreneurship, even in the absence of political freedom (Audretsch & Fiedler, 2022). High levels of economic freedom trigger high levels of entrepreneurial activity regardless of a country's developmental stage (Kuckertz *et al.,* 2016). In countries with a higher level of economic freedom, early-stage entrepreneurs expect more growth out of their innovation than their counterparts in depressed economies do (Saeedikiya *et al.,* 2022). Policy and practical implications are also discussed; for example, governmental restrictions of economic freedom appear to impact entrepreneurial activity differently depending on the particular freedom restricted and the entrepreneur's motive for engaging in entrepreneurial action (McMullen *et al.,* 2008).

Since the fundamental advantages of economic freedom for entrepreneurship are evident, its influence also extends greatly to the domain of digital start-up platforms. The settings where fewer regulations are imposed and intellectual property rights are vigorously protected should be more favorable for such start-ups. New ventures must find and master their strategy, respond to competitive pressures, and secure resources to run their businesses effectively (Agarwal & Shah, 2014). Thus, economic freedom is a key component of creating a positive atmosphere for the success of digital platform entrepreneurs (Carlos Diaz-Casero *et al.,* 2012).

A high level of economic freedom is linked to a welcoming atmosphere for entrepreneurship, fewer regulatory obstacles, and low barriers to market entry. The institutional environment plays a crucial role in reducing the burden of introducing technology for commercialization and influencing its capacity to generate value, which is fundamental to understanding how businesses and institutional players can promote technological advancement and achieve superior performance (Kapoor & Teece, 2021). This might be associated with fewer bureaucratic obstacles and regulations, enabling them to adapt quickly to changes in the market, implement new technology, and disrupt established markets. For example, countries with greater economic freedom tend to have fewer business regulations. Entering the market is easier for start-ups when the costs and time required to comply with regulations are reduced (Angulo-Guerrero *et al.,* 2017).

On the other hand, while acknowledging the importance of economic freedom, the research community offers little information on how to design regulatory frameworks for economic freedom (Kuckertz *et al.,* 2016), particularly those addressing evolving digital markets.

Based on the above theoretical implications, the first hypothesis is proposed:

H1: The higher the economic freedom, the more competitive digital platform start-up's performance.

Innovation Index and Entrepreneurship

The Global Innovation Index ranks countries in terms of their ability to foster and support innovation, it helps countries learn from their own experience and that of other countries in terms of defining the innovation context as a major input to innovation policy design (Crespo & Crespo, 2016). By investing in R&D, protecting the IP, creating a supportive entrepreneurial culture, providing access to capital, and developing a skilled workforce, governments can help create an environment that fosters innovation and supports start-up growth.

The entrepreneurship level of a country is simultaneously related to both its innovation level and its country risk score (Cervelló-Royo *et al.,* 2022). Placing high value on innovation, technology, entrepreneurship, and economic development leads to high fintech adoption (Huarng & Yu, 2022). Innovation-intensive business models thrive in environments where there is a strong emphasis on R&D, as this emphasis provides them with access to the latest scientific and technological advances (Chesbrough, 2003).

Building on de Reuver's (2018) insights, it is clear that digital platform start-ups thrive particularly well in countries with higher innovation levels. These environments are characterized as having strong support for R&D and a robust intellectual property regime, offering fertile ground for the business model attributes essential to digital platforms, such as data homogenization, editability, programmability, distribution, and self-referentiality. An environment that fosters and warmly embraces innovation enables firms to develop innovative products and services. These innovations not only enhance firm performance but also have the potential to disrupt existing markets. On the basis of the above literature, the second hypothesis is proposed:

H2: The higher the innovation intensity, the more competitive digital platform start-up's performance.

Governance Quality and Entrepreneurship

Several definitions of governance quality have emerged in the scientific literature (Omri, 2020). Within this study, the focus is on the Worldwide Governance Indicator as identified by the World Bank. This indicator measures the quality of public governance at the national level and is structured from six key governance dimensions: voice and accountability, political stability and absence of violence, government effectiveness, regulatory quality, rule of law, and control of corruption (Handoyo, 2023).

In reviewing the literature, a consensus on the pivotal role of governance in fostering an environment conducive to entrepreneurial activity is noted. Omri (2020) emphasized that effective governance is instrumental in creating the right conditions for people to initiate new ventures, drive innovation, and introduce new products and services. This is further supported by the finding that the distribution of different entrepreneurial activities among economies is influenced by the quality of governance. Furthermore, the relationship between governance quality and entrepreneurship is well documented, and a significant positive influence of governance on productive entrepreneurial activities was identified by Khyareh and Amini (2021). The authors argue that higher governance quality tends to benefit opportunity entrepreneurs (who are likely to launch new and innovative businesses), as opposed to necessity entrepreneurs (who are forced to start businesses owing to a lack of better employment options). These findings illustrate that the quality of governance not only fosters entrepreneurship but also determines its nature, encouraging a shift toward more productive, innovation-powered entrepreneurial activities. Bosma *et al*. (2018) present evidence that productive entrepreneurship substantially contributes to economic growth. Their research identifies financial stability, small government size, and perceived entrepreneurial skills as primary institutional factors that predict productive entrepreneurship. This link between institutional quality and productive entrepreneurship underscores the transformative power of governance in enhancing the economic landscape.

Building on previous scholarly contributions, a country's governance model affects the trajectory of digital platform start-ups. For example, streamlined and transparent procedures for business processes such as registration, taxation, licensing, and data regulation, as mentioned by Parker *et al*. (2020), facilitate easier market entry for start-ups. In contrast, an environment influenced by excessive bureaucracy, corruption, and opacity can significantly hinder entrepreneurial progress.

On the basis of the above insights, the third hypothesis is proposed:

H3: The higher the quality of a country's governance, the more competitive the digital platform start-up's performance.

The Effect of Founders' Managerial Effectiveness on Digital Platform Start-ups' Performance

Teece (2023, p. 402) argues that "the 'visible hand' of managers drives innovation and competition, which, along with the 'invisible hand' of the market, power the economic system." Innovation, an inherent element of dynamic competition, is significantly fostered by managerial actions. This emphasizes the importance of founders' characteristics in shaping business performance. Start-ups benefit from the pre-entry experience and knowledge embodied in their founders; thus, the prior experience of founders is essential for an entrepreneurial orientation. Founders are armed not only with technical and market know-how that enables product innovation but also with operational knowledge in the focal industry context (Agarwal & Shah, 2014). As such, scholars argue that high-skill entrepreneurs positively influence firm performance (Cruz-Cazares *et al.,* 2013).

The essence of overcoming experience gaps in organizations hinges on leadership and the entrepreneurial orientation of managers. It is the commitment and direction from management that catalyzes an organization toward embracing transformation. For employees to actively participate in the learning and adaptation process, their leaders must encourage them and provide the necessary resources (Teece & Linden, 2017).

With respect to any advanced technology-empowered market or digital platform start-up market, it could be argued that technological innovation is necessary but not sufficient for success (Teece, 2018). Thus, founders' capabilities significantly shape the performance of digital platform start-ups, as they contribute to their performance, ultimately influencing the dynamic competition landscape. This orientation, which embodies founders' prior experience, innovation, and proactive approach, plays a crucial role in determining how effectively a start-up can navigate the competitive digital landscape. Founders with a strong background in their respective fields, technology, and entrepreneurial experience bring unique skills and knowledge that contribute to start-up entrepreneurial activities and thus start-up performance. In other words, the founders' previous entrepreneurial experience and the number of founders participating in the birth of a start-up can be combined to offer potential insights into the available knowledge and expertise necessary for launching a new start-up or revitalizing an existing start-up (Florin, 2005). However, which mechanisms lead some founders, but not others, to create novel structures that stand out in terms of firm performance is not fully disclosed, especially in a digital healthcare environment (Snihur & Zott, 2020; Teece, 2018).

As scholars argue (Honore & Ganco, 2023), the choices that founders make at the early stage of business development are durable, and the characteristics attributed to the firm by founders have a lock-in effect (Snihur & Zott, 2020) as founders or founding teams are responsible for the initial internal organization of the start-up (Van Lancker *et al.*, 2023). Thus, the impact of founders' characteristics on start-up performance can be related to their ability to identify and implement opportunities.

While competition in the digital healthcare sector is based primarily on innovation due to the dynamic and rapidly evolving nature of the field, it is crucial for founders to maintain strong and favorable characteristics that enable them to navigate the complexities of the digital healthcare landscape and make informed decisions that drive innovation and allow their firms to demonstrate a competitive advantage over other start-ups.

On the basis of the above, it is argued that individual founders' capabilities related to their previous experience matter for managerial effectiveness. It is proposed that founders gain field experience first by having received their education at a top university and, second, through participating in multiple ventures. Both hypotheses are related to the ability to build and expand founders' networks and to understand the field in depth. Thus, the following hypotheses are formulated:

H4: Founders' serial experience positively affects digital platform start-ups' managerial effectiveness and, thus, performance.

H5: Founders' education at a top university positively affects digital platform start-ups' managerial effectiveness and, thus, performance.

The conceptual framework of the study is visually represented in Figure 1. This framework serves as a theoretical structure that guides the investigation by illustrating the relationships and interactions between external environment factors and their effect on digital platform start-up performance; additionally, an estimated managerial effectiveness, once the impact of the context is removed, can be used to analyze the impact of the founders' characteristics on performance.

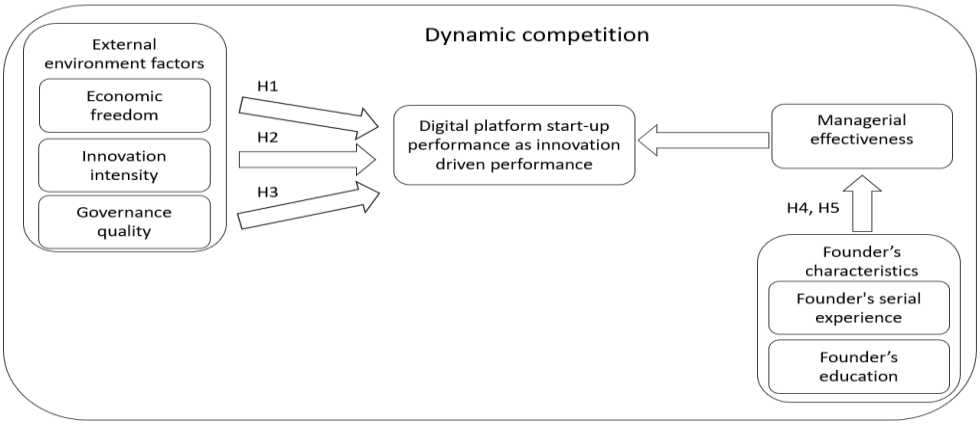

Figure 1. Conceptual Framework

Methodology

The following section details the methodology used, which is novel in this type of literature, for (i) calculating a composite index of start-up performance, (ii) quantifying the impact of external environment variables on it, and (iii) calculating managerial effectiveness, once the impact of the context is removed, to analyze the impact of the founders' characteristics on it.

Performance Composite Indicator

To assess the effectiveness of a set of start-ups from different countries operating in the digital healthcare platform sector on the basis of a composite indicator (CI), it is necessary to use a methodology that assesses all the dimensions related to the start-up's performance with sufficient flexibility. A methodology commonly used in the literature for the construction of CIs is the benefit of doubt (BoD) (Cherchye *et al.,* 2007; Despotis, 2005; Gaaloul & Khalfallah, 2014; Melyn & Moesen, 1991; Morais & Camanho, 2011; Zanella *et al.,* 2013). BoD models are a simplification of the nonparametric frontier DEA (Charnes *et al.,* 1978) or FDH (Deprins *et al.,* 2006) models widely used to measure efficiency on the basis of a consideration of only outputs instead of the outputs and inputs of a production process. The DEA and FDH models differ in that the former is a comparison of the evaluated firm with a virtual linear combination of the remaining units, whereas the FDH models force a comparison with another real firm of the sample. A main feature of both models is that the weight assigned to each of the indicators is endogenous and individualized for each firm evaluated, which provides them with great flexibility and adaptability in the evaluation of the different firms' strategies implemented. Nevertheless, in this study, the authors prefer to use FDH formulation because it provides easier managerial interpretation.

From a formal point of view, it is assumed that for the K firms whose performance is being evaluated, there is information on a set of J indicators to be maximized. Then, the CI of any start-up can be measured through the following linear program:

$$\begin{aligned} & Max\ CI^o = \beta \\ & s.t. \qquad \sum_{k=1}^{K} \lambda_k y_j^k \geq \beta y_m^o \ \ j = 1 \ldots J \\ & \qquad\quad \sum_{k=1}^{K} \lambda_k = 1 \\ & \qquad\quad \lambda_k \in \{0,1,\} \quad k = 1 \ldots K, \beta \geq 0 \end{aligned} \tag{1}$$

where y_{kj} represents the indicator j to be maximized for firm k and where and y_m^o represents the evaluated firm observed values of each indicator. CI^o represents the maximum increase achievable simultaneously in all the indicators. Specifically, $100 * CI^o - 100$ represents, as a percentage, the potential increase that could be achievable simultaneously in all the indicators. Consequently, $CI^o \in [1, \infty)$. The best-performing practices will obtain a value of $CI^o = 1$. In contrast, those start-ups underperforming will obtain a value of $CI^o > 1$, so the greater CI^o is, the lower the performance.

One criticism of nonparametric frontier models is their high sensitivity to the presence of extreme observations. This problem can be especially relevant when the data are provided mainly by the firms evaluated, as in our case. To reduce its

impact, (Cazals *et al.,* 2002) proposed order-m models. Their estimation can be from two different methodological approaches: the probabilistic formulation or an approximation based on a Monte Carlo algorithm with convergent results (Daraio & Simar, 2005; D'Inverno & Witte, 2020). The latter approach was adopted in this study. The method consists of performing B rounds of computation (where B is sufficiently large). In each round $b\,(b = 1, \ldots, B)$, a sample with replacement is drawn from m countries, and the linear program (1) is solved to obtain CI_b^o. Finally, a robust performance indicator for the evaluated unit CI^o is obtained as the arithmetic average of the different CI_b^o [1]:

$$CI^o = \frac{1}{B}\sum_{b=1}^{B} CI_b^o \quad (2)$$

However, to make the interpretation more intuitive (the greater the value is, the greater the performance), $PCI^o = 1/CI^o \in (0,1]$ is reported as a performance indicator for start-up o. $PCI^o = 1$ will be synonymous with good performance, whereas smaller values will represent the current level with respect to the maximum level achievable. For instance, $PCI^o = 0.75$ indicates that all indicators are at 75 % of their potential value.

Introducing the Effect of External Factors on Performance

In this study, the focus is on determining the importance of external environmental factors that positively or negatively affect digital platform start-up performance. The incorporation of external environment factors (the so-called z variables) in nonparametric frontier models has been widely discussed in the literature. Different methodological alternatives have been proposed (Muniz *et al.,* 2006). Most of these approaches are based on models with two or more stages, which basically regress the performance score against the external environment factors. Nevertheless, separability is not assumed in most novel approaches, such as conditional models (Daraio & Simar, 2005). The separability condition is satisfied when the external environment factors z do not affect the shape of the frontier determined by the best performers (Daraio & Simar, 2005). For this reason, it is crucial to carry out a statistical separability test (Simar & Wilson, 2020) to verify whether this condition is satisfied. If separability was assumed, two-stage models could be applied. In the data of one study, the separability condition was not rejected; consequently, a conditional approach was used. First, the conditional models evaluate the units without considering differences in their environmental conditions. Then, they re-evaluate but only compare the units with those that have similar environmental conditions in a similar way, obtaining an evaluation that is adjusted to their environment and therefore fairer. Finally, when both results are compared, the effect of the environment on effectiveness is quantified. As with order-m models, there are the same two approaches for the formulation of conditional models (Daraio & Simar, 2007). For methodological consistency, the Monte Carlo algorithm approach was selected again. In this case, a bandwidth h for the variables z is calculated for a particular kernel $k(\cdot)$ with bounded support (in this study, the Epanechnikov formulation is used). The method proposed by Bădin *et al*. (2010) is followed, which suggests its calculation in the case that all variables z are continuous. When the sample is subsequently drawn with replacement of size m in the order-m algorithm, we assign a higher probability of being drawn to those countries with similar environmental conditions to the one evaluated. The probability of being drawn is given by:

$$Probability_i = \frac{k(z_o - Z_i)}{\sum_{i=1}^{k} k(z_o - Z_i)} \quad (3)$$

thus, obtaining the conditional performance indicator (PCI_c^o). The impact of the environmental factors z on efficiency can be estimated by applying, for instance, a nonparametric kernel regression, as suggested by Daraio and Simar (2005) to explain the ratio between the unconditioned and conditioned PIs as a function of the environmental variables:

$$\Theta^o = \frac{PCI^o}{PCI_c^o} = f(z_i) + \epsilon_i \quad (4)$$

The closer the value of Θ is to one, the lower the impact of the environment on performance is because both performance indicators tend to converge. In other words, the evaluation does not differ when only the external environment conditions are considered. The marginal effects of each variable and the direction of their effect on effectiveness can be obtained from (4). An increasing marginal effect indicates a positive impact of variable z on performance, whereas a decreasing effect indicates the opposite. The marginal effects can be nonlinear—that is, U-shaped or inverted U-shaped—so that different impacts can be identified, changing according to the values of z.

Managerial Effectiveness and Founder Characteristics

Once the global performance of the start-ups has been obtained, comparing them with others from similar environments, as well as the importance and sense of the influence of the different external environment variables, as described in the previous section, a relevant question relates to calculating the relationship between the characteristics of founders and performance. For this purpose, it is essential to know what part of conditional performance can be attributed to external environment conditions and what part can be attributed to the performance of their founders, that is, managerial effectiveness. Badin *et al*. (2010) proposed a method of calculation. Their proposal consists of capturing the marginal effect of z on PCI_c via nonparametric regression. The residual of the regression can be interpreted as a measure of managerial effectiveness since it would include that part of PCI_c not explained by z. This information can be used to rank countries according to their management. The regression to be estimated is as follows:

$$PCI_c = \mu(z) + \sigma(z)\varepsilon \quad (5)$$

where $\mu(z)$ is the average effect of the environmental factors on effectiveness; $\sigma(z)$ provides additional information about the dispersion of the distribution of the effectiveness coefficients as a function of the environmental

[1] *In this case, due to the resampling process, $CI^o \geq 0$. Those units obtaining a score smaller than one, are known in the literature as superefficient units. See Daario and Simar (2005) for a detailed explanation.*

factors; and ε is the error that can be associated with managerial effectiveness.

If ε and z have a very low correlation, the error can be interpreted as pure managerial effectiveness; otherwise, it can be interpreted as a proxy for it. The managerial effectiveness (ε) for a country (y, b) is given by:

$$\varepsilon = \frac{CI_c^o - \mu(z)}{\sigma(z)} \quad (6)$$

The ε distribution is characterized by $\mathbb{E}(\varepsilon|Z = z) = 0$ and $\mathbb{V}(\varepsilon|Z = z) = 1$. A large (positive) value of ε is synonymous with good managerial effectiveness in our case. A small (negative) value is synonymous with poor managerial effectiveness. For the estimation of $\mu(z)$ and $\sigma(z)$, nonparametric local constant models and bandwidths calculated via least-squares cross-validation were used (see Bădin *et al*., 2012, for further details about how to compute $\mu(z)$ and $\sigma(z)$).

Finally, once managerial effectiveness has been isolated, the impact of founders' characteristics on it can be explored via different statistical techniques. In this study, and in accordance with the rest of the methodologies used, the authors opted for a nonparametric technique that facilitates the creation of groups or profiles of founders according to a dependent variable (managerial effectiveness) and some explanatory variables (founders' characteristics). Specifically, the use of a regression tree is proposed (Loh, 2014) a technique that imposes no restrictions on interaction effects, focuses on the importance of reducing predictive error, operates sequentially, and is independent of the extent of linearity in the classifications or the order in which the explanatory factors are introduced (Morgan & Sonquist, 1963).

In the next section, information about the performance indicators, external environment variables, and founders' characteristics required for applying the proposed methodology is provided.

Data and Variables

Sample

The sample consists of start-up firms that belong to the digital health platform industry. Data were obtained from Dealroom, a global provider of data and intelligence on start-ups and tech ecosystems around the world.[2] Dealroom was purposively selected because it provides a complete record of data disaggregated by industrial sectors. This allows us to obtain classified and precise information for digital healthcare platforms.

The final sample consists of 235 start-ups, founded between 2010 and 2021. According to Dealroom definitions, start-up is defined as an innovative company designed for rapid growth, typically featuring a novel product or business model. It is often tech-enabled, leveraging proprietary technology, software, or technology-driven processes to scale efficiently. More specifically, a digital health platform start-up is an innovation-driven, tech-enabled company that develops scalable digital solutions aimed at improving health management for both patients and healthcare providers. It is assumed that start-ups that offer digital healthcare platforms are in dynamic competition; they compete with different innovations.

Table 1 presents the main sample demographic data by country. It is important to note that while the number of start-ups per country varies, this does not affect the validity of the analysis, as the study does not aim to produce country-level comparisons. Instead, the selected BoD methodology evaluates each start-up individually. Specifically, the conditional BoD approach accounts for country-level environmental variation by comparing start-ups only to others operating in similar contextual environments. This ensures that performance assessment remains robust and fair, minimizing any bias resulting from unequal country representation. In addition, the concept of dynamic competition in this study is operationalized through the performance of individual start-ups, reflecting how they innovate in a digital healthcare context, rather than by the concentration of start-ups within each country.

Table 1

Sample Demographic Data by Country

			Market served by start-up			Product or service sub-industry
Country	**Number of start-ups**	**Average launch year**	**B2B**	**B2C**	**B2B&B2C**	**Digital healthcare platforms**
Austria	2	2015	1	1		2
Canada	3	2017	1		2	3
Denmark	3	2016	1		2	3
Estonia	2	2014		1	1	2
Finland	15	2014	12		3	15
France	51	2015	34	9	8	51
Germany	16	2015	10	4	2	16
Hungary	2	2014		1	1	2
Iceland	1	2013		1		1
Ireland	4	2013	4			4
Italy	14	2016	7	4	3	14
Lithuania	1	2013			1	1
Netherlands	2	2017			2	2

[2] Data downloaded from Dealroom.co in May 2023.

			Market served by start-up			Product or service sub-industry
Country	**Number of start-ups**	**Average launch year**	**B2B**	**B2C**	**B2B&B2C**	**Digital healthcare platforms**
Norway	4	2015	2	2		4
Poland	5	2015	3	1	1	5
Portugal	4	2016	3		1	4
Romania	2	2018	1		1	2
Russia	2	2013		2		2
Slovenia	2	2013			2	2
Spain	20	2015	9	6	5	20
Sweden	30	2015	13	13	4	30
Switzerland	6	2013	5	1		6
Ukraine	1	2017		1		1
United Kingdom	21	2014	8	9	4	21
United States	22	2013	9	9	4	22

Digital Platform Start-up Performance Variables

With respect to the selection of outputs, six variables that have an entrepreneurial and competitive orientation and are signs of companies' success were considered:

- Valuation: economic value for the whole company
- Funding: total money raised by the company in the funding rounds
- Revenues: the last known amount of revenue generated by the company
- Employees: employment generated by start-ups
- Website users: number of users that entered the website, proxying the scope of the services provided to the customers
- X (formerly Twitter) followers: number of followers (expressed in thousands) in the social network X.

The first three variables are related to the financial performance of the start-ups, whereas the last three variables reflect the traction impact of the start-ups. Table 2 shows the descriptive statistics for the output variables proposed.

Table 2

Descriptive Statistics for the Digital Healthcare Platform Start-ups' Performance Variables

	Mean	**Median**	**Q1**	**Q3**	**Std. Dev.**
Valuation[a]	132.64	13.75	5.27	55.00	513.87
Funding[a]	32.92	3.96	1.25	15.27	97.49
Revenues[a]	7.46	0.67	0.22	2.34	27.81
Employees	93.63	29.00	13.00	64.00	222.88
Website[b]	108.45	3.20	0.51	52.00	365.50
X[b]	1.22	0.44	0.12	1.18	3.28

[a] Expressed in millions of $
[b] Expressed in thousands

External Environment Variables

Some environmental variables related to the country where the firm has located its headquarters have also been considered. Specifically, three secondary sources of information are used: (i) *the Index of Economic Freedom* (see *https://www.heritage.org/index/* for details); (ii) the *Global Innovation Index*, (see *www.globalinnovationin dex.org* for details); and (iii) World Bank data regarding *worldwide governance quality indicators* (see https://info.world bank.org/ governance/wgi/Home) for details). The data are related to the year 2022 for all sources.

Importantly, the first two sources, the Index of Economic Freedom (a measure based on 12 quantitative and qualitative factors grouped into four broad categories of economic freedom, namely, the rule of law, government size, regulatory efficiency and open markets) and the Global Innovation Index (constructed from two subindices–the innovation input subindex and the innovation output subindex), are constructed from multiple variables defining two composite indicators. For the third component, worldwide governance quality indicators, the World Bank provides six variables. To harmonize the way environmental variables are considered, similar to variables *i* and *ii,* there is a need to estimate a unique composite indicator representative of dimension *iii*. To avoid potential collinearity problems, this composite indicator, representing the quality of governance, is estimated through an exploratory factor analysis, considering the following variables: rule of law, control of corruption, regulatory quality, voice and accountability, government effectiveness, and political stability. The resulting factor meets the standard requirements, so the composite indicator for the quality of governance is representative of the aforementioned variables.

After harmonizing the composite indicators for the three constructs, Table 3 presents the descriptive statistics for the external environment variables, the Global Innovation Index, the Index of Economic Freedom, and the new dimension identified: governance.

Table 3

Descriptive Statistics for the 3 Composite Indicators for External Environment Variables

	Economic freedom (i)	Innovation intensity (ii)	Governance (iii)
Mean	71.71	55.40	0.22
Median	73.40	57.30	0.06
Q1	65.70	50.40	-0.04
Q3	74.80	61.30	0.92
Std. Dev.	4.94	7.33	0.71

Founders' Characteristics

The Dealroom database offers individualized information on the characteristics of each start-up founder. However, to have homogeneous continuous variables, the information available from each founder was transformed in terms of percentage, obtaining the following variables, with full records for just 193 of the 235 start-ups:

- *Current founders*: percentage of original founders still with the start-up currently;
- Serial founders: percentage of founders who have demonstrated a continuous trajectory in founding start-ups; that is, whether they have participated in the foundation of more than one start-up;
- Top past founders: percentage of founders who have participated in the founding of Top 25 start-ups that have become relevant companies;
- Top universities founders: percentage of founders who have studied at one of the Top 25 universities in the world;
- Non-first company founders: percentage of founders for whom this is not their first start-up.

Table 4 shows the descriptive statistics for the founders' characteristics variables proposed.

Table 4

Descriptive Statistics for the Founders' Characteristics

	Mean	Std. Dev.
Current founders	92.72 %	0.21
Serial founders	25.25 %	0.35
Top past founders	5.52 %	0.19
Top universities founders	15.92 %	0.31
Non-first company founders	15.51 %	0.29

Results

Impact of the External Environment Variables on the Start-ups' Performance

For the computation of the order-m model (2), it is necessary to define previously the value for the parameters B and m. We have set $B = 500$, greater than the 200 iterations recommended by Daraio and Simar (2005). These authors also recommend setting the sample size m to that value from which the number of super-efficient units stabilizes. In this study, this condition occurs when $m = 180$, with a proportion of super-efficient units at approximately 9 % of the sample. Table 5 presents the results for both PCI (unconditioned and conditioned) as well as their ratio (Θ).

Table 5

Start-ups' Performance (BoD Model Results)

	PCI	PCI_c	Θ
Mean	0.30	0.53	0.61
Median	0.12	0.45	0.46
Q1	0.05	0.14	0.18
Q3	0.37	1.00	0.96
Std. Dev.	0.49	0.40	0.54

The results show that the average performance of the start-ups analysed without conditioning it to the context of each country (PCI) stands at 0.30; that is, at 30 % of the level reached by the best performers. The high variability observed between the different companies is noteworthy, as shown by the standard deviation of 0.49. When comparing start-ups with others operating in a similar context (PCI_c), the performance level almost doubles to 0.53, which suggests an important overall effect of the context on the start-ups' performance. Since the ratio between both scores is 0.61 (the nearest value to one the fewer external environment factors impact) suggests that the institutional context of each country significantly impacts the start-ups' performance.

Once a relevant effect of the environment on performance has been confirmed, it is interesting to delve into its characteristics; that is, what variables really influence it and whether the effect is positive or negative. Table 6 shows the results of performing the nonparametric kernel regression of the quotient Θ against the environment variables, as described in equation (4).

Table 6

Impact of External Environment Factors on Ratio Θ. Nonparametric Kernel Regression

				Marginal effects by quartile		
External environment variables	**Observed estimate [a]**	**Bootstrap std. err.**	**Percentile [95% conf. interval]**	**Q1**	**Q2**	**Q3**
Economic freedom	-.0244677***	.007472	-.0381781 -.0099733	Negative	Negative	Negative
Innovation intensity	.0610861***	.0065876	.0492795 -.0756282	Positive	Positive	Positive
Governance	-.5148158***	.0957007	-.7214262 -.3301817	Negative	Negative	Negative
Observations	235					
R-squared	0.3707					
*** p<0.01, ** p<0.05, * p<0.1						

Kernel: Epanechnikov; Bandwidth: improved AIC
[a] Effect estimates are averages of derivatives.

The results show that the variables of economic freedom, innovation intensity, and governance have a statistically significant effect on performance, with a p-value<0.01. Specifically, both economic freedom and governance have a negative effect on performance. In other words, those countries with high levels of these characteristics have a negative effect on the performance composite indicator. On the one hand, the results seem to indicate that those countries with higher levels of innovation can have a positive impact.

Nonparametric kernel regression does not assume a linear relationship between the dependent variable and its covariates. Therefore, it is interesting to explore in detail the marginal effect of each covariate on the dependent variable.[3] Columns 6 to 8 of Table *6* summarize the marginal effect of each variable fixing the rest at the three first quartile values, confirming that marginal effects are maintained for all of them. With the double objective of analyzing, on the one hand, the effect of the external environment factors for different levels of the Θ ratio and, on the other hand, checking whether they are robust with respect to those previously obtained, a quantile regression was carried out (see Table 7).

Table 7

Impact of External Environment Factors on Performance. Quantile Regression

	Q1 $\boldsymbol{\theta}$	**Q2** $\boldsymbol{\theta}$	**Q3** $\boldsymbol{\theta}$
Economic freedom	-.0264248**	-.024161**	| -.0217812***
	(.0113579)	(.0105713)	.0053943
Innovation intensity	.0767395***	.0624123***	.0327243***
	(.0094811)	(.0088245)	.004503
Governance	-.5385851***	-.5049475***	-.2422458***
	(.1190693)	(.1108235)	.0565513
Constant	-1.271421	-1.00558	.1181337
	(.882713)	(.8215838)	.4192394
N	235	235	235

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1*

The estimates shown in Table 7 for the first, second and third quartiles confirm that the significant factors and their signs fully coincide with those obtained in the nonparametric kernel regression, regardless of the degree of their impact on the performance indicator.

Impact of Founders' Characteristics on Managerial Effectiveness and Performance

After the performance of start-ups is quantified considering the environment in which they operate and its impact, the last step in our analysis strategy is to calculate managerial effectiveness. As mentioned previously, this measure is related to the level of effectiveness of the managers, after discounting the effect of the environment, to identify the characteristics of the founders associated with the best and worst performers. Solely as a preliminary exploratory analysis, a linear regression was carried out where the dependent variable was managerial effectiveness (the greater the value, the greater the effectiveness), and the covariates were all the characteristics of the founders described in Section 4.4. These preliminary results showed that the only variable that was significant in explaining managerial effectiveness was serial founders. Indeed, the results of the regression tree shown in Figure 2 confirm this first approximation, although they offer a greater level of detail and richness in identifying some additional influential variables, as they are based on a sequential process.

[3] The summarized marginal effects shown in Table 6 have been obtained from a graphical estimation for each variable. The results for the figures are available upon request.

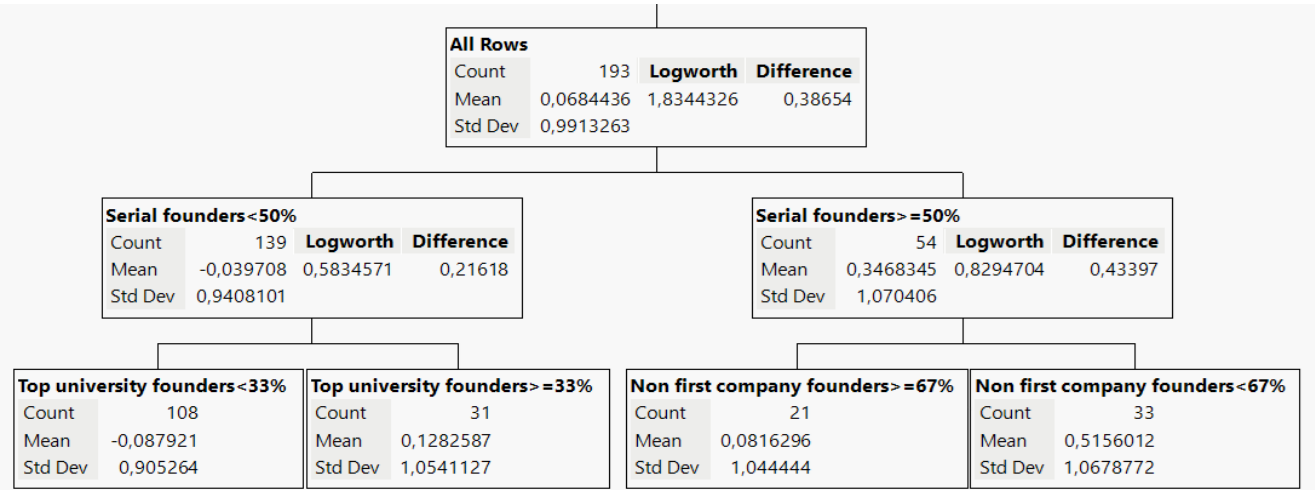

Figure 2. Founders' Characteristics and Managerial Effectiveness. Regression Tree Results

Owing to the presence of missing variables related to the characteristics of the founders, the regression tree could be applied only to a subset of 193 start-ups out of the original 235. Similarly, the size of the group has been restricted to a minimum of 20 units, and those groups that did not show significant differences from the rest have been eliminated. The results confirm that the main variable segmenting best and worst performers is serial founders. However, the regression tree makes it possible to identify other variables that also influence performance at a second level. Specifically, it can be seen in Figure 2 tree that the group of start-ups with the highest managerial effectiveness (with an average value of 0.516) is formed by a group of 33 start-ups characterized by the following two factors: having among their founders (i) for at least 67 % of their founders, this is not the first start-up they have created or, conversely, for at least 33 % of the founders, this is their first entrepreneurial experience; and (ii) a minimum of 50 % serial founders. This result suggests that the best performers are founders who combine entrepreneurial experience and knowledge together with the freshness, drive and original ideas of novice founders. The worst performers group is characterized by having fewer than 50 % serial founders, so they do not suffer to some extent from that experience and entrepreneurial vocation compared with the best performers. However, an interesting result is that the effect of not having serial founders seems to be offset to some extent when members from the top 25 universities participate in the founding team. Specifically, when the participation of this profile in the founding group is less than 33 %, the average managerial effectiveness of the group is -0.088, whereas if it is higher, the managerial effectiveness improves substantially, becoming 0.128 on average.

The results of the study allowed us to test the hypotheses presented in Table 8.

Table 8

Hypothesis Testing Results

Hypothesis	Coefficients' sign and significance	Rejected vs. non-rejected
H1: The higher the economic freedom, the more competitive the digital platform start-up's performance	-/ significant	Rejected
H2: The higher the innovation intensity, the more competitive the digital platform start-up's performance	+ / significant	Not rejected
H3: The higher the quality of a country's governance, the more competitive the digital platform start-up's performance	- / significant	Rejected
H4: Founders' serial experience positively affects digital platform start-up's managerial effectiveness and, thus, its performance	+/ significant	Not rejected
H5: Founders' education in top universities positively affects digital platform start-up's managerial effectiveness and, thus, its performance	+/ significant	Partially rejected

Discussion and Contributions

This study aimed to assess the impact of external environment factors and founders' characteristics on digital platform start-ups' performance and, thus, dynamic competition.

The findings suggest that greater economic freedom and governance quality have a negative effect on digital platform start-up performance. Only higher innovation intensity has a significant positive effect on start-up performance. In dynamic competition terms, the level of innovation positively affects the "effectiveness" of digital platform start-ups. This is in line with previous findings

(e.g., Petit & Teece, 2020; Vaaler & McNamara, 2010) that innovation-intensive environments stimulate innovation development and inspire the creation of new start-ups. However, surprisingly, previous findings (e.g., Hasani & O'Reilly, 2020) suggest positive effects of technological and environmental characteristics on the performance of start-up businesses, and the results demonstrate that economic freedom and governance quality have significant negative effects on digital platform start-up performance. The results add to the dynamic competition theory assumption that the essence of dynamic competition is competition in future markets rather than in today's markets (Petit & Teece, 2021). The more formalized a country's governance is, the more negative its impact on digital platform start-up performance. Despite the anticipation that policy regulations, given the high liability involved, would be favorable, this is not always the case. Interestingly, the results suggest that highly regulated, controlled, bureaucratized, and structured societies may not be the best ecosystem for the development of young, innovative, disruptive, and agile companies that must quickly take advantage of the opportunities detected in the environment. The same impact can be noted for high performance levels of the economic freedom index. This seems to indicate that highly competitive economies may make it easier for start-ups to create in this sector and thus cause greater competition between them and a deterioration in their performance by having to compete both for income and for the best human capital.

In addition, the findings of the study contradict other works related to the effect of governance quality on performance. For example, Orazalin and Mahmood (2021) analyzed country governance quality and environmental performance. The results of a study demonstrate that higher country governance quality leads to better performance. It is argued that higher governance quality might guarantee better access to financing, which might favor start-ups, but the results of our study do not support this assumption. The study results reflect a digital healthcare-specific context where high regulation might hinder a start-up's willingness to innovate. Furthermore, after discounting the effect of the environment and focusing on founders' characteristics of the best and worst performers among the start-ups, this study suggests that the best performers are founders who combine entrepreneurial experience and knowledge—strong entrepreneurial capabilities—together with the freshness, drive and original ideas of novice founders. Such findings are in line with entrepreneurship (e.g., (Cutolo & Kenney, 2021; Florin, 2005; Smith *et al.,* 2017) and dynamic competition theory, as Teece (2023) argues, that the conditions in the digital technology market can change overnight (e.g., the governmental policy to ban ChatGPT in Italy was issued with immediate action in 2023; thus, building business models based on open AI solutions might be hindered instantly); thus, founders' capabilities are important and must be maintained.

The findings of the study *extend both digital entrepreneurship theory and dynamic competition theory* in three directions. The first is that the dynamic competition framework is based on Schumpeterian theory and this entrepreneurial mindset. Dynamic competition scholars often refer to entrepreneurship and entrepreneurs. However, thus far, entrepreneurship scholars have been rather silent about the dynamic competition between start-ups and new ventures, particularly digital platform start-ups. This is a major knowledge gap because digital platform start-ups, by their definition, compete with innovations in complex and dynamic environments where they compete with other start-ups and interact heavily with incumbents and other ecosystem stakeholders. This study provides a significant link between digital entrepreneurship and dynamic competition theories.

Second, in the era of digital entrepreneurship, constant scanning of the external environment and dynamic adjustments to its changes are critical to the survival of digital platform start-ups. This study reveals that whereas innovation-intensive countries favor digital platform start-up performance, economic freedom and governance quality can hinder it. This is a novel finding that can be explained on the one hand by the less favorable environment to create entry barriers when economic freedom is high and, on the other hand, excessively structured and formalized governance slows innovation and suppresses the motivation of founders to innovate.

Third, although there have been few attempts by economic scholars to define founders' characteristics that affect start-up performance (e.g., (Gifford *et al.,* 2021), the results provide a holistic understanding of how external environment factors and managerial effectiveness expressed through founders' characteristics affect digital platform start-ups. This study demonstrates that for digital platform start-ups to achieve superior performance and succeed in dynamic competition, it is critical to have a founder with serial start-up experience. The importance of the education of the founder at a top university is secondary. The results suggest that the best performers have *a group of founders* who combine entrepreneurial experience and knowledge (strong entrepreneurial capabilities) together with the freshness, drive and surely original ideas of novice founders.

The study has a *threefold managerial contribution*. First, the digital healthcare sector is one of the most innovative sectors; thus, start-ups base their business models on advanced technologies such as digital platforms. Operating in such an environment requires founders to maintain their alertness and always remain aware of external environment factors, as dynamic competition can emerge quickly, for instance, from platform complementors or from new platform entrants exploiting innovative new combinations of features and technologies. As Teece (2023) argues, it can occur overnight. Applying a lens of dynamic competition theory to industry-specific research is useful for developing the theory and shedding light on the entrepreneurs and founders who lead businesses in the digital healthcare field to better account for environmental contingencies characterized by unique characteristics.

Second, dynamic competition concerns the effectiveness of the start-up, not its efficiency. It focuses on long-term innovation-based competition rather than price-cutting competition. Thus, the performance level of the start-up signals the level of managerial effectiveness. Start-ups that demonstrate greater performance manage dynamic competition in the field better than their rivals do.

Third, by continuously introducing new products or groups of products that bring novelty to the sector, digital platform start-ups are very much in line with the essence of dynamic competition. For start-up platform owners, the study clarifies which environmental conditions are more conducive to strong performance and highlights how founders' characteristics influence managerial effectiveness, which in turn impacts the overall performance of digital healthcare start-ups.

Conclusions, Limitations and Future Research

The aim of this study was to answer the research question of how external environment factors and founders' characteristics affect dynamic competition among digital platform start-ups. To achieve this goal, the impact of environmental contingencies on the performance of digital healthcare platform start-ups was assessed. The results were obtained by applying a benefit-of-doubt (BoD) methodology appropriate for nonparametric analysis. Five hypotheses were also tested. Two were not rejected, two were rejected, and one was partially rejected. The study concludes that innovation-intensive environments positively contribute to digital platform start-up performance, whereas higher levels of governance and economic freedom have a negative effect. In other words, although it is known that dynamic competition requires an innovation-intensive environment, we learn that it is negatively affected by economic freedom, which allows a higher level of competition and a higher level of governance that imposes rigid regulations and a slow pace of change on start-ups.

Furthermore, this study shows that founders' characteristics have a significant positive effect on digital platform start-up performance and thus ensure survival in dynamic competition. This finding significantly extends strategic entrepreneurship and dynamic competition theory by revealing empirical evidence of external environment factors and the role of founders' characteristics in navigating digital platforms' dynamic competition.

Despite its significance, this study is subject to several limitations. First, the focus on digital healthcare start-ups may limit the generalizability of findings to other sectors. Second, the analysis relies on secondary quantitative data, which does not capture the full range of contextual variables influencing start-up performance. Third, country coverage is limited, leaving emerging economies underexplored. Future studies could extend this work by examining other regulated industries (e.g., education, energy, country security), emerging economies and considering additional factors such as national culture, regulatory evolution, or founder behavior over time.

References

Afi, H., Boubaker, S., & Omri, A. (2022). Do foreign investment and economic freedom matter for behavioral entrepreneurship? Comparing opportunity versus necessity entrepreneurs. *Technological Forecasting and Social Change* (Vol. 181). Elsevier Science INC. https://doi.org/10.1016/j.techfore.2022.121761

Agarwal, R., & Shah, S. K. (2014). Knowledge sources of entrepreneurship: Firm formation by academic, user and employee innovators. *Research Policy*, *43*(7), 1109–1133. https://doi.org/10.1016/j.respol.2014.04.012

Angulo-Guerrero, M. J., Perez-Moreno, S., & Abad-Guerrero, I. M. (2017). How economic freedom affects opportunity and necessity entrepreneurship in the OECD countries. *Journal of Business Research*, *73*, 30–37. https://doi.org/10.1016/j.jbusres.2016.11.017

Audretsch, D. B., & Fiedler, A. (2022). The Vietnamese entrepreneurship paradox: How can entrepreneurs thrive without political and economic freedom? *Journal of Technology Transfer* (47(4), pp. 1179–1197). SPRINGER. https://doi.org/10.1007/s10961-021-09873-2

Autio, E., Nambisan, S., Thomas, L. D. W., & Wright, M. (2018). Digital affordances, spatial affordances, and the genesis of entrepreneurial ecosystems. *Strategic Entrepreneurship Journal*, *12*(1), 72–95. https://doi.org/10.1002/sej.1266

Badin, L., Daraio, C., & Simar, L. (2010). Optimal bandwidth selection for conditional efficiency measures: A data-driven approach. *European Journal of Operational Research*, *201*(2), 633–640. https://doi.org/10.1016/j.ejor.2009.03.038

Barcena-Martin, E., Medina-Claros, S., & Perez-Moreno, S. (2021). Economic regulation, opportunity-driven entrepreneurship and gender gap: Emerging versus high-income economies. *International Journal of Entrepreneurial Behavior & Research* (Vol. 27, Issue 5, pp. 1311–1328). Emerald Group Publishing LTD. https://doi.org/10.1108/IJEBR-05-2020-0321

Berggren, N. (2003). The Benefits of Economic Freedom: A Survey. *The Independent Review*, *8*(2), 193–211.

Bosma, N., Content, J., Sanders, M., & Stam, E. (2018). Institutions, entrepreneurship, and economic growth in Europe. *Small Business Economics*, *51*(2), 483–499. https://doi.org/10.1007/s11187-018-0012-x

Caliendo, M., Kritikos, A. S., & Stier, C. (2023). The influence of start-up motivation on entrepreneurial performance. *Small Business Economics*. https://doi.org/10.1007/s11187-022-00722-6

Carlos Diaz-Casero, J., Angel Manuel Díaz-Aunion, D., Cruz Sanchez-Escobedo, M., Coduras, A., & Hernandez-Mogollon, R. (2012). Economic freedom and entrepreneurial activity. *Management Decision*, *50*(9), 1686–1711. https://doi.org/10.1108/00251741211266750

Cazals, C., Florensa, J.-P., & Simar, L. (2002). Nonparametric frontier estimation: A robust approach. *Journal of Econometrics*, 106,1-25. https://doi.org/10.1016/S0304-4076(01)00080-X

Cennamo, C. (2021). Competing in Digital Markets: A Platform-Based Perspective. *Academy of Management Perspectives*, *35*(2), 265–291. https://doi.org/10.5465/amp.2016.0048

Cervello-Royo, R., Moya-Clemente, I., Perello-Marin, M., & Ribes-Giner, G. (2022). A configurational approach to a country's entrepreneurship level: Innovation, financial and development factors. *Journal of Business Research*, *140*, 394–402. https://doi.org/10.1016/j.jbusres.2021.11.009

Charnes, A., Cooper, W. W., & Rhodes, E. (1978). Measuring the efficiency of decision making units. *European Journal of Operational Research*, *2*(6), 429–444. https://doi.org/10.1016/0377-2217(78)90138-8

Cherchye, L., Lovell, C. K., Moesen, W., & Puyenbroeck, T. (2007). One market, one number? A composite indicator assessment of EU internal market dynamics. *European Economic Review*, *51*(3), 749–779. https://doi.org/10.1016/j.euroecorev.2006.03.011

Chesbrough, H. W. (2003). *Open Innovation: The New Imperative for Creating and Profiting from Technology*. Harvard Business Press.

Crespo, N. F., & Crespo, C. F. (2016). Global innovation index: Moving beyond the absolute value of ranking with a fuzzy-set analysis. *Journal of Business Research*, *69*(11), 5265–5271. https://doi.org/10.1016/j.jbusres.2016.04.123

Cruz-Cázares, C., Bayona-Sáez, C., & García-Marco, T. (2013). You can't manage right what you can't measure well: Technological innovation efficiency. *Research Policy*, *42*(6), 1239–1250. https://doi.org/10.1016/j.respol.2013.03.012

Cutolo, D., & Kenney, M. (2021). Platform-Dependent Entrepreneurs: Power Asymmetries, Risks, and Strategies in the Platform Economy. *Academy of Management Perspectives*, *35*(4), 584–605. https://doi.org/10.5465/amp.2019.0103

Daraio, C., & Simar, L. (2005). Introducing environmental variables in nonparametric frontier models: A probabilistic approach. *Journal of Productivity Analysis*, *24*(1), 93–121. https://doi.org/10.1007/s11123-005-3042-8

Daraio, C., & Simar, L. (2007). Conditional nonparametric frontier models for convex and nonconvex technologies: A unifying approach. *Journal of Productivity Analysis*, *28*(1–2), 13–32. https://doi.org/10.1007/s11123-007-0049-3

de Haan, J., & Sturm, J.-E. (2000). On the relationship between economic freedom and economic growth. *European Journal of Political Economy*, *16*(2), 215–241. https://doi.org/10.1016/S0176-2680(99)00065-8

de Reuver, M., Sorensen, C., & Basole, R. C. (2018). The Digital Platform: A Research Agenda. *Journal of Information Technology*, *33*(2), 124–135. https://doi.org/10.1057/s41265-016-0033-3

Deprins, D., Simar, L., & Tulkens, H. (2006). Measuring labor-efficiency in post offices. In P. Chander, J. Dreze, C. K. Lovell, & J. Mintz (Eds.), *Public goods, environmental externalities and fiscal competition*. Springer. https://doi.org/10.1007/978-0-387-25534-7_16

Despotis, D. K. (2005). A reassessment of the human development index via data envelopment analysis. *Journal of the Operational Research Society*, *56*(8), 969–980. https://doi.org/10.1057/palgrave.jors.2601927

Dillen, Y., Laveren, E., Martens, R., De, V. S., & Van, I. E. (2018). From "manager" to "strategist": An examination of the evolving role of persistent high-growth entrepreneurs. *International Journal of Entrepreneurial Behavior & Research*, *25*(1), 2–28. https://doi.org/10.1108/IJEBR-01-2017-0010

D'Inverno, G., & Witte, K. (2020). Service level provision in municipalities: A flexible directional distance composite indicator. *European Journal of Operational Research*, *17*. https://doi.org/10.1016/j.ejor.2020.04.012

Dynamic Competition and Public Policy: Reflecting on the Path Forward for Schumpeterian Antitrust (2022). Retrieved October 9, 2022, from https://itif.org/events/2022/04/14/dynamic-competition-and-public-policy-reflecting-path-forward-schumpeterian/

Florin, J. (2005). Is venture capital worth it? Effects on firm performance and founder returns. *Journal of Business Venturing*, *20*(1), 113–135. https://doi.org/10.1016/j.jbusvent.2003.12.006

Gaaloul, H., & Khalfallah, S. (2014). Application of the "benefit-of-the-doubt" approach for the construction of a digital access indicator: A revaluation of the "digital access index." *Social Indicators Research*, *118*(1), 45–56. https://doi.org/10.1007/s11205-013-0422-8

Gawer, A. (2020). Digital platforms' boundaries: The interplay of firm scope, platform sides, and digital interfaces. *Long Range Planning*, 102045. https://doi.org/10.1016/j.lrp.2020.102045

Gifford, E., Buenstorf, G., Ljungberg, D., McKelvey, M., & Zaring, O. (2021). Variety in founder experience and the performance of knowledge-intensive innovative firms. *Journal of Evolutionary Economics*, *31*(2), 677–713. https://doi.org/10.1007/s00191-020-00692-6

Handoyo, S. (2023). Worldwide governance indicators: Cross country data set 2012–2022. *Data in Brief*, *51*, 109814. https://doi.org/10.1016/j.dib.2023.109814

Hasani, T., & O'Reilly, N. (2020). Analyzing antecedents affecting the organizational performance of start-up businesses. *Journal of Entrepreneurship in Emerging Economies*, *13*(1), 107–130. https://doi.org/10.1108/JEEE-08-2019-0116

Honore, F., & Ganco, M. (2023). Entrepreneurial teams' acquisition of talent: Evidence from technology manufacturing industries using a two-sided approach. *Strategic Management Journal*, *44*(1), 141–170. https://doi.org/10.1002/smj.3127

Huarng, K., & Yu, T. (2022). Causal complexity analysis for fintech adoption at the country level. *Journal of Business Research*, *153*, 228–234. https://doi.org/10.1016/j.jbusres.2022.08.030

Kapoor, R., & Agarwal, S. (2017). Sustaining Superior Performance in Business Ecosystems: Evidence from Application Software Developers in the iOS and Android Smartphone Ecosystems. *Organization Science*, *28*(3), 531–551. https://doi.org/10.1287/orsc.2017.1122

Kapoor, R., & Klueter, T. (2020). Progress and setbacks: The two faces of technology emergence. *Research Policy*, *49*(1), 103874. https://doi.org/10.1016/j.respol.2019.103874

Kapoor, R., & Teece, D. J. (2021). Three Faces of Technology's Value Creation: Emerging, Enabling, Embedding. *Strategy Science*, *6*(1), 1–4. https://doi.org/10.1287/stsc.2021.0124

Khyareh, M. M., & Amini, H. (2021). Governance Quality, Entrepreneurship and Economic Growth. *Journal of Competitiveness*, *13*(2), 41–64. https://doi.org/10.7441/joc.2021.02.03

Kuckertz, A., Berger, E. S. C., & Mpeqa, A. (2016). The more the merrier? Economic freedom and entrepreneurial activity. *Journal of Business Research*, *69*(4), 1288–1293. https://doi.org/10.1016/j.jbusres.2015.10.094

Loh, W. Y. (2014). Fifty years of classification and regression trees. *International Statistical Review*, *82*(3), 329–348.

McMullen, J. S., Bagby, D. R., & Palich, L. E. (2008). Economic freedom and the motivation to engage in entrepreneurial action. *Entrepreneurship Theory and Practice* (Vol. 32, Issue 5, pp. 875–895). SAGE PUBLICATIONS INC. https://doi.org/10.1111/j.1540-6520.2008.00260.x

Melyn, W., & Moesen, W. (1991). Towards a synthetic indicator of macroeconomic performance: Unequal weighting when limited information is available. *Public Economics Research Papers*, 1–24.

Morais, P., & Camanho, A. S. (2011). Evaluation of performance of European cities with the aim to promote quality of life improvements. *Omega*, *39*(4), 398–409. https://doi.org/10.1016/j.omega.2010.09.003

Morgan, J. N., & Sonquist, J. A. (1963). Problems in the analysis of survey data, and a proposal. *Journal of the American Statistical Association*, *58*(302), 415–434. https://doi.org/10.1080/01621459.1963.10500855

Muñiz, M., Paradi, J., Ruggiero, J., & Yang, Z. (2006). Evaluating alternative dea models used to control for non-discretionary inputs. *Computers & Operations Research*, *33*(5), 1173–1183. https://doi.org/10.1016/j.cor.2004.09.007

Omri, A. (2020). Formal versus informal entrepreneurship in emerging economies: The roles of governance and the financial sector. *Journal of Business Research*, *108*, 277–290. https://doi.org/10.1016/j.jbusres.2019.11.027

Orazalin, N., & Mahmood, M. (2021). Toward sustainable development: Board characteristics, country governance quality, and environmental performance. *Business Strategy and the Environment*, *30*(8), 3569–3588. https://doi.org/10.1002/bse.2820

Ozalp, H., Cennamo, C., & Gawer, A. (2018). Disruption in Platform-Based Ecosystems. *Journal of Management Studies*, *55*(7), 1203–1241. https://doi.org/10.1111/joms.12351

Ozalp, H., Ozcan, P., Dinckol, D., Zachariadis, M., & Gawer, A. (2022). "Digital Colonization" of Highly Regulated Industries: An Analysis of Big Tech Platforms' Entry into Health Care and Education. *California Management Review*, *64*(4), 78–107. https://doi.org/10.1177/00081256221094307

Parker, G., Petropoulos, G., & Van Alstyne, M. W. (2020). *Digital platforms and antitrust*. 2021 Winner of Antitrust Writing Award, view at https://awards.concurrences.com/en/awards/2021/academic-articles/digital-platforms-and-antitrust, Available at SSRN: https://ssrn.com/abstract=3608397 or http://dx.doi.org/10.2139/ssrn.3608397

Petit, N., & Teece, D. (2020). *Taking Ecosystems Competition Seriously in the Digital Economy: A (Preliminary) Dynamic Competition/Capabilities Perspective* (SSRN Scholarly Paper 3745453). https://doi.org/10.2139/ssrn.3745453

Petit, N., & Teece, D. J. (2021). Innovating Big Tech firms and competition policy: Favoring dynamic over static competition. *Industrial and Corporate Change*, *30*(5), 1168–1198. https://doi.org/10.1093/icc/dtab049

Pundziene, A., Gerulaitiene, N., Bez, S. M., Georgescu, I., Mathieu, C., Carrabina-Bordoll, J., Rialp-Criado, J., Nieminen, H., Varri, A., Boethius, S., van Gils, M., Gimenez-Garcia, V., Narbon-Perpina, I., Prior-Jimenez, D., & Vilutiene, L. (2023). Value capture and embeddedness in social-purpose-driven ecosystems. A multiple-case study of European digital healthcare platforms. *Technovation*, *124*. https://doi.org/10.1016/j.technovation.2023.102748

Saeedikiya, M., Li, J., Ashourizadeh, S., & Temiz, S. (2022). Innovation affecting growth aspirations of early stage entrepreneurs: Culture and economic freedom matter. *Journal of Entrepreneurship In Emerging Economies* (Vol. 14, Issue 1, pp. 45–64). Emerald Group Publishing LTD. https://doi.org/10.1108/JEEE-05-2020-0145

Sermontyte-Baniule, R., Pundziene, A., Gimenez, V., & Narbon-Perpina, I. (2022). Role of cultural dimensions and dynamic capabilities in the value-based performance of digital healthcare services. *Technological Forecasting and Social Change*, *176*, 121490. https://doi.org/10.1016/j.techfore.2022.121490

Sidak, J. G., & Teece, D. J. (2009). Dynamic Competition in Antitrust Law. *Journal of Competition Law & Economics*, *5*(4), 581–631. https://doi.org/10.1093/joclec/nhp024

Simar, L., & Wilson, P. W. (2020). Hypothesis testing in nonparametric models of production using multiple sample splits. *Journal of Productivity Analysis*, *53*(3), 287–303. https://doi.org/10.1007/s11123-020-00574-w

Smith, C., Smith, J. B., & Shaw, E. (2017). Embracing digital networks: Entrepreneurs' social capital online. *Journal of Business Venturing*, *32*(1), 18–34. https://doi.org/10.1016/j.jbusvent.2016.10.003

Snihur, Y., & Zott, C. (2020). The Genesis and Metamorphosis of Novelty Imprints: How Business Model Innovation Emerges in Young Ventures. *Academy of Management Journal*, *63*(2), 554–583. https://doi.org/10.5465/amj.2017.0706

Teece, D. J. (2018). Profiting from innovation in the digital economy: Enabling technologies, standards, and licensing models in the wireless world. *Research Policy*, *47*(8), 1367–1387. https://doi.org/10.1016/j.respol.2017.01.015

Teece, D. J. (2023). The Dynamic Competition Paradigm: Insights and Implications. *Columbia Business Law Review*, *2023*(1), Article 1. https://doi.org/10.52214/cblr.v2023i1.11895

Teece, D. J., & Linden, G. (2017). Business models, value capture, and the digital enterprise. *Journal of Organization Design*, *6*(1), 8. https://doi.org/10.1186/s41469-017-0018-x

Tiwana, A. (2015). Evolutionary Competition in Platform Ecosystems. *Information Systems Research*, *26*(2), 266–281. https://doi.org/10.1287/isre.2015.0573

Toft-Kehler, R., Wennberg, K., & Kim, P. H. (2014). Practice makes perfect: Entrepreneurial-experience curves and venture performance. *Journal of Business Venturing*, *29*(4), 453–470. https://doi.org/10.1016/j.jbusvent.2013.07.001

Vaaler, P. M., & McNamara, G. (2010). Are Technology-Intensive Industries More Dynamically Competitive? No and Yes. *Organization Science*, *21*(1), 271–289. https://doi.org/10.1287/orsc.1080.0392

Van Alstyne, M. W., Parker, G. G., & Choudary, S. P. (2016). Pipelines, platforms, and the new rules of strategy. *Harvard Business Review*, *94*(4), 54–62.

Van Lancker, E., Knockaert, M., Collewaert, V., & Breugst, N. (2023). Preparing for scaling: A study on founder role evolution. *Journal of Business Venturing*, *38*(4), 106315. https://doi.org/10.1016/j.jbusvent.2023.106315

Zanella, A., Camanho, A., & Dias, T. G. (2013). Benchmarking countries' environmental performance. *Journal of the Operational Research Society*, *64*(3), 426–438. https://doi.org/10.1057/jors.2012.62

Authors' Biographies

Víctor Giménez is an Associate Professor at Universitat Autònoma de Barcelona, specializing in operations, quality, and project management. His research has been published in journals such as *Omega, Health Care Management Science, European Journal of Operational Research* and others.

Diego Prior Jimenez is a Full Professor of Finance, Financial Information and Management Control at the Department of Business, Universitat Autònoma de Barcelona. His research focuses on efficiency, performance measurement, and public sector management, with numerous publications in top-tier journals.

Asta Pundzienė is a Full Professor of Strategic management and organizational psychology in the School of Economics and Business, Kaunas University of Technology, Lithuania, and Affiliated Scholar at University of California, Berkeley, Haas School of Business. Her work has appeared in the *Strategic Entrepreneurship Journal*, *California Management Review* and *Journal of Business Research*.

Rima Sermontytė-Baniulė is a researcher at the School of Economics and Business, Kaunas University of Technology, Lithuania, and a member of the Digital Healthcare Innovation research group. Her current research interests include strategic management, dynamic capabilities, open innovation and value-based digital healthcare performance. Her work has been published in the *Strategic Entrepreneurship Journal*, *Journal of Business Research*, and *Technological Forecasting and Social Change*.

The article has been reviewed.
Received in March 2025; accepted in July 2025.