

# **Digital entrepreneurial ecosystems around the world: Supporting adoption and utilization of digital technology for innovation**

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## **Abstract**

**Purpose.** – The institutions and resource endowments for digitalization in a society form the digital entrepreneurial ecosystem in the society. The digital entrepreneurial ecosystem is a context for businesses in their adoption of digital technology and for their utilization of adopted technology for outputs, e.g. innovation. Effects of the digital entrepreneurial ecosystem, however, are little known. This frames our question, what are the effects of digital entrepreneurial ecosystems upon adoption and utilization of digital technology for innovation?

**Research design.** – The digital entrepreneurial ecosystems in 47 countries were surveyed, along with a globally representative sample businesses, by the Global Entrepreneurship Monitor, amenable to hierarchical linear modeling of effects of ecosystems on innovation in the businesses.

**Findings.** – Elaboration of digital entrepreneurial ecosystems is found to promote digitalization, and to amplify effect of early digitalization on recent digitalization and also amplify effect of digitalization upon innovation.

**Originality.** – Findings contribute to a global account of elaboration of digital entrepreneurial ecosystems around the world as supporting adoption and utilization of digital technology for performance-related outputs.

## **Keywords.**

Digital entrepreneurial ecosystem; digitalization; adoption; utilization; innovation; national; global.

# 1 Introduction

The institutions and resource endowments for digitalization in businesses in a society are forming a system, the digital entrepreneurial ecosystem in the society. The digital entrepreneurial ecosystem is the context for businesses in their adoption of digital technology and their utilization of the technology for outputs such as innovation. The digital entrepreneurial ecosystem is commonly believed to greatly benefit adoption and utilization, but evidence of effects is scarce (Appio et al., 2021; Bejjani et al., 2023; Berger et al., 2021). Our argument is that the digital entrepreneurial ecosystem, where elaborate, is conducive by promoting adoption of digital technology and by facilitating utilization of adopted technology for outputs such as innovation.

Digital technology, by its existence and availability, has been conceptualized as an affordance (Autio et al., 2018) and as an external enabler (Berger et al., 2021), enabling operations of businesses. The enablement is considered promoted and facilitated by the digital entrepreneurial ecosystem. A recent systematic literature review concludes that a digital entrepreneurial ecosystem has typically been characterized in terms of the actors in the system and the system's governance, resources, architecture and institutions, and its complementarity and reach to actors, and the actors' identification with the ecosystem (Bejjani et al., 2023). This macro-level focus is mirrored in the micro-level focus. Scholarship has mostly focused on the micro-level of digitalization in businesses, especially on adoption and utilization of digital technology in business (e.g. Lashitew, 2023). Not only scholarship, but also policymaking has a focus on digitalization, because leaders believe in digital technology as a capability of firms and societies which brings competitive advantages in outputs such as innovation (Bradley et al., 2021; European Commission, 2018; OECD, 2021; World Bank, 2016). A few studies have aggregated digitalization in business to the national level as a rate of digitalization in each country, and national-level analysis has revealed considerable inequality among societies and uneven globalization, a global divide in which some societies are leading and forging ahead, others are catching up, and yet others are falling behind (Rikap and Lundvall, 2021; Samsami and Schøtt, 2022; Song, 2019). The inequality among societies in business digitalization indicates that some national institutions and resource endowments are shaping digitalization, but such effects have hardly been conceptualized and rarely examined. Ecosystem effects on adoption and utilization is thus a gap in our scholarly understanding of digitalization. This gap is pointed out in a recent agenda for research on the coupling between digitalization and innovation, forwarded by Appio and colleagues (2021). They pose the question, "Which ecosystem orchestration strategies and practices are conducive to digital transformation?" (ibid., p.4). This question concerns adoption, is adoption of digital technology promoted by elaboration of the ecosystem? They also raise the question, "Which governance for innovation ecosystems is best suited to take advantage of digital transformation?" (ibid., p.4). This question concerns utilization, is utilization of adopted digital technology enhanced by elaboration of the ecosystem?

The concept of an ecosystem has in recent years been applied to conceptualize a digital entrepreneurial ecosystem as a more or less elaborate system of institutions and resource endowments for

digitalization (Bejjani et al., 2023; Venâncio et al., 2023). This conceptualization is analogous to but distinct from the concept of a national innovation system as a system of institutions shaping innovation in a society (Lundvall, 1992), and the concept of an entrepreneurial ecosystem as a system of institutions molding entrepreneurial endeavors and outputs (Stam and Spigel, 2018).

These considerations frame our research question, *what are the effects of elaboration of the digital entrepreneurial ecosystem upon adoption and utilization of digital technology for innovation?*

This question calls for measuring ecosystems as well as their businesses. A recent systematic literature review raises questions about measurements, “how can the performance of a digital entrepreneurial ecosystem be measured across (geographical/industry/firm) boundaries?” and “how can the relation between resources and outcomes be measured?” (Bejjani et al., 2023). Our approach is to combine a survey of digital entrepreneurial ecosystems with a survey of businesses. At the national level, the digital entrepreneurial ecosystem in 47 countries around the world has been assessed in a survey of experts. At the business level, digitalization in a large and globally representative sample of businesses has been reported in a survey of entrepreneurs. Both surveys have been conducted in 2021 by the research consortium Global Entrepreneurship Monitor (2022, 2023). We combine the national-level data with the business-level data for analyzing effects of elaboration of digital entrepreneurial ecosystems on businesses with their adoption of digital technology and their utilization of the technology for innovation.

We find that elaboration of a digital entrepreneurial ecosystem is promoting early and recent digitalization, and elaboration is amplifying the effect of early adoption on recent adoption and is also boosting the effects of early and recent digitalization upon innovation.

The study contributes to an account of digital entrepreneurial ecosystems as they vary from country to country in elaboration, as elaboration promotes adoption of digital technology in businesses, and as elaboration enhances utilization of digital technology for outputs such as innovation.

The following first develops a theoretical perspective with hypotheses, then describes our method for researching ecosystems, then reports analyses, and concludes by discussing findings and their contributions as well as their limitations suggesting further research.

## **2 Theoretical perspective and hypotheses**

Our theorizing considers two entities. The digital entrepreneurial ecosystem in a society is a macro-level entity, which differs from society to society in its elaboration. A business is a micro-level entity, an actor with possible adoption and utilization of digital technology. The entities form a two-level hierarchy in that businesses are nested within ecosystems. First, we briefly review extant theorizing about adoption of digital technology in a business and utilization of adopted technology for innovation. Second, we briefly review current theorizing about digital entrepreneurial ecosystems. Third, we develop hypotheses about effects of digital entrepreneurial

ecosystems upon businesses' adoption of digital technology. Fourth, we develop hypotheses about digital entrepreneurial ecosystems moderating effects of acquired technology upon innovation.

## **2.1 Adoption of digital technology in a business and utilization for innovation**

A business may adopt digital technology. Adopting digital technology is a form of creating or building capability in the business. Indeed, this capability is termed the digital capability as the ability of the business to adopt, manage, and use digital technology. Management research has a focus on how a business may build digital capability (e.g. Eller et al., 2020; Lashitew, 2023; Schiuma et al., 2022).

Digital technology differs from other technologies in several ways (Autio et al., 2018; Nambisan, 2017). Notably, digital technology obsolesces rapidly. Therefore, adoption of digital technology is often not a one-time occurrence. Rather, adoption of new technology may be recurring, in that a business that has adopted in the past will be adopting new technology in the present, and will intend to adopt newer technology in the future. Indeed, corporations have established a specific role, the digital officer, with the task of recurrently adopting new digital technology. Thus, a proposition is that early digitalization positively affects later adoption of new digital technology.

Acquired digital technology is a capability to utilize digital technology for creating outputs such as innovation (Nambisan et al., 2019). Thus, digital capability overlaps with innovative capability, as the capability of a business to create innovations (Gobble, 2018; Vigren et al., 2022). A well-known proposition is that adoption of digital technology tends to benefit innovation (e.g. Boeker et al., 2021; de Paula et al., 2022). Specifically, our analysis below confirms the following propositions concerning the impact of early and recent digitalization on innovation. First, digital technology positively affects innovation, and, second, early digitalization, and especially recent digitalization, are promoting innovation. These effects of early and recent digitalization upon innovation have recently been shown to prevail in businesses in Spain (Samsami, 2023). Here we confirm that the effects prevail globally.

## **2.2 The digital entrepreneurial ecosystem**

The currently most influential conceptualization of an entrepreneurial ecosystem is by Stam and colleagues (Leendertse et al., 2022; Stam and Spigel, 2018; Schrijvers et al., 2021; Wurth et al., 2022). An entrepreneurial ecosystem is conceptualized as a system of interrelated components in form of institutions and resource endowments that jointly channel, enable, and constrain enterprising (Spigel, 2022; Stam, 2015). The institutions comprise formal regulatory institutions, entrepreneurial culture, and networks. The resource endowments comprise physical infrastructure, demand for entrepreneurial production, intermediaries facilitating entrepreneurial work, talented people for staffing endeavors, knowledge enhancing production, leadership promoting enterprising, and financing of endeavors (Stam and van de Ven, 2021; Content et al., 2020).

This conceptualization of an entrepreneurial ecosystem can be applied specifically to a digital entrepreneurial ecosystem (Sussan and Acs 2017). Thus, a digital entrepreneurial ecosystem can be conceptualized as a system of institutions and resource endowments that jointly channel, enable, and constrain digital enterprising (Bejjani et al., 2023; Du et al., 2018; Elia et al., 2020; Li et al., 2017).

The ecosystem may affect digital endeavors rather directly. Elaboration of the ecosystem may promote performance-related outputs rather directly in that the support provided in an elaborate system will increase performance (Feld and Hathaway, 2020). Such direct effects of entrepreneurial ecosystems have been found (Stam and van de Ven, 2021; Leendertse et al., 2022), specifically for digital entrepreneurial ecosystems (Venâncio et al., 2023).

However, an ecosystem may also affect entrepreneurial endeavoring in other ways. Notably, when we conceive of enterprising as utilization of resources such as digital technology, we can conceive of the ecosystem as influencing the utilization of resources (Karim et al., 2022; Nicotra et al., 2018). That is, the ecosystem will facilitate or dampen the effects of resources on outputs. This conception leads us to think of the ecosystem effect, not as a direct effect, but as a moderating effect, moderating the impact of resources on outputs (e.g., Schøtt and Jensen, 2016).

### **2.3 Adoption promoted by the digital entrepreneurial ecosystem**

The above theorizing about an ecosystem as expectedly promoting performance-related outputs is the basis for specifying hypotheses.

The digital entrepreneurial ecosystem is more or less elaborated. Elaboration differs from one society to another. Indeed, some societies form very elaborate ecosystems. Authorities support elaboration of ecosystems, expecting the elaboration will be fruitful in terms of promoting performance-related outputs. Concretely, the digital entrepreneurial ecosystem will expectedly encourage businesses and in various ways support them to adopt digital technology. The more elaborate the digital entrepreneurial ecosystem is, the more it will promote digitalization, we hypothesize. We specify this as two hypotheses, distinguishing between early digitalization (before the pandemic) and recent digitalization (during the pandemic, up to data-collection in mid-2021),

*Hypothesis 1. Elaboration of the digital entrepreneurial ecosystem promotes early digitalization.*

*Hypothesis 2. Elaboration of the digital entrepreneurial ecosystem promotes recent digitalization.*

The distinction between early adoption (before pandemic) and recent adoption (during pandemic) can be informative. Digital technology differs in several ways from other technologies (Autio et al., 2018). Notably, digital technology obsolesces quickly. So digital technology adopted early is less useful than recently adopted technology. This motivates businesses to adopt new technology even if they adopted earlier.

We argue that early adopters tend to consider their adopted technology as obsolete and therefore are adopting new digital technology, more frequently than non-adopters will be adopting digital technology. In other words, adoption is recurring, as a rather continual updating; early adoption begets new adoption (Warner and Wäger, 2019). Moreover, such recurring or continual adoption is supported by the digital entrepreneurial ecosystem, we should think. That is, where the ecosystem is elaborate, it will boost the tendency of early adopters to again adopt new digital technology. This moderating influence from the ecosystem boosting the effect of early adoption upon recent adoption can be stated as a hypothesis,

*Hypothesis 3. Elaboration of the digital entrepreneurial ecosystem  
enhances effect of early adoption on recent adoption.*

From this focus on adoption of technology, we turn our focus to its utilization.

## **2.4 Utilization enhanced by the digital entrepreneurial ecosystem**

Adoption of digital technology is not an end in itself, but a means to other ends. Digital technology is adopted to build capability, capability to create performance-related outputs. One such output is innovation. Indeed, digital technology is often adopted with the intention that it will be utilized for creating innovations. Digitalization is positively coupled with innovation, even reciprocally (Samsami, 2023). Furthermore, utilization of technology for such performance-related output is expectedly supported by the ecosystem (Beliaeva et al., 2019). That is, the ecosystem will expectedly boost the effect of digital technology upon innovation. The boost is a positive moderation of the effect of digitalization upon innovation. We specify this as twin hypotheses,

*Hypothesis 4. Elaboration of the digital entrepreneurial ecosystem  
enhances effect of early adoption on innovation.*

*Hypothesis 5. Elaboration of the digital entrepreneurial ecosystem  
enhances effect of recent adoption on innovation.*

The five hypotheses are depicted in Figure 1 and tested in the following.

**Figure 1 here**

## **3 Research methods**

For analyzing business endeavors in the context of national ecosystems, we consider the ‘population’ of societies and the ‘population’ of businesses nested in the societies. The digital entrepreneurial ecosystems in a fairly representative sample of 47 countries were assessed in a survey of experts in 2021, along with a globally representative survey of business owners, for the Global Entrepreneurship Monitor (2022, 2023). GEM is scheduled to make the survey of business owners publicly available in 2025 on its website [www.gemconsortium.org](http://www.gemconsortium.org)

### 3.1 Sampling

GEM uses two-stage sampling (Bosma, 2013). First countries are sampled, essentially by self-selection when a national team is formed for conducting the two surveys in their country. In 2021, GEM surveyed adults and their businesses in 47 countries, Arab Emirates, Belarus, Brazil, Canada, Chile, Colombia, Croatia, Cyprus, Dominican Republic, Egypt, Finland, France, Germany, Greece, Guatemala, Hungary, India, Iran, Ireland, Israel, Italy, Japan, Kazakhstan, Korea, Latvia, Luxemburg, Morocco, Netherlands, Norway, Oman, Panama, Poland, Qatar, Romania, Russia, Saudi Arabia, Slovakia, Slovenia, South Africa, Spain, Sweden, Switzerland, Sudan, Turkey, United Kingdom, United States, and Uruguay. This sample of countries, with its diversity of regions, economies, and cultures, is fairly representative of the societies around the world.

Second, in each of the countries, adults were randomly sampled, reporting whether they were entrepreneurs owning and managing a starting or operating business. This sample of entrepreneurs reported on their businesses, notably on digitalization and innovation.

The fairly representative sampling in both stages implies that findings can be generalized, with usual statistical uncertainty, to the world's businesses and digital entrepreneurial ecosystems.

### 3.2 Measurements

#### 3.2.1 The digital entrepreneurial ecosystem in society

Elaboration of the national digital entrepreneurial ecosystem in a country was indicated when then GEM survey of national experts asked the experts to assess truthfulness versus falsity of three statements,

- *A substantial number of new and growing firms can afford the cost of digitalization required by the pandemic to become enough competitive.*
- *A substantial number of new and growing firms are promoting working from home as a result of the covid-19 pandemic.*
- *Due to the pandemic, there is sufficient government support in the form of specific subsidies, tax benefits or training to help all types of firms in all sectors to implement and/or adopt business digitalization.*

The experts rated truthfulness versus falsity of each question on a Likert scale 0 to 10, with 5 as the neutral midpoint, neither true nor false. The three variables are positively correlated, albeit not strongly, so the mean of the three standardized variables, across the experts in the country, is a formative index of the national digital entrepreneurial ecosystem. The digital entrepreneurial ecosystem has a weak elaboration in Sudan, Iran and Morocco, and is highly elaborated in the Netherlands, Finland, and Lithuania. The standardized index of elaboration of the digital entrepreneurial ecosystem is an independent variable in the tests of our hypotheses about its effects.

Reliability of our index can be gauged by its correlation with other measures of digital entrepreneurial ecosystems. The so-called Digital Platform Economy index for a country is a combination of subindexes measuring digital technology infrastructure, digital user citizenship, digital multi-sided platforms, and digital technology entrepreneurship, constructed by Szerb and colleagues (2020). Our index correlates .69 with the Digital Platform Economy index. The so-called Digital Adoption Index for a country is a combination of measures of usage of digital technology by government, by businesses, and by people, constructed by the World Bank (2023). Our index correlates .72 with the Digital Adoption Index. These rather high correlations suggest that our index has reasonably high reliability.

Both the Digital Platform Economy index and the Digital Adoption Index are partly based on a measure of use of digital technology in businesses, and therefore they would not be appropriate for testing effects of the ecosystem on adoption and utilization.

### **3.2.2 Innovation**

Innovation in a business is measured in the GEM survey of businesses by asking the entrepreneurs two questions,

- *Are any of the technologies or procedures used for this product or service new to people in the area where you live, or new to people in your country, or new to the world?*
- *Are any of your products or services new to people in the area where you live, or new to people in your country, or new to the world?*

For each question, the response is coded on a scale going from 1 if not new to any, through 2 if new locally, and 3 if new nationally, up to 4 if new to the world. The two variables are positively correlated, so the mean of the two is an index of innovation. This index of innovation is our dependent variable in tests of effects on innovation.

This measure of innovation is used in the annual report of the Global Entrepreneurship Monitor (2022, 2023). An earlier formulation of the question has been extensively used for innovation research (e.g. Schøtt & Jensen, 2016).

### **3.2.3 Digitalization**

Adoption of digital technology in a business was measured in the GEM survey of businesses in mid-2021 by asking the entrepreneurs,

- *In response to the coronavirus pandemic, has your business made any changes in its use of digital technologies for selling your product or service?*

The entrepreneur replied by giving one of these four possible answers,

- *Yes – you adopted digital technologies in response to the coronavirus pandemic.*
- *Yes – you enhanced the initial plans you had with new or improved digital technologies.*



- *No – you already planned a range of digital technologies before the coronavirus pandemic.*
- *No – your business can function without digital technologies.*

The four response options entail two dichotomies,

- early digitalization, as adoption before the pandemic, is reported by the second and third responses;
- recent digitalization, as adoption during the pandemic, is reported by the first and second responses.

### 3.2.4 Control variables

We are able to include control variables in the multivariate analyses through the GEM survey of businesses. Innovation and digitalization in a business are influenced by various conditions that should be controlled for by measures of the characteristics of businesses. The GEM survey of businesses enables our analysis to control for,

- Age of the business, measured in years, logged to reduce skewness.
- Number of employees in the business as a numerical variable, logged to reduce skewness.
- Number of owners of the business as a numerical variable, logged to reduce skewness.
- Sector, measured categorically as extracting, transforming, business services, and consumer-oriented.
- Gender of the responding entrepreneur, in GEM recorded as male (coded 0) and female (coded 1).
- Age of the entrepreneur, measured as years of age.
- Education of the entrepreneur, coded into years of schooling to highest completed degree.
- Self-efficacy is queried by asking for agreement with the statement, *“You personally have the knowledge, skill and experience required to start a new business”*, measured as a five-point Likert scale, going from Strongly disagree (coded 1) up to Strongly agree (coded 5).
- Risk-willingness is indicated by rating, *“You would not start a business for fear it might fail.”* measured on the five-point Likert scale.
- Opportunity-perception is measured by agreement with *“In the next six months, there will be good opportunities for starting a business in the area where you live”*, on the five-point Likert scale.
- Networking is indicated by the answer to *“How many people do you know personally who have started a business or become self-employed in the past 2 years? Would it be none, one, few or many people?”*, coded as a numerical variable, 0 none, 1 one, 2 two to four, 5 five or more.
- Four motives for the business were measured by asking the entrepreneur to rate, on a five-point Likert scale, each of four reasons for running the business,

*Please tell me the extent to which the following statements reflect the reasons you are trying to start a business.*

- *To make a difference in the world.*
- *To build great wealth or a very high income.*
- *To continue a family tradition.*

- *To earn a living because jobs are scarce.*

We also control for GDP per capita (logged), as published by the World Bank.

### 3.3 Techniques for analyzing the data

Businesses are nested within a country or an ecosystem, so our data from a two-level hierarchy. Our propositions concern effects within the micro-level and from the macro-level to the micro-level. To test these effects, we use two-level hierarchical linear modeling. This is similar to linear regression but takes into account that the data are at two levels (Snijders and Boskar, 2012).

## 4 Results

Here we first describe the background of the businesses, and then test our hypotheses.

### 4.1 Background of the businesses

The background of the businesses is briefly described by their characteristics, Table I. Most businesses have little innovation. Less than half had adopted digital technology before the pandemic, and less than half adopted new digital technology during the pandemic (with many businesses adopting both early and recently). By far most businesses are very young and very small in terms of owners and employees.

**Table I here**

The businesses are described further by the correlations among the variables of interest, and their correlations with control variables, Table II. The correlations among variables of interest are weak, less than .2, implying that the multivariate analyses will encounter no problem of multicollinearity.

**Table II here**

### 4.2 Effects of the ecosystem on digitalization

Our substantive question is, what are the effects of the digital entrepreneurial ecosystem upon adoption and utilization of digital technology for innovation? Effects are ascertained by multivariate linear models, Table III, with controls for several other conditions.

First, we reconfirm that early adoption positively affects recent adoption (model B), and that both early adoption and especially recent adoption positively affect innovation (model D). Such positive effects were found in a recent study of businesses within a single country, Spain (Samsami, 2023). Here we are extending that study by focusing on contextual effects.

Hypothesis 1 posits that the ecosystem promotes early digitalization. This hypothesis is tested in model A. The positive coefficient lends support for the hypothesis. The ecosystem had a positive effect on early digitalization.

Hypothesis 2 asserts that the ecosystem promotes recent digitalization. This hypothesis is tested in model B. The insignificant coefficient lends no support for H2. The ecosystem had no discernible effect on recent digitalization.

Hypothesis 3 claims that the ecosystem enhances effect of early adoption on recent adoption. This moderating effect is tested as the interaction in model C. The positive coefficient supports H3. The ecosystem boosts the already positive effect of early adoption on recent adoption.

Hypothesis 4 says that the ecosystem enhances effect of early adoption on innovation. This moderating effect is tested in model E. The insignificant coefficient lends no support for H4. The ecosystem is not discernibly moderating the effect of early adoption on innovation.

Hypothesis 5 posits that the ecosystem enhances effect of recent adoption on innovation. This moderating effect is tested in model E. The positive coefficient supports H5. The ecosystem boosts the effect of recent adoption on innovation.

### **Table III here**

In short, the digital entrepreneurial ecosystem promoted early adoption of digital technology, before the pandemic. But the ecosystem has not discernibly affected recent adoption, during the pandemic; conceivably the pandemic was such a pervasive external enabler that it overrode an otherwise normal effect of the ecosystem. The ecosystem also boosted the effect of recent adoption on innovation, i.e. promoted the utilization of digital technology for innovation (but the ecosystem had no discernible moderating effect on utilization of early adoption for innovation)

## **5 Discussion**

The above analyses address the question, *what are the effects of elaboration of the digital entrepreneurial ecosystem upon adoption and utilization of digital technology for innovation?* For addressing this question, we analyzed representatively sampled ecosystems and randomly sampled businesses nested within the ecosystems as a two-level hierarchy, for testing hypothesized macro-to-micro effects of ecosystems on business endeavors, with generalizability to the world's digital entrepreneurial ecosystems and businesses. Here we discuss the findings and their contribution, relevance, limitations, and further research.

## **5.1 Findings**

For a business, a most immediate context is the more or less elaborate ecosystem (Felin and Foss, 2023). An ecosystem, specifically an entrepreneurial ecosystem, and even more specifically a digital entrepreneurial ecosystem, is conceptualized as channeling, regulating, enabling and occasionally also constraining the actions of businesses. The ecosystem has here been theorized to influence actions in two ways.

First, the ecosystem directly affects action, which can be modeled with action as a dependent variable and ecosystem elaboration as an independent variable. Here we selected one action, adoption of digital technology in a business, and examined the effect on adoption from elaboration of the digital entrepreneurial ecosystem, and modeled the effect as a main effect in a model similar to regression. This kind of modeling with main effects in a regression-like model is becoming typical when analyzing a sample of ecosystems (Stam and van der Ven, 2021; Leendertse et al., 2022; Venâncio et al., 2023). The digital entrepreneurial ecosystem, indeed, was here found to affect adoption, with positive effects on early adoption.

Second, the ecosystem is theorized to be facilitating utilization of resources or capabilities for creating outputs. Such facilitation of transforming a resource into an output can be conceptually modeled as an effect of the resource on the output, where the effect is amplified by the ecosystem. The amplification can be modeled statistically as a moderation of the effect of the resource upon the output. This kind of modeling with moderation in a regression-style model is not common in analysis of ecosystems (but is common in analyses of societal institutions as they influence behavior of individuals; e.g. Schøtt and Jensen, 2016). The digital entrepreneurial ecosystem was here found to positively moderate the effect of acquired digital technology upon innovation in businesses. Specifically, the digital entrepreneurial ecosystem amplified effect of recent digitalization, upon innovation.

## **5.2 Contribution**

The study contributes to an evidence-based theoretical account of digital entrepreneurial ecosystems, as their elaboration vary from country to country, as elaboration promotes adoption of digital technology in businesses, and as elaboration enhances utilization of digital technology for innovation.

More abstractly, we can consider ecosystems rather than digital entrepreneurial ecosystems, consider resources rather than digital technology, and consider output rather than innovation. Thus, in this more abstract or general perspective, the study contributes to an account of ecosystems as their elaboration varies around the world, as elaboration promotes resources in businesses, and as elaboration enhances utilization of resources for outputs.

## **5.3 Relevance for research and for practice**

For research on ecosystems, a relevant result is our focus on facilitation as an important function of ecosystems, the facilitation of utilizing resources for creating performance-related outputs, and then modeling such

facilitation as a moderation, or interaction effect, in a regression-like model. This focus on facilitation or moderation augments the focus on direct or main effects which dominates research on ecosystems.

For practice, specifically practice concerning governance of ecosystems, our findings call for sustained attention to facilitation as an important role of ecosystems. Concretely, a digital entrepreneurial ecosystem can promote adoption of digital technology in businesses, but that is only part of the potential benefit of the ecosystem. The other part of the potential benefit is the facilitation of utilization.

#### **5.4 Limitations and further research**

A first limitation is that our study is limited to one business endeavor, adoption of digital technology. A second limitation is that we have studied only one output, innovation.

The limitations suggest further research on digital entrepreneurial ecosystems (Wurth et al., 2022). First, future research can informatively examine effects of digital entrepreneurial ecosystems on digital literacy and preparedness of businesses and their leaders and staff. There are micro-level studies of literacy and preparedness of businesses and persons (Millán et al., 2021; Secundo et al., 2020; Upadhyay et al., 2022), but studies of ecosystem effects are lacking. Second, digital technology is not merely a component of innovation capability but is a versatile dynamic capability that can be utilized for creating many outputs (Eisenhardt and Martin, 2000), for example business models, internationalization, market scope, and growth of businesses (Cassetta et al. 2020; Cirillo et al., 2022; Kraus et al., 2019; Tolba et al., 2022). It will be informative to examine how such other performance-related outputs are facilitated by digital entrepreneurial ecosystems.

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**Table I****Characteristics of the businesses.**

Innovation	Index on scale 1 to 4. Mean (SD)	1.4 (.7)
Recent adoption	Percent businesses that adopted recently (during pandemic)	42%
Early adoption	Percent businesses that adopted early (before pandemic)	46%
Motive: Make a difference	Scale 1 to 5. Mean (SD)	3.0 (1.5)
Motive: Accumulate wealth	Scale 1 to 5. Mean (SD)	3.3 (1.5)
Motive: Family tradition	Scale 1 to 5. Mean (SD)	2.5 (1.6)
Motive: Earning a living	Scale 1 to 5. Mean (SD)	3.8 (1.4)
Sector: Extracting	Percent businesses that are extracting	6%
Sector: Transforming	Percent businesses that are transforming	22%
Sector: Business services	Percent businesses that provide services	22%
Sector: Consumer-oriented	Percent businesses that are consumer-oriented	50%
Age of business	Years. Mean (SD)	6.5 (10.4)
Owners	Owners. Mean (SD)	1.8 (2.1)
Employees	Employees. Mean (SD)	6.8 (28.1)
Gender of entrepreneur	Percent owner who are women	41%
Age of entrepreneur	Years. Mean (SD)	41.3 (12.2)
Education	Years. Mean (SD)	13.9 (5.7)
Self-efficacy	Scale 1 to 5. Mean (SD)	4.1 (1.2)
Opportunity assessment	Scale 1 to 5. Mean (SD)	3.3 (1.4)
Risk-willingness	Scale 1 to 5. Mean (SD)	3.3 (1.5)
Networking	Scale 0 to 3. Mean (SD)	1.4 (1.1)
Income	Scale 1 to 3. Mean (SD)	2.2 (.8)
Household	Persons living together. Mean (SD)	3.7 (1.9)

**Table II****Correlations.**

	Ecosystem	Innovation	Recent adoption	Early adoption
Ecosystem elaboration				
Innovation	.06 ***			
Recent adoption	-.02 ***	.15 ***		
Early adoption	.14 ***	.08 ***	.03 ***	
Motive: Making a difference	.05 ***	.23 ***	.14 ***	-.02 **
Motive: Accumulating wealth	-.15 ***	.07 ***	.12 ***	-.06 ***
Motive: Family tradition	-.01 **	.06 ***	.05 ***	-.08 ***
Motive: Earning a living	-.12 ***	-.06 ***	-.01 *	-.07 ***
Sector: Extracting	-.03 ***	-.06 ***	-.07 ***	-.06 ***
Sector: Transforming	-.05 ***	-.01 *	-.06 ***	-.04 ***
Sector: Business services	.11 ***	.05 ***	.04 ***	.16 ***
Sector: Consumer-oriented	-.03 ***	.00	.05 ***	-.07 ***
Age of business	.02 ***	-.14 ***	-.11 ***	.03 ***
Owners	.03 ***	.12 ***	.11 ***	.05 ***
Employees	.00	.07 ***	.09 ***	.02 ***
Gender: Female	.00	-.05 ***	.00	.00
Age of entrepreneur	.08 ***	-.10 ***	-.12 ***	.02 ***
Education	.12 ***	.06 ***	.12 ***	.11 ***
Self-efficacy	-.01 †	.06 ***	.03 ***	.01
Opportunity assessment	.05 ***	.08 ***	.09 ***	-.05 ***
Risk-willingness	-.01 †	.00	.00	.00
Networking	-.02 ***	.13 ***	.11 ***	-.01
Income	-.01	.03 ***	.06 ***	.06 ***
Household	-.13 ***	-.04 ***	.05 ***	-.09 ***
GDP per capita	.64 ***	.06 ***	.01	.16 ***

† p<.10   \* p<.05   \*\* p<.01   p<.001

**Table III****Digitalization and innovation affected by the ecosystem.**

	Early adoption	Recent adoption		Innovation	
	Main effects	Main effects	Interaction included	Main effects	Interactions included
	Model A	Model B	Model C	Model D	Model E
Ecosystem elaboration	.03 † H1	-.02 H2	-.02	.01	.00
Early adoption		.02 **	.01 *	.11 ***	.11 ***
Recent adoption				.18 ***	.18 ***
Ecosystem * Early adoption			.02 ** H3		.00 H4
Ecosystem * Recent adoption					.02 * H5
Motive: Making a difference	.01 **	.03 ***	.03 ***	.18 ***	.18 ***
Motive: Accumulating wealth	.01 *	.01 *	.00	.02 *	.02 *
Motive: Family tradition	-.01 ***	.00	.01	.01	.01
Motive: Earning a living	-.02 ***	-.01 †	.00	-.02 ***	-.02 ***
Sector: Extracting	-.07 ***	-.09 ***	-.08 ***	-.08 **	-.08 **
Sector: Transforming	-.01 †	-.05 ***	-.05 ***	.00	.00
Sector: Business services	.10 ***	.02 *	.02 *	.06 ***	.06 ***
Age of business	.02 ***	-.02 ***	-.01 **	-.07 ***	-.07 ***
Owners	.02 ***	.02 ***	.02 ***	.05 ***	.05 ***
Employees	.01 †	.04 ***	.03 ***	.06 ***	.06 ***
Gender: Female	-.01	.01	.02 *	-.06 ***	-.06 ***
Age of entrepreneur	-.01 ***	-.02 ***	-.02 ***	-.01 *	-.01 *
Education	.04 ***	.03 ***	.04 ***	.03 ***	.03 ***
Self-efficacy	.01 **	.00	.00	.03 ***	.03 ***
Opportunity assessment	.00	.00	.00	.02 *	.02 *
Risk-willingness	.00	.00	.00	.01 *	.01 *
Networking	.00	.03 ***	.03 ***	.04 ***	.04 ***
GDP per capita	.04 †	.01	.01	.08 †	.08 †
Country	yes	yes	yes	yes	yes
Intercept	.40 ***	.41 ***	.40 ***	-.12 **	-.11 **

Hierarchical linear modeling, with random effect of Country

For sector, the reference is the consumer-oriented sector, that other sectors are compared to.

The dependent variables are standardized.

The numerical national-level independent variables are standardized.

The numerical individual-level variables are standardized and centered within country.

The dichotomous variables are 0 and 1 dummies.

† p<.10   \* p<.05   \*\* p<.01   p<.001

End