



# Assessing the role of FinTech in entrepreneurial ecosystems at the international level

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Accepted: 16 January 2024 / Published online: 21 February 2024

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## Abstract

The goal of the present research was to assess the role of FinTech progress in the enhancement of entrepreneurial ecosystems at the country level for ten European countries within four-time intervals of 2011, 2014, 2017, and 2021. Thus, the research plan involved an empirical approach that utilized twenty-five and six variables to create the consolidated EE and FinTech indices, respectively. The results revealed significant positive correlations between FinTech (financial and technological dimensions) and EE in all selected countries, exposing the overall effective role of the FinTech index in the EE framework during 2011–2021. This result supported two research hypotheses, revealing that high values of progress in the financial and technological dimensions of FinTech can enhance the EEs in European countries. Additionally, the results revealed the effective role of the FinTech index in the enhancement of EEs through the three enhancing EE elements of “networks”, “demand”, and “intermediate services”, supporting the third research hypothesis. According to our results, the overall status of FinTech in all European countries accelerated from 2011 to 2021. Additionally, the enhancement of the EE in European countries in recent years has transferred from formal and cultural components to technological networks and services. Hence, the technological dimension of FinTech can be defined as a driving power of economic growth in the study area and should be considered in economic programs and revisions of EE structures.

**Keywords** Entrepreneurial ecosystem (EE) · FinTech · Financial and technological dimensions · Correlation tests · European countries

## Introduction

An entrepreneurial ecosystem (EE) is an interaction system that consists of hierarchical ecosystem actors to support entrepreneurship (Autio, 2016). An EE represents a holistic approach to entrepreneurship through a focus on high-growth firms with a

bulk of new job creation, innovation systems, and social networks (Acs et al., 2017; Spigel, 2022; Spigel & Harrison, 2018). Hence, it can be assumed to be a balanced system between an interdependent subject and an entrepreneurial environment for gaining productive entrepreneurship (Feld, 2020; Lu et al., 2021; Szerb et al., 2019). A literature review on the EE concept revealed that it is an interaction of interrelated factors in entrepreneurial firms (e.g., Frimanslund, 2022; Liguori et al., 2019; Stam, 2018; Vedula & Kim, 2019). Additionally, the EE framework should be defined as a set of interdependent actors and factors coordinated in such a way as to enable productive entrepreneurship (Stam & Spigel, 2016). EEs can be considered the fuel of local economic vibrancy and national economic progress through the creation of fertile environments for new and developing businesses (Nieuwenhuizen et al., 2022). However, the problem in this approach is finding a driving power to enhance the set of EE frameworks in each economic sector. Hence, the progress of new approaches must be elaborated to enhance EE frameworks.

Recent developments in technologies and the spread of financial methodologies have focused on entrepreneurship sets, particularly when paired with the spatial affordances within EEs (Autio et al., 2018; Spigel, 2022). In this regard, using new digital technologies to solve setting problems and reduce costs in the financial services sector of entrepreneurship has been developed under the term FinTech (Dhar & Stein, 2017), which is a generic and specific knowledge and resource in each ecosystem. FinTech is developed to reduce information asymmetry and progress entrepreneurship in financial markets, which involves technological innovations from firm to country levels (Sheng, 2021; Su & Xu, 2023). Firms should benefit from an EE, supported by FinTech, so that technical knowledge can flow into the finance sector of businesses (Spigel, 2022). Understanding the link between EE attributes and the financial-technological components of FinTech is important for ensuring the most favourable conditions for developing finance and entrepreneurship, which can lead to economic growth in a particular territory (Koroleva, 2022; Nicotra et al., 2018). As mentioned by Isenberg (2010), finance is a relevant dimension of an EE, and progress in FinTech could enhance and support the outputs or elements of EEs. However, this link and support should be further addressed in research studies to explore hidden interactions through company firms.

As mentioned by Klimas and Czakon (2022) and Bouncken and Kraus (2022), despite the rapid growth of the EE literature, the EE structural models lack the relevant connecting components. For instance, there are numerous unknowns and unexplored areas relating to the research gap around connecting FinTech to EE or their elements and attributes Spigel (2022). Scott et al. (2022) also revealed that we need to define new information on the factors that influence the development and evolution of an EE. Furthermore, there are few existing studies on the new perspective of the FinTech framework in ecosystems (You et al., 2023). Based on the extant knowledge (see Autio et al., 2018; Spigel & Harrison, 2018; Spigel, 2022), there is no measurement tool for EE elements to correlate with the financial and technological attributes of FinTech through the entrepreneurship environment in country-level studies. Hence, this study attempts to fill this gap in the context of European countries.

On this basis, we propose a research question: Do FinTech attributes have significant positive associations with EE elements at the country level? This question

can be extended across the main elements of EEs (25 variables into ten components) and FinTech (6 variables in two dimensions of financial and technical), which are derived from small and medium-sized enterprises (SMEs) in each country.

To answer this research question, the research plan involves an empirical approach of the linear constant regression model, which uses 25 and 6 variables to create consolidated EE and FinTech elements and attributes, respectively. The current research attempts to contribute to a better understanding of the effects of FinTech in EEs. Some scholars have focused on the EE frameworks with different views (e.g., Leendertse et al., 2021; Mateos & Amorós, 2019; Stam & van de Ven, 2019). Additionally, there are several studies about the initial concept of FinTech (e.g., Gai et al., 2018; Molla & Biru, 2023; Nambisan, 2017; Spigel, 2022). However, the effects of FinTech on the EE concept have not been simultaneously analysed in previous research. Hence, the goal of the present research is to assess the role of FinTech progress in the enhancement of entrepreneurial ecosystems (EEs) at the country level for 10 European countries within 4 time series of 2011, 2014, 2017, and 2021.

Our research suggests that a linear regression model be used to investigate the relations between the FinTech index (including two dimensions) and EEs (including ten components). This macrolevel or country-level model can represent professional findings through effective financial and technological factors and relations, improving the entrepreneurial ecosystems of each European country. Our paper provides at least two main contributions. First, we empirically test the relationships between EE elements and FinTech attributes at the country level. Hence, our findings can support the literature in assessing the relations and factors by highlighting measurable factors and methods (e.g., Frimanslund, 2022; Liguori et al., 2019; Stam, 2018; Vedula & Kim, 2019). Moreover, this research can contribute to the literature by enhancing entrepreneurial ecosystems using FinTech characteristics (see Feldman, 2014; Feldman & Lowe, 2015; Spigel, 2022).

The remainder of this paper is structured as follows. The theoretical background, literature review, and research hypotheses regarding entrepreneurial ecosystem elements and financial and technological attributes are developed in the “[Introduction](#)” and “[Literature review and hypothesis development](#)” sections. The study area, data collection, and analysis approaches are defined in the “[Data and methods](#)” section. Then, a reanalysis of variables and a statistical interpretation of the tables and correlation tests, in addition to the comparative discussion using previous research, are described in the “[Results](#)” and “[Discussion](#)” sections. Finally, a set of conclusions, theoretical and managerial implications, research limitations, and future recommendations are described in the “[Conclusion and implications](#)” section.

## Literature review and hypothesis development

### Entrepreneurial ecosystem elements (EE)

In recent literature, EE is focused on the relationships between a series of individual/organizational and economic/social factors to support the growth of scale-up

entrepreneurship (Audretsch & Belitski, 2017; Spigel, 2022; Stam, 2015). Some scholars have emphasized the importance of interconnectedness and interacting components between different actors and processes to define the EE framework (Audretsch & Belitski, 2017; Bruns et al., 2017; Mack & Mayer, 2016; Mason & Brown, 2014; Rocha et al., 2022). EE is commonly defined as a set of actors and factors that are coordinated in such a way as to enable productive international entrepreneurship (Molla & Biru, 2023). Although there is no universal approach to classifying the attributes of EEs, various scholars (e.g., Isenberg, 2010; Spigel, 2017; Stam, 2015) have tried to create classifications and tools for measuring these ecosystems. Initially, Isenberg (2010) introduced the EE framework, which included six domains of policy, finance, markets, human capital, support, and culture (Molla & Biru, 2023; Spigel, 2017). In another study, Koroleva (2022) summarized EE attributes based on a content analysis of a literature review in the field of EE elements and domains, including 10 attributes of formal institutions, entrepreneurship culture, networks, physical infrastructure, finance, leadership, talent, new knowledge, demand, and intermediate services. Unlike the previous studies that only focused on EE elements, such as that by Isenberg (2010), Koroleva (2022) considered the EE variables adhering with the FinTech content and qualitative contributions. Hence, in our research, his classification of EE is used to define EE components and variables, which are more coordinated with measurable FinTech content.

### Financial and technological attributes (FinTech)

Simply defined, FinTech refers to the use of new digital technologies such as artificial intelligence (AI), smartphone apps, or machine learning to provide higher-value solutions in the financial service sector (Gai et al., 2018; Spigel, 2022). FinTech is now an innovative way to apply technology to improve financial activities (Schueffel, 2017). It can be used to create new models, businesses, processes, and products, with a significant impact on financial markets (Goldstein et al., 2019; You et al., 2023). Some papers have addressed FinTech as a positive development of innovative technologies in the financial sector to provide service processes, risk assessment, and new information collection (Berg et al., 2020; Fuster et al., 2019; Goldstein et al., 2019; Guo & Zhang, 2023). According to the international entrepreneurial framework, FinTech can revolve around the use of digital infrastructure, platforms, and artefacts (Molla & Biru, 2023; Nambisan, 2017) in the market with new, clever, and user-friendly financial services (Arner et al., 2016; Haddad & Hornuf, 2019; Su & Xu, 2023).

### Hypothesis development

The main research gap in the literature involves the numerous unknowns and unexplored areas related to connecting financial and technological factors to EE attributes. For an EE to be successful, financial and technological resources need to be reliably injected (Roundy et al., 2018; Spigel, 2017). Conversely, funding

and technical gaps can damage the advancement of entrepreneurial firms (Alvi & Ulrich, 2023; Block et al., 2018; Cumming et al., 2019;). However, the attention of the European government to enhancing the level of technologies in EEs is clearly observed, particularly as this plays a major role in the creation of new ventures and in providing support to innovative startups (Cavallo et al., 2018, 2019).

Based on previous works, FinTech provides a useful way to understand the significant dynamics and structures of an EE (Spigel, 2022). Additionally, FinTech is a vibrant industry for the innovation and implementation of digitalization in EEs (Gazel & Schwienbacher, 2021). Thus, the two following essential hypotheses could be retained:

H.1: High values of progress in the financial dimension of FinTech can enhance EEs in European countries.

H.2: High values of progress in the technological dimension of FinTech can enhance EEs in European countries.

We argue that higher values of progress in the financial and technological dimensions on a country level tend to enhance EE elements. In this regard, we anticipate that the effective role of the FinTech index in the enhancement of EE could be shaped through the enhancement of some technological EE elements, such as technological networks and services. Huarng and Yu (2022) noted that the combination of high values of innovation, technology, and entrepreneurship could lead to high fintech adoption in each economy. Additionally, as mentioned by Sheng (2021) and Su and Xu (2023), FinTech involves progressive entrepreneurship using technological innovations at the country level.

In this regard, innovative EEs can offer solutions to entrepreneurial problems and benefit businesses, contributing to country-level economic growth (Hossain et al., 2017). FinTech EEs may also change an organization, which leads to a change in the relevant set of exploitable opportunities, providing a competitive advantage in generating new business performance (Miles et al., 2009). Hence, the third hypothesis could be retained:

H.3: High values of progress in the FinTech index can enhance some technological EE elements, such as “networks”, “demand”, and “intermediate services”.

According to a systematic literature review on EE and networks (Fernandes & Ferreira, 2022), networks can improve the functioning, configuration, evolution, growth, performance, and resilience of EEs, contributing to the emergence of highly innovative ventures. Furthermore, the networks in EEs can determine the achievement levels and can minimize any potential weakness of the experiences or resources (Kuschel et al., 2017; McAdam et al., 2019; Motoyama & Knowlton, 2017; Theodoraki et al., 2018). Regarding the abovementioned hypotheses, correlation tests are used to examine the relationships between the independent variables of FinTech (two dimensions) and the EE index.

## Data and methods

### Study area

The research study areas were selected from European countries based on the registered and accessed data in the Small Business Act for Europe (SBA, 2022) dataset. Thus, we could obtain a list of ten countries that had entrepreneurial information at the country level, at least within four time intervals of 2011, 2014, 2017, and 2021. The ten countries include France, Germany, Greece, Italy, Netherlands, Poland, Portugal, Spain, Sweden, and the United Kingdom (UK) (Table 1). The total population of the selected countries is estimated to equal 410.98 M in 2021, which accounts for 54% of the total population of the EU region (World Bank, 2022). These countries also have an average rate of technicians in R&D SMEs of nearly 1400 per million people (in 2017), while this rate in the EU region was observed to be nearly 800 per million people (World Bank, 2022). These statistics highlight the higher technical level of R&D in these countries compared with that of the other countries in the EU region.

### Data preparation

For this study, the research plan involves an empirical approach that utilizes 25 and 6 variables to create the consolidated EE and FinTech indices, respectively. The EE variables are obtained from the Small Business Act for Europe (SBA, 2022) dataset, which is the European source of financial data extracted from SMEs (with 10 to 250 employees) via [https://single-market-economy.ec.europa.eu/smes/sme-strategy\\_en](https://single-market-economy.ec.europa.eu/smes/sme-strategy_en). The FinTech variables are obtained from the Global Findex Database (GFD, 2022), which is the definitive source of global data on financial and technical services from the World Bank via: <https://www.worldbank.org/en/publication/globalfindex/Data>.

The components and variables of EE and FinTech have been studied in previous studies, such as that by Koroleva (2022). In this regard, entrepreneurial ecosystem attributes are classified into ten main components: [1] formal institutions, [2]

**Table 1** Population profile of 10 selected European countries in 2021 (after World Bank, 2022)

Country Name	Population (million)
France	67.06
Germany	83.13
Greece	10.72
Italy	60.3
Netherlands	17.33
Poland	37.97
Portugal	10.27
Spain	47.08
Sweden	10.29
United Kingdom	66.83
Sum	410.98

entrepreneurship culture, [3] physical infrastructure, [4] demand, [5], networks, [6] leadership, [7] talent, [8] finance, [9] new networks, and [10] intermediate services. We attempt to adapt approximately 25 SME-based variables into these ten components. The main definition of these 25 variables based on the SBA (2022) dataset and the methodological assessment report of Pedraza and Katsinis (2022) upon monitoring SMEs' performance in Europe is shown in Table 2. In addition, the fin-tech index is defined as having two dimensions, financial (3 variables of financial institution accounts, received financial wages, and saved money at financial institutions) and technical (3 variables of making a digital technology payment, making a technological utility payment, and innovative technology), as shown in Table 3 (see GFD, 2022).

## Data analysis

In this research, a linear regression model (Pearson test) is utilized to investigate relations between the FinTech index (mean values of two dimensions) and the EE index (mean values of ten components). This macrolevel or country-level model can represent professional findings through effective financial and technological factors and relations, thus improving the entrepreneurial ecosystems of each European country. Ultimately, the research model implicitly is drawn as shown in Fig. 1. In this regard, the relations between the FinTech index (including two dimensions) and EE (including ten components) are investigated.

## Results

### Interpretation of the tables

As shown in Tables 4 and 5, we can estimate the values of ten dimensions of EE and two dimensions of FinTech to initially classify the European countries. In this regard, the integrated values of the EE index and FinTech index based on the mean values of the constructive variables are shown in Tables 6 and 7. On this basis, the countries with the highest EE index (above approximately 29–30) were recognized as different clusters in the two time periods 2011–2014 and 2017–2021. In this regard, Germany and the Netherlands had the most advanced EE frameworks in the study area during 2011–2014, while the UK had the frontier EE frameworks during 2017–2021. Based on the EE attributes, the components of “formal institutions” and “entrepreneurship culture” had main roles in the progression of EE in Germany and the Netherlands, while the effective components in the development of EE in the UK are assumed to be “networks”, “demand”, and “intermediate services”. These observations revealed that the enhancement of EE in recent years transferred from formal and cultural components to technological networks and services in European countries. As shown in Fig. 2, the overall status of the EE index in all European countries did not accelerate from 2011 to 2021, and its trend changed between 22 and 30. For instance, the index of the EE framework in Italy represented a sharp decline in 2021 compared with the last time intervals.

**Table 2** Definition of 25 SME-based variables to construct ten components of entrepreneurial ecosystems (after SBA, 2022)

Component	Variable	Definition
Formal institutions	SMEs introducing product innovations (%)	Percentage of SMEs who introduced at least one product innovation either new to the enterprise or new to their market. Higher shares of product innovators reflect a higher level of innovation activities.
	SMEs introducing business process innovations (%)	Percentage of the SMEs who introduced at least one business process innovation either new to the enterprise or new to their market.
	Strength of legal rights index (0–12)	Business process innovations include process, marketing and organizational innovation. This index measures the degree to which collateral and bankruptcy laws protect the rights of borrowers and lenders and thus facilitate lending. The index ranges from 1 to 12, with higher scores indicating that collateral and bankruptcy laws are better designed to expand access to credit.
Entrepreneurship culture	Improvement-Driven Opportunity Entrepreneurial Activity (%)	Percentage of actions involved in total entrepreneurial activity (TEA) driven by opportunities to be independent or increase their income, rather than just maintaining their income.
	Entrepreneurship as Desirable Career Choice (%)	Percentage of 18–64 population who agree with the statement that in their country, most people consider starting a business as a desirable career choice.
	High-status to successful entrepreneurship (%)	Percentage of 18–64 age group who agree with the statement that in their country successful entrepreneurs receive high status.
Physical infrastructure	Established Business Ownership Rate (%)	Percentage of 18–64 population who are currently owner-manager of an established business, i.e., owning and managing a running business that has paid salaries, wages, or any other payments to the owners for more than 42 months.
	Enterprises having access internet (%)	Percentage of enterprises with having internet access from total surveyed SMEs.

Table 2 (continued)

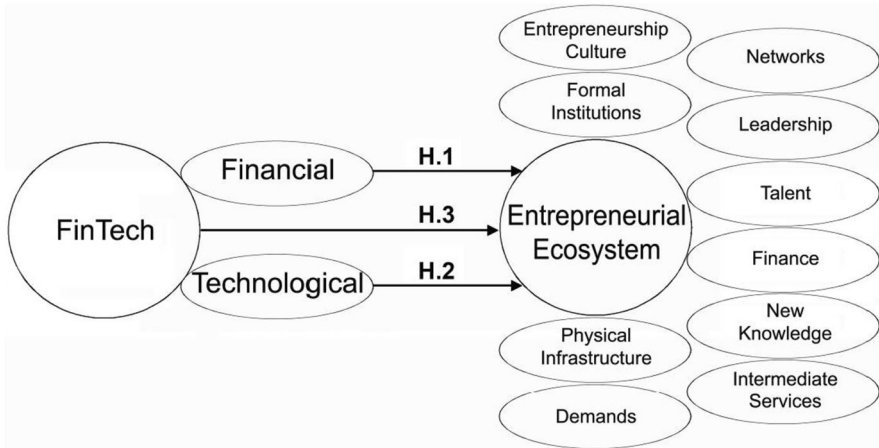
Component	Variable	Definition
Demand	Turnover from e-commerce (%)	Percentage of the SMEs with having turnover from e-commerce part, including all manufacturing and service sectors.
	Share of SMEs selling online (%)	Percentage of the SMEs with sales during the previous calendar year, via any computer networks (websites and other means of electronic data transfer), at least 1% of the total turnover value.
Networks	Innovative SMEs collaborating with others (%)	This indicator measures the degree to which SMEs, are involved in innovation cooperation and activities with other enterprises or institutions (percent of total SMEs).
	SMEs having done electronic sales to the rest of the world (%)	Percentage of the SMEs with electronic sales to countries outside the EU, via any computer networks (websites and other means of electronic data transfer).
Leadership	SMEs' share in the total value of public contracts awarded (%)	Percentage of the SMEs sharing in the total value of contracts awarded by Member State (only contracts above threshold levels).
	Total aid earmarked for SMEs (%)	Total aid earmarked for SMEs including risk capital (% of total aid earmarked for horizontal objectives of common interest).
	Percentage of calls for competition (%)	The proportion of tenders that have been divided into lots that in the SMEs can allow companies to make an offer.
Talent	Cost to resolve insolvency (%)	The cost of the proceedings is recorded as a percentage of the value of the debtor's estate. The cost is calculated on the basis of the survey responses and includes court fees and government levies, fees of insolvency administrators, auctioneers, assessors and lawyers.
	Fear of failure rate (%)	Percentage of 18–64 population with positive perceived opportunities who indicate that fear of failure would prevent them from setting up a business.
	Strength of insolvency framework index (0–16)	The strength of the insolvency framework index is the sum of the scores of some underlying indices, ranging from 0 to 16. Higher values indicate insolvency legislation is better designed for rehabilitating viable firms and liquidating nonviable ones.

Table 2 (continued)

Component	Variable	Definition
Finance	Depth of credit information index (0–8)	This index measures rules and practices affecting the coverage, scope and accessibility of credit information available through either a public registry or a private credit bureau, ranging from 0 to 8. Higher values indicate the availability of more credit information, from either a credit bureau or a credit registry, to facilitate lending decisions.
	Access to public financial support including guarantees (%)	Percentage of the SMEs with access to public financial support including guarantees, improved over the past six months.
New knowledge	Willingness of banks to provide a loan (%)	Percentage of the SMEs with access to willingness of banks to provide a loan (lender's attitude), improved over the past six months.
	Percentage of enterprises employing persons with ICT specialist skills (%)	Percentage of the SMEs with total employees that have ICT specialist skills.
	Environmental technologies (%)	Percentage of the SMEs with a wide range of environment-related technological inventions and domains, including environmental management, water-related adaptation, and climate change mitigation technologies.
Intermediate services	Enterprises having website-homepage (%)	Percentage of enterprises that have a website (percent of total SMEs).
	Online availability of info for business mobility (%)	Percentage of the SMEs with an available online public service (or information concerning service).

**Table 3** Definition of 6 FinTech dimensions and variables (after GFD, 2022)

Dimension	Variable	Definition
Financial	Financial institution accounts (0–1)	Percentage of the SMEs with employees who report having an account at a bank or another type of financial institution, ranging from 0 to 1.
	Received financial wages from public, private, and government (0–1)	Percentage of the SMEs with employees who report receiving any money from an employer (public, private, or government) in the past year in the form of a salary or wages for doing work.
	Saved money at a financial institution (0–1)	Percentage of the SMEs with employees who report personally saving or setting aside any money for any reason and using any mode of saving in the past year.
Technical	Making a digital technology payment (0–1)	Percentage of the SMEs with employees who report using a mobile phone to make an in-store purchase.
	Making a technological utility payment (0–1)	Percentage of the SMEs with employees who report personally making regular payments for technological affairs of water, electricity, or trash collection in the past year.
	Innovative technology (0–1)	Percentage of the SMEs with investment or activity, at least in one field of the high and new technologies (including smart and digital) in the past year.



**Fig. 1** Estimate model

From the FinTech viewpoint, we observed that Sweden is a unique country during time intervals (2011–2021), with the highest FinTech index of 0.75–0.79. In the next levels, Germany, the UK, and the Netherlands have the highest values (0.70–0.75) during the time periods. It seems that the high FinTech of Sweden is related to the high financial dimension, while in the other abovementioned countries, the technological dimension is the effective attribute of FinTech. Based on Fig. 3, the overall status of FinTech in all European countries accelerated from 2011 to 2021 (from a mean index of 0.64 to 0.71).

### Analysis of the correlation tests

The correlation test method is a reliable method in the research field of EE and FinTech (see Koroleva, 2022; Nugraha et al., 2022; Stephens et al., 2022). Using the Pearson test, the correlation coefficients were calculated, as shown in Table 8. For this purpose, the standardized mean values of FinTech and EE subjects were estimated to average in ten countries based on four time intervals from 2011 to 2021 (N=40). On this basis, we analysed the Pearson correlation test between the dependent variable of FinTech (financial and technological dimensions) and the independent variable of the EE index. The constant correlation results revealed significant positive correlations at the confidence level of 98% (R from 0.38 to 0.41, Sig.<0.02) between FinTech (financial and technological dimensions) and EEs in all selected countries, revealing the overall effective role of the FinTech index in the EE framework during 2011–2021.

In a detailed analysis, the correlation tests between the FinTech index and ten elements of EE were estimated in Table 9, revealing significant positive relationships between the FinTech index and five EE elements of “networks”, “demand”, and “intermediate services” during the time period of 2011–2021 at the 99% confidence level (R from 0.55 to 0.76, Sig.<0.01). This result confirmed the effective

**Table 4** EE components and variables

Country	Year	Formal institutions			Entrepreneurship culture			Physical infrastructure			Demand		Networks	
		SMEs introducing product innovations	SMEs introducing business process innovations	Strength of legal rights index	Improvement-Driven Opportunity Entrepreneurial Activity	Entrepreneurship as Desirable Career Choice	High-status to successful entrepreneurship	Established Business Ownership Rate	Enterprises having access internet	Turnover from e-commerce	Share of SMEs selling online	Innovative SMEs collaborating with others	SMEs having done electronic sales to the rest of the world	
France	2011	22.8	40.0	5	70.7	65.8	68.0	2.4	52	7.7	10.0	11.1	3.3	
France	2014	22.8	40.0	4	69.2	59.1	70.4	2.9	52	9.4	11.1	11.5	5.2	
France	2017	26.2	41.6	4	61.5	59.1	74.2	3.6	46	11.1	15.8	13.2	4.6	
France	2021	31.8	39.0	4	63.7	58.2	71.5	2.5	41	11.9	12.9	13.5	4.0	
Germany	2011	34.5	35.8	7	54.9	55.0	78.4	5.6	41	10.3	21.4	14.0	4.9	
Germany	2014	34.5	35.8	6	53.7	51.7	79.1	5.2	41	9.5	21.9	11.5	4.7	
Germany	2017	33.0	36.8	6	59.9	51.3	77.9	6.1	24	11.4	23.5	10.1	7.1	
Germany	2021	38.7	54.2	6	52.8	54.9	81.8	6.2	16	10.6	17.2	15.0	4.8	
Greece	2011	19.0	43.2	3	36.8	61.0	69.1	15.8	36	3.0	5.7	12.4	3.4	
Greece	2014	19.0	43.2	2	30.5	58.4	66.4	12.8	36	3.0	9.1	12.4	2.4	
Greece	2017	22.8	41.4	2	37.0	63.4	66.5	12.4	20	3.4	10.7	14.8	4.5	
Greece	2021	41.8	54.5	2	47.4	69.5	70.3	14.6	13	4.0	9.2	20.6	2.8	
Italy	2011	28.6	44.6	3	54.6	69.1	69.3	3.7	62	2.9	3.8	4.4	2.0	
Italy	2014	28.6	44.6	2	38.6	65.1	72.1	4.3	62	4.8	5.1	4.8	3.4	
Italy	2017	24.0	35.4	2	35.2	64.2	73.2	6.0	40	5.8	7.9	6.7	3.8	
Italy	2021	36.0	53.4	2	31.2	19.0	13.1	2.2	25	9.3	11.3	14.4	4.4	
Netherlands	2011	31.6	32.4	5	62.3	83.4	67.2	8.7	23	8.7	19.1	14.9	3.8	
Netherlands	2014	31.6	32.4	2	62.8	79.1	67.8	9.6	23	6.5	13.0	14.5	4.2	
Netherlands	2017	31.8	35.5	2	72.6	81.0	67.5	8.6	14	9.5	15.3	17.5	4.6	

**Table 4** (continued)

Country	Year	Formal institutions			Entrepreneurship culture			Physical infrastructure			Demand		Networks	
		SMEs introducing product innovations	SMEs introducing business process innovations	Strength of legal rights index	Improvement-Driven Opportunity Entrepreneurial Activity	Entrepreneurship as Desirable Career Choice	High-status to successful entrepreneurship	Established Business Ownership Rate	Enterprises having internet access	Turnover from e-commerce	Share of SMEs selling online	Innovative SMEs collaborating with others	SMEs having done electronic sales to the rest of the world	
Netherlands	2021	26.8	39.4	2	69.3	85.8	76.4	7.0	10	12.6	18.8	14.5	5.2	
Poland	2011	8.1	16.4	9	31.5	72.9	64.4	5.0	46	3.5	8.4	4.2	1.8	
Poland	2014	8.1	16.4	7	47.1	63.3	56.5	7.3	46	6.6	9.3	3.9	1.8	
Poland	2017	8.4	14.9	7	67.6	79.3	67.7	9.8	27	6.6	9.5	3.5	1.8	
Poland	2021	12.2	17.3	7	55.1	59.9	60.1	12.2	19	6.6	13.3	4.3	2.7	
Portugal	2011	24.9	46.0	3	58.1	67.5	70.5	5.7	30	9.9	15.3	8.1	2.9	
Portugal	2014	24.9	46.0	2	49.3	62.2	62.9	7.6	30	10.7	13.5	6.8	4.9	
Portugal	2017	27.6	43.9	2	55.8	68.8	63.4	7.1	16	13.1	17.3	7.8	5.8	
Portugal	2021	27.2	31.6	2	55.8	72.7	71.7	11.0	13	15.5	18.9	7.8	6.1	
Spain	2011	9.7	24.6	6	39.3	65.2	66.5	8.9	45	5.9	10.7	5.8	2.1	
Spain	2014	9.7	24.6	5	33.5	53.9	49.0	7.0	45	8.1	16.3	6.0	2.9	
Spain	2017	10.3	26.9	5	48.2	53.8	47.9	7.1	29	10.1	19.6	6.7	4.2	
Spain	2021	13.8	22.9	5	43.8	56.7	61.1	6.7	15	9.6	24.3	7.0	4.6	
Sweden	2011	30.6	33.8	9	67.6	51.8	70.8	7.0	30	10.6	23.6	17.5	4.8	
Sweden	2014	30.6	33.8	7	56.2	51.6	70.9	6.5	30	13.6	23.8	12.7	5.5	
Sweden	2017	30.6	33.8	7	44.8	53.6	70.5	4.2	13	15.0	28.5	13.5	6.1	
Sweden	2021	41.8	47.3	7	40.9	62.7	78.7	6.0	5	15.1	30.5	15.4	6.1	
UK	2011	23.8	30.2	1	46.3	51.9	81.0	7.2	39	7.1	14.0	25.2	5.3	
UK	2014	23.8	30.2	7	52.7	60.3	75.0	6.5	39	8.4	19.1	22.4	7.0	
UK	2017	26.4	37.0	7	60.8	55.6	75.6	6.7	23	9.3	19.2	24.7	6.8	
UK	2021	24.9	17.7	7	48.2	69.6	77.1	6.5	13	11.1	26.5	23.6	5.9	

Table 4 (continued)

Country	Year	Leadership			Talent		Finance		New knowledge			Intermediate services		
		SMEs' share in the total value of public contracts awarded	Total aid earmarked for SMEs	Percentage of calls for competition	Cost to resolve insolvency	Fear of failure rate	Strength of insolvency framework index	Depth of credit information index	Access to public financial support including guarantees	Willingness of banks to provide a loan	Percentage of enterprises employing persons with ICT specialist skills	Environmental technologies	Enterprises having website-homepage	Online availability of info for business mobility
France	2011	48.7	10.6	39.5	9	37.1	10.5	4	28.5	33.2	13.5	13.4	59	47
France	2014	34.8	7.3	40.9	9	41.2	11	6	31.6	27.4	13.2	12.5	63	63
France	2017	37.9	8.1	42.4	9	39.1	11	6	13.0	14.1	15.7	10.5	66	70
France	2021	37.9	1.4	43.0	9	36.7	11	6	9.0	11.0	16.4	14.5	70	100
Germany	2011	59.1	7.6	18.9	8	42.0	15	6	10.6	15.9	16.4	14.4	81	92
Germany	2014	56.8	2.1	18.9	8	40.0	15	8	13.0	15.8	20.2	12.6	85	93
Germany	2017	64.2	2.3	19.5	8	36.3	15	8	7.4	9.0	17.1	11.3	87	60
Germany	2021	64.2	1.5	17.9	8	38.4	15	8	9.3	13.4	17.4	17.5	88	100
Greece	2011	71.7	1.3	16.2	9	37.8	10	5	25.8	46.4	33.7	20.1	63	10
Greece	2014	42.8	1.7	31.2	9	61.6	11.5	7	39.4	37.2	23.6	11.8	61	7
Greece	2017	92.5	0.2	40.3	9	55.5	11.5	7	32.7	21.4	19.4	12.6	64	50
Greece	2021	92.5	3.7	39.2	9	62.8	11.5	7	21.8	26.0	18.4	8.3	60	50
Italy	2011	31.6	19.3	21.3	22	36.8	12	5	13.4	28.0	13.2	11.0	62	57
Italy	2014	64.3	7.5	23.1	22	49.1	13.5	7	35.6	33.2	14.2	10.1	69	77
Italy	2017	14.4	20.1	27.8	22	49.4	13.5	7	12.8	11.2	15.2	9.1	72	60
Italy	2021	14.4	10.7	27.8	22	27.1	13.5	7	17.7	12.1	11.6	9.1	73	100
Netherlands	2011	35.5	1.6	14.8	3.5	35.1	11.5	4	32.2	32.9	11.6	11.7	82	96
Netherlands	2014	65.7	1.2	22.4	3.5	34.8	11.5	6	20.9	36.6	25.1	9.0	90	93
Netherlands	2017	49.9	1.7	19.3	3.5	29.7	11.5	6	5.9	13.9	25.0	8.7	85	60

**Table 4** (continued)

Country	Year	Leadership		Talent		Finance		New knowledge			Intermediate services			
		SMEs' share in the total value of public contracts awarded	Total aid earmarked for SMEs	Percentage of calls for competition	Cost to resolve insolvency	Fear of failure rate	Strength of insolvency framework index	Depth of credit information index	Access to public financial support including guarantees	Willingness of banks to provide a loan	Percentage of enterprises employing persons with ICT specialist skills	Environmental technologies	Enterprises having website-homepage	Online availability of info for business mobility
Netherlands	2021	49.9	3.0	16.4	3.5	37.4	11.5	7	18.0	28.6	22.9	8.7	84	60
Poland	2011	41.1	0.6	43.5	15	42.9	12.5	6	15.0	14.6	12.2	12.3	64	24
Poland	2014	51.8	0.1	43.4	15	51.1	12.5	8	13.7	9.2	8.3	13.9	65	52
Poland	2017	66.0	2.0	47.1	15	34.4	14	8	8.6	6.6	10.2	9.9	66	50
Poland	2021	66.0	1.4	45.5	15	40.3	14	8	13.1	16.4	23.2	9.9	71	60
Portugal	2011	36.0	4.4	17.7	9	39.6	14.5	5	22.5	35.6	27.9	12.9	53	100
Portugal	2014	43.2	6.3	17.0	9	38.4	14.5	7	26.8	16.6	17.9	7.0	53	100
Portugal	2017	5.9	15.6	22.5	9	38.1	14.5	7	9.2	9.4	18.4	10.6	64	60
Portugal	2021	5.9	23.0	35.8	9	52.8	14.5	7	16.6	16.4	18.3	10.6	61	60
Spain	2011	43.5	2.6	18.8	11	38.9	12	5	44.4	50.0	21.3	14.6	64	51
Spain	2014	20.3	2.5	20.5	11	38.0	12	7	30.7	24.3	23.4	12.8	72	50
Spain	2017	29.5	2.4	23.9	11	39.2	12	7	10.2	7.0	19.7	9.9	76	100
Spain	2021	29.5	2.2	31.9	11	64.0	12	7	22.7	15.3	15.6	9.9	75	100
Sweden	2011	22.6	0.1	3.3	9	34.6	12	4	3.1	8.6	20.7	11.4	89	77
Sweden	2014	5.9	0.0	2.6	9	36.5	12	5	5.2	9.4	18.6	14.0	89	100
Sweden	2017	22.9	0.5	4.8	9	36.7	12	5	2.6	5.2	18.9	11.6	91	80
Sweden	2021	22.9	1.2	5.9	9	46.4	12	5	6.2	18.0	19.5	11.6	90	80
UK	2011	18.1	17.0	23.3	6	36.1	11	6	23.4	22.7	28.6	13.2	78	81
UK	2014	22.8	18.6	24.8	6	36.8	11	8	8.9	16.0	22.6	11.7	79	89
UK	2017	39.4	12.5	27.3	6	35.9	11	8	11.4	8.0	20.4	10.7	83	100
UK	2021	39.4	7.7	28.1	6	56.2	11	8	11.7	12.7	27.8	10.7	83	100

**Table 5** FinTech dimensions and variables

Country	Year	Financial		Technical			
		Financial institution accounts	Received financial wages from public, private, and government	Saved money at a financial institution	Making a digital technology payment	Making a technological utility payment	Innovative technology
France	2011	0.97	0.54	0.50	0.93	0.83	0.40
France	2014	0.97	0.54	0.52	0.93	0.83	0.48
France	2017	0.94	0.56	0.48	0.92	0.82	0.50
France	2021	0.99	0.40	0.54	0.98	0.86	0.52
Germany	2011	0.98	0.51	0.56	0.96	0.87	0.40
Germany	2014	0.99	0.51	0.58	0.96	0.87	0.45
Germany	2017	0.99	0.60	0.55	0.98	0.88	0.47
Germany	2021	1.00	0.55	0.57	0.99	0.92	0.48
Greece	2011	0.78	0.29	0.20	0.61	0.81	0.50
Greece	2014	0.88	0.29	0.13	0.61	0.81	0.61
Greece	2017	0.85	0.38	0.13	0.74	0.71	0.60
Greece	2021	0.95	0.42	0.26	0.91	0.76	0.58
Italy	2011	0.71	0.37	0.15	0.73	0.81	0.45
Italy	2014	0.87	0.37	0.34	0.73	0.81	0.55
Italy	2017	0.94	0.48	0.45	0.90	0.82	0.57
Italy	2021	0.97	0.36	0.49	0.96	0.80	0.53
Netherlands	2011	0.99	0.62	0.58	0.98	0.72	0.41
Netherlands	2014	0.99	0.62	0.59	0.98	0.72	0.50
Netherlands	2017	1.00	0.63	0.59	0.98	0.71	0.49
Netherlands	2021	1.00	0.58	0.66	0.99	0.70	0.44
Poland	2011	0.70	0.46	0.18	0.65	0.73	0.38
Poland	2014	0.78	0.46	0.21	0.65	0.73	0.47

Table 5 (continued)

Country	Year	Financial		Technical			
		Financial institution accounts	Received financial wages from public, private, and government	Saved money at a financial institution	Making a digital technology payment	Making a technological utility payment	Innovative technology
Poland	2017	0.87	0.57	0.33	0.82	0.68	0.45
Poland	2021	0.96	0.57	0.36	0.93	0.83	0.38
Portugal	2011	0.81	0.37	0.26	0.75	0.81	0.42
Portugal	2014	0.87	0.37	0.25	0.75	0.81	0.52
Portugal	2017	0.92	0.50	0.32	0.86	0.79	0.59
Portugal	2021	0.93	0.51	0.43	0.91	0.76	0.54
Spain	2011	0.93	0.49	0.35	0.94	0.85	0.40
Spain	2014	0.98	0.49	0.48	0.94	0.85	0.49
Spain	2017	0.94	0.47	0.51	0.90	0.78	0.53
Spain	2021	0.98	0.47	0.54	0.98	0.67	0.51
Sweden	2011	0.99	0.67	0.64	0.99	0.73	0.50
Sweden	2014	1.00	0.67	0.75	0.99	0.73	0.52
Sweden	2017	1.00	0.68	0.75	0.98	0.74	0.49
Sweden	2021	1.00	0.69	0.80	0.99	0.78	0.48
UK	2011	0.97	0.54	0.44	0.97	0.83	0.45
UK	2014	0.99	0.54	0.52	0.97	0.83	0.47
UK	2017	0.96	0.58	0.64	0.96	0.85	0.44
UK	2021	1.00	0.39	0.61	0.99	0.79	0.39

**Table 6** Mean values of EE components and integrated EE index

Country	Year	Formal institutions	Entrepreneurship culture	Physical infrastructure	Demand	Networks	Leadership	Talent	Finance	New knowledge	Intermediate services	EE index
France	2011	22.6	68.2	27.2	8.9	7.2	32.9	18.9	21.9	13.5	53.0	27.4
France	2014	22.3	66.2	27.5	10.3	8.4	27.7	20.4	21.7	12.9	63.0	28.0
France	2017	23.9	64.9	24.8	13.5	8.9	29.5	19.7	11.0	13.1	68.0	27.7
France	2021	24.9	64.5	21.8	12.4	8.8	27.4	18.9	8.7	15.5	85.0	28.8
Germany	2011	25.8	62.8	23.3	15.9	9.5	28.5	21.7	10.8	15.4	86.5	30.0
Germany	2014	25.4	61.5	23.1	15.7	8.1	25.9	21.0	12.3	16.4	89.0	29.8
Germany	2017	25.3	63.0	15.1	17.5	8.6	28.7	19.8	8.1	14.2	73.5	27.4
Germany	2021	33.0	63.2	11.1	13.9	9.9	27.9	20.5	10.2	17.5	94.0	30.1
Greece	2011	21.7	55.6	25.9	4.4	7.9	29.7	18.9	25.7	26.9	36.5	25.3
Greece	2014	21.4	51.8	24.4	6.1	7.4	25.2	27.4	27.9	17.7	34.0	24.3
Greece	2017	22.1	55.6	16.2	7.1	9.7	44.3	25.3	20.4	16.0	57.0	27.4
Greece	2021	32.8	62.4	13.8	6.6	11.7	45.1	27.8	18.3	13.4	55.0	28.7
Italy	2011	25.4	64.3	32.9	3.4	3.2	24.1	23.6	15.5	12.1	59.5	26.4
Italy	2014	25.1	58.6	33.2	5.0	4.1	31.6	28.2	25.3	12.2	73.0	29.6
Italy	2017	20.5	57.5	23.0	6.9	5.3	20.8	28.3	10.3	12.2	66.0	25.1
Italy	2021	30.5	21.1	13.6	10.3	9.4	17.6	20.9	12.3	10.4	86.5	23.2
Netherlands	2011	23.0	71.0	15.9	13.9	9.4	17.3	16.7	23.0	11.7	89.0	29.1
Netherlands	2014	22.0	69.9	16.3	9.8	9.4	29.8	16.6	21.2	17.1	91.5	30.3
Netherlands	2017	23.1	73.7	11.3	12.4	11.1	23.6	14.9	8.6	16.9	72.5	26.8
Netherlands	2021	22.7	77.2	8.5	15.7	9.9	23.1	17.5	17.9	15.8	72.0	28.0
Poland	2011	11.2	56.3	25.5	6.0	3.0	28.4	23.5	11.9	12.3	44.0	22.2
Poland	2014	10.5	55.6	26.7	8.0	2.9	31.8	26.2	10.3	11.1	58.5	24.1
Poland	2017	10.1	71.5	18.4	8.1	2.7	38.4	21.1	7.7	10.1	58.0	24.6
Poland	2021	12.2	58.4	15.6	10.0	3.5	37.6	23.1	12.5	16.6	65.5	25.5

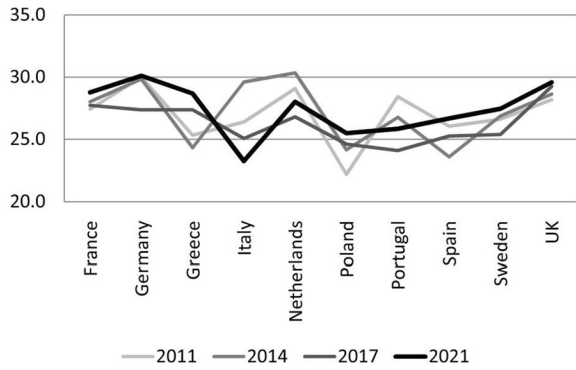
Table 6 (continued)

Country	Year	Formal institutions	Entrepreneurship culture	Physical infrastructure	Demand	Networks	Leadership	Talent	Finance	New knowledge	Intermediate services	EE Index
Portugal	2011	24.6	65.4	17.9	12.6	5.5	19.4	21.0	21.0	20.4	76.5	28.4
Portugal	2014	24.3	58.1	18.8	12.1	5.9	22.2	20.6	16.8	12.5	76.5	26.8
Portugal	2017	24.5	62.7	11.6	15.2	6.8	14.7	20.5	8.5	14.5	62.0	24.1
Portugal	2021	20.3	66.7	12.0	17.2	7.0	21.6	25.4	13.3	14.5	60.5	25.8
Spain	2011	13.4	57.0	27.0	8.3	4.0	21.6	20.6	33.1	18.0	57.5	26.0
Spain	2014	13.1	45.5	26.0	12.2	4.5	14.4	20.3	20.7	18.1	61.0	23.6
Spain	2017	14.1	50.0	18.1	14.9	5.5	18.6	20.7	8.1	14.8	88.0	25.3
Spain	2021	13.9	53.9	10.9	17.0	5.8	21.2	29.0	15.0	12.8	87.5	26.7
Sweden	2011	24.5	63.4	18.5	17.1	11.2	8.7	18.5	5.2	16.1	83.0	26.6
Sweden	2014	23.8	59.6	18.3	18.7	9.1	2.8	19.2	6.5	16.3	94.5	26.9
Sweden	2017	23.8	56.3	8.6	21.8	9.8	9.4	19.2	4.3	15.3	85.5	25.4
Sweden	2021	32.0	60.8	5.5	22.8	10.8	10.0	22.5	9.7	15.6	85.0	27.5
UK	2011	18.3	59.7	23.1	10.6	15.3	19.5	17.7	17.4	20.9	79.5	28.2
UK	2014	20.3	62.7	22.8	13.8	14.7	22.1	17.9	11.0	17.2	84.0	28.6
UK	2017	23.5	64.0	14.9	14.3	15.8	26.4	17.6	9.1	15.6	91.5	29.3
UK	2021	16.5	65.0	9.8	18.8	14.8	25.1	24.4	10.8	19.3	91.5	29.6

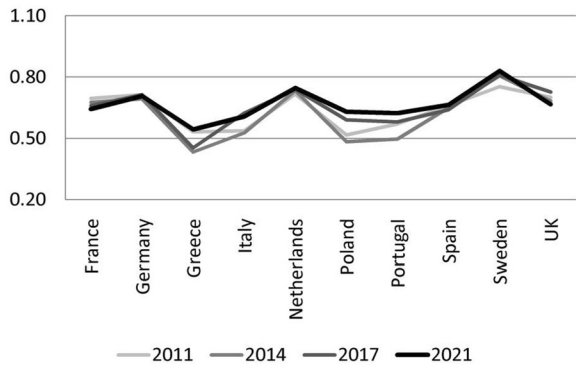
**Table 7** Mean values of FinTech dimensions and integrated FinTech index

Country	Year	Financial	Technical	FinTech index
France	2011	0.67	0.72	0.70
France	2014	0.68	0.75	0.71
France	2017	0.66	0.75	0.70
France	2021	0.64	0.79	0.72
Germany	2011	0.68	0.74	0.71
Germany	2014	0.69	0.76	0.73
Germany	2017	0.71	0.78	0.75
Germany	2021	0.71	0.80	0.75
Greece	2011	0.42	0.64	0.53
Greece	2014	0.43	0.68	0.56
Greece	2017	0.45	0.68	0.57
Greece	2021	0.54	0.75	0.65
Italy	2011	0.41	0.66	0.54
Italy	2014	0.53	0.70	0.61
Italy	2017	0.62	0.76	0.69
Italy	2021	0.61	0.76	0.69
Netherlands	2011	0.73	0.70	0.72
Netherlands	2014	0.73	0.73	0.73
Netherlands	2017	0.74	0.73	0.73
Netherlands	2021	0.75	0.71	0.73
Poland	2011	0.45	0.59	0.52
Poland	2014	0.48	0.62	0.55
Poland	2017	0.59	0.65	0.62
Poland	2021	0.63	0.71	0.67
Portugal	2011	0.48	0.66	0.57
Portugal	2014	0.50	0.69	0.60
Portugal	2017	0.58	0.75	0.66
Portugal	2021	0.62	0.74	0.68
Spain	2011	0.59	0.73	0.66
Spain	2014	0.65	0.76	0.71
Spain	2017	0.64	0.74	0.69
Spain	2021	0.66	0.72	0.69
Sweden	2011	0.77	0.74	0.75
Sweden	2014	0.81	0.75	0.78
Sweden	2017	0.81	0.74	0.77
Sweden	2021	0.83	0.75	0.79
UK	2011	0.65	0.75	0.70
UK	2014	0.68	0.76	0.72
UK	2017	0.73	0.75	0.74
UK	2021	0.67	0.72	0.70

**Fig. 2** Trend of the EE index in European countries during 2011–2021



**Fig. 3** Trend of the FinTech index in European countries during 2011–2021



**Table 8** The correlation results between FinTech and the EE index (2011–2021)

Indicators	Test	EE
Financial	R	0.38
	Sig.	0.02
	N	40
Technological	R	0.41
	Sig.	0.01
	N	40
FinTech	R	0.41
	Sig.	0.01
	N	40

N = number of 10 countries multiplied by 4 time intervals

**Table 9** The correlations between FinTech and EE elements (2011–2021) (N = 40)

Indicators	Test	Fintech
Formal institutions	R	0.32
	Sig.	0.04
Entrepreneurship culture	R	0.27
	Sig.	0.09
Physical infrastructure	R	-0.49
	Sig.	<sup>a</sup>
Demand	R	0.76
	Sig.	0.01
Networks	R	0.55
	Sig.	0.01
Leadership	R	-0.45
	Sig.	<sup>a</sup>
Talent	R	-0.46
	Sig.	<sup>a</sup>
Finance	R	-0.33
	Sig.	<sup>a</sup>
New knowledge	R	0.01
	Sig.	<sup>a</sup>
Intermediate services	R	0.72
	Sig.	0.01

<sup>a</sup>Insignificant correlations

role of the FinTech index in the enhancement of EE through the enhancement of the five aforementioned EE elements in European countries. This actual result can be estimated as the distributed relationships between the FinTech index and EE index based on four time intervals in Table 10, revealing the decreasing trend of relationships between FinTech and EE from 2011 to 2021 (R from 0.64 to 0.33). Despite the overall effective role of FinTech in the EE frameworks of European countries, it seems that the relationships have decreased during the last decade. The reasons for this finding should be studied in the future.

**Table 10** The correlation results between FinTech and EE based on four time intervals

Indicators	Test	EE			
		2011	2014	2017	2021
FinTech	R	0.64	0.48	0.23	0.33
	Sig.	0.05	0.16	0.52	0.36
	N	10	10	10	10

N = number of 10 countries in each period

## Discussion

The proposed framework for EE in our study (based on 25 variables into ten components) may differ from another EE framework (e.g., Isenberg, 2010, 2011). The reason for this difference, as mentioned by Frimanslund (2022), is the lack of equivalence of the EE frameworks in contextual studies, qualitative data, or measures.

The results revealed significant positive correlations between FinTech (financial and technological dimensions) and EE in all selected countries at the 98% confidence level ( $R$  from 0.38 to 0.41,  $\text{Sig.} < 0.02$ ), revealing the overall effective role of the FinTech index in the EE framework during 2011–2021. This result supported two of the research hypotheses (H.1 and H.2), revealing that high values of progress in the financial and technological dimensions of FinTech can enhance the EE in European countries. Hence, we state that FinTech can be used to enhance the structures of an EE effectively, as mentioned by Spigel (2022), and it can be defined as a driving power of economic growth in countries worldwide (Molla & Biru, 2023). This finding is flexible at the national level and can be generalized to the other boundaries of regional economies, as observed in similar studies by Stam (2018), Stam and van de Ven (2019), Leendertse et al. (2021), and Koroleva (2022).

Moreover, the detailed analysis revealed the effective role of the FinTech index on the enhancement of EE through the enhancing three EE elements of “networks”, “demand”, and “intermediate services”, supporting the third research hypothesis (H.3). This finding is consistent with the research of Fernandes and Ferreira (2022) regarding the abilities of networks to improve the functioning of EEs. With increased FinTech setting, the financial market of EEs has become more accessible for users, easier for providers to use to promote new products, and more efficient for managers (You et al., 2023). Moreover, the results revealed that the relationships between FinTech and EE have decreased during the last decade from 2011 to 2021 year-by-year. The reasons for this finding should be examined in the future, but initially, FinTech was connected to applying innovations, which are often restricted by compliance with country-level regulations (Bromberg et al., 2017). Hence, governmental regulations may modulate the relationships between FinTech and EE indices.

## Conclusion and implications

### Conclusion

Our research suggested a linear regression model for investigating relations between the FinTech index (including two dimensions) and EEs (including ten components). This macrolevel or country-level model provided professional findings through effective financial and technological factors and relations, improving the entrepreneurial ecosystems of each European country. Based on EE attributes, the components of “formal institutions” and “entrepreneurship culture” had main roles in the progression of EE in 2011–2014, while the effective components in the development of EE in 2017–2021 are assumed to be “networks”, “demand”, and “intermediate

services”. This fact revealed that the enhancement of EE in recent years transferred from formal and cultural components to technological networks and services in European countries. In addition, the overall status of FinTech in all European countries accelerated from 2011 to 2021. Hence, the technological dimension of FinTech can be defined as a driving power of economic growth in the study area and should be considered in economic programs and revising EE structures.

## Implications

Our results can complement the literature on EE and FinTech. Hence, this research can contribute to the literature by enhancing entrepreneurial ecosystems using FinTech characteristics (see Feldman, 2014; Feldman & Lowe, 2015; Spigel, 2022). Thus, our findings can support the literature in assessing relations and factors by recognizing measurable factors and methods (e.g., Frimanslund, 2022; Liguori et al., 2019; Stam, 2018; Vedula & Kim, 2019). The findings also provide sufficient empirical evidence for a significant influence of FinTech in progressing EEs at the country level. The findings, despite completing the recent aforementioned literature, respond to the calls from recent scholars. For example, one research call focused on measuring EE attributes and productive entrepreneurship, investigating the relationship between them and determining territories with more productive entrepreneurship (Koroleva, 2022). Our results show that despite the main role of FinTech in the EE frameworks, it could enhance all EEs through the improvement of the three EE elements of “networks”, “demand”, and “intermediate services”.

Furthermore, the practical and managerial implications of the current research depend on the effects of FinTech on the EE elements, which can be assumed to be “networks”, “demand”, and “intermediate services”. These technological aspects of the EE frameworks could be added to policies and protocols for European policy-makers, company decision-makers, and stakeholders. In recent years, scholars have addressed EE as an interaction of interrelated factors in entrepreneurial firms (e.g., Frimanslund, 2022; Liguori et al., 2019; Stam, 2018; Vedula & Kim, 2019). Our study suggests that the effective financial and technological factors of FinTech can be considered as six independent variables: financial institution accounts, received financial wages, saved money at a financial institution, making a digital technology payment, making a technological utility payment, and innovative technology. In this regard, national policy-makers can practically appraise the growth of EE elements based on the growing variations of the aforementioned variables. The proposed method of our study may be considered an initial approach to examine the EE frameworks by handling the appropriate variables and quantifying the applicable indices.

## Limitations and future studies

One of the limitations of this research was its level of analysis. There is no agreement in the EE literature regarding the level of analysis due to their openness (Koroleva, 2022). For instance, the investigation of EE attributes has been measured at the country level by Laidroo et al. (2021). However, to provide a better

understanding of EE attributes, they need to be studied at more than one level of analysis (i.e., city, region, and country) simultaneously. Another limitation of this research was the different components of the proposed EE framework in our study (based on 25 variables into ten components) compared with other EE frameworks in the literature (e.g., Isenberg, 2010, 2011) due to the restriction in data availability. Hence, a broader database should be accessed to define certain components of EE frameworks in future studies. In this regard, future studies could examine the experimental procedures for comparing the particular values of EE variables in several boundaries from municipal and regional to national levels.

The third limitation depends on the availability of data, limited to the annual scale at the national level. Hence, future studies should be repeated using more study areas of countries, regions, or provinces in extended periods.

**Funding** The research was supported by the Scientific Grant Agency of the Ministry of Education, Science, Research, and Sport of the Slovak Republic and the Slovak Academy Sciences (VEGA), project No 1/0364/22: Research on eco-innovation potential of SMEs in the context of sustainable development.

**Data availability** The data that support the findings of this study are available from the corresponding author upon request.

## Declarations

**Competing interest** The authors declare that they have no competing interests.

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