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# The ICT ecosystem of Thessaloniki


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## Abstract

What city will be the next Silicon Valley? It has turned into a tired narrative. The world is a multi – centered and complex place. It is likelier for many successors of the Bay area model to emerge, as the global ICT market comprises of many innovation hubs, venture capital attractors and assets of these unique ecosystems.

It would be preferable to develop a realistic business plan, tailored after the specific needs of each locale. Regarding the ICT ecosystem of Thessaloniki: One that showcases highly educated human capital, that is hard to retain. Greek macro-economic flaws like bureaucracy, heavy taxation, chaotic and unstable policies, and constant law reforms, to a persistent record - high software piracy and a low entrepreneurship mentality keep strong till today and hinder development. The driving force behind Greek ICT has been stately or EU funded software, services, and infrastructure – far from a viable economic model, that is being put under further pressure in the aftermath of a decade long economic recession and the unfolding COVID-19 crisis.

The scope of the dissertation is to study the ICT ecosystem of Thessaloniki, considering its properties and assess quantifiable and qualitative data of the financial landscape, compare them to similar cities, showcase strengths and weaknesses, classify Thessaloniki in a global scale and highlight realistic proposals and suggestions.

Keywords: Ecosystem, entrepreneurship, ICT, Thessaloniki, start-up

Dritsas Dimitrios – Adamantios

26/02/2022

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## Contents

## Introduction

This piece of research literature initially embarks upon a literature review of ecosystems, specifically entrepreneurial, innovation and digital ones. Apart from documenting the theory, key terms, actors, and aspects are identified as potential study targets. Studied conceptual models help organize the study and depict the ICT ecosystem of Thessaloniki. The study of benchmarking frameworks, alongside case studies, preferably at a metropolitan / city level, may lead to tried and tested methods to produce metrics to assess entrepreneurial ecosystems worldwide. This comparison will likely lead to the adoption of a benchmarking framework, to produce questionnaires for the primary field search for the case study of the Thessalonikean ecosystem. Also, it provides points of reference for comparison.

A macro-economic analysis of the Greek and the larger metropolitan area of Thessaloniki follows to better explain the landscape pertinent to the case under scrutiny. Similarly, to the literature review a top-down approach is followed, examining the ICT sector globally and specifying findings with our magnifying lens as we go down from national to local city level. The method of primary research is explained, presenting the questionnaires and raw data in the appendix, followed by a thorough presentation of each meaningful metric (having dropped out those with few or no data).

The dissertation tries to encompass the socio-economic spectrum of activities of the ICT ecosystem of Thessaloniki, applying a representative framework and offering a post COVID-19 snapshot. The metrics produced present strengths, weaknesses and distinctive characteristics of the ecosystem and allow for a direct comparison across global national – level ecosystems, offering an estimation of a meaningful global ranking of the ICT sector of Thessaloniki.

Finally, a discussion of conclusions, with suggestions for leaders, policy – makers and those at administrative posts for the ICT ecosystem of Thessaloniki, wrap up this dissertation.

## Literature Review

The research literature has seen the rise of the term ecosystem over recent years, in favor of other terms describing similar concepts such as clusters, hubs, markets. A brief ecosystem theory follows, to highlight differences, as well as benefits and disadvantages that usage of this term may entail.

### *Ecosystem theory*

The ecosystem concept traces its roots to biological research. Comparison between biological and societal ecosystems aims to discover similarities and differences between the two and use established theories from the former to the latter field of study or as a metaphor to characterize inter-dependence and co-evolution that is synonymous with contemporary business activities (Moore, J.F., 1993). Identifying common patterns, mechanisms, decision – making principles and behavioral chains may help clarify the complexity of multi – actor networks and help study the ecosystem and predict growth or decline. In essence, this approach, involves businesses, organizations, products that are the focal point of examination of a wider interdependent environment. Although use of the ecosystem perspective in the field of technology and innovation management is in its infancy, distinct promising research streams have appeared. Of particular interest are the streams of the business perspective, emphasizing co-evolution and business perspective (Moore, 1993); (Li, 2009), innovation ecosystems, emphasizing national or regional innovation (Fukuda & Watanabe, 2008; Clarysse et al., 2014), technological (Markard & Truffer, 2008) and entrepreneurial and start-up ones as nurseries and incubators of new business (Isenberg, 2010; Berger & Kuckertz, 2016; Acs et al., 2017). Research streams that link strategic management and ecosystems offer design proposals and best strategies for growth (Zahra and Nambitian, 2012).

Although coherent, commonly accepted definitions of business ecosystems are yet elusive, firm ties to organizational boundary theory are evident (Tsujimoto, M. et al, 2017). Popular definitions of business ecosystems focus on dynamic nature, co-evolution (Li, 2009), value capture and co-creation (Romero and Molina, 2011) and

complex interactions (Teece, 2007), stages of maturity and roles (Moore, 1993), network dynamics (Santos and Eisenhardt, 2005), (Iansity and Levien, 2004) complementarity between network actors (Carayiannis and Campbell, 2009), (Jacobides MG et al, 2018) and technological and behavioral uncertainties (Adner and Kapoor, 2010). Ecosystems differ from markets by their dynamic evolution capacity. Ecosystems involve balance and symmetry disruption by actors introducing novel business model elements, leading to reaction and adaptation to retain equilibrium (Storbacka & Nenonen, 2011).

Differentiating factors that set ecosystems apart from markets, alliances, or supply – chains, are interaction of different actors, enabled by modularity, lacking hierarchy, bound together by non-redeployability and difficulty in replication. Different types of complementarities, allow shaping a classification of ecosystems. (Jacobides MG et al, 2018). This analysis deviates from similar ones used in transaction cost economies, which are based on risk mitigation stemming from dyadic relationships. It targets maximization of benefits by participating in a group of firms, with appropriate complementary roles. Through the prism of policy making the interest lies in ways to achieve best ecosystem design, with an ideal set of complementarities between participating actors. Because of complex relationships and complementarities requiring varied investment, redeployability of the whole ecosystem may be unfeasible. Strategically distinct relations between actors of the ecosystem, that tie them to it, makes the concept stand out. The nature and direction of dependencies, the extent of complementarities and the interchangeability of investments, are descriptors of an ecosystem.

The following diagram is designed upon a vertical axis, that values complementarity types in production (from generic – that can be produced independently, to super modular, where the quality or efficiency of products or services are enhanced by the increase in production efficiency of a complementary third product or service).

The horizontal axis depicts complementarity in terms of consumption. The lowest level corresponds to products consumed at large, while to the other extreme - super modular, where joint consumption greatly benefits the customer. Ecosystems are identified as those that score as high in both axes to achieve super modularity or at least guarantee uniqueness in production and consumption (Jacobides MG et al, 2018).

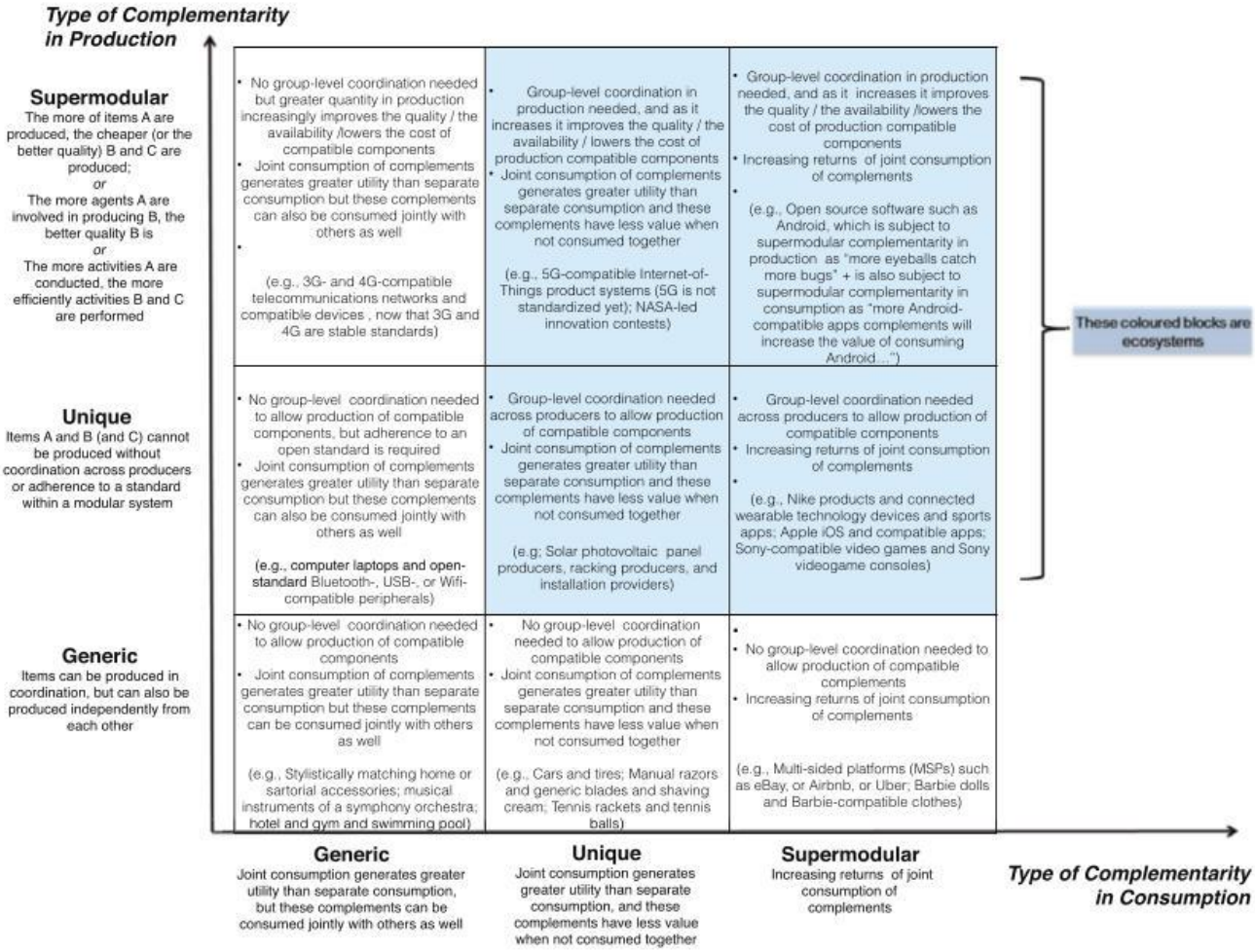



Figure 1: Types of complementarities and ecosystems

Dynamic co-evolution of actors (i.e., business) and ecosystems is emphasized in the ecosystem approach (Muzellec, Ronteau, & Lambkin, 2015), while it offers a holistic view of competition and collaboration (Ritala et al., 2014). The landscape of established start-ups (Baraldi, Ingemansson, & Launberg, 2014; Boehm & Hogan, 2013; Purchase, Olaru, & Denize, 2014), as well as universities (Jahanmir, 2016; Janeiro, Proença, & da Conceição Gonçalves, 2013) and investors (Lutz, Bender, Achleitner, & Kaserer, 2013) affect the potential emergence of new start-ups and their growth. The ecosystem approach highlights new innovative co-development and financing methods, such as crowdsourcing (Simula & Ahola, 2014). The business ecosystem focuses on value capture, while the innovation ecosystem focuses on value creation

(Vasconcelos Gomes de L.A. et al, 2018). Four major categories applying the ecosystem approach to B2B research by their interaction focus and by system dynamics focus:

- Competition and evolution, studying market – based competition and collaboration, within and across ecosystems.
- Emergence and disruption, focusing on the development of new business and innovation, creating value for stakeholders.
- Stable business exchange, identifying ecosystems, which strive to remain stable by extending business relationships over time.
- Value co-creation. Ecosystem analysis occurs consequently. Value creation and its delivery to the ecosystem's stakeholders are focal points. (Aarikka-Stenroos, L. and Ritala, P., 2017).

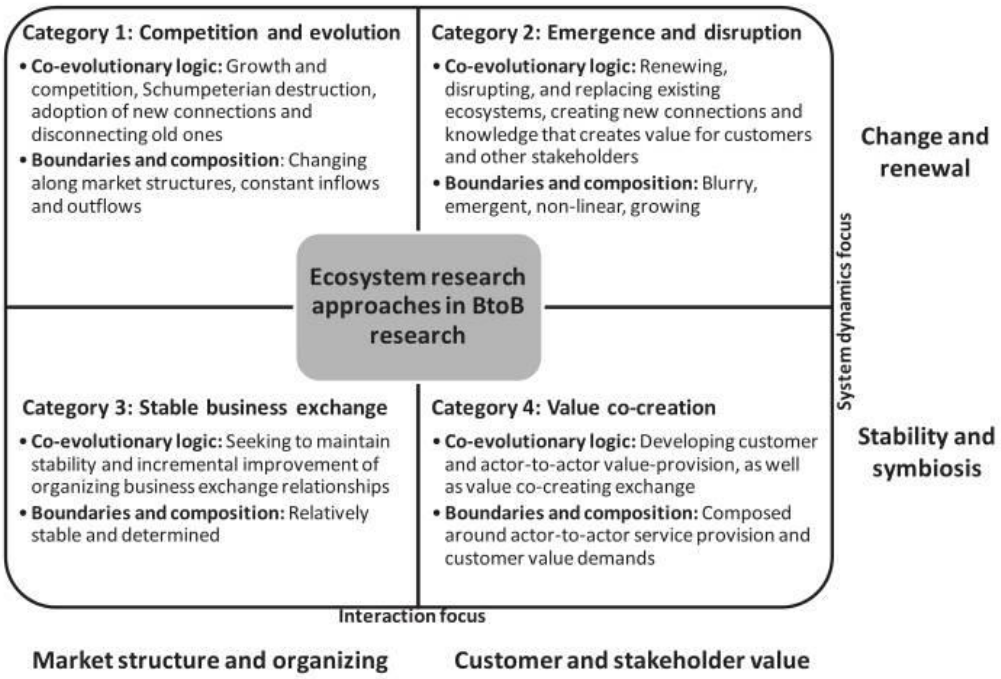



Figure 2: Ecosystem approach in B2B research

Three meta – characteristics are unique to business ecosystems:

1. Sustainability, implying that it can meet present needs, without comprising its future ones.
2. Self – governance, implying its independence from external or dominant internal actors.

3. Evolution, through competition and experimentation.

Ecosystems can be classified by these (Sako, M., 2018).

**Different types of business ecosystems.**

| | Platform-based ecosystem | Startup ecosystem | Mobility ecosystem |
|---|---|---|---|
| **Sustainable (in resource use today and the future)** | × | × | × |
| **Self-governing (with some competing rules)** | | × | × |
| **Evolutionary (via competition and experimentation)** | | × | × |

Figure 3: Business ecosystem types by key meta-characteristics

Beside the biological context, the term should be used prudently, to avoid being an unscientific, fancy buzzword. It may help explain geographical shift in activities. The differentiation of ecosystems may cover the lack of a unified theory of ecosystems (D.-S. Oh et al., 2016).

Innovation ecosystems are of particular interest to the study of entrepreneurial ecosystems of the ICT sector, as the rapid evolution rate of technology, mandates high innovation. They also offer an insight in the birth process of an ecosystem. Several roles are important during this phase, namely: An ecosystem leader, user, expert, champion, and sponsor, not excluding others. Their interrelation is better understood in the context of contribution to the ecosystem (organizing corresponding actor activities across four thematic domains, while the time axis offers a further dimension of study, by highlighting entry timing of each role (Dedehayir, O. et al, 2018).

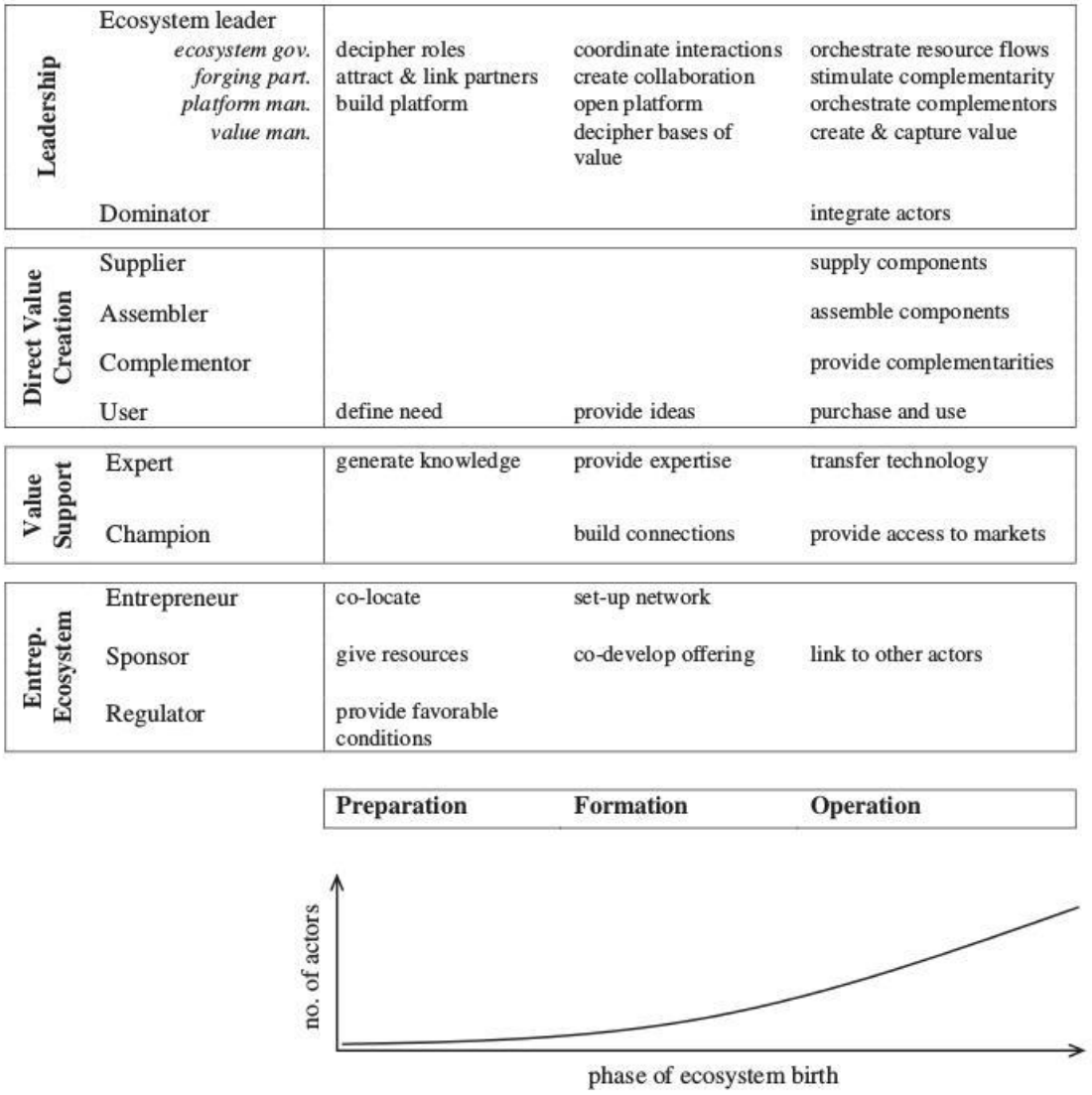



Figure 4: Roles and activities across the genesis of innovation ecosystems

### *Ecosystem Frameworks and models*

Schumpeterian evolutionary economics offer useful insights towards the design of conceptual models. The new ICT ecosystem is driven by innovation, the creation of new knowledge by actors of the ecosystem, emerging from the key symbiotic relationships between them. The evolutionary process of creative destruction is essential for value creation, present in capitalism (Schumpeter, 1943) and natural evolution (Darwin, 1859). Symbiotic relationships, with either beneficial or damaging consequences of this pairing, shed new light in the evolutionary process. Contemporary criticism to Darwin's theory, regards evolution not through the prism of competition but rather through symbiosis. "*Life did not take over the globe by combat, but by networking.*" (Margulis & Sagan, 1986). These ideas are incorporated in the simplified model of the new ICT ecosystem (Fransman, M., 2017).

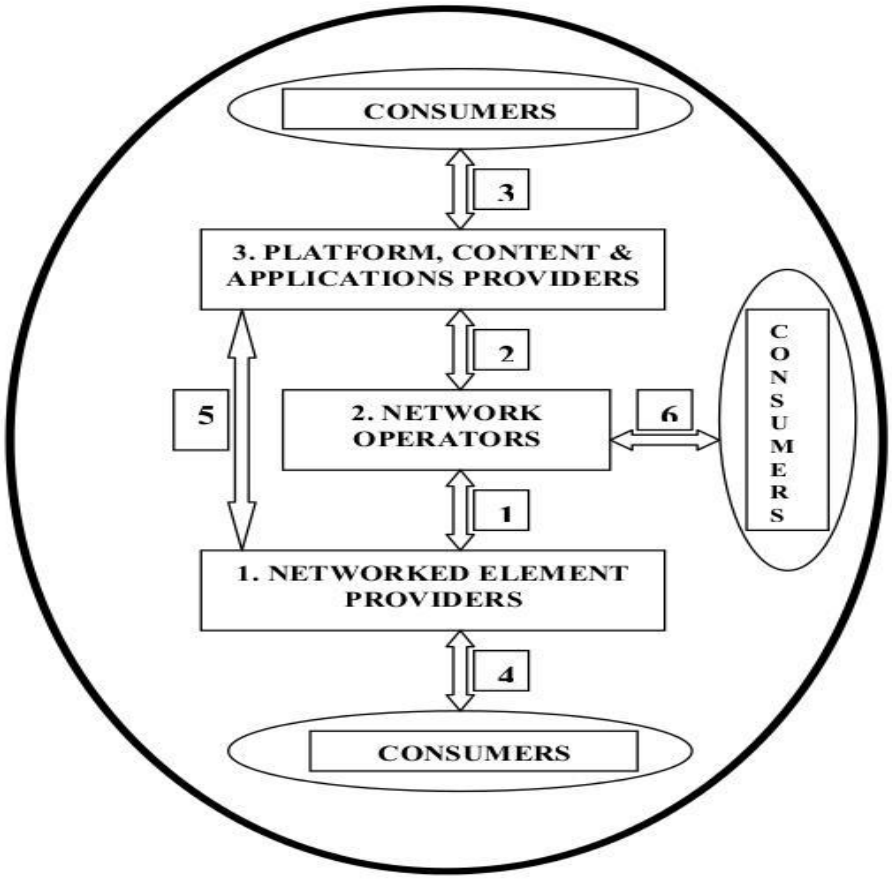



Figure 5: Six symbiotic relationships in the simplified model of the new ICT ecosystem

Four factors affect these relationships:

1. Competition between similar actors of the ecosystem, with its intensity being a determinant of innovation and evolution.
2. Financial institutions, influencing the whole ecosystem.
3. Regulation and competition law determine the rules under which the relationships function and innovation occurs.
4. Legal institutions, universities, which incubate actors and the ones managing standardization, benefit the interoperability of the ecosystem (Fransman, M., 2017).

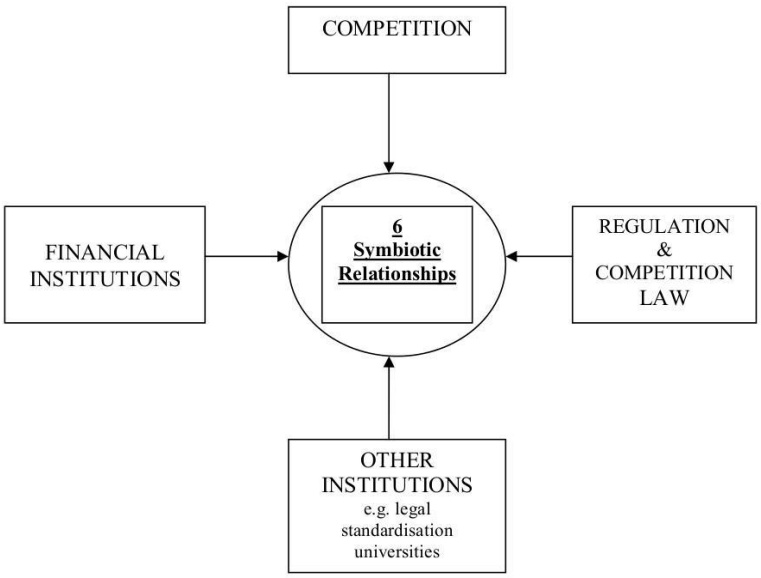



Figure 6: The environmental context of the symbiotic relationships

ICT ecosystems vary as income and opportunities differ. A single model may not be replicated exactly in different localities, due to macro-economic differences or individual components of these ecosystems. Gender perceptions, cultural backgrounds, historical context, shape interrelations. Human well-being is introduced in the enhanced ICT framework (Diga, K., May, J., 2016).

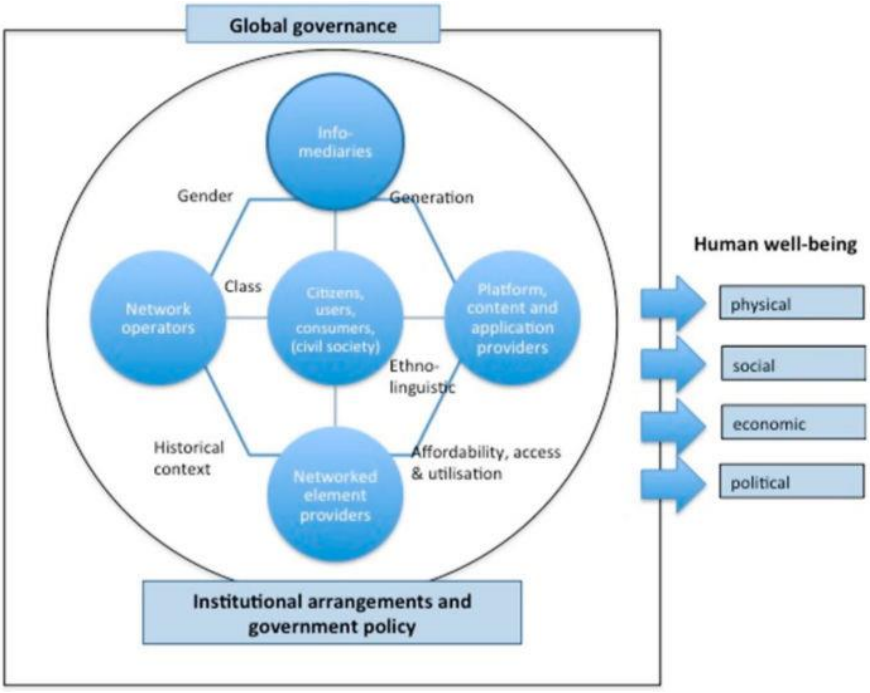



Figure 7: Enhanced ICT ecosystem framework

A novel approach to study the evolution and dynamics of an entrepreneurial ecosystem in the software sector, considers maturity stages. Entrepreneurs initiate startup creation, identifying opportunities. To overcome challenges, they seek support from their personal networks, a subset of the ecosystem and influence the entrepreneurs' behavior. Societal characteristics, such as demographics shape the entrepreneur's conduct, while geopolitical factors influence the overall culture. Other actors, such as universities or research centers either provide education or through incubators / accelerators promote entrepreneurs or through establishment of spin-offs act as competitors. Funding agents, through their economic activity, boost a startup's growth, while the legal landscape adds form to the startup business model and influences business establishment costs (Cukier, D. & Kon, F.,2018).

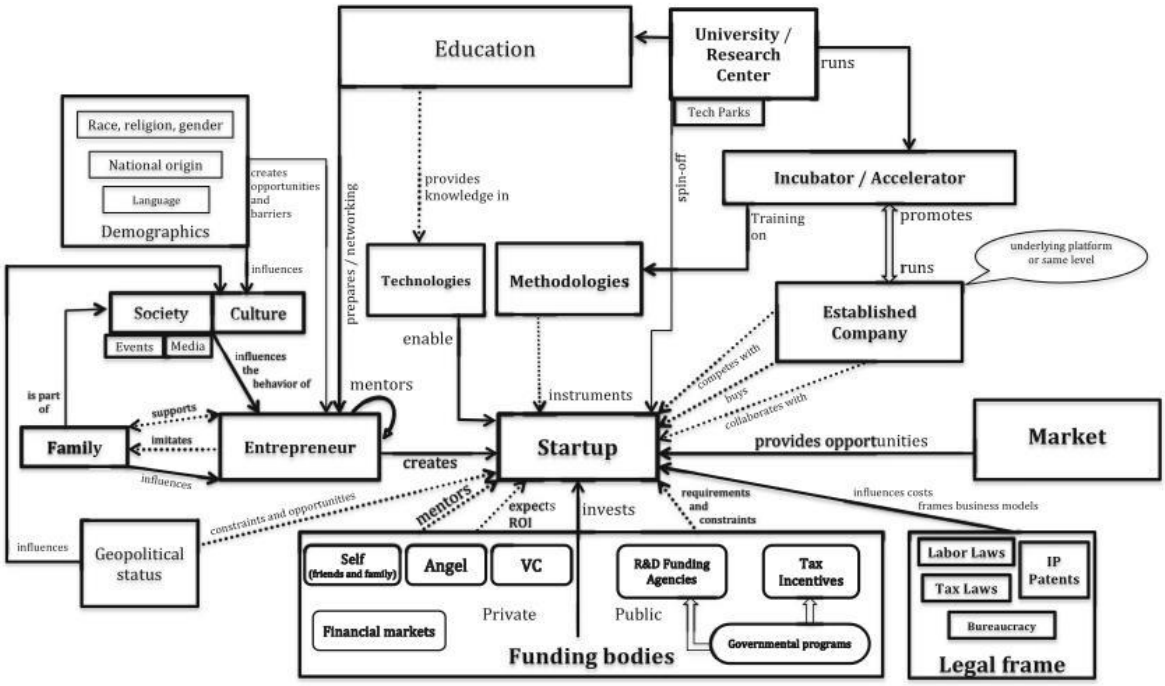



Figure 8: Startup ecosystem conceptual framework

The Digital Entrepreneurial Ecosystem Framework attempts to integrate the facets of digital and entrepreneurial ecosystems. It positions digital entrepreneurship at the juncture of users, platforms, and institutions, so that living components (users and agents), combined with abiotic ones (platforms and digital infrastructure) complement the external environment. A healthy digital entrepreneurship ecosystem requires: User privacy, secure digital infrastructure, efficient digital platforms, enhanced by third-

party agents and market competition to remain unhindered by the prevalence of platforms (Acs et al,2020). The following figure, depicts its four core elements:

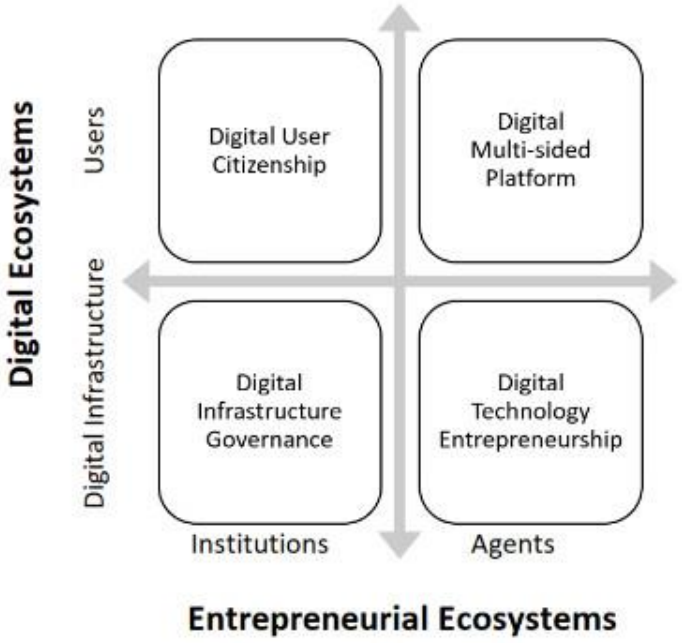



Figure 9: Digital Entrepreneurship Ecosystem framework

"*Entrepreneurial Ecosystems are complex socioeconomic structures having properties of self-organization, scalability, and sustainability that are brought to life by individual-level action of participating actors*". New entrepreneurs belong at the heart of the ecosystem. Attitudes, abilities and aspirations of the adult population, influence entrepreneurs, a specific subset. The intermediate layer is the entrepreneurial trial and error equilibrium. Entrepreneurs constantly search for perceived opportunities. To validate, they exploit them, causing this dynamic state. The periphery is occupied by outlying conditions: The education system, the market structure, infrastructure, government agencies, corporations, the financial sectors, and research & development, describe the conditions, which frame the potential that an entrepreneurial venture can fulfill. (Acs et al, 2018), (Acs et al, 2019).

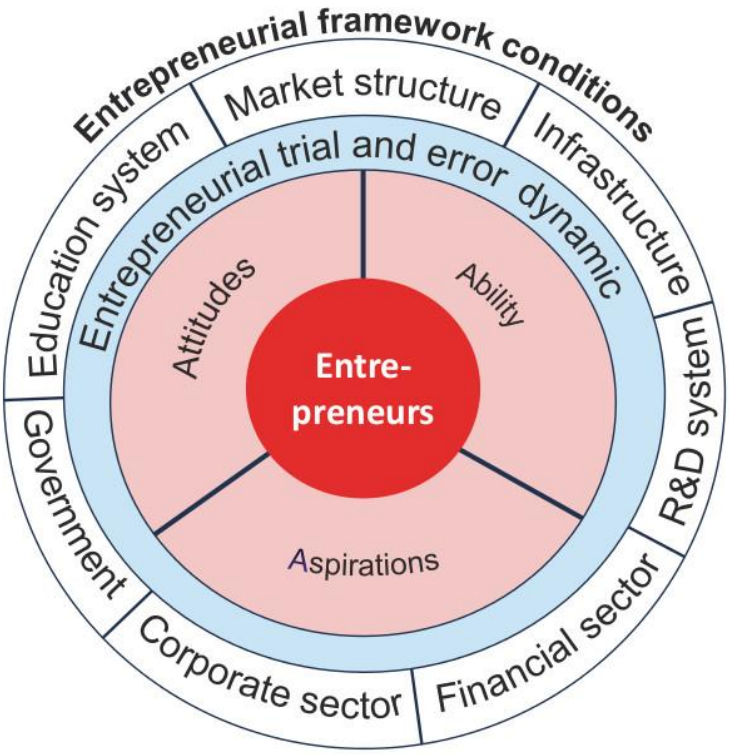



Figure 10: Entrepreneurial ecosystem configuration

***Ecosystem Assessment, Benchmarking and Metrics***

Research has led to diverse assessment frameworks of entrepreneurial ecosystems, a multitude of benchmarks, key performance indicators and metrics. Many are presented alongside real-world case studies.

Those most appropriate for the current dissertation include:

- The Digital City Index, which compares the attractiveness of tech hubs for digital startups. It incorporates data from national (hence its sibling benchmarking framework "Digital Country Index") and city levels. Its 40 indicators are based both on primary and secondary data. Primary data consist of big data, collected through search engines. Its 3rd iteration in 2017 included 67 cities and digital hubs and prompted similar indices across the world (Bloom Consulting, 2018). There exist no traces of its application since 2018.
- A maturity model for software startup ecosystems was developed in 2018, based on the model of figure 8. It is comprised of 22 indicators, that are based on secondary data from the Global Competitiveness Report (Schwab, 2013), the

Global Entrepreneurship and Development Index (Acs et al. 2015) and the Global Startup Ecosystem Report (Herrmann et al. 2015) The model was applied to three cities in 2018: Tel-Aviv, Sao Paolo, New York (Cukier, D. & Kon, F., 2018).

- A spatial entrepreneurship model analyzes venture capital's geographical distribution across 170 global metropolitan areas, using 3 metrics and 5 for US metros (Adler et al, 2019).
- The Global Entrepreneurship & Development Index 2018 is comprised of 31 variables. The primary data were collected across 137 countries. The index is incremental, incorporating data from previous years and editions. The aggregate version of 2018 corresponds to a bit over 0.5 M participants since 2009 (Acs et al, 2018).
- The Global Entrepreneurship Index 2019 is comprised of 14 components and based on data across 137 countries. It has been discontinued since2019, leaving DEI/DEEI (Digital Entrepreneurship Index / Digital Entrepreneurship Ecosystem Index) as its successor.
- The DEI Index 2020, successor to the GEI index, is based upon the DEE framework, integrating the facets of both digital and entrepreneurial ecosystems. It contains 32 indicators across 116 countries.
- The Digital Platform Economy Index 2020 is the final evolution of the DEI index. It is comprised of 46 indicators, applied across 116 countries and the top 100 companies owning digital platforms (Acs et al, 2020).
- The Global Entrepreneurship Monitor Index 2020/2021 is comprised of 49 indicators, following data collected through two distinct surveys, the adult population survey (APS) and the national expert survey (NES). This index is also incremental, incorporating data from 1999 and 10 countries to 3.2 M and 46 countries in 2020 for the APS and 130 K for the NES (GERA, 2021).
- The Network Readiness Index 2020, is comprised of 60 indicators, based solely on secondary data, through databases of recognized third party authorities, namely UNESCO, UN, Wikimedia, World Economic Forum, OECD, World Bank (Dutta & Lanvin, 2020).

- A benchmarking framework, developed to assess entrepreneurship policies for hi-tech, hi-growth companies is comprised of 8 metrics, collected from secondary sources through the past 20 years from 2 cities (Egan, 2021).
- The Entrepreneurial Ecosystem Index 2020 is the Global Entrepreneurship Monitor version tailored for city level cases. It has been applied to 19 localities. Indicators and the report itself remain still undisclosed (GERA, 2020).
- The Startup Ecosystem Report 2021 includes 19 indicators, runs uninterruptedly for 20 years, across 100 countries (Startup Genome, 2021).
- The IMD-SUTD Smart City Index (SCI) 2021 examines perceptions of citizens, regarding technology infrastructure and applications available to the public. The benchmarking framework of 2021 is comprised of 39 indicators, across 118 cities globally, using a sample of 120 citizens / city (IMD-SCO, 2021).
- The Global Startup Ecosystem Index 2021 includes 19 indicators, runs uninterruptedly since 2017, across 100 countries and 1,000 cities globally, using a minimum sample of 100 startups per city (Startup Blink, 2021).
- The Global Innovation Index 2021 measures an economy's innovative capacity and output, using 81 indicators, across 132 countries (GII, 2021).
- The "Going Digital Integrated policy framework", boils down to 41 indicators, which produces maps that allows comparisons between countries with a single glance.
- The Digital Economy and Society Index (DESI) summarizes indicators on Europe's digital performance and tracks evolution of EU member states, since 2014.

Table 1 of the appendix summarizes the frameworks.

***Ecosystem Case Studies***

Why is the ICT ecosystem of Thessaloniki a proper candidate for study? The object of the focus will be studied entrepreneurial ecosystems, especially in the ICT sector, if available.

The proposition of the enhanced ICT ecosystem conceptual model discusses national – level ICT ecosystem cases in Brazil, Kenya, South Africa, and Philippines (Diga, K., May, J., 2016). While arguing about the importance of spatial organization of

entrepreneurship 170 global metropolitan areas are discussed, where top 20 global metros and top 20 US metros are highlighted (Adler et al., 2019). The framework developed to assess municipal hi-growth and high-tech policies discusses findings over the cases of Houston and St. Louis (Egan, 2021). Evaluating success of female entrepreneurship, showcases 20 cities globally (Berger & Kukertz, 2016). The Digital City Index includes 67 European cities – Athens, among them (Bloom Consulting, 2017). The Global Entrepreneurship & Development Index 2018 was applied to 137 countries – among them Greece, using the average of data collected in 2015 and 2016, for 4,000 individuals (Acs et al, 2018). The Digital Platform Economy Index 2020/21 was applied to 116 countries – Greece among the participants (Acs et al, 2020). Network Readiness Index 2020 resulted from the application of the benchmark to 134 countries – Greece as well (Dutta & Lanvin, 2020). The Entrepreneurial Ecosystem Index 2020 was applied to 19 cities globally (GEM, 2020). The Startup Ecosystem Report 2021 has been applied to 100 countries – including Greece (Startup Genome, 2021). The IMD-SUTD Smart City Index (SCI) 2021 was applied to 118 cities globally – Athens among them, ranking 116$^{th}$ among them, interviewing 120 citizens / city (IMD-SCO, 2021). The Global Startup Ecosystem Index 2021 has been applied, across 100 countries – Greece among them and 1,000 cities globally – Athens, Thessaloniki, and Ioannina among them (Startup Blink, 2021). The Global Innovation Index 2021 is applied to 132 countries – Greece among them (GII, 2021). Investigating whether smart cities pose additional entrepreneurship opportunities 44 Spanish cities are put to the test (Barba-Sánchez et al, 2019). Studying the correlation between the intensity of innovation in entrepreneurial ecosystems and the well-being in the same locales, a quality-of-life survey is conducted among 43 European smart cities – Athens among them, ranking 40th. (Penco, L. et al., 2021). Indicative comparative studies have been published pitting different but comparable cities against each other in terms of entrepreneurial ecosystem assessments: Tokyo and Bangalore (Kapturkiewicz, A.,2021), their maturity status: Tel-Aviv, São Paulo, and New York (Cukier, D. & Kon, F., 2018), venture capital investment: Silicon Valley/Bay area vs Austin vs New York, London vs Helsinki (Pokidko, N. et al., 2017), ecosystem's innovation capacity: Nairobi vs Kampala vs Dar Es Salaam (Cunningham et al, 2015).

Benchmarking aside, Thessaloniki is the second most populous city and the second most important economy in Greece. It has been so for the past 2 centuries of the newly formed Greek democracy and has been an important economy for the rest of its lengthy history. Being 500 km north of Athens, means closer proximity to neighboring Balkan countries as well as Istanbul, which is a major economy at a global scale. Thessaloniki has access to a large ICT talent pool, being the seat of 3 universities, as well as colleges and college branches and other education institutes at various levels. These will be further examined in the macro-economic analysis.

Among the sampled studies in the literature review, Thessaloniki appears in the Global Startup Ecosystem Index, ranked 379$^{th}$ among 1,000 studied cities globally. To further support, whether Thessaloniki is a good candidate for assessment of its ICT ecosystem, papers, case studies and indices that were mentioned in the literature review are distilled to produce a table of ecosystems at city or metropolitan level. Non-European, non – Mediterranean locales are excluded. They are sorted by economy size as per GDP and secondary by population size, both in descending order. The use of two metrics (GDP and population size) may offer a shallow representation of an ecosystem's size and quality. The source used was primarily Wikipedia, by they are deemed as satisfactory approximations for the needs of the argument in question.

What can be deduced from this table is that although Thessaloniki appears in the lower end of the table (rank 70/86), it is comparable to many of the cities at the lower end of the spectrum, it is higher than few, some of which are capitals. Conclusively it is reasonable for Thessaloniki to be an object of study as it belongs to the table (Appendix, Table 2).

## Methodology

Following the study of the literature, an analysis of the macro – economic elements of the ICT entrepreneurial ecosystem of Thessaloniki will take place. After the presentation of the secondary data, those produced from primary research will be presented.

Screening the benchmarking frameworks, resulted in excluding those unsuitable for city level analysis, those that relied on secondary data only or those that their methodology (down to questionnaires) could not be recovered. Based on these criteria the Global Entrepreneurship Monitor Index 2020/2021 was adopted. Transparent data, down to every question asked were available.

This index is produced by two surveys, one addressing the public and the other national experts. The National Experts Survey (NES) was dropped. Data and conclusions reached by the NES survey of 2021 for the GEM index relevant to Greece could be applied satisfactorily for Thessaloniki's ICT ecosystem. The Active Population Survey (APS) was followed through by reframing the 49 questions in the context of information and communication technology economic activities in the greater metropolitan area of Thessaloniki. Exclusively online questionnaires were used with a target of amassing 50 replies. Reaching participation levels, such as those accomplished by the national teams of the Global Entrepreneurship Research Association (2,000 nationally) were deemed beyond the capacity of a single surveyor and the time constraints of the dissertation. It does not discredit the quality of the findings as the national experts' survey uses a sample of 75 consultants nationally (GEM, 2021) and there exist other established or published frameworks that are based on similar samples: 100 experts for the maturity model tested against 3 ecosystems (Cukier, D. & Kon, F., 2018), 120 residents per city for developing the IMD-SCO Smart City Index 2021 IMD-SCO, 2021).

An array of 8 similarly themed past dissertations from International Hellenic University's and Aristotle University's repositories that were studied, ranged from 13 to 425 participants, with a median value of 30 participants.

The 49 questions corresponding in equally numbered indicators of the GEM framework are presented in the Appendix (Tables Q1- Q8) and were incorporated to an electronic survey, published through Google Forms.

Standard emails were sent to students currently enrolled in ICT related and MBA post graduate courses of International Hellenic University (132 in total), to the moderators of the 17 ICT related meetup groups of Thessaloniki's metropolitan area (11,096 members in total), to personal acquaintances, former and present collaborators from the ICT sector and ICT suppliers and freelancers of the Special Account Comittee of International Hellenic University, while the survey form was active for 1.5 month. Missing values in various answers, were excluded from the sample. The latter four sections of the survey were specific to entrepreneurs. Respondents not in charge of a firm, did not answer these questions as instructed, counting as part of the periphery of the ecosystem studied, while the entrepreneurs, the heart of the ecosystem and the survey, where a subset of the sample. The primary data, resulting from 37 respondents provided a benchmarking comparison of the ICT ecosystem of Thessaloniki to the Greek national average and GEM'S sample average of 46 countries.

Although, not originally planned, some of the entrepreneurs were quite eager to share their experiences, opinions and lessons learned. Unconstructed, spontaneous interviews were documented in 3 different cases, providing valuable insights, not recorded in the questionnaire, but distilled and represented in the final conclusions.

## Findings / Data Analysis

An analysis of the ICT ecosystem of Thessaloniki ensues, based on macro-economic evidence, stemming from publicly available secondary data, such as public administration agency reports, benchmarking frameworks and indices follows. A top-down approach is used from global level to set the landscape, then at Greek level to focus on the end to data pertinent with the ICT ecosystem of Thessaloniki. The analysis is not meant to be exhaustive, rather to frame the greater picture.

***Macro – economic evidence of the global ICT economy***

Increasing broadband speeds since the late 90s and the establishment of the Internet has led to consecutive growth in revenues, reaching almost 35% growth in 2018. For the past 10 years however, investments in the telecommunications sector in OECD countries have been relatively stable reaching US$ 202 billion in 2018, 15% relative to revenues, dropping from respective shares of early 1980s and 1990s (OECD, 2020b).

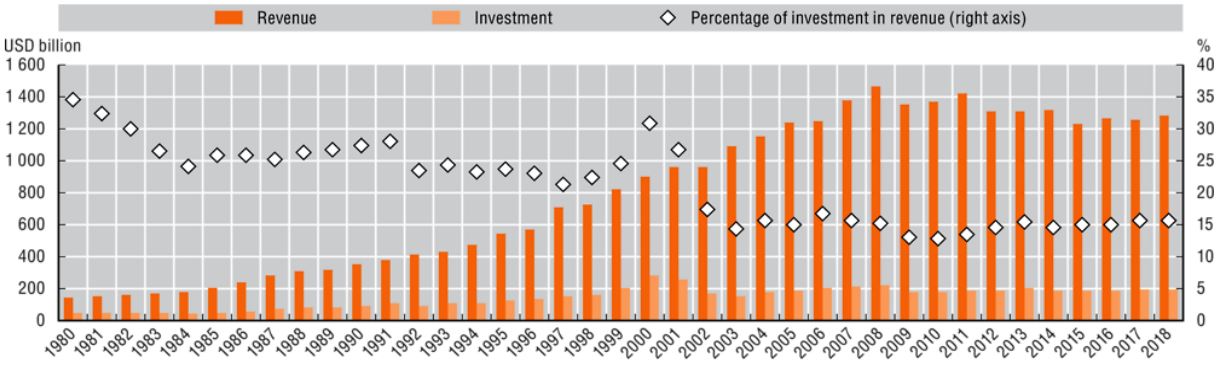



Figure 11: Telco revenue & investment in OECD area, 1980 – 2018

The aggregate of revenues and investment in the telco sector has seen a gradual decline in the OECD countries for the past, post – recession decade (2008-2018), if expressed as a share of gross domestic product, averaging at 2.8% of GDP. Revenues have seen a further negative

growth, two years prior to the onset of the COVID-19 Pandemic (2016-2018), dropping from 3.2% to 2.4% of GDP, (OECD, 2020b).

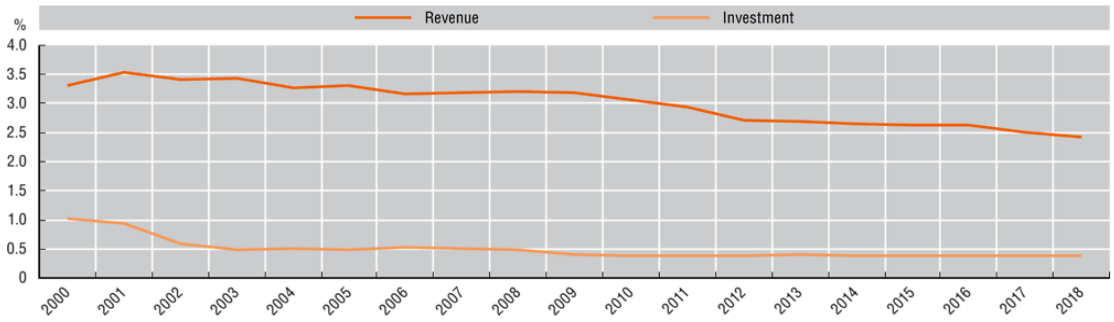



Figure 12: Telco revenue & investment as share of GDP in OECD area, 1980 – 2018

Prior to the outbreak of the COVID-19 Pandemic, R&D expenditure of ICT businesses had been on the rise. R&D intensity was high in OECD countries, with the ICT industry contributing more than half. Israel and Korea are leading the race. Greece was lagging behind the OECD and the EU average, in overall business expenditure as well as ICT expenditure in 2017 (OECD, 2020c).

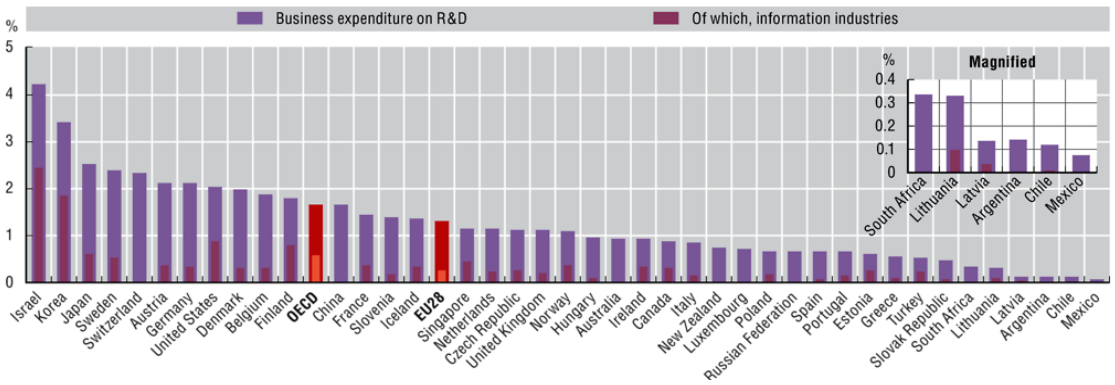
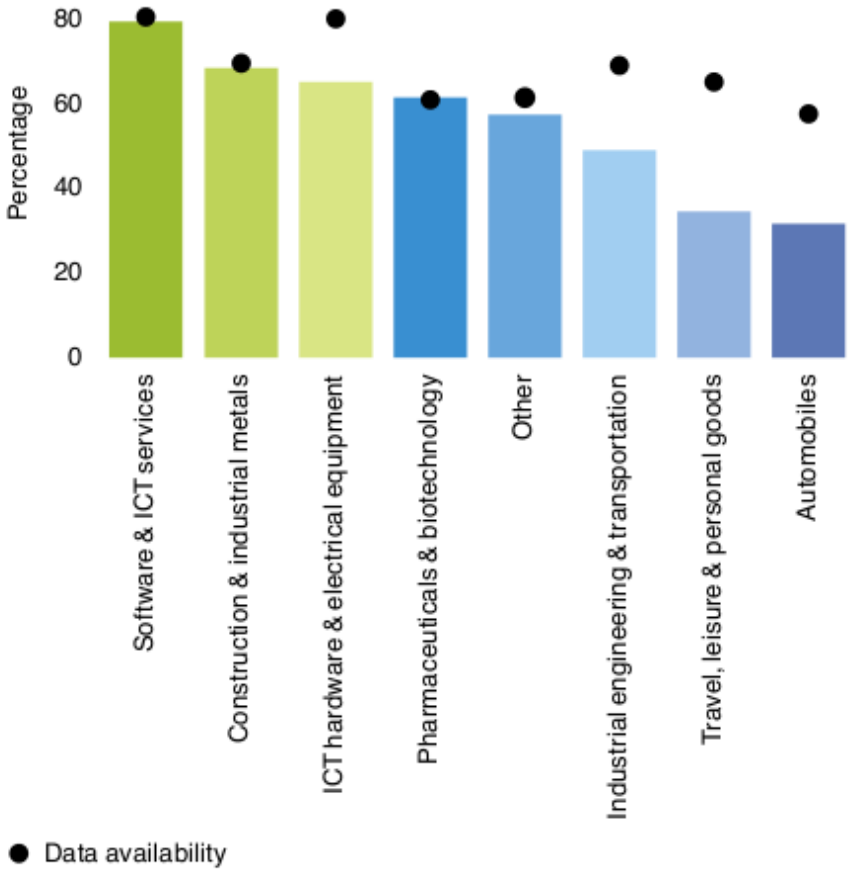



Figure 13: Business R&D expenditure in total and in ICT sector, as share of GDP, 2017

The ICT sector has found a catalyst of digital transformation in the face of the Pandemic. All aspects of socioeconomic activities have grown to depend on digital technology in disparate fields, from distance learning, to e-commerce, to remote

working, with digital solutions being a pillar of the pandemic management (OECD, 2020c). Nationwide data regarding R&D spending are mostly pending for 2020 due to the outbreak of COVID-19. Corporate R&D investment data for 2,500 of the largest spenders globally report a 10% increase in spending, with 60% of the corporations closing the year with an increase in R&D spending. The software sector leads the race with 80% increase, while hardware trails from 3rd position with a 65% increase (WIPO, 2021).




Source: Data sourced from the Bureau van Dijk Orbis database, where annual 2019 and 2020 data were utilized.

Note: Percentage changes were calculated as the difference between the 2020 and 2019 financial results over the 2019 results.

Figure 14: Share of firms reporting R&D expenditure increases, 2020

Industry patterns reveal the diverse pandemic impact. The ICT sector, software more than hardware, gained from the crisis as seen by the increase of R&D expenditure global leaders (WIPO, 2021).

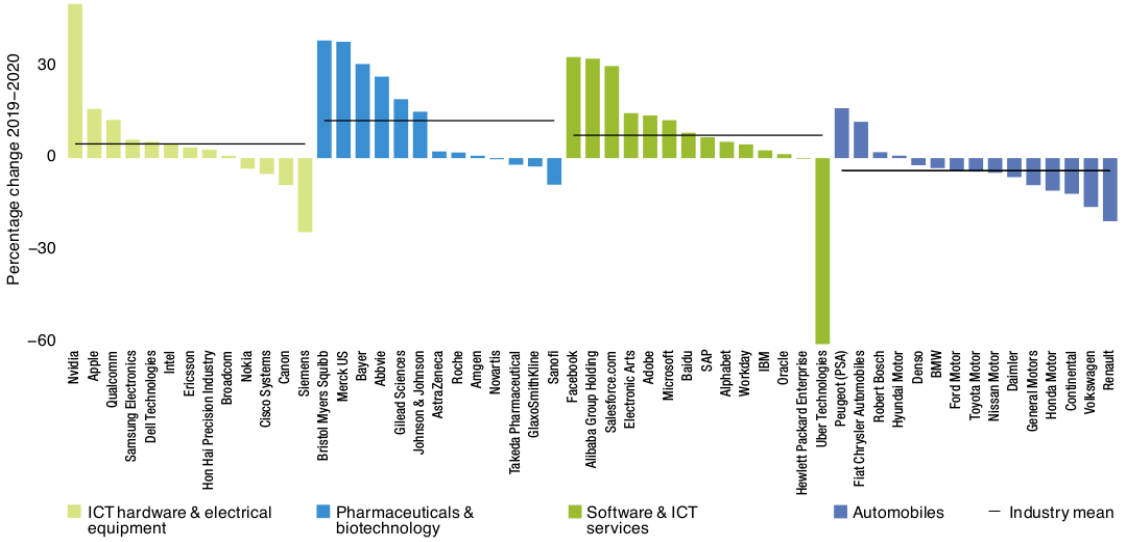



Figure 15: Corporate R&D expenditure, global top R&D spenders worldwide, 2020 growth

A 2019 snapshot of the global state of entrepreneurship of the Global Entrepreneurship Index (GEI) map of 2019, offers a benchmark metric of both the quality of entrepreneurship across countries and the extend and depth of supporting entrepreneurial ecosystems. Dark colored countries top the index, while lighter colored ones follow (Acs et al, 2019).

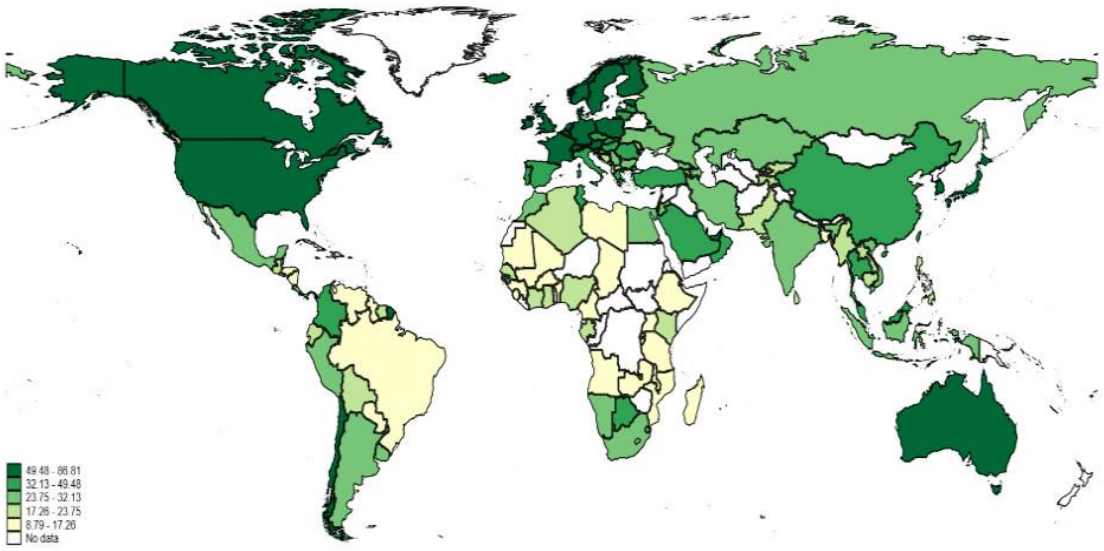
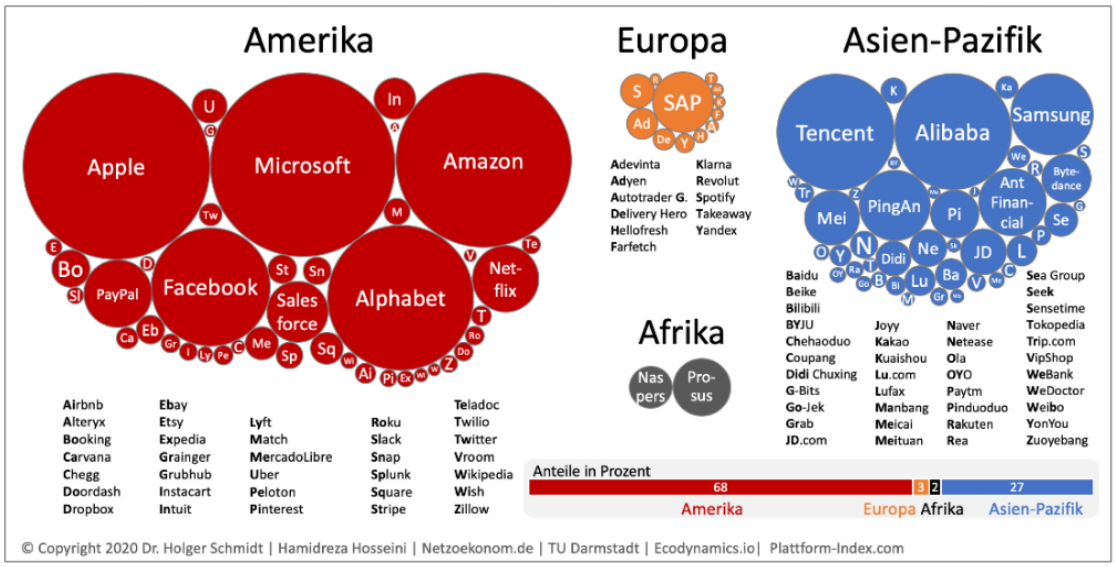



Figure 16: Global Entrepreneurship Index Map, 2019

***Macro – economic evidence of the global ICT economy and relative position of the European one***

Studying top digital platform companies, such as Apple, Amazon, Microsoft, Facebook, and Google, gives an insight on the state of the global digital ecosystem. Firms based in US and China dominate the global digital ecosystem. The top 15 companies account for 75% of the whole digital platform market value, where 68% is held by US corporations. Country size plays a definitive role. European platform-based companies are a fraction of the global pie (3%), getting even smaller after Brexit. Uniform EU policies towards nurturing sustainable, dynamic entrepreneurship and platform-based ecosystems and open, compatible, innovative ones, are viable measures to counter small presence (Acs et al, 2020b).




Source: https://www.netzoekonom.de/plattform-oekonomie/

Figure 17: Top 100 platform companies globally, 2020

Switzerland topped the GEI 2018 Europe rankings. Recommendations were the same: Supporting geographical and social networks that connect entrepreneurs would correct problems encountered in the European region (Acs et al., 2018). Europe is the second most innovative world region, behind North America, with 16 European countries occupying the top 25 global innovative leaders. Conversely, the region's declining and older population size, keeps Europe behind in terms of market size and number of venture capital deals, trailing third after both N. America and the Asia – Pacific region (WIPO, 2021).

***Macro – economic evidence of the global ICT economy and relative position of the Greek one***

The Greek state of Entrepreneurship according to the GEI index of 2019 is 50$^{th}$ among 137, with an index score of 35,4 (Acs et al, 2019).

| Country | GEI Score | GEI Rank | ATT | ATT Rank | ABT | ABT Rank | ASP | ASP Rank |
|---|---|---|---|---|---|---|---|---|
| Greece | 35.4 | 50 | 33.8 | 58 | 39.6 | 42 | 32.7 | 55 |

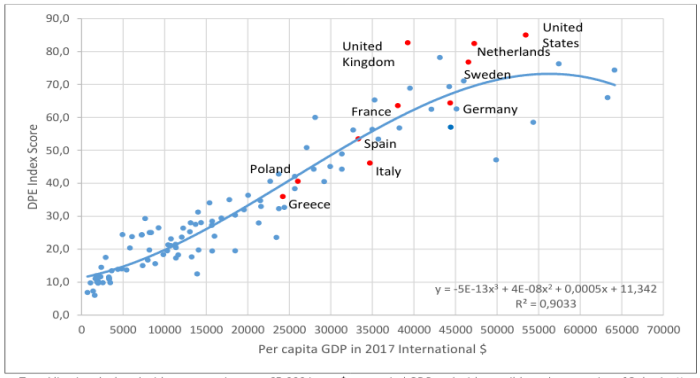
Table 3: GEI Index 2019, Greece

The Greek ecosystem deteriorates, ranking 48th among 137 countries, with a score of 37.1, as registered in the compatible index Global Entrepreneurship and Development Index (GEDI) 2018. The total factor productivity metric (TFP) as a product of productivity * innovation reveals stagnancy, where marginal innovative growth does happen, but gets negated by inefficiency in exploiting resources and potential capital (Acs et al, 2018).

Though entrepreneurial abilities (ABT), such as talent and capacity for absorption of technology, position the Greek economy in the 42nd place, the prevalent cultural norms, registered under the attitudes (ATT) sub-index, such as low opportunity perception and low risk acceptance and the low aspiration for growth or presence in the international environment of the aspirations (ASP) sub-index, keep the country's entrepreneurial ecosystem lower than the potential of its human capital.

Using the successor framework of GEI, the Digital Entrepreneurship Index of 2020, presents similar results. The Greek digital entrepreneurship ecosystem ranks 43rd among 116 countries, with an index score of 35.9. Due to lack of more detailed data, it is prudent to mention that Greece belongs to the 3rd group by DEI ranking (out of 4), nicknamed "Gainers". In this group there are abundant citizens, that are users of digital technologies, who will gain by unexploited development opportunities.

The Digital Platform Economy Index 2020, which is the most up to date iteration of the DEI index, shares common characteristics. In all these three indices, top ranks are occupied by highly developed, innovation driven economies. A close correlation is noted between digital entrepreneurship and development as expressed by per capita GDP in purchasing power parity (Acs et al, 2020a).




Note: Trend line is calculated without countries over 65 000 inter. $ per capital GDP and without oil-based economies of Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, United Arab Emirates.

Figure 18: Connection between development and DPE Index scores, 2020

Although there exists no causality between the two, the trend line marks a strong connection. Deviations do exist. Greece among them, scores lower than expected in the DPE index. Therefore, more reasons than the low GDP per capita should be sought. A hypothesis could be that low income, functions as a multiplier and impacts disproportionately the health of a digital entrepreneurship ecosystem. This idea stems from a joint econometric analysis by Facebook, OECD, and the World Bank, during May – December 2020, conducted among 32 OECD countries, stating that the smaller the firms, the more likely they were to cease operation. The percentage difference between self-employed single person enterprises and SMEs employing between 50-249 persons, was 10% (OECD, 2021a)

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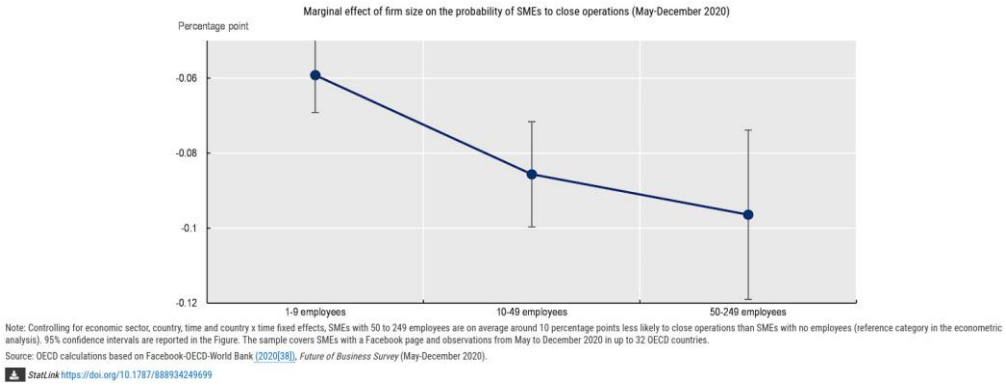



Figure 19: The smaller the SMEs the more likely they were to close operations

Delving further into sub-indices of GEI, DEI and DPE and their constituent indicators, may reveal strengths and weaknesses. On the horizontal axis of the following figure is presented the deviation between the efficiency of the digital entrepreneurship environment and development, expressed by GDP per capita, as per the previous figure and implied by its trend line. The vertical axis depicts the difference between the score of the digital ecosystem sub-score and the entrepreneurial ecosystem ones. Countries are classified in four different quadrants. One particularly interesting and highlighted case is Greece, belonging to the second quadrant: The overall DPE index development is well below the expected. The positive difference vertically, means that the Greek entrepreneurial ecosystem lags behind the digital one. Though the

difference lies below the alarming 10% threshold, that would describe two out of sync ecosystems, corrective measures are advised to develop both ecosystems, with the entrepreneurial dimension being in need for more correction (OECD, 2021a).

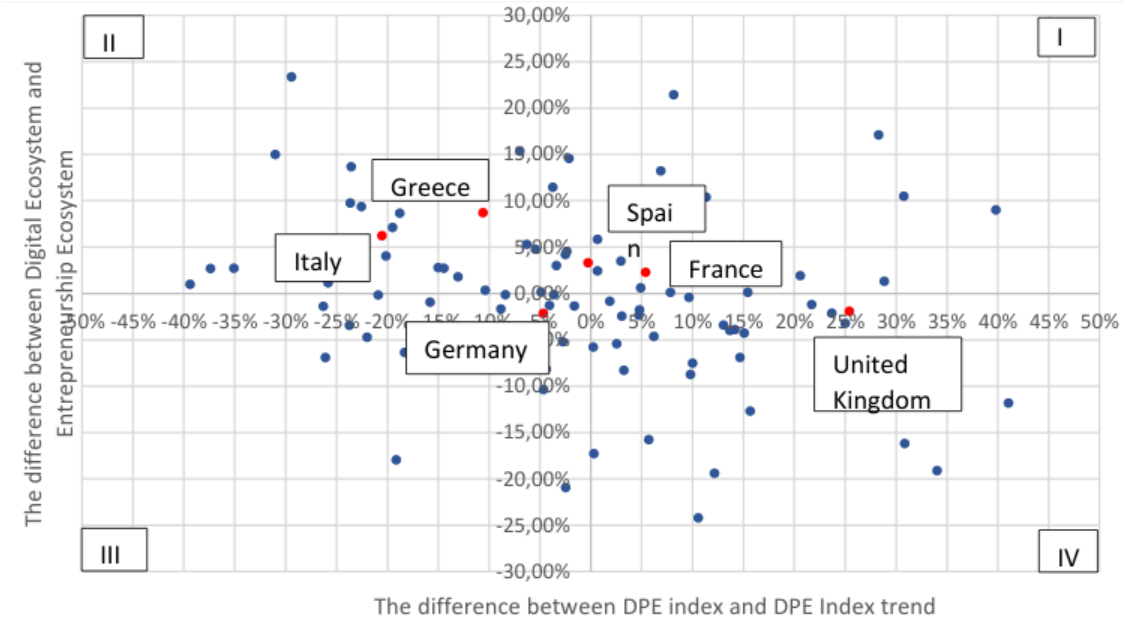



Figure 20: Four groups of countries based on difference between digital and entrepreneurship ecosystems and DPE Index and development

Similar results are cross – validated by the Global Innovation Index (GII) 2021. Greece ranks 47$^{th}$ among 132 countries, with a GII index score of 36.3 (WIPO, 2021).

| GII Rank | Economy | Score | Income Group Rank | Region Rank |
|---|---|---|---|---|
| 47 | Greece | 36.3 | 39 | 30 |

Table 4: GII Index 2021, Greece

Greece registers in the GII index as under-performing innovation-wise relative to its development level in the group high income countries, one of the only three underperforming European countries, the other two being Lithuania and Romania. This is also clearly seen from the ranking difference between the innovation input (39th) and the output (60$^{th}$). The Greek innovation ecosystem is inefficient in transforming innovation inputs into outputs.

The spearhead of the Greek ecosystem is its human capital and research. It ranks 16th globally in the GII index of 2021, while the economy is hindered mainly by market and business sophistication (70th and 60th rankings in GII 2021 respectively) among other weaknesses (WIPO, 2021).

Greece ranks 45th among 134 countries, by the Network Readiness Index (NRI) 2020, with an index score of 55.2. Ranking per pillar shed more light into national strengths and weaknesses (Dutta & Lanvin, 2020).

| Economy | NRI Ranking | Technology | People | Governance | Impact |
|---|---|---|---|---|---|
| Greece | 45 | 39 | 46 | 49 | 55 |

Table 5: NRI Index 2020, Greek Ranking per pillar

***Macro – economic evidence of the Greek Economy***

GII 2020 indicators of note for presenting crucial comparative strengths of the Greek ICT ecosystem are (WIPO, 2021):

| | Indicator name | Score / Value | Rank |
|---|---|---|---|
| 2.2.1 | Tertiary enrollment, % gross | 142.9 | 1 |
| 3.1.1 | ICT access | 84.2% | 21 |
| 6.1.4 | Scientific and technical articles/bn PPP$ GDP | 38 | 21 |
| 6.2.3 | Software spending, % GDP | 0.5 | 10 |
| 6.2.4 | ISO 9001 quality certificates/bn PPP$ GDP | 19.4 | 14 |

Table 6: GII Index 2021, Greek Economy Strengths as per high-ranking indicators

Greece holds the 1st position globally for the percentage of tertiary enrollment from the age group that could potentially enroll for university degrees. It is well over 100%, due to repetitive registration, but denotes the Greek social norm for higher education. The ICT access ranking is quite high (21st), broadband bandwidth being the drawback, revealing however an adequate digital infrastructure. The number of published articles on scientific and technical domains indicator, holds a higher ranking (21st) than the total index ranking of Greece, revealing a higher potential on account of human capital. Software spending, reaching 0.5% of the country's GDP, ranking Greece 10th comes as a positive surprise, given the long history of prevalent piracy. BSA's (most renowned authority on unlicensed software) latest report of

2018, still registered Greece as a negative outlier of the group of Western Europe countries, with 61% unlicensed software installations, accounting for an estimated lost commercial value of 173M US$ (BSA, 2018), roughly equivalent to 55.27% of the software market value of Greece for 2018 (EITO – SEPE, 2020). ISO quality certificates, occupies the 14th place, telling the story of an ecosystem investing for quality and vying for brand recognition. On the contrast are the respective crucial comparative weaknesses (WIPO, 2021):

| | **Indicator name** | **Score/Value** | **Rank** |
|---|---|---|---|
| 1.1.1 | Political and operational stability | 71.4 | 54 |
| 1.1.2 | Government effectiveness | 59.7 | 50 |
| 1.2.1 | Regulatory quality | 57.3 | 47 |
| 1.2.2 | Rule of law | 52 | 54 |
| 3.1.3 | Government's online service | 70.6 | 65 |
| 3.2.3 | Gross capital formation, % GDP | 11.9 | 121 |
| 4.1.1 | Ease of getting credit | 45 | 101 |
| 4.2.2 | Market capitalization, % GDP | 22.7 | 56 |
| 4.2.4 | Venture capital recipients, deals/bn PPP$ GDP | 0.0 | 81 |
| 5.2.1 | University-industry R&D collaboration | 31.0 | 110 |
| 5.2.2 | State of cluster development and depth | 32.8 | 118 |
| 5.3.2 | High-tech imports, % total trade | 5.1 | 110 |
| 6.1.3 | Utility models by origin/bn PPP$ GDP | 0.0 | 61 |
| 6.2.1 | Labor productivity growth, % | -2.1 | 104 |
| 6.2.5 | High-tech manufacturing, % | 14.1 | 78 |
| 7.1.2 | Global brand value, top 5,000, % GDP | 4.9 | 68 |
| 7.1.4 | ICTs and organizational model creation | 44.6 | 97 |

Table 7: GII Index 2021, Greek Economy Weaknesses as per low-ranking indicators

A decade long recession, combined with frequent changes in office, spells a volatile political and public administration environment. This instability plays a negative role

for business activities, whereas the lack of credibility on implementing policies and reforms as well as the quality of civil service and state function being affected by political changes forms a damaging perception for investors. The failing public sentiment about justice delivery, as well the incapacity to formulate and pass socially acceptable policies that promote the development of entrepreneurship are negative factors. Credit is inaccessible for most Greek entrepreneurs, ranking the country very low (101$^{st}$). Gross capital formation is very low (11.9% of GDP), among the lowest in the index (121$^{st}$) revealing the untapped potential of uninvested wealth. Combined with Greece's small population size and the low market capitalization of domestic firms and the very low input of fund, as expressed by venture capital recipients draws a picture of an unsophisticated, immature market, that is not likely to grow. The extremely low ranking (110$^{th}$) of the university – industry R&D collaboration indicator, explains clearly why Greece does not manage to capitalize on research and innovation conducted by trained and talented people and why its entrepreneurial ecosystem falls largely behind its digital ecosystem. The very low ICT and organizational model creation indicator (97$^{th}$) explains why advanced digital and information technologies do not contribute as anticipated in reforms and restructuring of the ecosystem. Administrative (business or state) decisions take place in isolation of digital evolution and do not consider innovation that takes place in Greece. The complete Greek GII profile is presented in figure 59 of the appendix (WIPO, 2021).

The NRI index 2020 shares common insights. The following indicators highlight strengths of the Greek ICT economy (Dutta & Lanvin, 2020):

| | **Indicator** | **Rank/134** | **Score** |
|---|---|---|---|
| 1.1.5 | Fixed broadband subscriptions | 17 | 95.64 |
| 1.3.4 | Computer software spending | 13 | 52.90 |
| 2.1.4 | Tertiary enrollment | 1 | 100.00 |
| 3.2.4 | E-Commerce Legislation | 1 | 100.00 |

Table 8: NRI Index 2020, Greek Economy Strengths as per high-ranking indicators

The NRI 2020 findings are roughly common with the GII 2021 for the first three indicators. E-commerce legislation comes as a surprise, given the late adoption of e-

commerce in Greece (3.1.4: Internet shopping ranks 47th) and the imbalance of other regulatory indicators, such as "Legal framework's adaptability to emerging technologies, which ranks 78th) lagging significantly behind. A more balanced outlook of all regulatory indicators would yield more meaningful and valuable results for the ecosystem. A respective table highlighting weaknesses, showcased by NRI 2020 follows:

| | **Indicator** | **Rank/134** | **Score** |
|---|---|---|---|
| 1.3.1 | Adoption to emerging technologies | 85 | 38.50 |
| 1.3.2 | Investment in emerging technology | 110 | 23.53 |
| 2.3.3 | Government promotion of investment in emerging technologies | 107 | 17.92 |
| 4.1.5 | Prevalence of gig economy | 104 | 24.40 |
| 4.2.2 | Freedom to make life choices | 127 | 40.60 |

Table 9: NRI Index 2020, Greek Economy Weaknesses

The first four indicators are based on the annual executive opinion survey of the World Economic Forum and the picture the first three draw is of insufficient adoption or promotion of new technologies by both the public and the private sector. Gig economy is focusing on short-term contracts. Low scores can be interpreted both as low penetration of digital platforms and undocumented labor relations in Greece. The last indicator, based on survey conducted to the public, reveals unhappy, unmotivated actors of the Greek ecosystem (Dutta & Lanvin, 2020). The complete Greek NRI 2020 profile is presented in figure 60 of the appendix.

The Going Digital Policy Frameworks indicators summarized map is depicted in the following figure (OECD, 2020a).

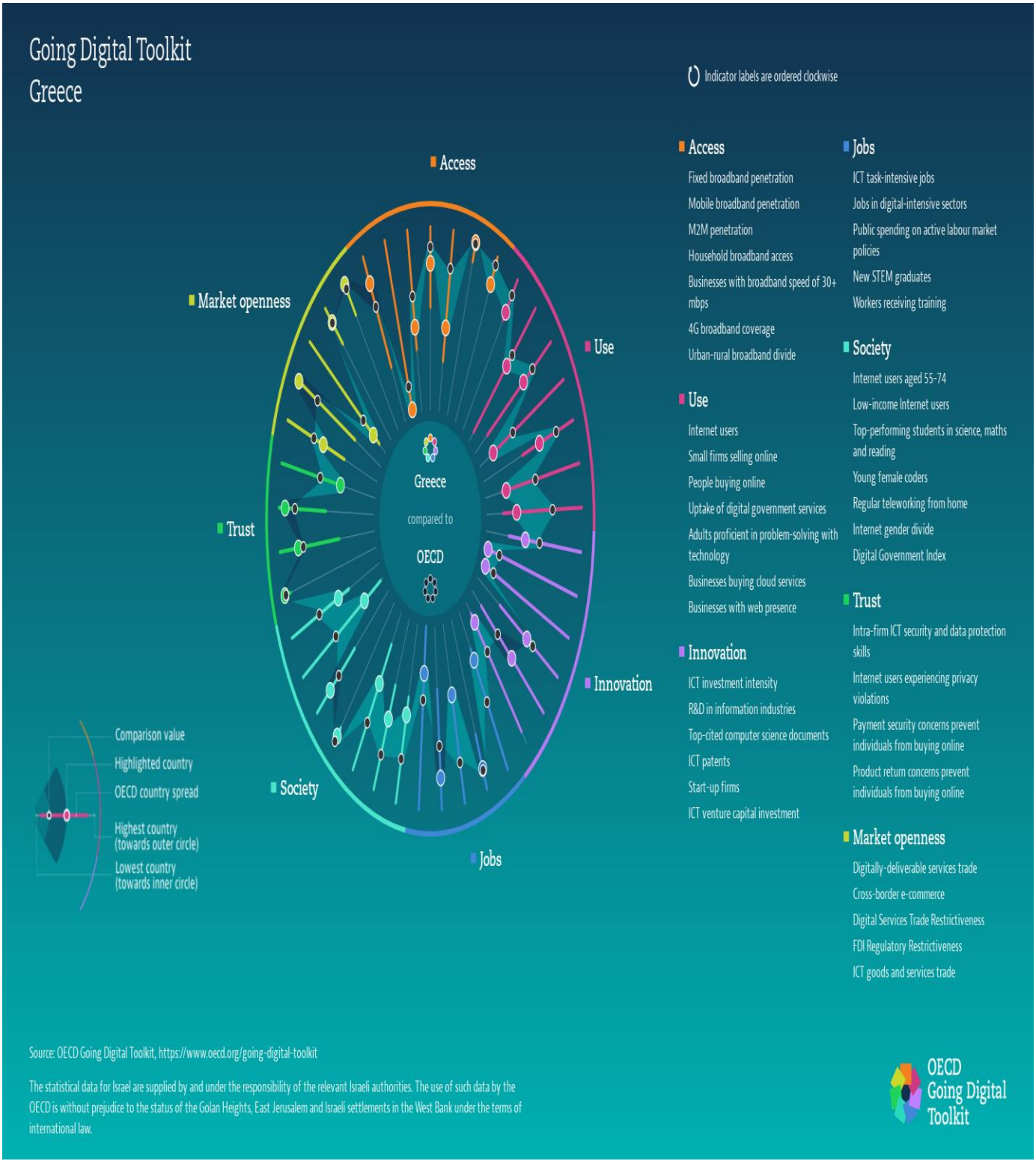



Figure 21: Going Digital Toolkit, Greek map

The top leading Greek indicators, highlighting the strengths of the Greek digital entrepreneurship ecosystem are listed in the following table (OECD, 2020a):

| Indicator | Rank | Score |
|---|---|---|
| Workers' job stress related to computer use | 3/26 | 1.5% |
| Internet users experiencing privacy violations | 7/33 | 1.7% |
| 4G broadband coverage | 25/44 | 98.8% |

Table 10: Going Digital Toolkit 2020, Greek strengths, expressed by top leading indicators

The first indicator is linked with work unhappiness and burnout likelihood. Greece shows the 3rd lowest score among 26 countries, surpassed only by Czech Republic and Turkey. The Greek ecosystem manages to keep satisfactory safety standards for personal information, with only 1.7% of the population reporting being a victim of privacy violations in 2019, below EU average (3.43%). 4G broadband coverage is the 3rd leading indicator, especially considering the heterogeneous, mountainous or island dotted geographic landscape of the country. In contrast, the lowest 3 indicators, are listed in the next table (OECD, 2020a).

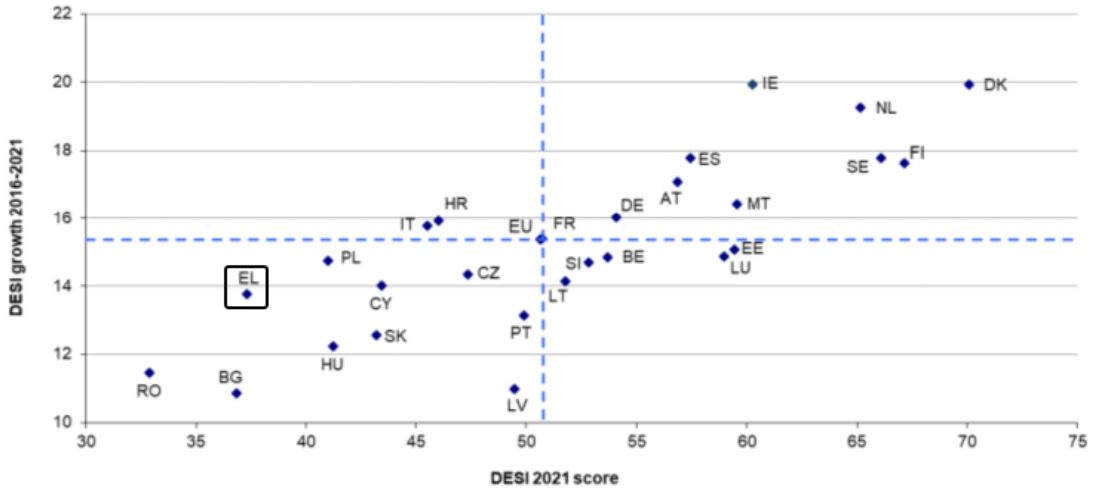
| Indicator | Rank | Score |
|---|---|---|
| Digital-intensive sectors' contribution to growth | 28/28 | -9.07% |
| M2M penetration | 35/39 | 5.51% |
| R&D in information industries | 33/40 | 0.09% |

Table 11: Going Digital Toolkit 2020, Greek weaknesses, expressed by low lagging indicators

Greece holds the last position and the only negative contribution of high-intensity digital sector either by technology or human capital. Greek M2M (Machine to Machine) penetration stands at 5.51% (M2M SIM card / 100 consumer subscriptions), one of the lower rankings (35/39), much lower than the OECD average of 27%, marking the non – readiness of the Greek ecosystem for Internet of Things (IoT). R&D in information industries is one the lowest lagging indicators of Greece. It should be studied with indicators 6.2.3 of the GII 2021 index (Software spending, % GDP) and

1.3.4 of the NRI 2020 index (Computer software spending) in mind where Greece registers high rankings. Taking all three into account, Greece is a top consumer of software products, while R&D investment by firms is kept at a minimum. Seeing through this contradiction, one may reason that most software is imported and not developed in house.

Digital Economy and Society Index (DESI) 2021 assesses the overall level of digitization of each country's ecosystem over the past 5 years. Romania, Bulgaria, and Greece have the lowest index scores (DESI, 2021).




*Source: DESI 2021, European Commission.*

Figure 22: DESI 2021, EU member states' progress

Greece ranks 25$^{th}$ among 27 EU member states. The country continues to improve its performance almost among all the index's dimensions, yet it falls below the EU average, as witnessed in the following figure (DESI, 2021).

| | Greece | | EU |
|---|---|---|---|
| | rank | score | score |
| DESI 2021 | 25 | 37.3 | 50.7 |

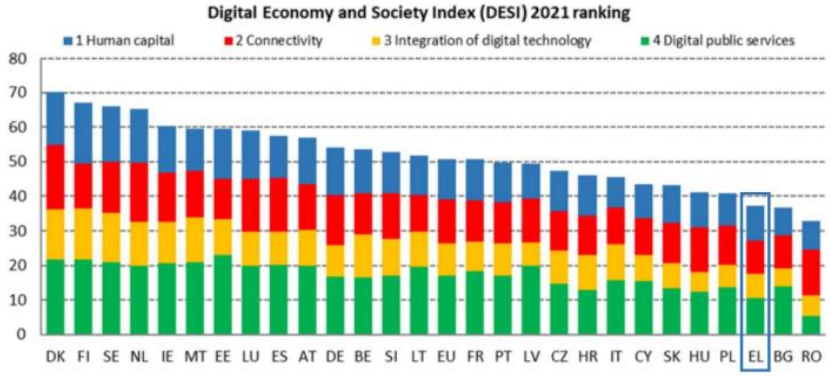
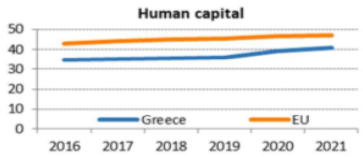



Figure 23: DESI 2021 ranking

Percentages of ICT specialists and ICT graduates, as well as people with basic digital and software literacy remain low and relatively stable. Female ICT specialists are growing extremely fast, above EU average since 2020, making the difference and the country a front-runner in the region in this specific indicator(DESI, 2021)

## 1 Human capital

| 1 Human capital | Greece | | EU |
|---|---|---|---|
| | rank | score | score |
| DESI 2021 | 21 | 41.0 | 47.1 |




| | Greece | | | EU |
|---|---|---|---|---|
| | DESI 2019 | DESI 2020 | DESI 2021 | DESI 2021 |
| **1a1 At least basic digital skills**<br>% individuals | 46%<br>2017 | 51%<br>2019 | 51%<br>2019 | 56%<br>2019 |
| **1a2 Above basic digital skills**<br>% individuals | 22%<br>2017 | 23%<br>2019 | 23%<br>2019 | 31%<br>2019 |
| **1a3 At least basic software skills**<br>% individuals | 52%<br>2017 | 56%<br>2019 | 56%<br>2019 | 58%<br>2019 |
| **1b1 ICT specialists**<br>% individuals in employment aged 15-74 | 2.3%<br>2018 | 2.1%<br>2019 | 2.0%<br>2020 | 4.3%<br>2020 |
| **1b2 Female ICT specialists**<br>% ICT specialists | 16%<br>2018 | 20%<br>2019 | 27%<br>2020 | 19%<br>2020 |
| **1b3 Enterprises providing ICT training**<br>% enterprises | 14%<br>2018 | 15%<br>2019 | 12%<br>2020 | 20%<br>2020 |
| **1b4 ICT graduates**<br>% graduates | 2.9%<br>2017 | 3.1%<br>2018 | 3.4%<br>2019 | 3.9%<br>2019 |

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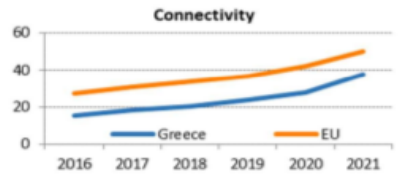
Figure 24: DESI 2021, Greek human capital ranking

Concerning connectivity, Greece ranks last in EU. However, progress across most indicators leads to a convergence with EU average, namely fast broadband coverage

and 4G coverage. Very high-capacity networks have started to be deployed in 2020. Though there is progress in infrastructure and price competitiveness to access digital services of high requirements, more efforts are needed to maximize investments and foster a promising digital ecosystem (DESI, 2021).

## 2 Connectivity

| 2 Connectivity | Greece | | EU |
|---|---|---|---|
| | rank | score | score |
| DESI 2021 | 27 | 37.7 | 50.2 |



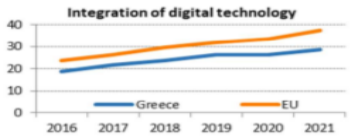

| | Greece | | | EU |
|---|---|---|---|---|
| | DESI 2019 | DESI 2020 | DESI 2021 | DESI 2021 |
| **2a1 Overall fixed broadband take-up**<br>% households | 74%<br>2018 | 76%<br>2019 | 77%<br>2020 | 77%<br>2020 |
| **2a2 At least 100 Mbps fixed broadband take-up**<br>% households | 0%<br>2018 | 1%<br>2019 | 3%<br>2020 | 34%<br>2020 |
| **2a3 At least 1 Gbps take-up**<br>% households | NA | <0.01%<br>2019 | <0.01%<br>2020 | 1.3%<br>2020 |
| **2b1 Fast broadband (NGA) coverage**<br>% households | 66%<br>2018 | 81%<br>2019 | 87%<br>2020 | 87%<br>2020 |
| **2b2 Fixed Very High Capacity Network (VHCN) coverage**<br>% households | 0%<br>2018 | 7%<br>2019 | 10%<br>2020 | 59%<br>2020 |
| **2c1 4G coverage**<br>% populated areas | 98.2%<br>2018 | 99.1%<br>2019 | 99.2%<br>2020 | 99.7%<br>2020 |
| **2c2 5G readiness**<br>Assigned spectrum as a % of total harmonised 5G spectrum | 0%<br>2019 | 0%<br>2020 | 99%<br>2021 | 51%<br>2021 |
| **2c3 5G coverage**<br>% populated areas | NA | NA | 0%<br>2020 | 14%<br>2020 |
| **2c4 Mobile broadband take-up**<br>% individuals | 52%<br>2018 | 60%<br>2019 | 60%<br>2019 | 71%<br>2019 |
| **2d1 Broadband price index**<br>Score (0-100) | NA | 49<br>2019 | 53<br>2020 | 69<br>2020 |

Figure 25: DESI 2021, Greek connectivity ranking

The integration of digital technologies to business activities, brings Greece to 22nd place in the EU. Electronic information sharing by enterprises, big data and ICT usage for environmental sustainability are the indicators that are on par with EU average. Greek firms show a state-of-the-art integration of Artificial Intelligence. The country is still struggling, with the everyday staple of entrepreneurial value, such as e-invoices, SMEs selling online, low SMEs turnover or selling internationally (DESI, 2021).

## 3 Integration of digital technology

| 3 Integration of digital technology | Greece rank | Greece score | EU score |
|---|---|---|---|
| DESI 2021 | 22 | 28.5 | 37.6 |



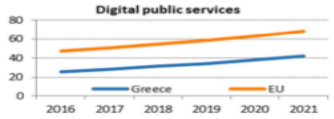

| | Greece DESI 2019 | Greece DESI 2020 | Greece DESI 2021 | EU DESI 2021 |
|---|---|---|---|---|
| 3a1 SMEs with at least a basic level of digital intensity<br>% SMEs | NA | NA | NA<br>2020 | 60%<br>2020 |
| 3b1 Electronic information sharing<br>% enterprises | 37%<br>2017 | 38%<br>2019 | 38%<br>2019 | 36%<br>2019 |
| 3b2 Social media<br>% enterprises | 21%<br>2017 | 19%<br>2019 | 19%<br>2019 | 23%<br>2019 |
| 3b3 Big data<br>% enterprises | 13%<br>2018 | 13%<br>2018 | 13%<br>2020 | 14%<br>2020 |
| 3b4 Cloud<br>% enterprises | 7%<br>2018 | 7%<br>2018 | NA<br>2020 | 26%<br>2020 |
| 3b5 AI<br>% enterprises | NA | NA | 34%<br>2020 | 25%<br>2020 |
| 3b6 ICT for environmental sustainability<br>% enterprises having medium/high intensity of green action through ICT | NA | NA | 65%<br>2021 | 66%<br>2021 |
| 3b7 e-Invoices<br>% enterprises | 9%<br>2018 | 9%<br>2018 | NA<br>2020 | 32%<br>2020 |
| 3c1 SMEs selling online<br>% SMEs | 11%<br>2018 | 9%<br>2019 | NA<br>2020 | 17%<br>2020 |
| 3c2 e-Commerce turnover<br>% SME turnover | 4%<br>2018 | 4%<br>2019 | NA<br>2020 | 12%<br>2020 |
| 3c3 Selling online cross-border<br>% SMEs | 7%<br>2017 | 4%<br>2019 | 4%<br>2019 | 8%<br>2019 |

Figure 26: DESI 2021, Greek digital integration ranking

Greece holds the 26th position among 27 EU member states in relation to digital public services. Though e-Government users are over the EU average, the main service they subscribe to is paying taxes. Pre-filled forms, interoperable information systems, digital public services for citizens and business are still lagging below EU average. COVID-19 sped things towards a digital transformation and a one stop shop e-government (egov.gr). Next year's DESI should encompass these changes and it remains to be seen how much progress has been achieved across this dimension (DESI, 2021).

## 4 Digital public services

| 4 Digital public services | Greece rank | Greece score | EU score |
|---|---|---|---|
| DESI 2021 | 26 | 41.9 | 68.1 |




| | Greece DESI 2019 | Greece DESI 2020 | Greece DESI 2021 | EU DESI 2021 |
|---|---|---|---|---|
| 4a1 e-Government users<br>% internet users | 68%<br>2018 | 68%<br>2019 | 67%<br>2020 | 64%<br>2020 |
| 4a2 Pre-filled forms<br>Score (0 to 100) | NA | NA | 36<br>2020 | 63<br>2020 |
| 4a3 Digital public services for citizens<br>Score (0 to 100) | NA | NA | 54<br>2020 | 75<br>2020 |
| 4a4 Digital public services for businesses<br>Score (0 to 100) | NA | NA | 54<br>2020 | 84<br>2020 |
| 4a5 Open data<br>% maximum score | NA | NA | 85%<br>2020 | 78%<br>2020 |

Figure 27: DESI 2021, Digital public services ranking

The GEM index of 2020/2021 assesses the impact of the COVID-19 Pandemic on entrepreneurship. It is the framework used to address the ICT ecosystem of Thessaloniki. Knowing an entrepreneur is important because it modifies one's perspective. The likelihood of personally knowing an entrepreneur depends on dispersal of entrepreneurship across an ecosystem, as well as on its perceived importance. Knowing personally an entrepreneur is highly variable both across and within regions. In Greece just 32.5% personally know an entrepreneur, holding one of the last positions among sampled countries (41/43). Another interesting ratio is the proportion of knowing someone who has stopped a business due to pandemic over someone who started one. Within Europe and North America, 15 economies report a ratio of more than two to one. Greece has one of the worst ratios to show for (3.5) (GERA, 2021).

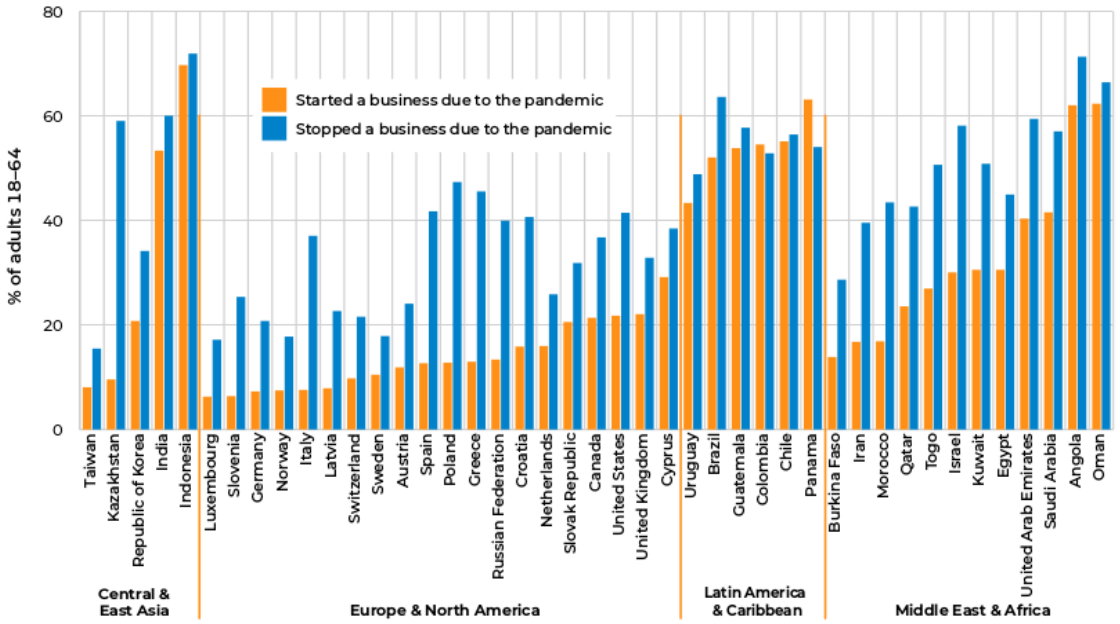



Figure 28: GEM 2020/21, Knowing someone who started or stopped a business due to the pandemic

Greek potential entrepreneurs are very conservative. Of those that can distinguish a good opportunity, more than half would not embark upon it for fear of failure. Greek respondents share the third worst position, behind Indians and Spaniards (GERA, 2021).

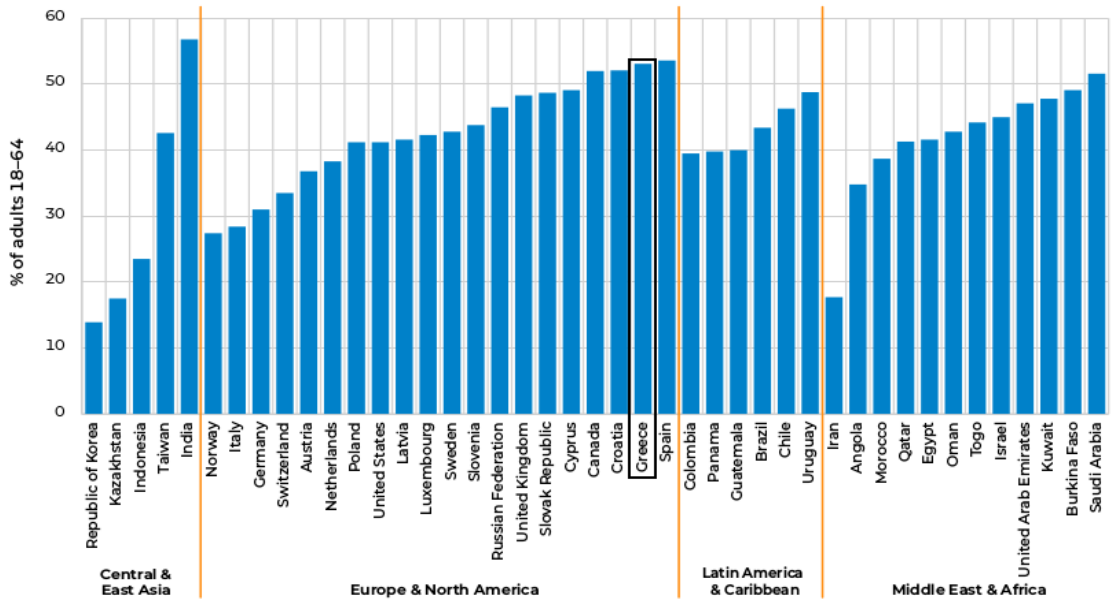



Figure 29: GEM 2020/21, Fear of failure

The entrepreneurial ecosystem in Greece is one of the least developed amongst GEM sample and this shows in indicator of the proportion of new starts in business services. On the other hand, of those enterprises that embark upon their journey, Greek ones show great international growth potential as they belong to the top 5 among 43 countries, where more than 40% of the firms have international customers (GERA, 2021).

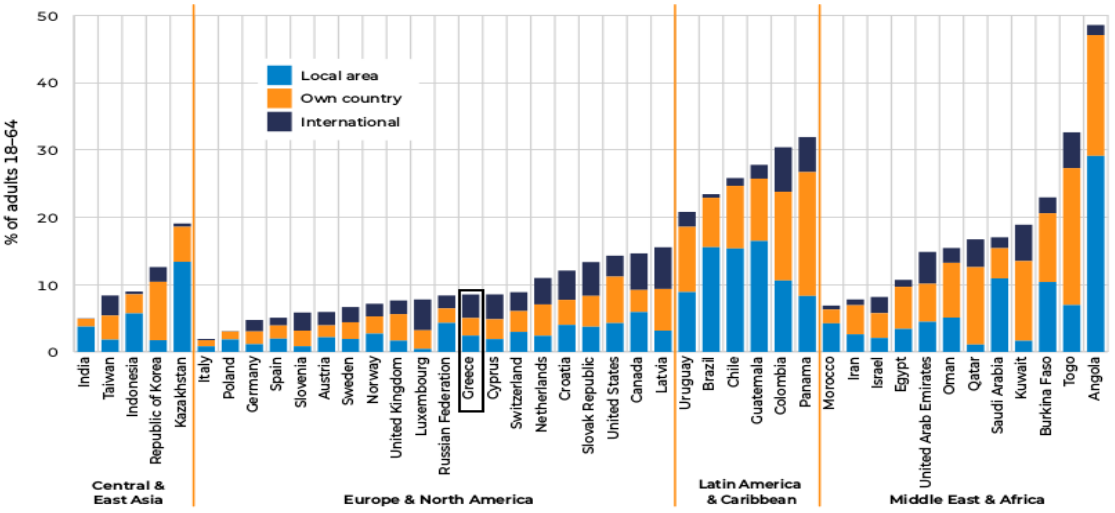



Figure 30: GEM 2020/21, Total early-stage Entrepreneurial activities

COVID-19 decreased 55% of household incomes in Greece. 77% of those starting a business stated the pandemic as the reason, hinting at a reactive attitude to the crisis and the skepticism of short-lived business ventures. Only 1% of Greek entrepreneurs plan on hiring 6 or more employees over the next 5 years, betraying a low growth mentality. A fallback and potential recovery asset of the Greek economy in case things go sour is the highest Established Business Ownership (EBO) rate of 14.6%. A detailed fact sheet of the Greek entrepreneurial ecosystem is presented in figure 61 of the appendix.

The Greek ICT market followed the growth rally of the global ICT market for the past 5 years, registering growth rates. Unfortunately, the uncertainty that was introduced at all levels of social and financial activity by the COVID-19 Pandemic, the ensuing health and financial crisis brings arrhythmia and financial turmoil to the Greek economy. This puts further strain both to Greek consumers and enterprises of all sizes as it comes in the aftermath of a decade long recession, that has depleted endurance levels of most ecosystem actors. Despite the important role that both information technology and the telecommunications sector play in the management of the pandemic and the rapid reform and rebound of the economy, both sectors registered negative market rates in 2020. This new crisis put an abrupt stop to a consecutively rising economy since 2017, albeit having less negative impact than other sectors of the Greek economy, such as tourism and leisure. 2021 was a rebound year, anticipated to close as a welcoming positive relief (albeit marginally) closing the fiscal year with a market value of 5.548 € B (EITO – SEPE, 2020).

| | **2017** | **2018** | **2019** | **2020** | **2021** | **2018/ 2017** | **2019/ 2018** | **2020/ 2019** | **2021/ 2020** |
|---|---|---|---|---|---|---|---|---|---|
| IT hardware | 510 | 560 | 597 | 555 | 586 | 9.7% | 6.6% | -7.0% | 5.7% |
| IT services | 940 | 973 | 1011 | 934 | 909 | 3.5% | 3.8% | -7.6% | -2.7% |
| Software | 296 | 313 | 340 | 322 | 326 | 5.8% | 8.5% | -5.4% | 1.2% |
| IT Total | 1747 | 1846 | 1947 | 1811 | 1821 | 5.7% | 5.5% | -7.0% | 0.6% |
| | | | | | | | | | |
| Telecommunications | 561 | 660 | 699 | 680 | 722 | 17.7% | 5.8% | -2.7% | 6.3% |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| hardware | | | | | | | | | |
| Telephony services | 3202 | 3154 | 3158 | 3059 | 3004 | -1.5% | 0.1% | -3.1% | -1.8% |
| Telecommunications Total | 3763 | 3815 | 3856 | 3739 | 3727 | 1.4% | 1.1% | -3.0% | -0.3% |
| | | | | | | | | | |
| ICT Total | 5.51 | 5.66 | 5.8 | 5.55 | 5.548 | 2.7% | 2.5% | -4.4% | 0.0% |

Table 5: ICT Greek market size by sectors

The Greek ICT sector offers employment to 89K people with dependent job relationship in 2020 (marginal decline by 1.000 employees from 2019) representing 2,64% of total domestic wage earners, while those self-employed reach 13K, down from high values of 2014 and 2015, representing a mere 1,03% of total domestic entrepreneurs (OECD, 2021c).

***Macro – economic evidence of the ICT Ecosystem of Thessaloniki***

A concise, non-exhaustive conceptual map of the ICT ecosystem of Thessaloniki like the ones used by Cunningham et al (2015) follows:

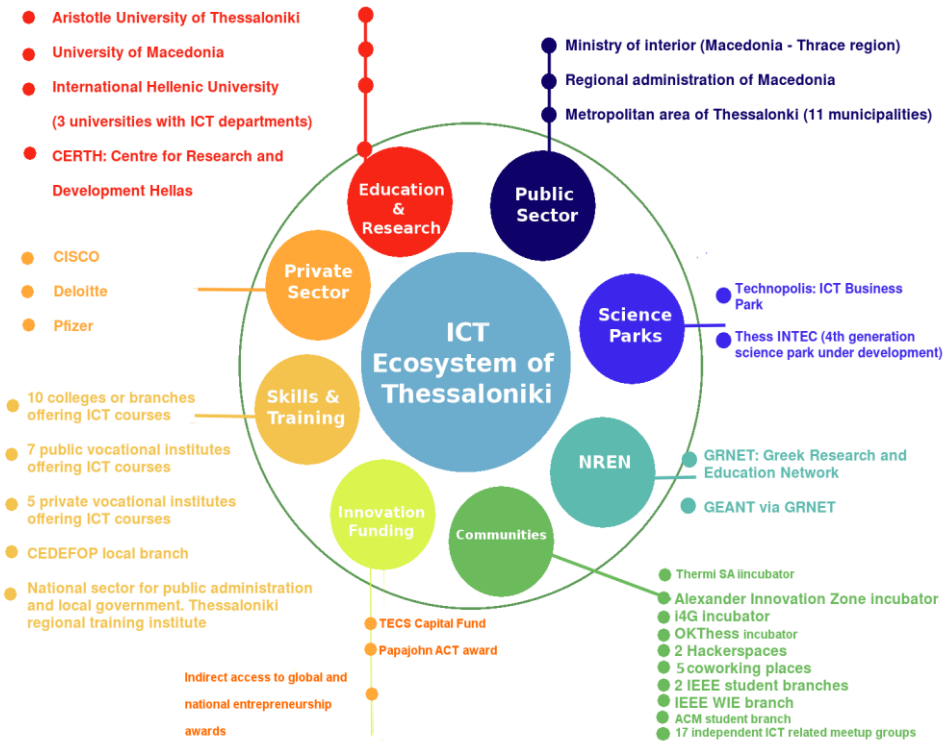



Figure 31: ICT ecosystem of Thessaloniki map

Though most seats of public administration lie in Athens, Thessaloniki is the regional seat of many agencies in the region of Macedonia. There exists an established ICT business park, while an advanced next generation one is under development. Thessaloniki has access to national and EU research and education networks, through GRNET.

The dimension of talented human capital is more than evident in Thessaloniki, which boasts of 3 universities, at least a long-standing center for advanced research, 10 colleges or branches thereof, 7 public and 5 private vocational institutes, all of which offer courses in ICT related domains, CEDEFOP's Greek branch for the European development of vocational training and the regional training center of the national center for public administration and local government.

It has a vibrant ICT community comprised of professionals and students alike. Indicatively, there exist 17 independent meetup.com groups, with 650 participants on average, from programmers, to engineers, to cryptocurrency and startup enthusiasts that managed to stay active during the pandemic. Four incubators, participating in accelerator, mentoring and entrepreneurship programs are functioning. At least 4 university student groups, affiliated with accredited science and technology organizations are active, meeting either in university amphitheaters, at least 2 open hacker spaces and at least 5 co-working spaces or open labs.

Its shortage of funds that are based on Thessaloniki, only one claiming so (TECS Capital Fund), is saturated by those based in Athens (6 new VC funds, facilitated by the EquiFund initiative), national entrepreneurship awards and competitions curated by the 4 systemic banks of Greece, the Hellenic Development Bank of Investment (HDBI), philanthropy foundations, as well as those curated by global agencies numbering just over 40 annually. This builds trust for further investors either managing venture capital or branching out of respected private sector firms with global reach. Cases, such as the recent local branch setting up in Thessaloniki of CISCO, Deloitte, and Pfizer (Pfizer Digital Innovation Hub), create ecosystem brand awareness and build expectations. Unicorns (startups valued over 1 US$ billion) is beyond the reach of the ecosystem of Thessaloniki, but it helps putting it in perspective, studying the Athenian ecosystem, which just in 2021 entered the global club of top 100 emergent ecosystem and

attained its first three unicorns: PeopleCert, Blueground and Viva Wallet (Found.ation-eitDigital, 2021).

An estimate of the ICT market of Thessaloniki can be made, based on source data by the Hellenic Statistical Authority. A minimum low end can be set at 1,695 business units, employing 5,163 people, generating a financial turnover just over 243M €. This is a much lower figure because due to statistical confidentiality, data are not disclosed for the following financial activities: “Computer and peripheral manufacturing”, “ICT hardware gross commerce”, “Wireless telecommunications activities”, “Satellite telecommunications activities”, “Research and experimental development in engineering and physical sciences”. A detailed table of the latest available data (2018) follows (Hellenic Statistical Authority, 2018):

| **Financial Activity Description** | **Number of business entities** | **Number of employees** | **Gross turnover (thousands of Euros)** |
|---|---|---|---|
| Reproduction of recorded media | 8 | 19 | 237 |
| Manufacture of electronics | 30 | 54 | 2,394 |
| Manufacture of ICT H/W | N/A | N/A | N/A |
| Manufacture of telco H/W | 13 | 24 | 1,169 |
| Manufacture of consumer electronics | N/A | N/A | N/A |
| Manufacture of cabling | 5 | 43 | 4,943 |
| ICT wholesale | N/A | N/A | N/A |
| ICT retail | 259 | 769 | 47,936 |
| Software Publishing | 28 | 413 | 35,201 |
| Fiber / copper telecommunications | 52 | 237 | 8,007 |
| Wireless telecommunications | N/A | N/A | N/A |
| Satellite telecommunications | N/A | N/A | N/A |
| Other telecommunications | 51 | 448 | 10,431 |

| | | | |
|---|---|---|---|
| Software development | 830 | 2,489 | 110,652 |
| Data editing and storage | 233 | 391 | 13,810 |
| Other information activities | 90 | 123 | 2,740 |
| R&D in sciences & engineering | N/A | N/A | N/A |
| Research activities | 11 | 26 | 247 |
| ICT hardware maintenance | 85 | 127 | 5,244 |
| Total | 1,695 | 5,163 | 243,0212 |

Table 6: Thessaloniki ICT activities businesses, employees, gross turnover, 2018

The upper end could be set much higher. Considering the analogy of national GDP (source: ELSTAT) with the gross turnover of the ICT sector at a national level (source: SEPE) and the GDP of Thessaloniki, an approximation of the ICT sector of Thessaloniki turnover could be estimated at almost 749M €.

| | **GDP (2018)** | **ICT GDP (2018)** |
|---|---|---|
| Greece | 165.3 B € | 5.66 B € |
| Thessaloniki | 21.87 B € | 748.85 M € |

Table 7: Calculating approximate Thessaloniki ICT sector GDP, 2018

Citing StartupBlink's Global Startup Ecosystem Index 2021, the only one containing Thessaloniki, the entrepreneurial ecosystem of the city, across all sectors of financial activities, held 379$^{th}$ position among 1,000 cities globally. Thessaloniki, dropped dramatically 117 spots from the 2020 index, attributed to a significant mismanagement of the pandemic in relation to financial activity and the over reliance to the overperforming service industry (Social & Leisure), which proved rigid and unfit in handling lockdowns. Still, it ranks 11$^{th}$ among the Balkans. Loceye, a biometric eye tracking platform assisting marketers, securing more than 300K € is identified as a champion of the city's ICT startup ecosystem. Overall, Thessaloniki is regarded as under-performing, considering its proximity to European, Balkan, and Middle Eastern

markets and world-class ecosystems such as Athens (ranking 153rd) and Istanbul (ranking 69th). Excessive bureaucracy and lack of an entrepreneurial mindset, the social norm being waged jobs are identified as the culprits. On the other hand, highly skilled IT specialists with strong ties to big corporations may play their networking part in bringing sponsorships for accelerator and incubator programs. (StartupBlink, 2021).

***Primary data – survey evidence of the ICT Ecosystem of Thessaloniki***

37 anonymous and random actors of the ICT ecosystem of Thessaloniki, participated in the survey, adapted from the GEM 2020/2021 index. Two simple profiling questions studied the sex and age of respondents. Most ICT actors of Thessaloniki are men (83.3%). It does not come as a surprise, as it is following the trend of low women participation in STEM education fields. However, the portion of women working as ICT specialists in Thessaloniki (16.7%) is lagging behind the Greek average of female ICT specialists (27%), one of the commentated indicators of the country, registered in DESI 2020/21 and the EU average of 19% (DESI, 2021).

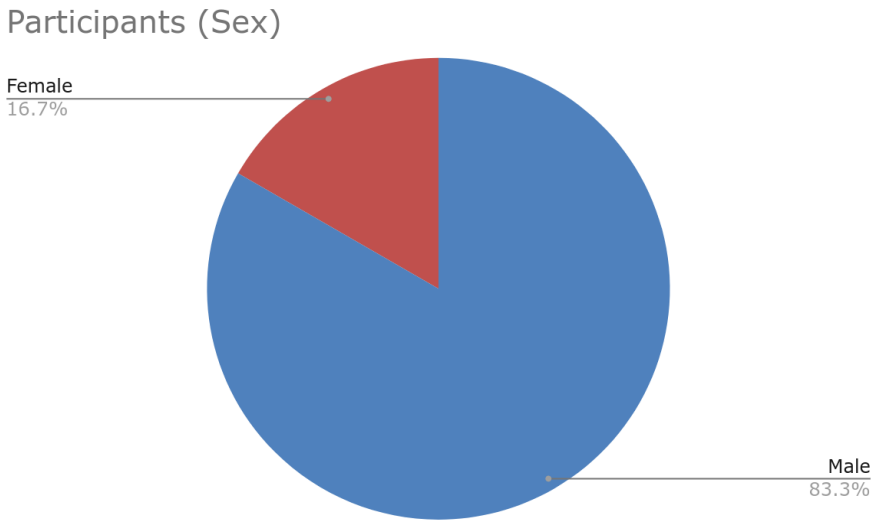



Figure 32: ICT specialists in Thessaloniki by sex

Promoting the percentage of female ICT specialists, let alone founders widens the perspective of the ecosystem, as its products target a larger audience (Berger & Kuckertz, 2016) and benefits social dimensions of the ecosystem, social goals being a

distinctive characteristic of female entrepreneurship (Jennings & Brush, 2013), (Hanson, 2009).

The younger participant is 22 years old, while the older one is at the brink of retirement (63 years of age), with a median of 40 years of age and an average of 40.3. 48.6% of the adult population of Thessaloniki, involved with the ICT sector responded that the pandemic had a negative impact (significantly & somewhat decreased) on household income.

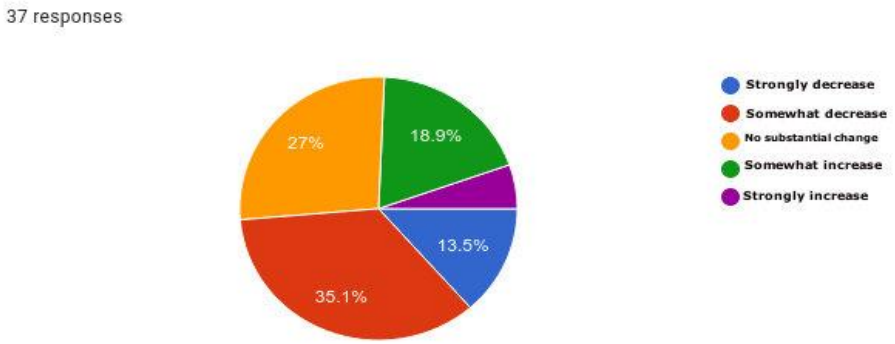



Figure 33: Household Income, Thessaloniki ICT ecosystem, 2021

Though it is an alarming portion, it is somewhat better than the Greek average (55.1%) and the GEM index's average (53.04%), showing better coping signs of the ICT sector, in comparison to the rest of the Greek economy.

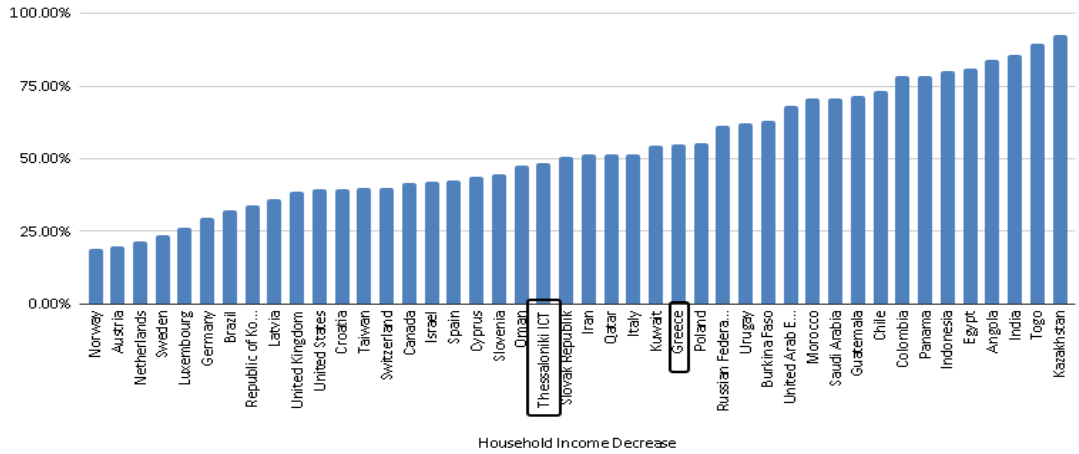



Figure 34: Household Income Decrease, Thessaloniki ICT ecosystem among GEM index countries, 2021

Nascent entrepreneurship ratio, the percentage of entrepreneurs that are in the process of starting a business stands at 5.41% of the adult population for the ICT

ecosystem of Thessaloniki, higher than in the general entrepreneurial ecosystem of Greece (3.3%), but much lower than the average of GEM index (7.7%).

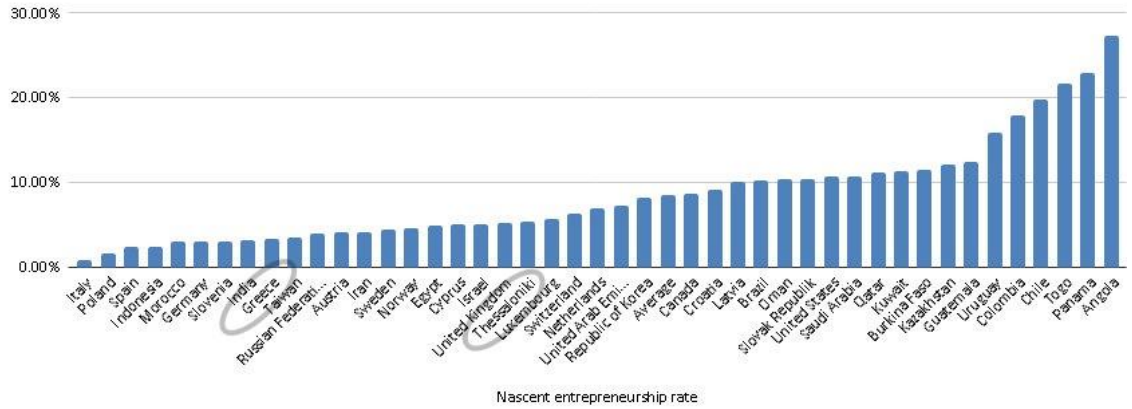



Figure 35: Nascent entrepreneurship rate, Thessaloniki ICT & GEM index 2021

New business ownership rate, the percentage of entrepreneurs that currently own a business, that is operational between 3 and 42 months stands at 10.81% of the adult population for the ICT ecosystem of Thessaloniki, higher than Greek overall (5.5%) and GEM average (6.35%).

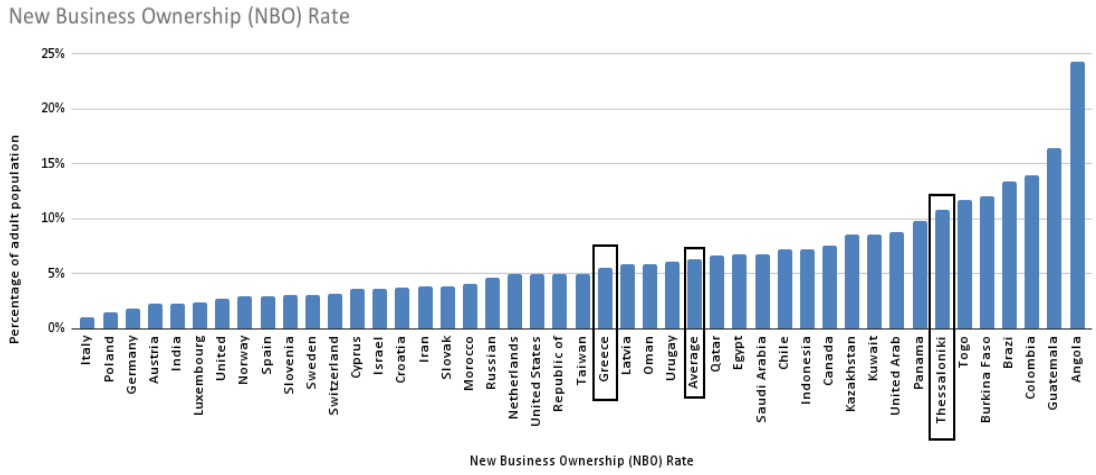



Figure 36: New business ownership (NBO) rate, Thessaloniki ICT & GEM Index 2021

The aggregate of the two latter indicators, presents the total early-stage entrepreneurial activity (TEA), which at 16.22% for Thessaloniki ICT, is higher than Greek overall (8.6%) and GEM average (15.51%).

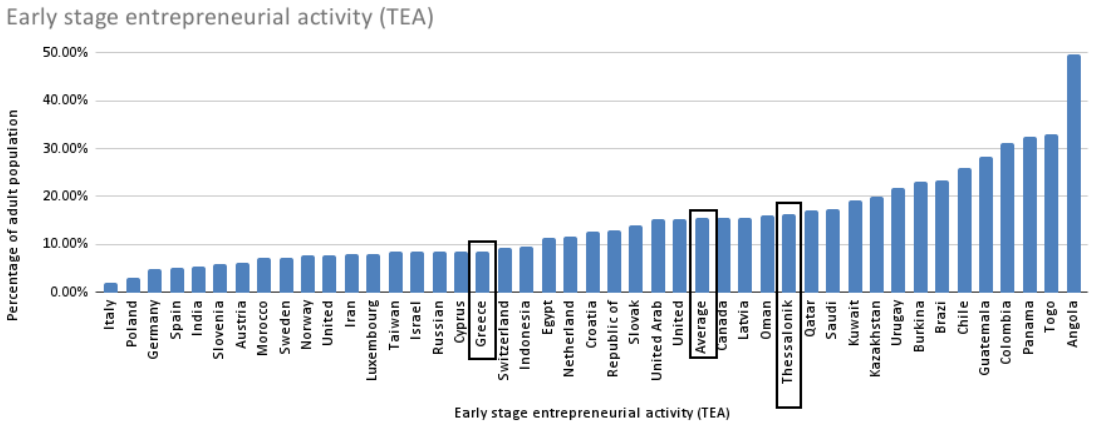



Figure 37: Total early-stage entrepreneurial activity (TEA) rate, Thessaloniki ICT & GEM Index 2021

The ICT ecosystem of Thessaloniki is characterized by top ranking rates of businesses that are owned by entrepreneurs and are functional for more than 3 years, at 16.22% of active population, even higher than the Greek top performing one (14.6%) and much higher than the GEM average (7.52%).

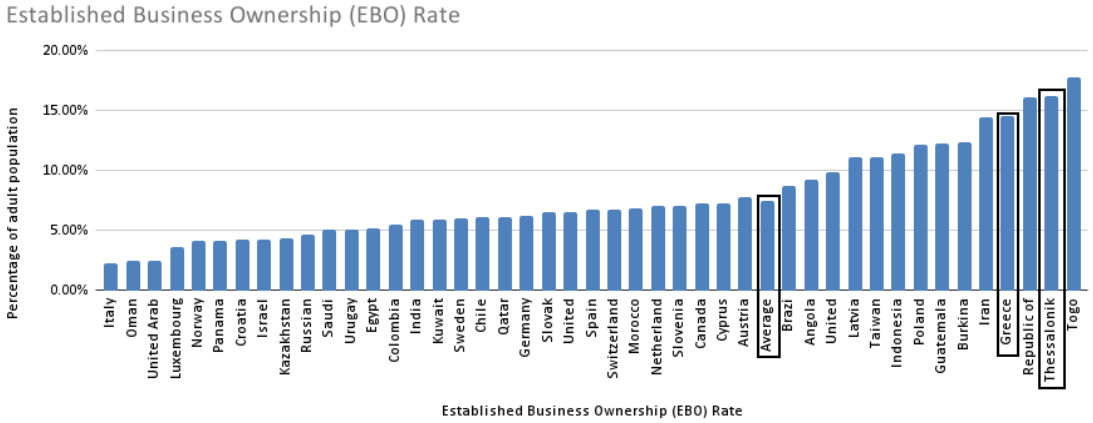



Figure 38: Established business ownership (EBO) rate, Thessaloniki ICT & GEM Index 2021

The metric indicating personal knowledge of an entrepreneur stands at 43.24% of the active population, higher than the Greek average (32.5%), yet among the low end of the GEM 2021 spectrum. A low rank, which discourages actors of the ecosystem, who lack a reference point of entrepreneurial feasibility in their personal networks.

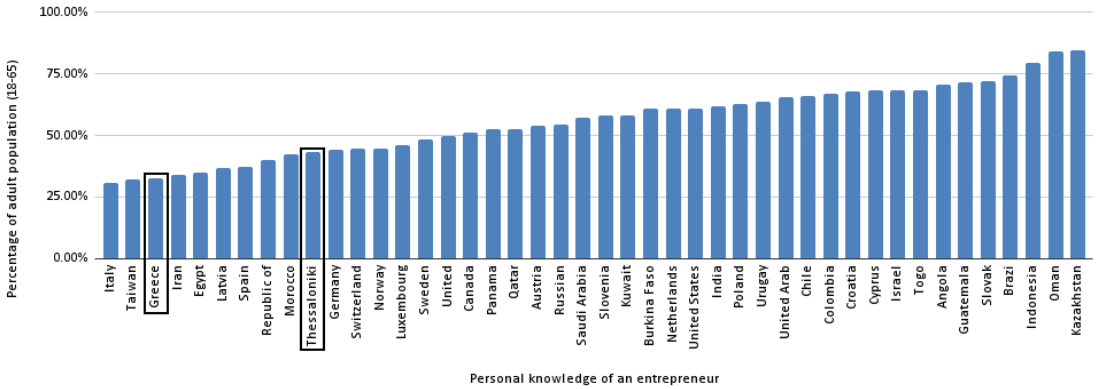



Figure 39: Personal knowledge of an entrepreneur, Thessaloniki ICT & GEM Index 2021

The ICT market seems more promising, thus setting the bar for perceived opportunities higher than the average of the Greek market (27.90%) at 48.65%, rather closer to GEM 2021 average (50.47%).

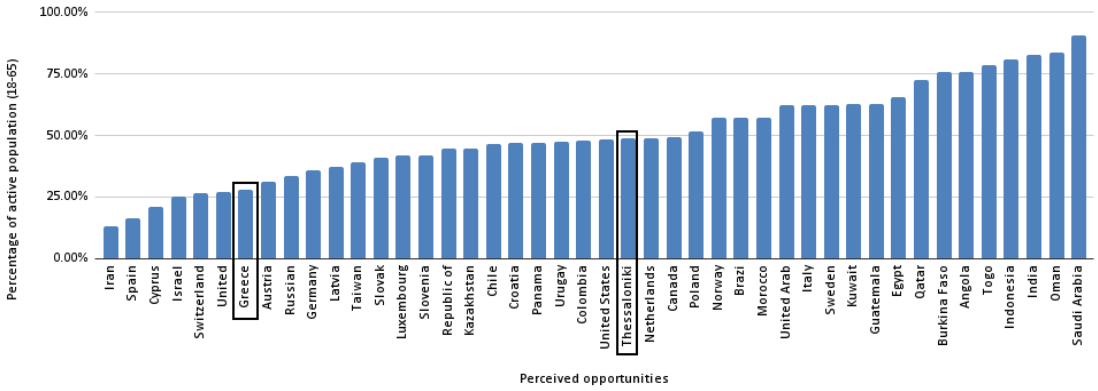



Figure 40: Perceived opportunities, Thessaloniki ICT& GEM Index 2021

Perceived ease of starting a business in the ICT ecosystem of Thessaloniki (35.14%) is significantly lower than the Greek average (53.30%) and the GEM 2021 average (59%). Combined with the latter indicator, the rather adequate environment of perceived opportunities is hindered by negative perception of chronic deficiencies of the ecosystem of Thessaloniki.

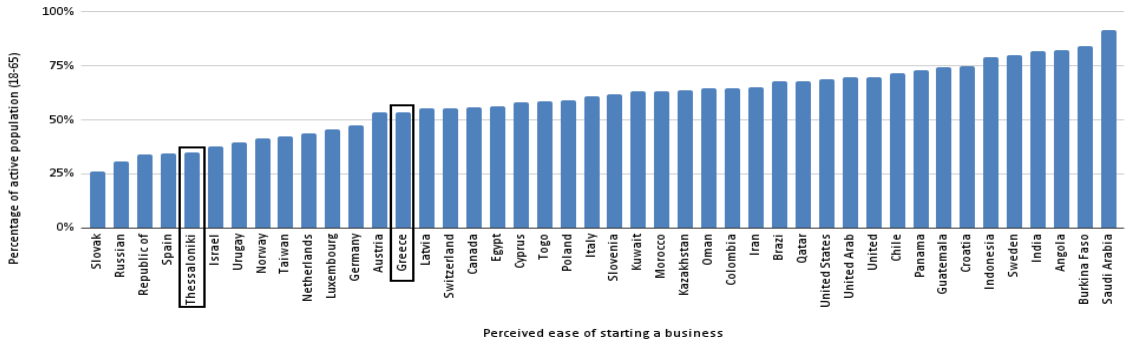



Figure 41: Perceived ease of starting a business, Thessaloniki ICT& GEM Index 2021

Despite a highly skilled workforce, as noted in most indices of the macro analysis, ICT residents of Thessaloniki (48.65%) and slightly more Greeks (53.3%) find themselves lacking in capabilities and having lower self-esteem, enjoying much lower perceived capabilities than GEM average (60.74%) to embark on the entrepreneurship vessel. A possible explanation could be the high unemployment rates, leading to scarce work experience and the total absence of entrepreneurship in education as well as the negligence of the School Occupational Orientation (SEP) as a serious subject in second grade education.

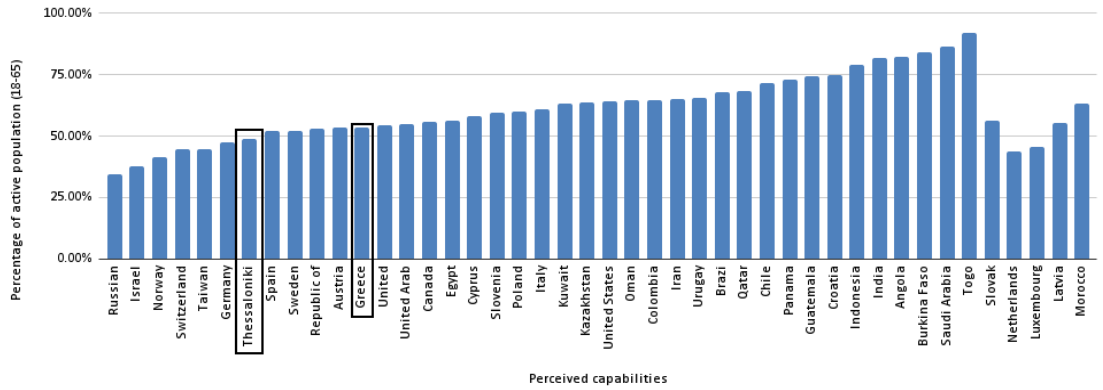



Figure 42: Perceived capabilities, Thessaloniki ICT& GEM Index 2021

Fear of failure across Greece is remarkably high (53.1%), the third highest among GEM index and should not be neglected as one of the most damaging factors of the development of the entrepreneurial ecosystem. The ICT ecosystem of Thessaloniki on the other hand shares a significantly lower failure fear factor (45.95%), hinting at other variables mitigating the country – wide high rate, such as a perceived low investment capital for many software endeavors.

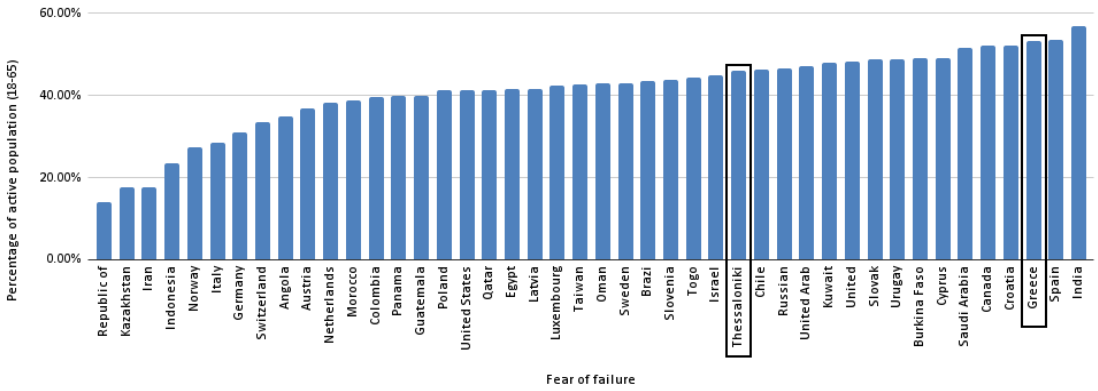



Figure 43: Fear of failure, Thessaloniki ICT& GEM Index 2021

Knowing a business which shut down due to COVID-19 stands at 45.6%, a bit over the GEM 2021 average (41,84%). The ICT ecosystem of Thessaloniki seems to have shown much more resilience, with first-hand accounts of entrepreneurial folding at almost half the national rate (24.32%), a testament to the flexibilities offered by the digital economy, concurring with the global ICT sector behavior.

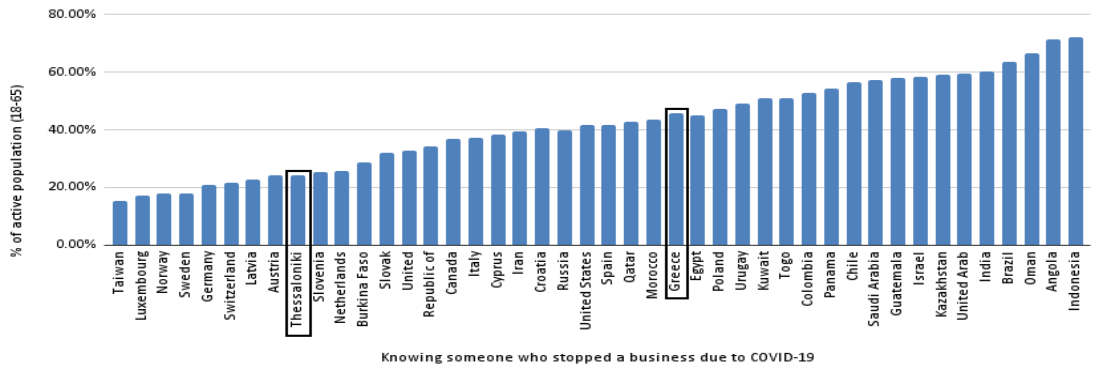



Figure 44: Knowing someone who stopped a business due to COVID-19, Thessaloniki ICT& GEM Index 2021

On the contrary the market of Thessaloniki, the ICT ecosystem being no exception, is much more conservative than the Greek average, registered in entrepreneurial beginnings due to COVID lying at 8.11%, significantly lower than the national rate (13%), which in turn is almost half than GEM's average (26.42%). The ratio of knowing someone who stopped a business over someone who started one due to COVID – 19, stands at 2.99 (slightly better than 3.5 registered for the average of the Greek economy), yet worse than ratios noted in most EU states and other developed economies.

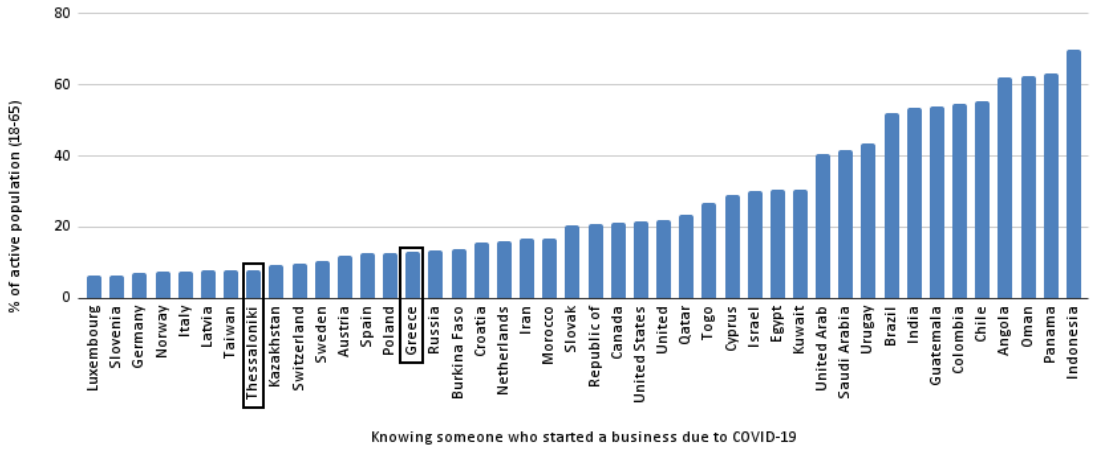



Figure 45: Knowing someone who started a business due to COVID-19, Thessaloniki ICT & GEM Index 2021

The ICT market regarded the pandemic positively as a source of new opportunities. The ICT ecosystem of Thessaloniki lies at the 3rd ranking position (76.92%), whereas the Greek average lies at the low end of the spectrum (20.6%), almost half of the average (45.02%).

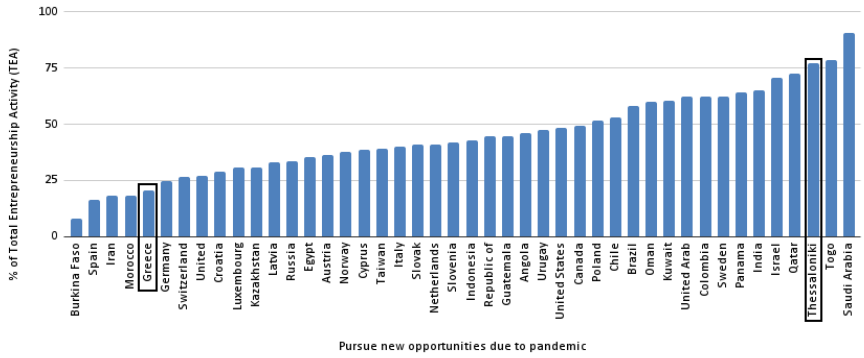



Figure 46: Pursue new opportunities due to pandemic, Thessaloniki ICT & GEM '21

Did the pandemic create a barrier in starting a business? The average GEM 2021 value lies at 59.37% of the Total Entrepreneurial Activity (TEA), with Thessaloniki ICT's rank (50%) lying significantly below this threshold, while the Greek average is one of the top values (75.5%), registering again the resilience of the ICT sector during the pandemic.

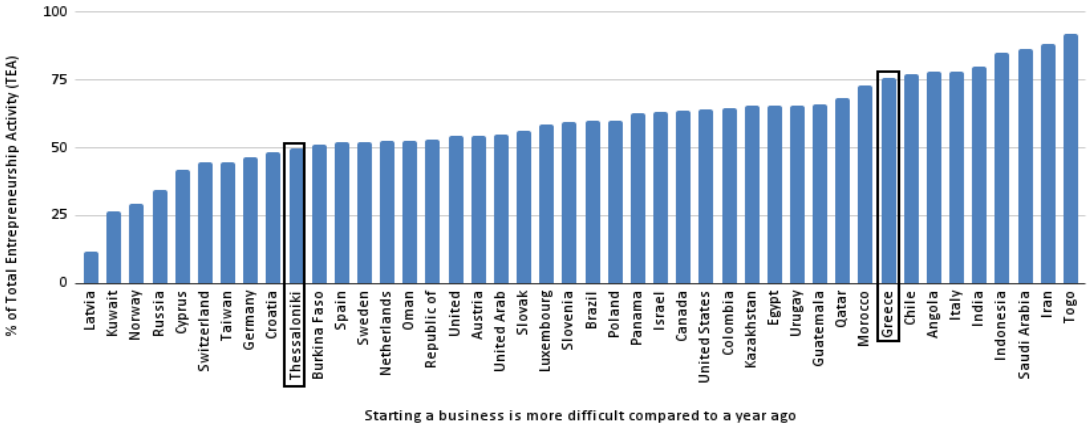



Figure 47: Starting a business is more difficult than a year ago, Thessaloniki ICT& GEM 2021

Has the pandemic led to a delay in getting a business operational? The average GEM 2021 value lies at 68.57% of the Total Entrepreneurial Activity (TEA). Thessaloniki ICT's rate (40%) is the best rank of the GEM sample, while the Greek average is very close to the average (69.3%), registering again the resilience of the ICT sector during the pandemic.

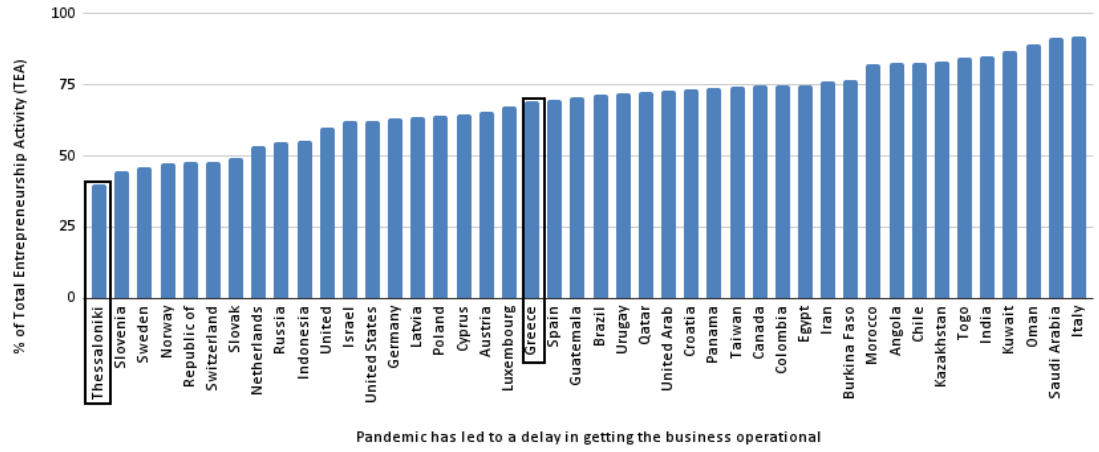



Figure 48: Pandemic has led to a delay in getting the business operational, Thessaloniki ICT& GEM Index 2021

Male TEA in the ICT ecosystem of Thessaloniki stands at 36.67% of the adult male, much higher than the Greek average entrepreneurship rate of 10.6% indicating again the vibrant nature of the ICT sector.

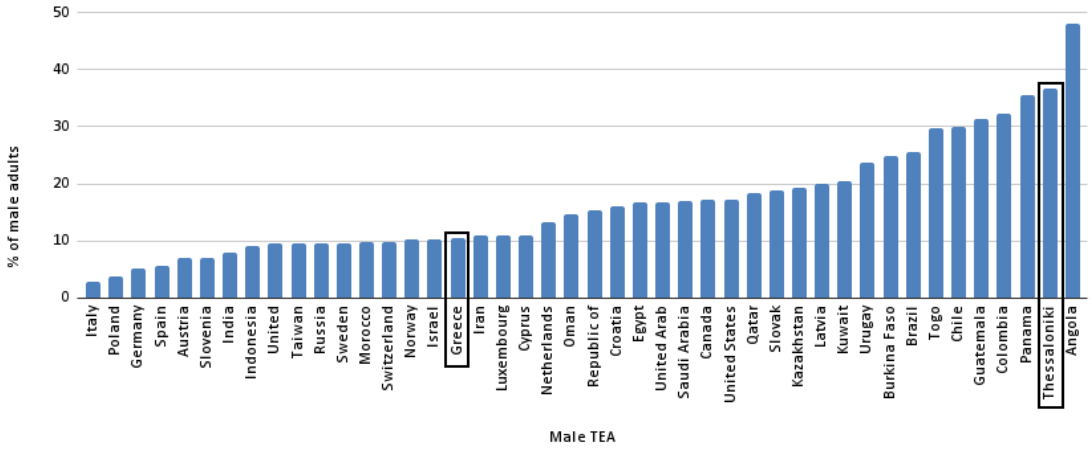



Figure 49: Male Total early Entrepreneurship Activity (TEA), Thessaloniki ICT& GEM '21

Female TEA in the ICT ecosystem of Thessaloniki stands at 50% of the adult female population, much higher than the Greek average entrepreneurship rate of 6.7%, hinting at the prospects of the ICT sector, considering, however the small female sample.

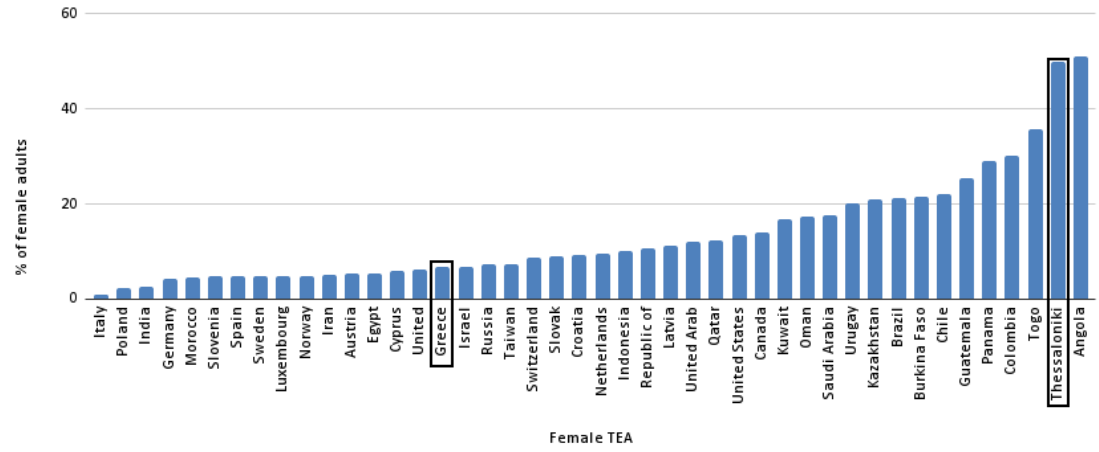



Figure 50: Female Total early Entrepreneurship Activity (TEA), Thessaloniki ICT& GEM Index 2021

Sponsored businesses are higher in the ICT ecosystem of Thessaloniki (8.7%), than at the average of Greece for all economy sectors (2.3%). More restricted access to capital may explain the difference.

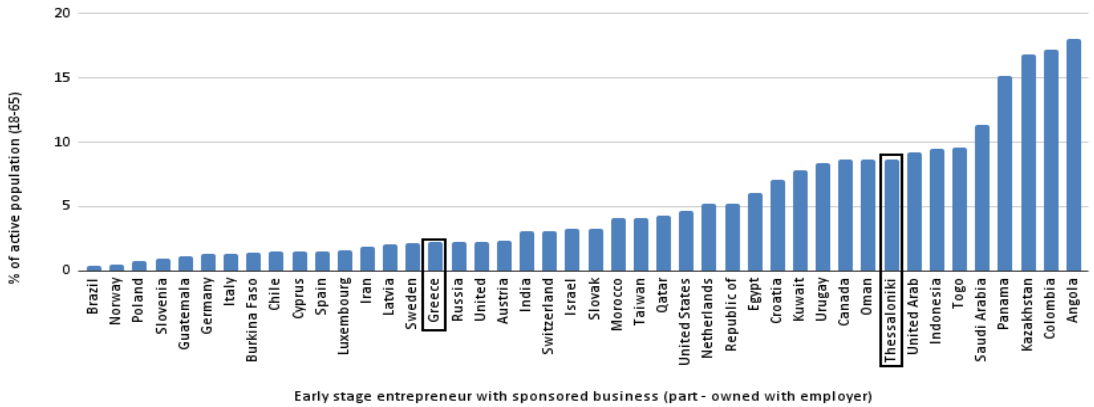



Figure 51: TEA with sponsored business, Thessaloniki ICT& GEM Index 2021

Highly independent ICT businesses in Greece (registered in other indices) are evident in the ICT ecosystem of Thessaloniki (21.62%), one of the highest of the sample. Conservative strategies by local entrepreneurs as well as low investment opportunities in the ecosystem may offer plausible explanation.

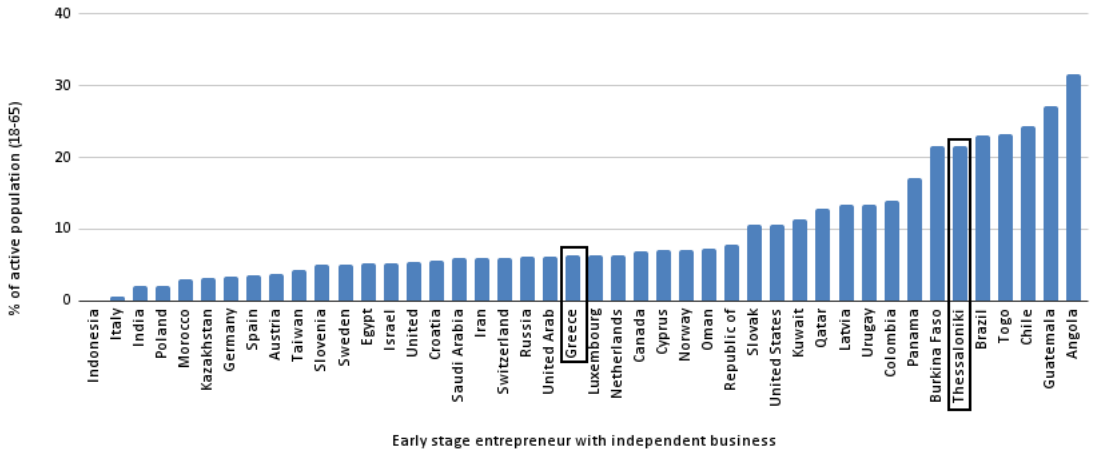



Figure 52: TEA with independent business, Thessaloniki ICT& GEM Index 2021

Informal investment in third party businesses in the ICT ecosystem of Thessaloniki is higher (5.41%) relative to the total Greek indicator (3.1%) and to GEM 2021 average (4.99%).

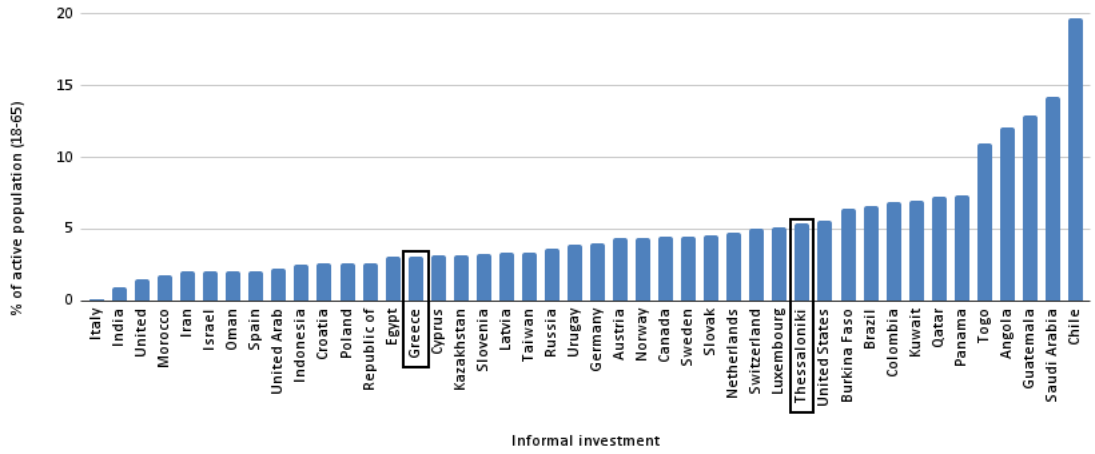



Figure 53: Informal Investment

However, the median amount of investment in the ICT ecosystem of Thessaloniki stands at 4,279 US$, much lower, almost a third of its Greek counterpart (11,360 US$) and lower than the GEM 2021 average (6,521 US$).

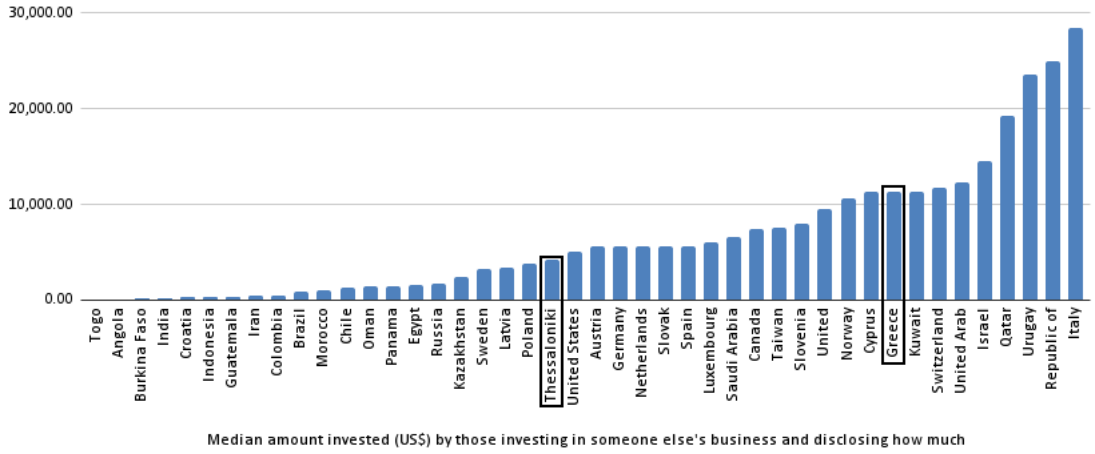



Figure 54: Median amount of investment (US$)

The ICT ecosystem of Thessaloniki suffers from a low growth expectation mindset. It is on par with the Greek all sector average in both indicators of small (1-5 future job

creations) or larger (6+) and lower than the GEM 2021, while it registers an unprecedented, outlying high value (18.92%) for no future job creation expectations.

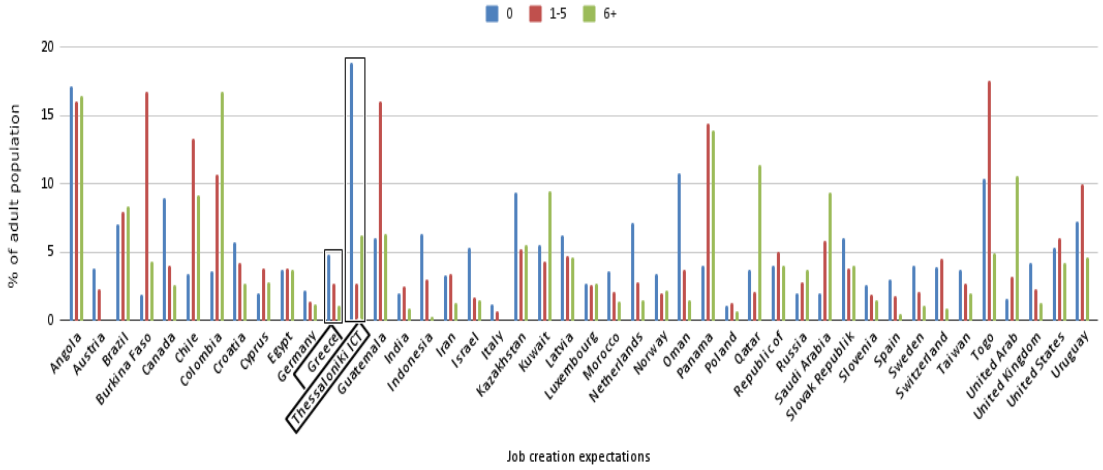



Figure 55: Job creation expectations

The ICT ecosystem of Thessaloniki is totally aligned with the Greek indicator of higher ideals and motives to start a business, such as leaving one's mark in the world, both of which (28.57% and 26.9% respectively) are quite lower than GEM 2021 average (42.82%).

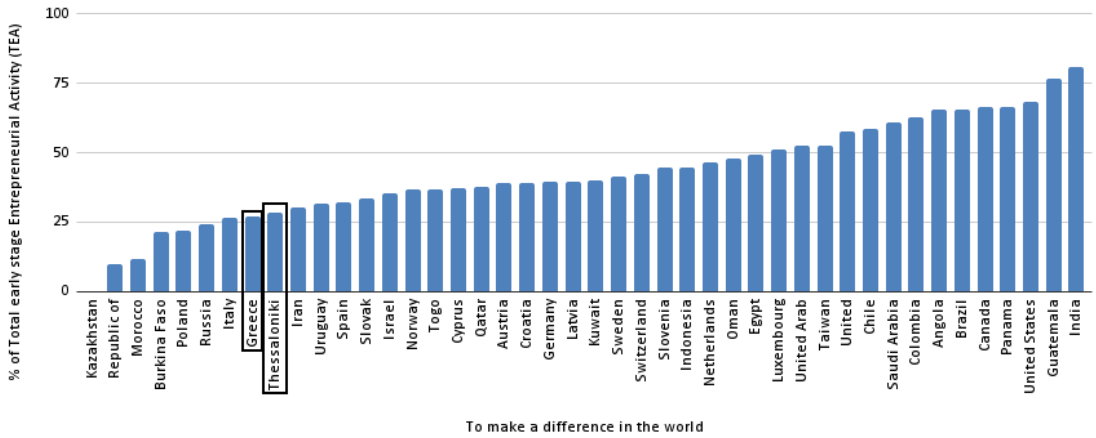



Figure 56: Motivation to start a business – To make a difference in the world

Building wealth is the strongest motivation for aspiring entrepreneurs of the ICT ecosystem of Thessaloniki (50%), a bit over the Greek indicator (45.8%) but still lower than GEM average (59.68%).

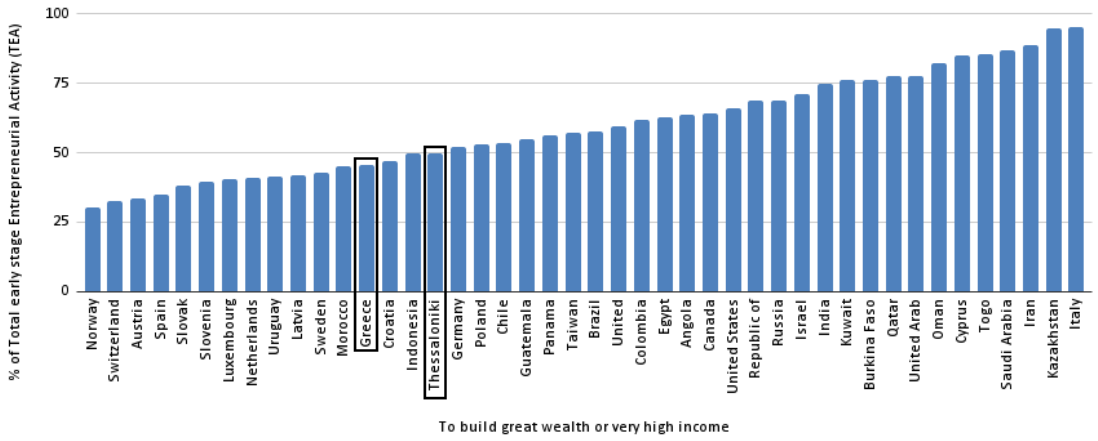



Figure 57: Motivation to start a business – To build great wealth or very high income

The ICT ecosystem of Thessaloniki has no long – standing history spanning generations. This is registered in the motivation: "To continue a family tradition", which lies at 0%, much lower than the GEM average (29.6%) and the Greek overall metric (35.7%).

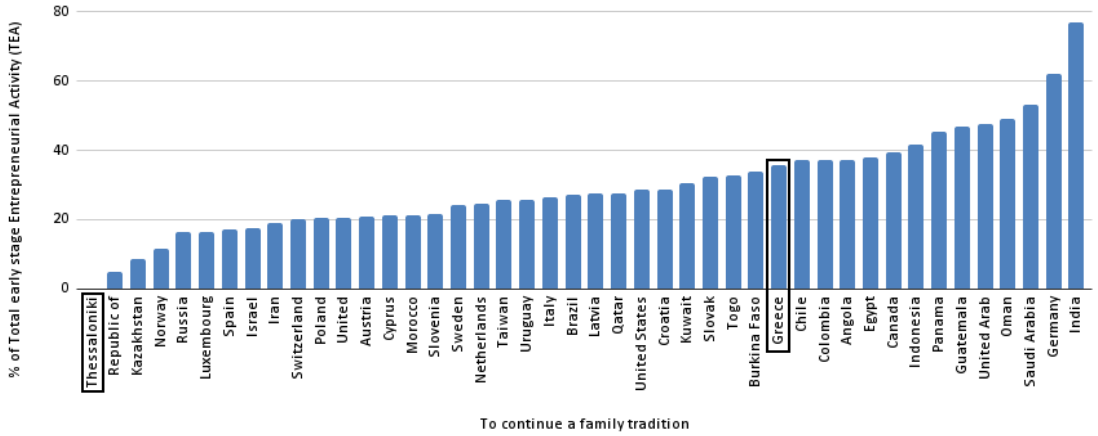



Figure 58: Motivation to start a business – To continue a family tradition

The motivation to avoid unemployment is not such a strong parameter (21.43%), as with the Greek overall benchmark (69%) and the lowest of the GEM sample, which averages at 64.42%.

## Interpretation of Findings / Discussion

The ICT ecosystem of Thessaloniki as well as the Greek ICT market, met the pandemic crisis, while still recovering from the sovereign debt crisis of 2008. Business research & development expenditure in the ICT sector has been lagging behind the EU and the OECD average. Enterprises in the ICT ecosystem of Thessaloniki are rather positioned in the middle in terms of capacity to exploit the growth opportunities that the Pandemic offered, especially for software ventures.

Innovation - wise, the Greek economy neither tops the ranks neither does it fall dramatically behind in global terms. What is more troubling however is the small market size and the old age of the population, downplaying the global footprint of an ICT entrepreneurial venture that happens to be born and grown in Thessaloniki.

The background history of both the ICT ecosystem of Thessaloniki and the Greek one, is marred by absence of growth. Moreover, cultural norms such as low risk acceptance and inability to perceive opportunities, combined with low growth international aspirations, undermine the capacities of a talented human capital, that is fit for a higher caliber. Greek citizens are ardent digital users, that may enjoy benefits from further development.

Greece underperforms in terms of digital innovation. A plausible reason is a landscape crowded with numerous very small SMEs, multiplying negative growth. Mismanagement of resources and an underdeveloped entrepreneurial ecosystem hinder the development of digital ventures as well. The immaturity of the entrepreneurial ecosystem is reflected especially upon the low market and business sophistication, combined with low market size, capital, and investment opportunities.

Highly trained human capital, high R&D capacity, an adequate digital infrastructure, are countered by the ever-present high levels of software piracy, disproportionate lower spending in R&D of software development, political and operational instability, the gross incapacity to transform high R&D inputs to business gains, as registered by the extremely low ranks of university-industry collaboration, low funding, and credit access.

Undocumented labor and low penetration of digital platforms may hinder future development and the transition to digital platform ecosystems. Low M2M penetration, showcases an ICT ecosystem unfit to keep up with developments in the promising IoT domain. There exist stories of innovative software solutions, but this is not the norm as the largest portion of software spending refers to software licenses of proprietary software and off the self-solutions.

Bureaucracy and lack of an entrepreneurial mindset, risk avoidance, low access to credit, the social norm being waged jobs are taking their toll. The decade long brain drain has left its mark as high unemployment rates, even in ICT graduates, are coupled with lack of ICT specialists.

Low number of female ICT specialists, restrict the horizons of the ecosystem. The ICT ecosystem handled better than the other economy sectors the pressure imposed by the pandemic. Nascent entrepreneurs surpass other economy sectors in the ICT ecosystem of the city, yet they are much lower than in other developed countries. Early-stage entrepreneurial activity in Thessaloniki, is promising. Both male and female entrepreneurial activity is satisfying. Though, knowing personally an entrepreneur is higher in Thessaloniki than in the average of Greece, it still lags behind other countries, meaning that actors of the ecosystem and potential in-house investors, lack promising reference points of entrepreneurial success.

On the other hand, the ICT ecosystem seems more optimistic and capable in perceiving opportunities than the other sectors or the rest of Greece and are closer to the international average. Bureaucracy in Thessaloniki is perceived as more persistent and damaging than the Greek average in starting a business.

Actors of the ICT ecosystem of Thessaloniki perceive themselves as lacking in capabilities to starting a business, a proof of low work experience and an inadequate entrepreneurial and financial education. Fear of failure is mitigated and not as high in other sectors of the economy, yet still at high levels. Coupled with the social norm of a waged job and low access to capital, this factor will be resilient in uprooting. A direct consequence is the low rate of startups in the face of the pandemic recovery, low sponsorship, and informal investment rates (of low informal investment capital) and high enterprise independence ones, a low growth mindset with few prospective job

creations in the upcoming future, despite the evident outward and internationally bound character of many local enterprises.

## Conclusion and Recommendations

The size of the domestic market of Thessaloniki is small by international standards, its population ages, offering fewer chances for an idea to blossom into a successful business venture. Incentives to relocate to the greater metropolitan area of the second largest city in Greece, are important to be provided by improving the quality of life. Infrastructure development to improve public transportation, harbor, and airport, to increase the city's connectivity with the world, public spaces to allow the city to breathe, development plans to allow for a healthy expansion, improving the housing problems, lowering rent, and purchasing prices are important aspects to grow the city landscape. Brain drain will not be reversed if Thessaloniki does not offer a nice place to settle by European standards. Most importantly, if quality jobs that cater to personnel that is described as overqualified remain scarce, the trend of exporting valuable human capital will not be reversed.

According to current ecosystem conditions, nascent enterprises must be extrovert and develop an approach to international markets early on, because long -term sustainability, relying on the domestic ecosystem may not be sufficient. Incentives, for start-ups, SMEs, especially those that have business plans targeting international markets should be provided. A strategy to provide motivations for well-known international firms to open shop in Thessaloniki are essential if the city aspires to delve into the global arena. Attracting such big players may have a multiplying, snowballing effect, as well as improving the brand name of the ecosystem.

Co-ordinated attempts to improve the entrepreneurial ecosystem to exploit the potential posed by its digital and innovation counterpart must take place. Mismanagement of resources may be countered by targeted allocation of funds. The main criterion of decades long EU fund allocation is absorption, leading to horizontal actions, such as one size fits all seminars, vouchers for office or digital equipment and off the shelf software licenses. More targeted criteria must be registered, for capital to be put to good use. Funds to support business plans through incubators and accelerators should be increased, considering that there are few alternatives to provide access to capital, while the banking market in Greece is immature and

recovering from a decade long recession that has made loan-givers extremely conservative.

Bureaucracy can be battled. International experience has shown best practices. Multiple and contradicting legislation can be countered by open, democratic procedures and the use of competent executives, regulators, and judiciaries to improve upon the law-making establishment. Innovators and digital visionaries must be part of the decision-making processes if examples like the Estonian digital reform are to be adopted. State stability is imperative to offer a secure investment and entrepreneurial environment. As long as general secretaries of ministries keep changing, alongside the governing political party, such stability will remain elusive.

To counter fear of failure, dynamic responses are needed such as the transformation of bankruptcy law for SMEs to a more forgiving outlook. Having provided the previous conditions, to tackle the deeply rooted waged job or public servant social norm, entrepreneurship should be reinstated as an everyday and essential social phenomenon. Financial and occupational education should be reviewed, while youth entrepreneurship programs, university networking, alumni and job finding programs must be improved and supported with funds to disseminate either through spin-offs or entrepreneurship awards and competitions.

*Future Research*

This dissertation opens an avenue for future work based on new questions posed. Obviously, repeating the survey for a more prolonged period would yield a larger and more representative sample and it could serve as a new snapshot of the ecosystem.

The same framework could be adapted and applied to another audience to produce a similar assessment of a different ecosystem in the same region, highlighting a different sector of socio-economic activity.

Key actors of the ICT ecosystem of Thessaloniki are prime targets as prospective case studies to assess their impact on the ecosystem. Such case studies from the education and research sector could include the following subjects: The 3 universities of Thessaloniki and CERTH, from the private sector: Cisco, Deloitte, and Pfizer, from the public sector the regional administration of Macedonia, the municipality of

Thessaloniki and the charter of the ministry of the interior, from the community, OK Thess and Alexander Innovation Zone incubators and the Technopolis ICT business park.

Fear of entrepreneurial failure is not merely a strong characteristic of the ICT ecosystem of Thessaloniki, but also observed in the rest of Greece, Cyprus, Spain, and India (figure 43). Apart from the multi facets of the problem, as presented in the epilogue, are there traces of social trends that should be co-assessed? Strong family ties, high percentage of adults living with parents, hinting at cultural dimensions of this phenomenon?

One significant weakness that the ICT ecosystem of Thessaloniki shares is its incapacity to retain highly trained human capital. What conditions would transform the ICT ecosystem into an attractive one? Such research would serve the scope of producing viable strategies in reversing the brain drain wave of the past decade.

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## Appendix

| Framework | Metrics | Application case | Source |
|---|---|---|---|
| Digital City Index Europe 2017 | 40 variables | 136 cities globally. 67 European ones. | Bloom Consulting (2017) |
| Maturity model for software startup ecosystems | 22 indicators | Tel-Aviv, Sao Paolo, New York | Cukier, D. & Kon, F. (2018) |
| Spatial organization of Schumpeterian entrepreneurship | 3 indicators, 5 for US metropolitan areas | 170 global metropolitan areas | Adler et al. (2019) |
| Global Entrepreneurship & Development Index 2018 | 31 variables | 137 countries | Acs et al (2018) |
| GEI (Global Entrepreneurship Index 2019) | 14 components | 137 countries | Acs et al (2019) |
| DEI (Digital Entrepreneurship Index 2020) | 12 components 32 indicators | 116 countries | Acs et al (2020a) |
| Digital Platform Economy Index 2020/21 | 46 indicators, across 4 sub-indices | 116 countries, top 100 platform companies | Acs et al (2020b) |
| Global Entrepreneurship Monitor Index 2020/21 | 49 indicators, across 9 themes. | 46 countries | GERA (2021) |

| | | | |
|---|---|---|---|
| Network Readiness Index 2020 | 60 indicators, across 4 pillars | 134 countries | Dutta & Lanvin (2020) |
| Global Entrepreneurship Monitor – Entrepreneurial Ecosystem Index 2020 | Undisclosed. Same logic as GEM | 19 metropolitan areas | GEM (2020) |
| Municipal hi – growth, hi – tech entrepreneurship policy | 8 metrics | Houston & St. Louis | Egan (2021) |
| Startup Ecosystem Report 2021 | 19 indicators | 100 countries | Startup Genome (2021) |
| Smart City Index 2021 | 39 indicators | 118 cities | IMD-SCO (2021) |
| Global Startup Ecosystem Index 2021 | 19 indicators | 100 countries. 1,000 cities. | StartupBlink (2021) |
| Global Innovation Index 2021 | 81 indicators | 132 countries | WIPO (2021) |
| OECD Going Digital Toolkit | 41 indicators | 44 countries | OECD (2020a) |
| Digital Economy & Society Index (DESI) 2021 | 32 indicators | 28 EU countries | DESI (2021) |

Table 1: Summary of indicative and prominent frameworks assessing social ecosystems

| | City | Country | Population | GDP (US$ B) |
|---|---|---|---|---|
| 1 | Paris | France | 7,068,810 | 882.00 |
| 2 | London | UK | 8,961,989 | 690.00 |
| 3 | Moscow | Russia | 20,000,000 | 684.00 |
| 4 | Rhine-Ruhr | Germany | 11,300,000 | 350.30 |
| 5 | Milan | Italy | 4,336,121 | 304.50 |
| 6 | Madrid | Spain | 6,791,667 | 296.00 |
| 7 | Istanbul | Turkey | 15,462,452 | 237.00 |
| 8 | Frankfurt | Germany | 5,604,523 | 229.99 |
| 9 | Amsterdam & Rotterdam | Netherlands | 8,116,000 | 223.00 |
| 10 | Munich | Germany | 5,991,144 | 190.00 |
| 11 | St. Petersburg | Russia | 5,351,935 | 179.00 |
| 12 | Stockholm | Sweden | 2,402,609 | 170.00 |
| 13 | Rome | Italy | 4,342,212 | 166.80 |
| 14 | Berlin | Germany | 6,144,600 | 155.00 |
| 15 | Tel Aviv | Israel | 3,854,000 | 153.30 |
| 16 | Copenhagen | Denmark | 2,057,142 | 134.40 |
| 17 | Barcelona | Spain | 5,474,482 | 125.48 |
| 18 | Hamburg | Germany | 5,107,429 | 123.00 |
| 19 | Dublin | Ireland | 1,904,806 | 118.72 |
| 20 | Manchester | UK | 2,705,000 | 113.70 |
| 21 | Zurich | Switzerland | 415,215 | 109.00 |
| 22 | Ankara | Turkey | 5,663,322 | 105.00 |
| 23 | Warsaw | Poland | 3,100,844 | 105.00 |
| 24 | Marseille | France | 1,760,653 | 104.10 |
| 25 | Cairo | Egypt | 21,323,000 | 102.00 |

| | | | | |
|---|---|---|---|---|
| 26 | Vienna | Austria | 2,600,000 | 100.00 |
| 27 | Athens | Greece | 3,753,783 | 93.70 |
| 28 | Helsinki | Finland | 1,526,694 | 90.80 |
| 29 | Lyon | France | 518,635 | 88.20 |
| 30 | Brussels | Belgium | 2,500,000 | 87.00 |
| 31 | Lille | France | 3,800,000 | 83.30 |
| 32 | Birmingham | UK | 3,683,000 | 81.80 |
| 33 | Turin | Italy | 852,223 | 76.90 |
| 34 | Lisbon | Portugal | 2,871,131 | 72.00 |
| 35 | Oslo | Norway | 1,588,457 | 71.68 |
| 36 | Luxembourg | Luxembourg | 633,622 | 66.85 |
| 37 | Glasgow | UK/Scotland | 1,861,315 | 66.40 |
| 38 | Bern | Switzerland | 133,791 | 66.34 |
| 39 | Prague | Czech Rep | 2,709,418 | 64.00 |
| 40 | Bucharest | Romania | 2,315,173 | 63.43 |
| 41 | Naples | Italy | 967,068 | 62.80 |
| 42 | Venice | Italy | 258,685 | 62.20 |
| 43 | Valencia | Spain | 2,522,383 | 60.27 |
| 44 | Budapest | Hungary | 3,011,598 | 58.50 |
| 45 | Bordeaux | France | 257,068 | 55.90 |
| 46 | Bruges | Belgium | 118,284 | 48.33 |
| 47 | Jerusalem | Israel | 1,253,900 | 48.00 |
| 48 | Bratislava | Slovakia | 660,000 | 46.51 |
| 49 | Lausanne | Switzerland | 139,111 | 45.53 |
| 50 | Leeds | UK | 2,638,127 | 44.80 |
| 51 | Geneva | Switzerland | 201,818 | 43.98 |
| 52 | Edinburgh | UK/Scotland | 901,455 | 41.80 |

| | | | | |
|---|---|---|---|---|
| 53 | Bologna | Italy | 1,017,196 | 40.60 |
| 54 | Florence | Italy | 383,083 | 40.10 |
| 55 | Malmo | Sweden | 749,427 | 38.10 |
| 56 | Bilbao | Spain | 1,037,847 | 36.90 |
| 57 | Kiel | Germany | 643,954 | 36.72 |
| 58 | Newcastle | UK | 1,650,000 | 36.00 |
| 59 | Nice | France | 341,032 | 36.00 |
| 60 | Zagreb | Croatia | 1,153,255 | 35.80 |
| 61 | Porto | Portugal | 1,737,395 | 31.30 |
| 62 | Gothenburg | Sweden | 579,281 | 31.22 |
| 63 | Kiev | Ukraine | 3,475,000 | 30.00 |
| 64 | Salzburg | Austria | 157,245 | 29.05 |
| 65 | Bristol | UK | 465,866 | 26.90 |
| 66 | Belfast | UK | 671,559 | 25.50 |
| 67 | Cork | Ireland | 305,222 | 24.00 |
| 68 | Vilnius | Lithuania | 588,412 | 23.00 |
| 69 | Sofia | Bulgaria | 1,674,651 | 22.40 |
| 70 | Thessaloniki | Greece | 1,030,338 | 20.83 |
| 71 | Riga | Latvia | 107,000 | 20.00 |
| 72 | Dubrovnik | Slovenia | 65,808 | 19.90 |
| 73 | Belgrade | Serbia | 1,687,132 | 17.40 |
| 74 | Zaragoza | Spain | 681,877 | 17.35 |
| 75 | Ljubljana | Slovenia | 295,504 | 15.74 |
| 76 | Tallinn | Estonia | 437,619 | 15.30 |
| 77 | Cambridge | UK | 124,798 | 14.50 |
| 78 | Brighton | UK | 290,885 | 14.25 |
| 79 | Minsk | Belarus | 2,009,786 | 14.00 |

| | | | | |
|---|---|---|---|---|
| 80 | Valletta | Malta | 393,938 | 13.20 |
| 81 | Skopje | N. Macedonia | 578,144 | 11.00 |
| 82 | Reykjavik | Iceland | 131,136 | 10.00 |
| 83 | Tirana | Albania | 557,422 | 5.75 |
| 84 | Sarajevo | Bosnia Herzegovina | 555,210 | 4.50 |
| 85 | Chisinau | Moldova | 779,300 | 4.00 |
| 86 | Podgorica | Montenegro | 185,915 | 2.50 |

Table 2: City – level ecosystems by economy size and population that have been studied in recent literature

# Greece

GII 2021 rank **47**

| Output rank | Input rank | Income | Region | Population (mn) | GDP, PPP$ (bn) | GDP per capita, PPP$ | GII 2020 rank |
|---|---|---|---|---|---|---|---|
| 60 | 39 | High | EUR | 10.4 | 310.7 | 29,045 | 43 |

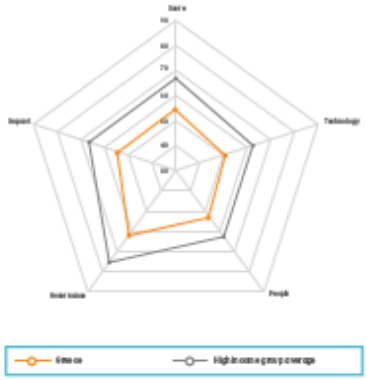
| | Score/ Value | Rank |
|---|---|---|
| **Institutions** | **69.2** | **51** |
| **1.1 Political environment** | **63.6** | **50** ◇ |
| 1.1.1 Political and operational stability* | 71.4 | 54 ◇ |
| 1.1.2 Government effectiveness* | 59.7 | 50 ◇ |
| **1.2 Regulatory environment** | **69.5** | **51** |
| 1.2.1 Regulatory quality* | 57.3 | 47 ◇ |
| 1.2.2 Rule of law* | 52.0 | 54 ◇ |
| 1.2.3 Cost of redundancy dismissal | 15.9 | 64 |
| **1.3 Business environment** | **74.6** | **53** |
| 1.3.1 Ease of starting a business* | 96.0 | 11 ● ◆ |
| 1.3.2 Ease of resolving insolvency* | 53.1 | 66 |
| **Human capital and research** | **54.3** | **16** ● |
| **2.1 Education** | **66.2** | **13** ● |
| 2.1.1 Expenditure on education, % GDP | n/a | n/a |
| 2.1.2 Government funding/pupil, secondary, % GDP/cap | 21.5 | 37 |
| 2.1.3 School life expectancy, years | 19.5 | 5 ● ◆ |
| 2.1.4 PISA scales in reading, maths and science | 453.5 | 43 |
| 2.1.5 Pupil-teacher ratio, secondary ⊘ | 8.5 | 15 ● ◆ |
| **2.2 Tertiary education** | **63.4** | **1** ● ◆ |
| 2.2.1 Tertiary enrolment, % gross | 142.9 | 1 ● ◆ |
| 2.2.2 Graduates in science and engineering, % | 28.3 | 21 |
| 2.2.3 Tertiary inbound mobility, % | 3.4 | 63 |
| **2.3 Research and development (R&D)** | **33.4** | **34** |
| 2.3.1 Researchers, FTE/mn pop. | 3,827.2 | 27 |
| 2.3.2 Gross expenditure on R&D, % GDP | 1.3 | 30 |
| 2.3.3 Global corporate R&D investors, top 3, mn US$ | 41.4 | 37 |
| 2.3.4 QS university ranking, top 3* | 21.2 | 49 |
| **Infrastructure** | **48.5** | **45** |
| **3.1 Information and communication technologies (ICTs)** | **77.4** | **43** |
| 3.1.1 ICT access* | 84.2 | 21 ● |
| 3.1.2 ICT use* | 76.3 | 35 |
| 3.1.3 Government's online service* | 70.6 | 65 ◇ |
| 3.1.4 E-participation* | 78.6 | 50 |
| **3.2 General infrastructure** | **22.5** | **94** ◇ |
| 3.2.1 Electricity output, GWh/mn pop. | 4,961.0 | 44 |
| 3.2.2 Logistics performance* | 53.7 | 41 |
| 3.2.3 Gross capital formation, % GDP | 11.9 | 121 ○ ◇ |
| **3.3 Ecological sustainability** | **45.4** | **23** |
| 3.3.1 GDP/unit of energy use | 13.8 | 35 |
| 3.3.2 Environmental performance* | 69.1 | 25 |
| 3.3.3 ISO 14001 environmental certificates/bn PPP$ GDP | 4.7 | 21 ● |
| **Market sophistication** | **45.2** | **70** |
| **4.1 Credit** | **38.5** | **76** |
| 4.1.1 Ease of getting credit* | 45.0 | 101 ○ ◇ |
| 4.1.2 Domestic credit to private sector, % GDP | 79.2 | 38 |
| 4.1.3 Microfinance gross loans, % GDP | n/a | n/a |
| **4.2 Investment** | **21.7** | **104** ○ |
| 4.2.1 Ease of protecting minority investors* | 70.0 | 36 |
| 4.2.2 Market capitalization, % GDP | 22.7 | 56 ○ |
| 4.2.3 Venture capital investors, deals/bn PPP$ GDP | 0.0 | 48 |
| 4.2.4 Venture capital recipients, deals/bn PPP$ GDP | 0.0 | 81 ○ |
| **4.3 Trade, diversification, and market scale** | **75.4** | **42** |
| 4.3.1 Applied tariff rate, weighted avg., % | 1.8 | 25 |
| 4.3.2 Domestic industry diversification | 87.0 | 63 |
| 4.3.3 Domestic market scale, bn PPP$ | 310.7 | 53 |

| | Score/ Value | Rank |
|---|---|---|
| **Business sophistication** | **25.9** | **60** ◇ |
| **5.1 Knowledge workers** | **35.7** | **55** |
| 5.1.1 Knowledge-intensive employment, % | 30.1 | 47 |
| 5.1.2 Firms offering formal training, % ⊘ | 21.6 | 73 |
| 5.1.3 GERD performed by business, % GDP | 0.6 | 36 |
| 5.1.4 GERD financed by business, % | 41.6 | 40 |
| 5.1.5 Females employed w/advanced degrees, % | 18.3 | 36 |
| **5.2 Innovation linkages** | **20.1** | **69** ◇ |
| 5.2.1 University-industry R&D collaboration† | 31.0 | 110 ○ ◇ |
| 5.2.2 State of cluster development and depth† | 32.8 | 118 ○ ◇ |
| 5.2.3 GERD financed by abroad, % GDP | 0.2 | 22 |
| 5.2.4 Joint venture/strategic alliance deals/bn PPP$ GDP | 0.0 | 51 |
| 5.2.5 Patent families/bn PPP$ GDP | 0.3 | 38 |
| **5.3 Knowledge absorption** | **21.8** | **80** ◇ |
| 5.3.1 Intellectual property payments, % total trade | 0.4 | 72 |
| 5.3.2 High-tech imports, % total trade | 5.1 | 110 ○ |
| 5.3.3 ICT services imports, % total trade | 1.0 | 74 |
| 5.3.4 FDI net inflows, % GDP | 2.0 | 79 |
| 5.3.5 Research talent, % in businesses | 25.6 | 49 |
| **Knowledge and technology outputs** | **25.2** | **52** |
| **6.1 Knowledge creation** | **23.7** | **41** |
| 6.1.1 Patents by origin/bn PPP$ GDP | 1.5 | 50 |
| 6.1.2 PCT patents by origin/bn PPP$ GDP | 0.3 | 39 |
| 6.1.3 Utility models by origin/bn PPP$ GDP | 0.0 | 61 ○ |
| 6.1.4 Scientific and technical articles/bn PPP$ GDP | 38.0 | 21 ● |
| 6.1.5 Citable documents H-index | 33.2 | 29 |
| **6.2 Knowledge impact** | **36.3** | **37** |
| 6.2.1 Labor productivity growth, % | −2.1 | 104 ○ ◇ |
| 6.2.2 New businesses/th pop. 15–64 | 1.4 | 71 |
| 6.2.3 Software spending, % GDP | 0.5 | 10 ● |
| 6.2.4 ISO 9001 quality certificates/bn PPP$ GDP | 19.4 | 14 ● ◆ |
| 6.2.5 High-tech manufacturing, % | 14.1 | 78 ◇ |
| **6.3 Knowledge diffusion** | **15.5** | **69** |
| 6.3.1 Intellectual property receipts, % total trade | 0.1 | 57 |
| 6.3.2 Production and export complexity | 46.4 | 55 |
| 6.3.3 High-tech exports, % total trade | 2.2 | 55 |
| 6.3.4 ICT services exports, % total trade | 1.5 | 69 |
| **Creative outputs** | **22.9** | **69** ◇ |
| **7.1 Intangible assets** | **21.1** | **96** ◇ |
| 7.1.1 Trademarks by origin/bn PPP$ GDP | n/a | n/a |
| 7.1.2 Global brand value, top 5,000, % GDP | 4.9 | 68 ◇ |
| 7.1.3 Industrial designs by origin/bn PPP$ GDP | 2.8 | 38 |
| 7.1.4 ICTs and organizational model creation† | 44.6 | 97 ○ ◇ |
| **7.2 Creative goods and services** | **21.8** | **45** |
| 7.2.1 Cultural and creative services exports, % total trade | 0.7 | 38 |
| 7.2.2 National feature films/mn pop. 15–69 | 11.5 | 14 ● |
| 7.2.3 Entertainment and media market/th pop. 15–69 | 24.2 | 27 |
| 7.2.4 Printing and other media, % manufacturing | 1.1 | 50 |
| 7.2.5 Creative goods exports, % total trade | 1.3 | 41 |
| **7.3 Online creativity** | **27.5** | **40** |
| 7.3.1 Generic top-level domains (TLDs)/th pop. 15–69 | 13.2 | 34 |
| 7.3.2 Country-code TLDs/th pop. 15–69 | 19.8 | 30 |
| 7.3.3 Wikipedia edits/mn pop. 15–69 | 70.5 | 34 |
| 7.3.4 Mobile app creation/bn PPP$ GDP | 3.8 | 62 |

Figure 59: Greece's GII profile (WIPO, 2021)

# Greece

| | Rank (out of 134) | Score |
|---|---|---|
| **Network Readiness Index** | **45** | **55.20** |
| **A. Technology pillar** | **39** | **51.37** |
| 1st sub-pillar: Access | 37 | 38.91 |
| 2nd sub-pillar: Content | 36 | 46.79 |
| 3rd sub-pillar: Future Technologies | 62 | 28.42 |
| **B. People pillar** | **46** | **52.95** |
| 1st sub-pillar: Individuals | 25 | 68.24 |
| 2nd sub-pillar: Businesses | 61 | 46.02 |
| 3rd sub-pillar: Governments | 64 | 44.59 |
| **C. Governance pillar** | **49** | **61.80** |
| 1st sub-pillar: Trust | 62 | 44.55 |
| 2nd sub-pillar: Regulation | 46 | 72.95 |
| 3rd sub-pillar: Inclusion | 54 | 67.91 |
| **D. Impact pillar** | **55** | **54.67** |
| 1st sub-pillar: Economy | 67 | 25.29 |
| 2nd sub-pillar: Quality of life | 63 | 66.08 |
| 3rd sub-pillar: SDG Contribution | 42 | 72.64 |




## The Network Readiness Index in detail

| INDICATOR | RANK/134 | SCORE |
|---|---|---|
| **A. Technology pillar** | | |
| **1st sub-pillar: Access** | | |
| 1.1.1 Mobile tariffs | 48 | 69.95 |
| 1.1.2 Handset prices | 26 | 65.09 |
| 1.1.3 Households with internet access | 63 | 70.88 |
| 1.1.4 4G mobile network coverage | 34 | 98.80 |
| 1.1.5 Fixed-broadband subscriptions | 17 | 95.64 |
| 1.1.6 International Internet bandwidth | 31 | 78.10 |
| 1.1.7 Internet access in schools | n/a | n/a |
| **2nd sub-pillar: Content** | | |
| 1.2.1 GitHub commits | 36 | 18.23 |
| 1.2.2 Wikipedia edits | 31 | 73.44 |
| 1.2.3 Internet domain registrations* | - | - |
| 1.2.4 Mobile apps development | 36 | 77.90 |
| **3rd sub-pillar: Future Technologies** | | |
| 1.3.1 Adoption of emerging technologies | 85 | 38.50 |
| 1.3.2 Investment in emerging technology | 110 | 23.53 |
| 1.3.3 ICT PCT patent applications | 36 | 20.42 |
| 1.3.4 Computer software spending | 13 | 52.90 |
| 1.3.5 Robot density | 37 | 6.74 |
| **B. People pillar** | | |
| **1st sub-pillar: Individuals** | | |
| 2.1.1 Internet users | 57 | 72.47 |
| 2.1.2 Active mobile-broadband subscriptions | 56 | 31.71 |
| 2.1.3 Use of virtual social networks | 55 | 58.76 |
| 2.1.4 Tertiary enrollment | 1 | 100.00 |
| 2.1.5 Adult literacy rate | 31 | 97.38 |
| 2.1.6 ICT skills | 72 | 49.14 |
| **2nd sub-pillar: Businesses** | | |
| 2.2.1 Firms with website | 55 | 57.81 |
| 2.2.2 Ease of doing business | 74 | 67.55 |
| 2.2.3 Professionals | 25 | 46.57 |
| 2.2.4 Technicians and associate professionals | 61 | 33.96 |
| 2.2.5 Business use of digital tools | 76 | 56.17 |
| 2.2.6 R&D expenditure by businesses | 36 | 14.04 |
| **3rd sub-pillar: Governments** | | |
| 2.3.1 Government online services | 64 | 69.70 |
| 2.3.2 Publication and use of open data | 36 | 38.94 |
| 2.3.3 Government promotion of investment in emerging technologies | 107 | 17.92 |
| 2.3.4 R&D expenditure by governments and higher education | 30 | 51.79 |

| INDICATOR | RANK/134 | SCORE |
|---|---|---|
| **C. Governance pillar** | | |
| **1st sub-pillar: Trust** | | |
| 3.1.1 Secure Internet servers | 45 | 70.24 |
| 3.1.2 Cybersecurity | 78 | 56.23 |
| 3.1.3 Online access to financial account | 76 | 23.33 |
| 3.1.4 Internet shopping | 47 | 28.40 |
| **2nd sub-pillar: Regulation** | | |
| 3.2.1 Regulatory quality | 56 | 57.91 |
| 3.2.2 ICT regulatory environment | 28 | 93.05 |
| 3.2.3 Legal framework's adaptability to emerging technologies | 78 | 33.58 |
| 3.2.4 E-commerce legislation | 1 | 100.00 |
| 3.2.5 Privacy protection by law content | 27 | 80.19 |
| **3rd sub-pillar: Inclusion** | | |
| 3.3.1 E-Participation | 49 | 77.78 |
| 3.3.2 Socioeconomic gap in use of digital payments | 45 | 78.80 |
| 3.3.3 Availability of local online content | 63 | 61.34 |
| 3.3.4 Gender gap in Internet use | 61 | 57.88 |
| 3.3.5 Rural gap in use of digital payments | 74 | 63.76 |
| **D. Impact pillar** | | |
| **1st sub-pillar: Economy** | | |
| 4.1.1 Medium and high-tech industry | 76 | 26.53 |
| 4.1.2 High-tech exports | 38 | 23.54 |
| 4.1.3 PCT patent applications | 37 | 3.17 |
| 4.1.4 Labour productivity per employee | 37 | 48.81 |
| 4.1.5 Prevalence of gig economy | 104 | 24.40 |
| **2nd sub-pillar: Quality of Life** | | |
| 4.2.1 Happiness | 59 | 64.06 |
| 4.2.2 Freedom to make life choices | 127 | 40.60 |
| 4.2.3 Income inequality | 47 | 73.71 |
| 4.2.4 Healthy life expectancy at birth | 21 | 85.96 |
| **3rd sub-pillar: SDG Contribution** | | |
| 4.3.1 SDG 3: Good Health and Well-Being | 50 | 77.05 |
| 4.3.2 SDG4: Quality Education | 43 | 47.42 |
| 4.3.3 SDG 5: Gender Equality | 78 | 72.80 |
| 4.3.4 SDG 7: Affordable and Clean Energy | 41 | 84.68 |
| 4.3.5 SDG 11: Sustainable Cities and Communities | 35 | 81.27 |

*Data on indicator 1.2.3 is confidential, but has been included in the computation. Please see Appendix I: Technical Notes for further details.

Figure 60: Greece's NRI profile (Dutta & Lanvin, 2020)

*GEM 2020/21, Greek fact – sheet*

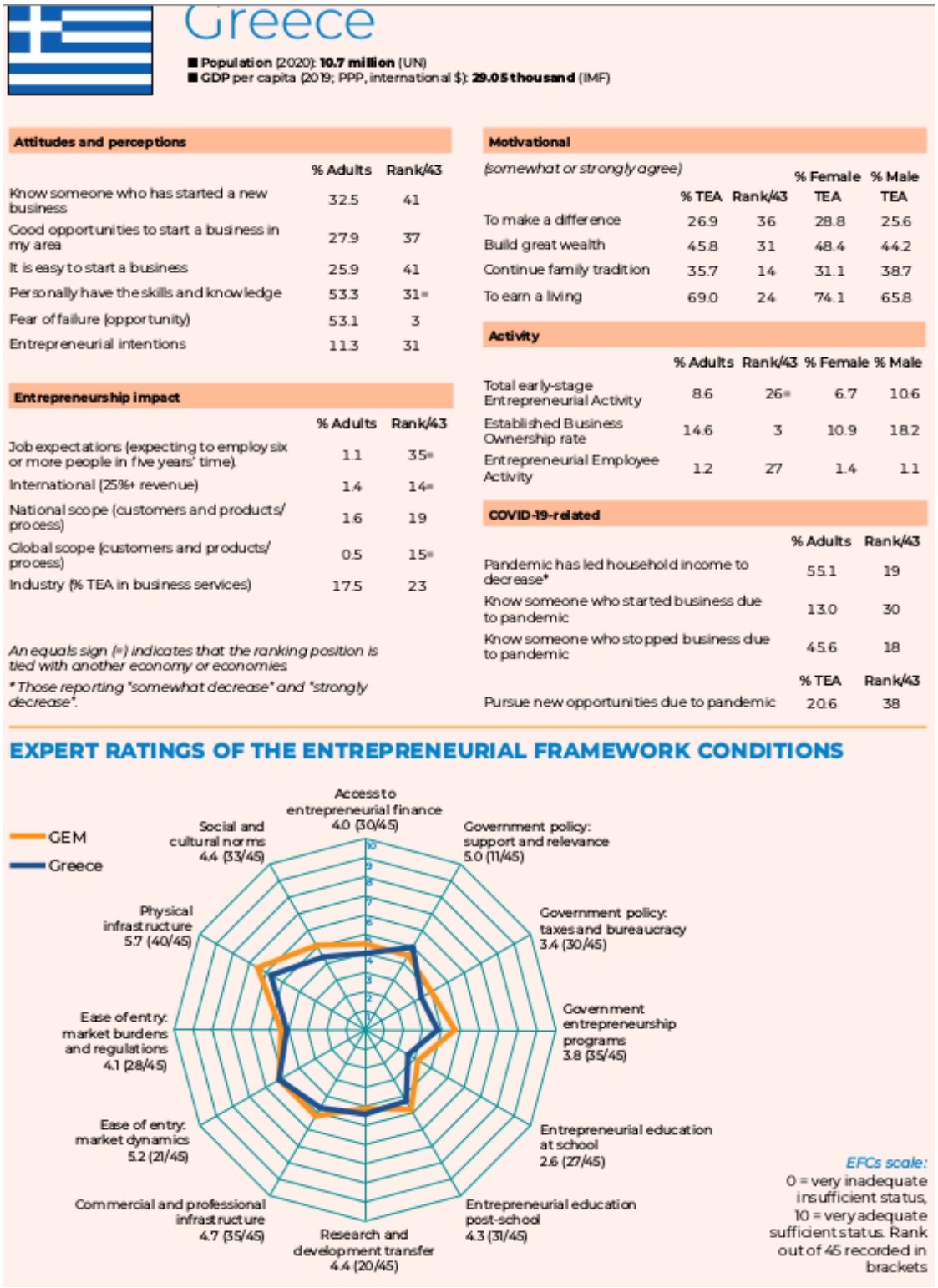



Figure 61: Greece's GEM profile (GERA, 2021)

The following 10 tables represent the questionnaire, adapted from the Global Entrepreneurship Monitor Index 2020/2021, for the needs of the survey regarding the assessment of the ICT ecosystem of Thessaloniki.

| |
|---|
| Sex |
| Age |

Table Q1: Questionnaire's profiling sections

| | |
|---|---|
| Are you actively involved in setting up an ICT business based in Thessaloniki you will own or co-own? (No payments to owner or employees for more than 3 months). | Yes / No |
| Do you own or manage an ICT new business based in Thessaloniki? (Paid salaries, wages at least to owner for more than three months, but not more than 42 months - 3.5 years). | Yes / No |
| Do you own or manage an ICT established business based in Thessaloniki? (Paid salaries, wages at least to owner for more than 42 months - 3.5 years) | Yes / No |
| If you are an employee of an ICT business based in Thessaloniki, are you involved in developing or launching new goods or services, or setting up a new business unit, a new establishment or subsidiary. If you are an owner or manager of said business are employees involved in the previously mentioned activities? | Yes / No |

Table Q2: Questionnaire's entrepreneurial activity section

| | |
|---|---|
| Do you personally know someone who has started an ICT business based in Thessaloniki in the past two years? | Yes / No |
| Do you find it easy to start an ICT business in Thessaloniki? | Yes / No |
| (ANSWER IF NOT INVOLVED IN ENTREPRENEURIAL ACTIVITY). Do you see good opportunities to start an ICT firm in Thessaloniki? | Yes / No |

| | |
|---|---|
| (ANSWER IF NOT INVOLVED IN ENTREPRENEURIAL ACTIVITY). Do you believe that you have the required skills and knowledge to start an ICT business? | Yes / No |
| (ANSWER IF NOT INVOLVED IN ENTREPRENEURIAL ACTIVITY). Would fear of failure prevent you from setting up an ICT business? | Yes / No |

Table Q3: Questionnaire's entrepreneurial attitudes and perceptions section

| | |
|---|---|
| What do you consider was the impact of the COVID -19 pandemic to your household's income? | Strongly decrease<br>Somewhat decrease<br>No substantial change<br>Somewhat increase<br>Strongly Increase |
| Do you know someone who has stopped an ICT business based in Thessaloniki, because of the pandemic? | Yes / No |
| Do you know someone who has started an ICT business based in Thessaloniki, because of the pandemic? | Yes / No |
| (ANSWER IF YOU OWN OR MANAGE A NON - ESTABLISHED ICT BUSINESS IN THESSALONIKI). Do you agree that the pandemic has provided new opportunities that you wish to pursue? | Yes / No |
| (ANSWER IF YOU OWN OR MANAGE A NON - ESTABLISHED ICT BUSINESS BASED IN THESSALONIKI). Do you find starting a business more difficult compared to a year ago? | Yes / No |

| | |
|---|---|
| (ANSWER IF YOU OWN OR MANAGE A NON - ESTABLISHED ICT BUSINESS BASED IN THESSALONIKI). Has the pandemic led to a delay in getting the business operational? | Yes / No |

Table Q4: Questionnaire's impact of the COVID-19 Pandemic section

| | |
|---|---|
| Is your business sponsored (partially owned)? | Yes / No |
| Is your business independently owned? | Yes / No |
| Have you invested in someone else's new business in the last three years? | Yes / No |
| How much have you invested? | |

Table Q5: Questionnaire's gender, sponsorship, and informal investment section

| | |
|---|---|
| Did you exit from your business in the past 12 months, either by selling, shutting down or otherwise discontinuing an owner/management relationship with that business? | Yes / No |
| Did you exited a business in the past 12 months and that business has continued? | Yes / No |
| Did you exited a business in the past 12 months and that business has discontinued? | Yes / No |
| Was the exit's reason positive? | Yes / No |
| (ANSWER IF NEGATIVE) Was it due to | Yes / No |

| | |
|---|---|
| the COVID-19 pandemic? | |

Table Q6: Questionnaire's business exits section

| | |
|---|---|
| How many people do you expect to employ five years from now? | Yes / No |
| Do you have exclusively customers from Greece? | Yes / No |
| Do you anticipate 25% or more revenue coming from outside Greece? | Yes / No |

Table Q7: Questionnaire's expectations and scope section

| | |
|---|---|
| Did you start your business "To make a difference in the world"? | Yes / No |
| Did you start your business "To build great wealth or very high income"? | Yes / No |
| Did you start your business "To continue a family tradition"? | Yes / No |
| Did you start your business "To earn a living because jobs are scarce"? | Yes / No |

Table Q8: Questionnaire's motivation to start a business section