Case Study on the Hungarian new tech entrepreneurial ecosystem

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Executive summary

In this case study, we intend to depict and evaluate the state of the new tech entrepreneurial ecosystem in Hungary. As a descriptive case study, this paper does not directly formulate policy suggestions, but the information presented and discussed is highly relevant for policy makers. The comparisons between Hungary and other EU countries tell policy makers how Hungary is doing in terms of supporting new tech start-ups and which areas are in need of more, new or different types of policy making.

New technology oriented firms, as a small subset of startups, are believed to be important drivers of economic growth and job creation via the facilitation of technological change and innovation (Audretsch 1995, Colombo and Grilli 2010). Indeed, the reforms to European Cohesion Policy have sought to place entrepreneurship center-stage via the introduction of the 'smart specialization' strategy (European Commission, 2012; McCann and Ortega-Argilés 2013, 2015, 2016). Entrepreneurship, and in particular its role on fostering innovation, is now seen as being key to the new EU smart growth and development agenda.

The most recent emerging digital entrepreneurship ecosystem approach is looking for the emergence of new technologies at the intersection of entrepreneurial and digital ecosystems (Autio et al 2017, Nambasian 2017, Sussan–Acs 2017). Sussan and Acs (2017) define the digital entrepreneurship ecosystem as "the matching of digital customers (users and agents) on platforms in digital space through the creative use of digital ecosystem governance and business ecosystem management to create matchmaker value and social utility by reducing transactions cost." (Sussan–Acs 2017, p. 63). This definition of digital entrepreneurship seems to be a suitable theoretical framework for our study.

To design tailor-made new tech policies, it is essential to use the best available evidence to develop appropriate data baselines on which targets can be set and policies can be developed to support the digital entrepreneurship ecosystem. Therefore, the knowledge of specific strengths and weaknesses of the individual regional entrepreneurial and digital ecosystems is essential. This case study describes and applies an empirical approach that can serve to assess different elements of the digital entrepreneurial ecosystems.

There are no direct indicators of digital entrepreneurship. Therefore, we can only examine the entrepreneurial and digital environments independently. To have a comprehensive view on the Hungarian entrepreneurial ecosystem where new technology businesses operate, first, we review the Hungarian GEI (Global Entrepreneurship Index) scores and the ranking of Hungary among the EU countries during 2011–2015. Unlike in the case of the system of entrepreneurship where we have a dominant index (GEI), there is no leading indicator of digital ecosystems. In the European Union, the most widely used composite indicator is the Digital Economy and Society Index (DESI 2017). Another often used indicator is the World Economic Forum's Network Readiness Index (NRI) (2016). Next to these two prominent composite indicators, there are some other country level indicators that capture important dimensions of digitalization, namely the Digital Country Index (DCI), the Evolution Index (DEI), the Digital Tax Index (DTI) and the Digital Money Index (DMI). Next to assessing the digital ecosystem in Hungary based on all six indices, we look at the importance of the Hungarian new tech startup sector as well. Finally, we present the results of our expert survey to obtain better indications on specific characteristics of the Hungarian entrepreneurial ecosystem. In the survey, we distinguished between eight, partially overlapping, topics related to the entrepreneurial as well as to the digital ecosystems.

Our results on the Hungarian entrepreneurial ecosystem signal a relatively low value of venture capital and a lack of sophisticated business strategy that are believed to be vital to the emergence of high growth ventures (low Finance and Strategy institutional GEI variable). Moreover, the relatively low values of all the attitude related individual variables suggest relatively poor basic entrepreneurial capabilities, skills and cultural support of the population. The recognition of entrepreneurial opportunities is particularly problematic even if we compare Hungary with other former socialist CEE countries. The percentage of young businesses applying a technology that is younger than five year-old is also relatively weak. As of the digital ecosystem, both DESI and NRI indicate that, in general, the business level digital technology usage in Hungary is well below the EU average. Looking at the various indicators on medium and new tech businesses, startups and new technology high growth ventures, Hungary ranks around the 15–18 place among out the 28 EU countries. Altogether, Hungary is performing better in terms of the number or the density of new tech businesses as compared to the digital or the entrepreneurship ecosystems, where Hungary belongs to the fourth, weakest quartile of the EU countries. Our overall impression from the answers of the expert survey is that the Hungarian entrepreneurship ecosystem has many aspects that need improving to become favourable for the emergence of new technology firms. The results indicate that experts evaluate Hungary's performance moderate in Human capital and education, Regulatory environment, Financing and Support. Policy makers can achieve economic growth with the highest efficiency and efficacy of resource usage, by targeting the mentioned bottlenecks in the way of the development of digital entrepreneurship.

1. Introduction

While entrepreneurship scholars share diverse opinions about the meaning, content and context of entrepreneurship, the importance of new firms is a widely accepted view. New firms play an important role in job growth and wealth creation. Entrepreneurs, as agents of change, contribute to innovation and technology development (Acs 2002). However, not all startups are equally important. Many new businesses remain small, have minor economic effects, and only a tiny proportion is becoming large and has measurable or even significant influence on the economy (Shane 2009, Nightingale and Coad 2014). New technology oriented firms, as a small subset of startups, are believed to be important drivers of economic growth and job creation via the facilitation of technological change (Audretsch 1995, Colombo and Grilli 2010).

Recognizing the disproportionate effect of new technology based startups (NTBS) policy makers have been looking for the appropriate ways to enhance the development of NTBS. According to Brown and Mason (2014), "Promoting new technology-based firms is the cornerstone of technology entrepreneurship policies in advanced industrial economies." (p. 773) Although, creating favorable environment for startups, improving the access to financial resources, establishing technology transfer offices, supporting technology parks or accelerators seem to be inadequate if the widely interpreted environmental contexts and players are ignored (Isenberg 2010, Mason and Brown 2014). The entrepreneurship ecosystem research line goes even further claiming that all the influential factors, context and players should be viewed, not in isolation, but as a part of a self-sustaining system. The most recently emerging digital ecosystem approach is looking for the emergence of new technologies at the intersection of entrepreneurship and digital systems (Autio et al 2017, Nambasian 2017, Sussan–Acs 2017).

The basic aim of this case study is to verify and capture the elements of the entrepreneurial ecosystem in Hungary influencing the emergence of new high-tech start-ups. In particular, we are looking for answering the following research questions.

1. How well is Hungary performing in terms of the entrepreneurship ecosystem, as compared to other European countries?
2. How is the Hungarian entrepreneurship ecosystem supporting the emergence of new high tech startups?
3. What is the size/magnitude of the high tech start-up industry?
4. What are the weak and the strong elements of the Hungarian entrepreneurship ecosystem?

The goal of this case study is to describe how well the Hungarian entrepreneurship ecosystem support the emergence of new high tech startups. As a descriptive case study, it does not directly formulate policy suggestions, but the information presented and discussed is highly relevant for policy makers. The comparisons between Hungary and other EU countries tell policy makers how Hungary is doing and which areas are in need of more, new or different types of policy making.

The study was structured by first, discussing the relevance of the entrepreneurship ecosystem. In chapter 2, we also describe the digital dimension of the ecosystem, since digitalization plays a fundamentally important role in the emergence of new technology based startups. The position of the Hungarian entrepreneurship ecosystem is analyzed in chapter 3, based on the Global Entrepreneurship Index (GEI) the Network Readiness Index (NRI) and the Digital Economy and Society Index (DESI). Chapter 4 provides a description about the size and the magnitude of the Hungarian new tech startup industry. The analysis is based on Global Entrepreneurship Monitor (GEM) medium and high technology data, the Deloitte Technology Fast report and an online data collection about

startup from startupranking.com and AngelList. Both chapters 3 and 4 provide a comparison of Hungary to other European Union (EU) countries. In Chapter 5 we analyze the strengths and weaknesses of the Hungarian new tech ecosystem based on a survey of 43 experts, while Chapter 6 summarizing the findings and concluding the study.

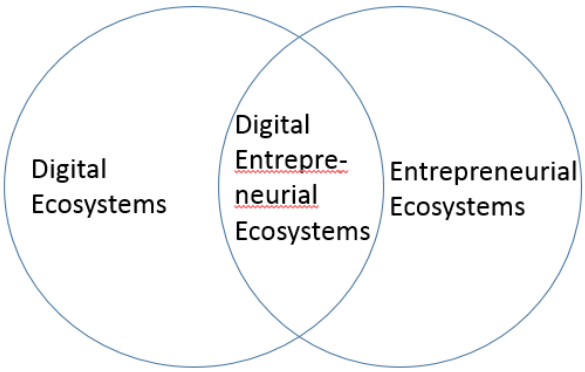
2. Digital entrepreneurship at the intersection of entrepreneurial and digital ecosystems

The purpose of this section is to give a short introduction on the chosen conceptual framework for analysing the condition of entrepreneurship in the digital era. This can be realized by integrating the concept of entrepreneurial and digital ecosystems.

The most recently emerging digital entrepreneurship ecosystem approach is looking for the emergence of new technologies at the intersection of entrepreneurial and digital ecosystems (Autio et al 2017, Nambasian 2017, Sussan–Acs 2017). Sussan and Acs (2017) define the digital entrepreneurship ecosystem as "the matching of digital customers (users and agents) on platforms in digital space through the creative use of digital ecosystem governance and business ecosystem management to create matchmaker value and social utility by reducing transactions cost." (Sussan–Acs 2017, p. 63). This definition of digital entrepreneurship seems to be a suitable theoretical framework for our study.

Thus, the concept of digital entrepreneurship ecosystem is the integration of two phenomena: digital and entrepreneurial ecosystems (Figure 1).

Figure 1: The Integration of Two Ecosystems



Source: Sussan–Acs (2017)

On one hand, we need to assess the entrepreneurial ecosystem. The hart of the entrepreneurship research is how to get more innovation out of the system is the question of who are the focal actors in the system: agents or institutions. Entrepreneurs may be the agents that, by commercializing innovations, provide the transmission mechanism transferring advances in knowledge into economic growth. However, even where entrepreneurial initiative is present, this process of transmission may be hampered or facilitated by the institutional environment. To formalize these ideas, we measure entrepreneurship and institutional arrangements in a national system of entrepreneurship (NSE). In

the National System of Entrepreneurship it is the entrepreneur that plays that role where institutions create the incentive structure for the system (Baumol 1990). This brings together human agency and the institutional context jointly and it allows us to compare the separate and combined roles of entrepreneurship and institutions in economic growth (North 1990, Baumol 1990, Leibenstein 1968). National systems of entreprenurship are resource allocations systems that are propelled by entrepreneurial attitudes, abilities and aspirations.

Research on the entrepreneurial ecosystem (EE) considers the emergence of productive entrepreneurship as a result of actors and factors within a focal territory (Acs et al. 2014). EE includes different attributes that increase entrepreneurship and support economic growth: cultural attributes as attitudes and history; social attributes like social network and capital as well as skilled employees among others; and material attributes that include institutions (Spigel 2017). These factors create a supporting background for innovative firms and motivate nascent entrepreneurs in order to start-up their own venture. The ecosystem approach in entrepreneurship policy requires a shift from the focus on quantity to the quality of entrepreneurship (Stam–Spigel 2016).

We recognize that country level entrepreneurship is a multifaceted phenomenon where individual capabilities and actions are contextualized by institutional incentives. This suggests that the building blocks of entrepreneurial activity cannot be viewed in isolation. On the contrary, they constitute a system where the final outcome is moderated by the weakest performing elements. Different economic ecosystems will have different outcomes in different parts of the world as the different agents and institutions interact.

In discussing the abilities of nations to innovate technology is the central issue. However, in the modern era the technology itself has changed from what one might call industrial technology to information or digital technology. The idea is that the stronger the entrepreneurial ecosystem, the more productive the technology, the higher the propensity to create new technologies and the greater the impact of technology on economic growth. As new technologies and innovation has come up, activities of “traditional” (non-tech) firms might be endangered through “creative destruction”. This process of replacement seems to be relatively quick compared to the introduction of former technologies and innovations. (Filippov and Hofheinz 2016.) As platforms can support a wide range of entrepreneurial activities, new ventures exploiting digital platforms for business model experimentation will have an incentive to share their experiences, as reciprocal sharing of such knowledge will help all occupants of the entrepreneurial ecosystem to become more effective in business model innovation. (Acs et al. 2017b)

These technologies and tools create a new dimension of location factors, regional differences and economic environments. Roller and Waverman (2001) demonstrate that investments in digital infrastructure fostered subsequent economic performance in 21 OECD countries from 1970 to 1990. The positive impact of telecommunication technologies on economic growth was especially present over a critical mass what is near universal service. Similar effects have been reported for EU countries (Timmer, Ypma and Ark 2003), Central and Eastern Europe (Madden and Savage 1998) and on a global level as well (Hardy 1980, Jorgenson and Vu 2005).

A significant difference among NTBFs and “traditional” ventures is that the inputs and outputs of NTBFs depend on the internet; without digital platforms they would not exist. (Sussan–Acs 2017). Digitalization and digital tools support the exploitation of entrepreneurial opportunities by restructuring functions and relationships, decreasing the “distance” between product or service providers and consumers as well as driving generativity (Autio el at. 2017). The introduction of technological development is an important driver of recognizing emerging opportunities and this process might lead indirectly to entrepreneurial activity as well (Autio et al. 2013). The use of digital

technologies affects entrepreneurial processes and outcomes, as they become more fluid, flexible and ubiquitous. Furthermore, digitization has an impact on the agents itself, since in case of tech-firms the entrepreneurial activity become less predefined and more distributed (Nambisan et al. 2017, Nambisan 2017).

On the other hand, we need to evaluate the digital ecosystem. The concept of digital ecosystems (DE) has emerged as digitization becomes more and more important, and it describes a system within the included entities (like agents, institutions, organizations) and their interrelations that focus on supporting each other in order to expand their utility, benefits and promote information sharing among them (Li et al. 2012, Sussan–Acs 2017). DE is defined as "an open, loosely coupled, domain-clustered, demand-driven, self-organizing and agent-based environment, in which each species is proactive and responsive for its own benefit and profit".[1]

As a synthesis of the two concepts, Sussan and Acs (2017) have introduced the concept of the digital entrepreneurship ecosystem as "the matching of digital customers (users and agents) on platforms in digital space through the creative use of digital ecosystem governance and business ecosystem management to create matchmaker value and social utility by reducing transactions cost." (Sussan–Acs 2017, p. 63). There is strong evidence that investing in the digital infrastructure is beneficial for the economy. Nevertheless, in the framework of digital entrepreneurship ecosystem, the implication for policy, is that in order to make the economy stronger and more dynamic a country should invest in not only the digital infrastructure but also the entrepreneurial ecosystem. Participating in the digital economy is not the same as having broadband internet access. Although it has a crucial role there are other factors that influence the evolution of the digital economy: regulations that create an adequate business climate; digital skill in order to facilitate the use of these technologies; and institutions that support these processes (Peña-López 2016).Adaption, technology absorption and diffusion digital technologies, solutions and tools have a crucial role in the intensity of digital entrepreneurship ecosystem. The core competencies of the tech-companies that build their activities on digital technologies are their ability to match one group of customers with another group of customers by reducing the transactions cost of a match. (Sussan–Acs 2017).

3. The entrepreneurial and digital ecosystems in Hungary

In chapter 2 we presented a conceptual framework of digital entrepreneurship at the intersection of entrepreneurial and digital ecosystems. This seems to be an appropriate conceptual framework to examine the situation of the Hungarian new technology oriented businesses. However, there are no direct indicators of digital entrepreneurship. Therefore, we can only examine new technology entrepreneurship and digital environments independently. To have a comprehensive view on the framework within Hungarian new technology businesses operate and to identify the strengths and the weaknesses, first we review the GEI (Global Entrepreneurship Index) scores and the ranking of Hungary among EU countries during 2011–2015. In the second part of the chapter we analyse the digital ecosystem based on the EU Digital Economic and Society Index (DESI) and the Network Readiness Index (NRI).

3.1. Entrepreneurial ecosystem in Hungary based on the Global Entrepreneurship Index

[1]Chang, E. & West, M. "Digital Ecosystem - A next generation of the collaborative environment," keynotes in iiWAS2006

Several composite indicators exist that measure country level competitiveness (Global Competitiveness Index (Scwab, Sala-I-Martin, Samans 2017)), innovation (Global Innovation Index 2017, European Innovation Scoreboard 2017), corruption (Corruption Perception Index 2016), business start-up regulation (Doing Business in 2018) or prosperity (The Legatum Prosperity Index 2017). While many of these indicators have direct or indirect connections to entrepreneurship, only the Global Entrepreneurship Index (GEI) provides a comprehensive measure about the system of entrepreneurship at the country level[2] (Acs and Szerb 2011, 2012; Acs et al 2014).

GEI defines country level entrepreneurship in terms of the National System of Entrepreneurship: *the dynamic, institutionally embedded interaction between entrepreneurial attitudes, abilities, and aspirations, by individuals, which drives the allocation of resources through the creation and operation of new ventures"* (Acs et al 2014, p.479). The distinctive characteristics of the GEI can be summarized as the followings (Szerb et al 2016b):

- entrepreneurship is a multifaceted phenomenon that requires a composite indicator;
- the indicator should capture the quality aspects of entrepreneurship;
- both the individual efforts/capabilities and the environmental/institutional aspects of entrepreneurship are important;
- the different aspects/components of entrepreneurship constitute a system where the interrelation of the elements is vital;
- entrepreneurship policy should be formulated from a systems perspective by providing a tailor-made policy mix that fits to a particular country's entrepreneurial profile rather than providing a one size fits approach.

The GEI super-index measures entrepreneurship at the country level. The GEI pyramid has three sub-indices (attitudes, abilities and aspirations) that comprise fourteen pillars, 28 variables and49 indicators. All pillars consist of an individual and an institutional variable component. Taking the system's perspective, GEI takes into account the connection between the individual and the institutional factors. Most recently, the institutional components of the GEI have been critically reviewed and changed (Szerb et al 2016a). This new version is presented in Table 1.

[2]The GEI formerly was named as GEDI, Globl Entrepreneurship and Development Index.

Table 1: The structure of the Global Entrepreneurship Index (GEI)

	Sub-indexes	Pillars	Variables*
GLOBAL ENTREPRENEURSHIP INDEX	ATTITUDES SUB-INDEX	OPPORTUNITY PERCEPTION	*OPPORTUNITY*
			FREEDOM AND PROPERTY
		STARTUP SKILLS	*SKILL*
			EDUCATION
		RISK PERCEPTION	*RISK ACCEPTANCE*
			COUNTRY RISK
		NETWORKING	*KNOWENT*
			CONNECTIVITY
		CULTURAL SUPPORT	*CARSTAT*
			CORRUPTION
	ABILITIES SUB-INDEX	OPPORTUNITY STARTUP	*TEAOPPORT*
			TAXGOVERN
		TECHNOLOGY ABSORPTION	*TECHSECT*
			TECHABSORP
		HUMAN CAPITAL	*HIGHEDUC*
			LABOR MARKET
		COMPETITION	*COMPET*
			COMPREGULATION
	ASPIRATION SUB-INDEX	PRODUCT INNOVATION	*NEWP*
			TECHTRANSFER
		PROCESS INNOVATION	*NEWT*
			SCIENCE
		HIGH GROWTH	*GAZELLE*
			FINANCE AND STRATEGY
		INTERNATIONALIZATION	*EXPORT*
			ECONOMIC COMPLEXITY
		RISK CAPITAL	*INFINV*
			DEPTH OF CAPITAL MARKET

*Individual variables are colored with white background while institutional ones with grey background.
Source: Szerb et al. (2016a)

The entrepreneurial attitude (ATT) sub-index captures the attitudes of a region's population towards entrepreneurship. The variable opportunity indicates the recognition and exploration of opportunities for starting a new business. Starting a new enterprise is affected by personal networks ("Networking") and adequate skills related to new business formation ("Startup skills"). Risk perception represents the attitude about the fear of failure that may have a negative effect, and cultural support indicates the population's main believes about the entrepreneurs like career opportunities, success stories or negative impressions (for e.g. corruption).

The entrepreneurial abilities (ABT) sub-index is principally concerned with measuring certain important characteristics of both entrepreneur and start-up with high growth potential. It captures skills that may contribute the high growth of a start-up. These pillars are measured among entrepreneurs whose businesses are up to 42 months old. Opportunity start-up represents the individual entrepreneurial motivation on the one hand and the business environment (taxes and quality of government) within start-up embedded on the other hand. Technological orientation ("Technology absorption") reflects to the technology level of young firms' activities, since human capital represents the educational level of employees. Competition indicates the concentration of markets through the number of competitors of young firms as well as regulations concerning competition in the economy.

The entrepreneurial aspiration (ASP) sub-index refers to the distinctive, qualitative, strategy-related nature of entrepreneurial start-up activity. Product and process innovations represent the abilities of the start-up for new products and/or newly organized parts in the production process. The high growth measure indicates the orientation for expanding the number of jobs in the startup as well as the strategy sophistication. Internationalization represents the international orientation, the foreign customers of the start-up as well as the economic complexity of the country. Risk capital refers to the financial background of startup business that is measured by the informal investments on the one hand and the concentration of financial sector on the other hand.

The more detailed description of the GEI components with their calculation methodology can be found in Acs et al. (2017a).

Following Szerb et al. (2016b), we first examine Hungary's overall position. Data is available for 26 out of the 28 EU member countries except Cyprus and Malta. The individual data is from the 2011 and 2015 cycles of the Global Entrepreneurship Monitor Adult Population Survey (APS). The institutional data is derived from various sources (see Acs et al., 2017a). In order to decrease measurement error and maximize the number of investigated countries, we use country averages for 2011–2015.

Table 2: The Entrepreneurial Attitudes (ATT), Entrepreneurial Abilities (ABT), the Entrepreneurial Aspirations (ASP), and the Global Entrepreneurship Index (GEI) scores and rankings of EU countries

Country	Included years	ATT Score	ATT rank	ABT Score	ABT rank	ASP Score	ASP rank	GEI Score	GEI rank
Austria	2012, 2014	64.0	6	67.7	7	58.6	11	63.5	10
Belgium	2011-2015	57.9	11	68.2	6	68.4	4	64.8	8
Bulgaria	2015	24.7	25	22.6	26	20.8	26	22.7	26
Croatia	2011-2015	22.5	26	33.4	23	40.8	23	32.2	25
Czech Republic	2011, 2013	35.6	20	40.2	19	54.8	12	43.5	18
Denmark	2011, 2012, 2014	73.3	4	86.4	1	68.9	3	76.2	2
Estonia	2012-2015	57.9	10	53.8	12	54.0	14	55.2	12
Finland	2011-2015	81.0	1	57.7	11	64.1	7	67.6	6
France	2011-2014	59.9	8	67.4	8	69.9	2	65.8	7
Germany	2011-2015	58.1	9	66.5	9	67.2	5	63.9	9
Greece	2011-2015	31.4	22	39.7	20	36.0	25	35.7	23
Hungary	2011-2015	37.0	18	41.9	18	42.8	22	40.6	21
Ireland	2011-2015	62.4	7	78.4	4	65.1	6	68.6	5
Italy	2012-2015	29.7	23	32.3	24	47.5	19	36.5	22
Latvia	2011-2013, 2015	33.2	21	45.5	16	44.8	20	41.2	20
Lithuania	2011-2014	37.8	17	45.9	15	48.9	17	44.2	17
Luxembourg	2013-2015	48.3	14	66.0	10	61.7	10	58.7	11
Netherlands	2011-2015	77.6	3	69.1	5	62.5	9	69.7	4
Poland	2011-2015	43.0	16	38.1	21	54.1	13	45.1	16
Portugal	2011-2015	47.2	15	42.5	17	48.4	18	46.0	14
Romania	2011-2015	26.8	24	32.2	25	44.8	21	34.6	24
Slovakia	2011-2015	36.4	19	36.7	22	53.8	16	42.3	19
Slovenia	2011-2015	49.9	12	51.7	13	53.9	15	51.8	13

Spain	2011-2015	48.4	13	50.9	14	37.7	24	45.7	15
Sweden	2011-2015	78.8	2	80.2	3	72.7	1	77.2	1
United Kingdom	2011-2015	67.2	5	81.0	2	63.3	8	70.5	3

Source: Szerb et al (2016b)

According to Table 2, Hungary ranks 21 among 26 EU counties with a GEI score of 40.6. Another two Central Eastern European (CEE) countries, Slovakia (19) and Latvia (20) precede, while Italy (22) and Greece (23) follow Hungary. Hungary's GEI score is almost half of the leading Swedish score. Comparing Hungary to other CEE countries, Hungary is ahead only of Romania (24), Croatia (25) and Bulgaria (26). The best CEE country, Estonia ranks 12th with a GEI score of 55.2, 36% larger than Hungary's GEI score. Looking at the three sub-indices, Hungary performs the best but ranks the worst in the innovation and strategy related aspirations (22nd). The country's scores are lower in attitudes (37.0) and abilities (41.9) but the ranking is better – 18 both in Attitudes and Abilities. The reason of this odd phenomenon is that the raw data are transformed (e.g.: capping, penalty of bottleneck, etc.) and the benchmark calculations are based on the overall dataset that includes 93 countries (see Szerb et al., 2016b). Attitudes is the weakest sub-index of Hungary.

Table 3 focuses on Hungary's GEI and sub-index scores and ranking over the 2011-2015 time period on a yearly base.

Table 3: The scores and rank of Hungary in GEI and its sub-indices (2011–2015)

	Attitudes Sub-index		***Abilities Sub-index***		***Aspirations Sub-index***		***GEI Index***		***GDP (2011, Internat. USD)***	
	Score	**Rank**	**Score**	**Rank**	**Score**	**Rank**	***Score***	***Rank***	**Value**	**Rank**
2011	40.7	14 (23)	49.1	13 (23)	43.2	15 (23)	***44.3***	***15 (23)***	22270.5	17 (23)
2012	38.5	16 (23)	42.6	16 (23)	42.7	20 (23)	***41.3***	***18 (23)***	22737.2	18 (23)
2013	36.9	17 (24)	38.4	19 (24)	39.0	22 (24)	***38.1***	***20 (24)***	22517.1	19 (24)
2014	38.5	18 (24)	41.2	19 (24)	41.3	21 (24)	***40.3***	***20 (24)***	22913.9	19 (24)
2015	29.1	22 (24)	38.2	18 (24)	41.0	20 (24)	***36.1***	***21 (24)***	22683.8	19 (24)

Source: own creation based on the GEI report Note: Scores are measured on a scale from 0 to 100. Rank shows the position of Hungary within the involved EU countries, number of involved EU countries in parentheses

According to Table 3, Hungary's GEI scores and its overall position was declining over the 2011-2015 time period resulting Hungary to drop the overall ranking from the 15th place to the 24th. This decline was accompanied by a stagnation of the per capita GDP. Out of the three sub-indices, Attitudes show the largest decline from 40.7 (2011) to 29.1 (2015). The Abilities sub-index decrease was very similar to the Attitudes but Abilities fall was only a little.

Table 4: The entrepreneurial profile of Hungary based on the fourteen pillars, the individual and the institutional scores (2011–2015 averages)

	PILLARS		INSTITUTIONAL VARIABLES		INDIVIDUAL VARIABLES	
Entrepreneurial Attitudes	Opportunity Perception	0.29	Freedom and Property	0.67	Opportunity Recognition	0.31
	Start-up skills	0.35	Education	0.58	Skill Perception	0.46
	Risk Acceptance	0.52	Business Risk	0.83	Risk Perception	0.42
	Networking	0.35	Connectivity	0.62	Know Entrepreneurs	0.44
	Cultural Support	0.37	Corruption	0.58	Career Status	0.45
	Entrepreneurial Attitudes	**37.0**				
Entrepreneurial Abilities	Opportunity Startup	0.42	Tax and government	0.61	Opportunity Motivation	0.51
	Technology Absorption	0.56	Tech Absorption	0.49	Technology Level	0.75
	Human Capital	0.45	Labor Market	0.53	Educational Level	0.68
	Competition	0.30	Competitiveness and Regulation	0.43	Competitors	0.58
	Entrepreneurial Abilities	**41.9**				
Entrepreneurial Aspirations	Product Innovation	0.30	Technology Transfer	0.53	New Product	0.53
	Process Innovation	0.45	Science	0.70	New Tech	0.41
	High Growth	0.44	Finance and strategy	0.37	Gazelle	0.85
	Internationalization	0.74	Economic complexity	0.83	Export	0.79
	Risk Capital	0.32	Depth of Capital Market	0.52	Informal Investment	0.51
	Entrepreneurial Aspirations	**42.8**				
	GEI	**40.6**	**Institutional**	**0.59**	**Individual**	**0.55**

Legend: Dark Blue: Belonging to the top quartile; Light Blue: belonging to the second quartile; Yellow: belonging to the third quartile; Red: belonging to the bottom quartile

Table 4 shows the full profile of the Hungarian national System of Entrepreneurship based on the fourteen pillars and the 28 variables. It reveals that Hungary's best performing pillar is Internationalization, where Hungary belongs to the top 25% of the countries. Hungary's relative good position can be noticed in the pillars of Technology Absorption, Risk Acceptance and Human Capital, where Hungary belongs to the second best quartile of the countries. The pillars of Process Innovation and Opportunity Startup have scores of over 0.40 with "middle-of-the-road" values. Cultural Support, Startup Skill, and Networking pillars are in the 0.35–0.37 range, below the median pillar values. While Risk Capital, Product Innovation, Competition and Opportunity Perception pillars are all in the third quartile of the countries. These are the weakest components of the Hungarian system of entrepreneurship.

Taking a closer look at the individual and institutional components, the overall quality of institutions scoring 0.59 outperforms the individual components' average result. The exception is the Finance and Strategy variable implying the lack of venture capital and the existence of sophisticated business strategy that are believed to be vital to the emergence of high growth ventures (see the exact composition of the index: Szerb et al., 2016b). High growth is also a key feature of the new tech businesses. The average of the individual variables is 0.55. This result assigns Hungary in the bottom quartile of the countries. All of the attitude related individual variables are colored red, suggesting

weak basic entrepreneurial capabilities, skills and cultural support of the population. Opportunity Recognition is particularly problematic even if we compare it to other former socialist CEE countries.

From the viewpoint of new tech startups two individual variables are important. The Technology Level variable shows the normalized value of the percentage of the nascent and baby businesses[3] that are initiated in the medium or in the high technology sector. Hungary appears to perform relative well in this area, as the 0.75 value of the pillar is the second highest individual variable of Hungary after Exports. Another important variable is New Tech, measured as the normalized value of the percentage of young businesses applying a technology that is younger than five years. With its 0.41 variable value it is the second lowest individual variable score. At the same time, the institutional variable component of the New Tech variable Science, including the Research & Development indicator, is relatively high.

Summarizing, Hungary has a relatively disadvantageous system of entrepreneurship according to the GEI scores, when compared to other EU countries. Based on its three sub-indices, in 2015, Hungary ranked on 18th-22nd among the examined 24 EU countries in the examined period. This result corresponds to Hungary's GDP based rank (19th). Over the 2011-2015 time period, the relative position of the ecosystem has been weakened as compared to the other EU countries, their rate of decline is different, however. Entrepreneurial Attitudes sub-index shows a relatively large drop, while Entrepreneurial Aspirations sub-index has remained relatively stable. Over the whole time period, Entrepreneurial Abilities was the best performing sub-index. On the pillar level, Internationalization and Technology Absorption are the best ones. On the contrary, Opportunity Perception, Competition and Risk Capital are found to be main bottlenecks of the Hungarian system of entrepreneurship. From the viewpoint of the emergence of new technology oriented businesses, compared to the other variables, the Finance and Strategy and the New Tech variables are relatively low.

3.2. The digital performance of Hungary

Unlike in the case of the system of entrepreneurship where we have a dominant index, there is no leading, dominant indicator of digitalization. In the European Union, the most widely used composite indicator is the Digital Economy and Society Index (DESI 2017). Another often used indicator is the World Economic Forum's Network Readiness Index (NRI) (2016). Next to these two leading composite indicators, there are some other important country level indicators that capture important dimensions of digitalization:

- The Digital Country Index (DCI) captures the total amount of searches performed by all worldwide citizens toward any given country. The position of each country is solely determined by their search volume in each of the five dimensions of investment, tourism, talent, prominence and export. (Digital Country Index 2017).

- The Digital Evolution Index (DEI) analyses the underlying drivers that govern a country's digitalization: Supply Conditions, Demand Conditions, Institutional Environment, and Innovation and Change. (Digital Planet 2017)

[3] According to the Global Entrepreneurship Monitor classification nascent business owners are those who are in the gestation of a start-up process and baby businesses are those who own and manage a young businesses aged less than 42 months.

- The Digital Tax Index (DTI) measures how favorable the taxation environment of a country including the effective average tax rate (EATR) and the cost of capital (CoC) for basic types of investments in digital business models (Digital Tax Index 2017)[4]

- The Digital Money Index (DMI) measures the shift from cash to the use of digital money in terms of four aspects as Government and Market Environment, Financial and Technological Infrastructure, Digital Money Solutions, and Propensity to Adopt. (Digital Money Index 2017)

To form a comprehensive picture of the position of Hungary, we present all of the above mentioned indices scores and the rankings. Note that data is not always available for each EU country and sometimes we only know the ranking of the countries (Table 5).

Hungary's overall position, according to the six digital measures, is moderate at best, compared to other EU countries. Hungary ranks highest in the taxation variable as it has a negative effective tax rate, meaning that Hungarian authorities subsidize digital businesses. However, on all of the other indices, Hungary ranks considerably lower. Based on the DEI and the DMI indicators, Hungary ranks on 17th and 18th in the EU. Looking at the number of the out of country digital searches, Hungary occupies the 20th position (Digital Country Index). Out of the two comprehensive digital indicators, DESI shows Hungary's more favorable position (22nd) place, whilst NRI posits Hungary on the 24th place out of the 28 EU countries. Summing up, we can conclude that Hungary's digital development is moderate, placing Hungary in the bottom quartile in the 28 EU countries. Hungary is ahead only of Greece, Croatia, Romania and Bulgaria and it has a performance similar to Cyprus, Italy and Poland.

[4] Here we use only the EATR component of the report. Explain.

Table 5: Hungary's position in the European Union, in terms of the leading digital development indicators and indices

Country	Network Readiness Index 2016		Digital Economy and Society Index 2017		Digital Country Index		Effective Average Tax Rate 2017		Digital Evolution Index 2017		Digital Money Index (2017)	
	NRI Score	NRI rank	DESI Score	DESI rank	DCI world rank (243)	DCI EU rank	EATR %	EATR rank	DEI Score	DEI rank (22)	DMI World ranking (90)	DMI EU ranking (20)
Austria	5.4	8	56.8	10	36	13	15.16%	23	3.28	9	14	6
Belgium	5.4	10	60.8	5	35	12	2.28%	6	3.32	8	24	11
Bulgaria	4.1	27	37.0	27	74	22	9.52%	12	2.41	22		
Croatia	4.3	25	42.5	24	60	18	5.19%	7			37	16
Cyprus	4.6	20	45.9	20	71	21	8.73%	10				
Czech Republic	4.7	18	50.0	18	77	23	7.48%	9	2.90	14	40	17
Denmark	5.6	6	70.7	1	39	14	14.81%	21	3.72	2	3	3
Estonia	5.4	9	60.6	6	104	24	16.27%	25	3.24	11		
Finland	6.0	1	67.9	2	47	15	15.86%	24	3.72	3	1	1
France	5.3	11	51.2	16	8	4	12.39%	16	3.25	10	19	9
Germany	5.6	7	53.7	14	4	2	22.81%	28	3.36	7	17	7
Greece	4.1	28	38.5	26	25	9	16.73%	26	2.44	21	55	20
Hungary	4.4	24	45.3	22	70	20	-6.85%	3	2.66	17	47	18
Ireland	5.3	12	57.9	9	17	6	-10.32%	1	3.41	6	18	8
Italy	4.4	22	42.0	25	10	5	-8.84%	2	2.58	19	32	14
Latvia	4.8	15	47.3	19	116	27	0.33%	4	2.86	15		
Lithuania	4.9	13	55.4	12	108	26	0.44%	5				
Luxembourg	5.7	5	60.2	7	56	17	10.76%	13				
Malta	4.8	16	55.8	11	52	16	13.12%	19				
Netherlands	5.8	3	67.1	4	33	11	13.61%	20	3.55	5	13	5
Poland	4.5	21	42.6	23	27	10	12.63%	17	2.53	20	36	15
Portugal	4.9	14	52.9	15	21	7	11.63%	15	3.01	12	23	10
Romania	4.1	26	33.2	28	62	19	6.62%	8			50	19
Slovak Republic	4.4	23	45.8	21	117	28	15.09%	22	2.65	18		
Slovenia	4.7	19	50.5	17	105	25	9.51%	11	2.86	16	28	13
Spain	4.8	17	55.4	13	7	3	12.85%	18	2.95	13	25	12
Sweden	5.8	2	67.5	3	23	8	16.93%	27	3.79	1	8	4
United Kingdom	5.7	4	58.6	8	1	1	11.11%	14	3.67	4	2	2

In order to form a more nuanced picture about the strengths and weaknesses of the Hungarian digital system, we analyze in detail the country's position according to the two leading digital indicators DESI and NRI.

3.2.1 Hungary's digital development based on the DESI

The European Union's DESI index is a composite indicator summarizing Europe's digital performance. Moreover, DESI tracks the evolution of EU countries in digital competitiveness (https://ec.europa.eu/digital-single-market/en/desi). DESI has five distinctive dimensions:

- The Connectivity dimension measures the deployment of broadband infrastructure and its quality.
- The Human Capital dimension measures the skills needed to take advantage of the possibilities offered by a digital society.
- The Use of Internet dimension accounts for the variety of activities performed by citizens already online.
- The Integration of Digital Technology dimension measures the digitization of businesses and their exploitation of the online sales channel.
- The Digital Public Services dimension measures the digitization of public services, focusing on eGovernment. (https://ec.europa.eu/digital-single-market/en/desi).

Hungary's overall position in the DESI ranking can be seen in Table 6.

Table 6: Hungary's position according to the DESI and the DESI components in the European Union (2017)

Country	Connectivity	Human Capital	Use of Internet	Integration of Digital Technology	Digital Public Services	DESI Score	DESI rank
Austria	15.87	15.53	6.58	7.87	10.97	56.82	10
Belgium	19.70	18.31	9.58	5.97	7.29	60.84	5
Bulgaria	13.08	7.69	5.79	4.50	5.97	37.03	27
Croatia	11.25	11.48	7.53	6.92	5.35	42.53	24
Cyprus	13.53	12.56	7.40	6.05	6.37	45.91	20
Czech Republic	15.59	13.28	6.27	8.16	6.66	49.96	18
Denmark	19.11	17.22	10.80	12.47	11.08	70.68	1
Estonia	19.48	14.31	7.78	10.39	8.60	60.56	6
Finland	16.12	19.11	9.27	11.13	12.23	67.86	2
France	13.79	14.71	6.05	6.94	9.74	51.23	16
Germany	14.87	12.51	7.12	8.33	10.87	53.70	14
Greece	12.00	9.18	6.30	4.87	6.11	38.46	26
Hungary	13.65	9.63	7.63	6.85	7.51	45.27	22
Ireland	15.55	14.49	9.00	6.33	12.56	57.94	9
Italy	13.45	9.89	5.42	6.60	6.67	42.02	25
Latvia	15.93	10.92	8.17	4.55	7.70	47.28	19
Lithuania	16.98	12.39	8.80	8.02	9.20	55.40	12
Luxembourg	18.54	17.84	8.91	7.39	7.48	60.16	7
Malta	17.88	15.30	7.09	8.56	6.94	55.77	11
Netherlands	20.43	16.21	9.33	9.59	11.51	67.07	4
Poland	13.11	11.20	6.06	4.32	7.90	42.59	23
Portugal	16.86	11.13	6.59	8.57	9.74	52.89	15
Romania	13.54	7.63	4.36	3.72	3.98	33.22	28

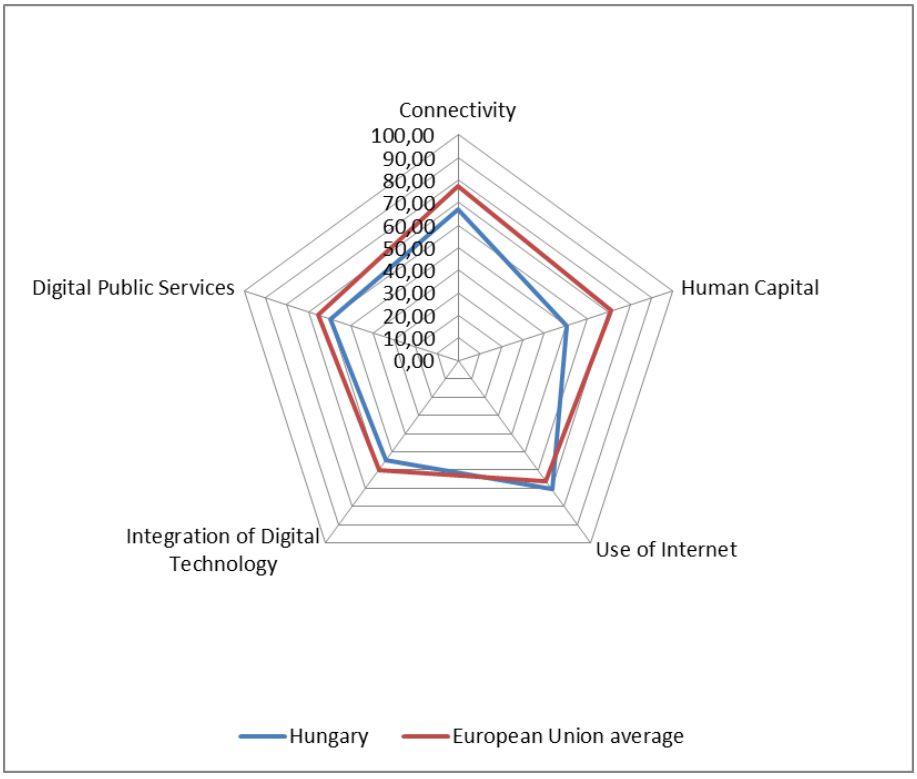
Slovakia	15.90	12.16	7.76	4.71	5.32	45.84	21
Slovenia	14.41	13.03	6.21	9.20	7.66	50.51	17
Spain	17.61	11.26	8.34	8.82	9.34	55.36	13
Sweden	18.88	17.33	10.71	10.77	9.81	67.49	3
United Kingdom	16.18	14.01	7.17	11.15	10.12	58.62	8
European Union 28	15.78	13.64	7.13	7.47	8.24	52.61	

Source: Hungary's DESI profile 2017, p.1

According to the DESI, Hungary ranks 22nd, ahead of Poland, Croatia, Italy, Greece, Bulgaria and Romania. Based on its overall performance, Hungary belongs to the Low performing cluster of countries.

Having a closer look at the DESI five dimensions we can get an inside view about the strengths and weaknesses of Hungary's digital system. (Figure 2)

Figure 2: Hungary's position as compared to the EU averages based on the five dimensions of DESI (2017)



Source: Own calculation based on DESI data

Hungary's performance is highest in Use of the Internet where Hungary exceeds the EU average. Connectivity and Digital Public Services are below to the EU average and the relative low scores of the Integration of Digital Technologies (19th place in ranking) imply that the business sector is not capitalizing on the digital technology opportunities and ICT use as much as other countries are. Human capital is the worst element of Hungary's five DESI pillars where Hungary ranks 25th.

From our perspective, the Integration of the Digital Technologies pillar is particularly important, so it is worth analysing its components further (Table 7).

Table 7: Hungary's performance in the Integration of the Digital Technologies pillar components (2017)

Category	Hungary DESI 2017		EU DESI 2017
	Value	Ranking	Average value
Integration of Digital Technology	6.85	24	7.47
Electronic information sharing	16.0%	27	36.0%
RFID ((Radio Frequency Identification)	3.9%	16	3.9%
Social media	13.0%	21	20.0%
eInvoices	8.0%	25	18.0%
Cloud	8.0%	23	13.0%
SMEs selling online	12.0%	20	17.0%
eCommerce turnover	7.6%	18	9.4%
Selling online cross border	4.5%	23	7.5%

Source: Hungary's DESI profile 2017, p. 7

Out of the Hungarian businesses 16% uses electronic information sharing (44% of the EU average) 13% use social media (65% of the EU average), 8% send eInvoices (44% of the EU average), 8% use cloud services (61% of the EU average) and 12% of SMEs sell online (71% of the EU average). It is clear that the Hungarian enterprises perform well below the EU average in all aspects but one (RFID) of the Integration of the Digital Technologies.

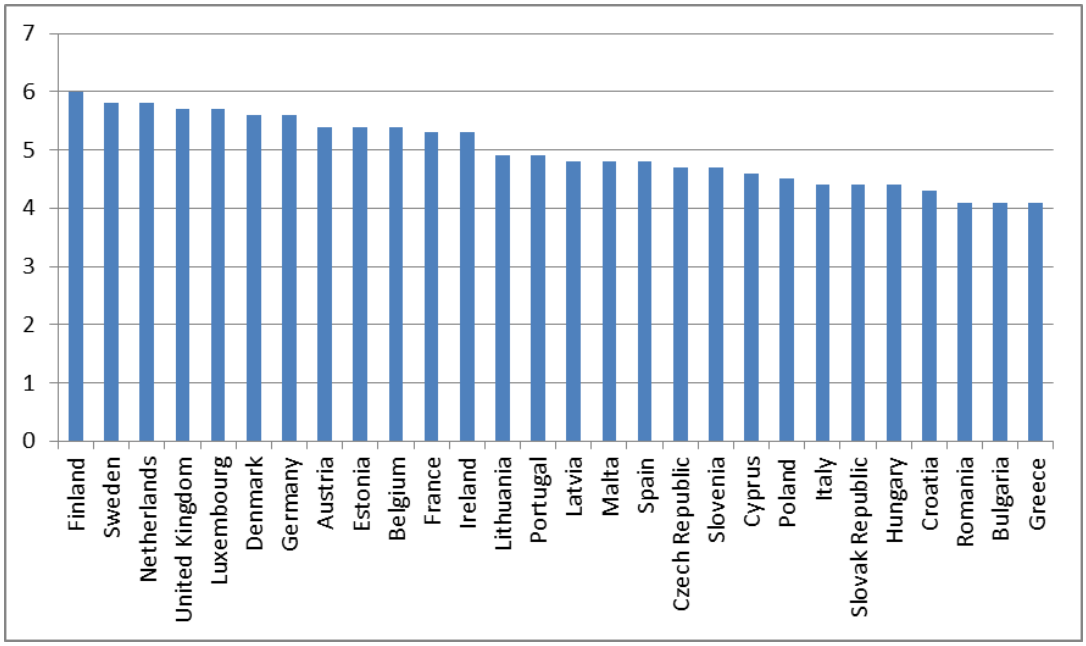
3.2.2 Hungary's digital development based on the NRI

NRI measures countries' readiness and performance in the digital word, how well they are using information and communications technologies, and how well they capitalize on the opportunities presented by the digital revolution. (Network Readiness Index 2016) "Networked readiness depends on whether a country possesses the drivers necessary for digital technologies to meet their potential, and on whether these technologies are actually having an impact on the economy and society." (https://www.weforum.org/agenda/2016/07/what-is-networked-readiness-and-why-does-it-matter/). NRI is made up of four sub-indices and ten pillars.

- The Environment sub-index assesses the extent to which a country's market conditions and regulatory framework support entrepreneurship, innovation, and ICT development.
- The Readiness sub-index measures the extent to which a country has in place the infrastructure and other factors supporting the uptake of ICTs.
- The Usage sub-index assesses the extent of ICT adoption by a society's main stakeholders: Government, businesses, and individuals.
- The Impact sub-index gauges the broad economic and social impacts accruing from ICTs. (http://reports.weforum.org/global-information-technology-report-2015/structure-and-methodology/)

As Figure 3 shows, with an overall score of 4.4 Hungary's ranks 24th out of the 28 European Union countries, preceding only Croatia, Romania, Bulgaria and Greece.

Figure 3: Hungary's position in the European Union based on the NRI scores, 2016 (1-7)



Source: Network Readiness Index 2016

Table 8 serves to examine Hungary's position in terms of the four subindices and the ten pillars. Similar to the previous case, we present Hungary's ranking based on the EU 28 countries.

Table 8: Hungary's performance and ranking in the NRI subindices and pillars in the European Union

Category	Rank (out of 28)	Value (1-7)
Networked Readiness Index	**24**	**4.4**
A. Environment subindex	**22**	**4.2**
1st pillar: Political and regulatory environment	19	4.0
2nd pillar: Business and innovation environment	24	4.4
B. Readiness subindex	**25**	**5.0**
3rd pillar: Infrastructure	25	4.8
4th pillar: Affordability	24	5.0
5th pillar: Skills	25	5.3
C. Usage subindex	**22**	**4.2**
6th pillar: Individual usage	21	5.3
7th pillar: Business usage	25	3.6
8th pillar: Government usage	19	3.8
D. Impact subindex	**21**	**4.0**
9th pillar: Economic impacts	20	3.8
10th pillar: Social impacts	22	4.2

Source: Network Readiness Index 2016, p. 108

Out of the four sub-indices, Hungary is performing the worst in the Impact (4.0) category followed by the Usage (4.2) and the Environment (4.2) sub-indices. Hungary achieves the best in the Readiness sub-index (5.0). Strange, but the rankings are almost the opposite: Hungary is the best in the Impact (21st) followed by Usage (22nd) and Environment (22nd) and Readiness (25th). Digitization has a moderate impact on the economy and the society.

The business usage pillar is particularly relevant for new technology startups, so we examine its components further (Table 9)

Table 9: Hungary's performance and ranking in Business usage pillar components in the European Union (values are in the 1–7 range, except PCT patents application)

Category	Rank (out of 28)	Value
Business usage	**25**	**3.6**
Firm-level technology absorption	22	4.7
Capacity for innovation	28	3.1
PCT patents, applications/million pop.	15	23.5
ICT use for business-to-business transactions	20	5.1
Business-to-consumer Internet use	23	4.8
Extent of staff training	25	3.4

Source: Network Readiness Index 2016, p. 108

Business usage with its 3.6 overall score is Hungary's worst pillar. Looking at its components a contradictory picture is emerging. ICT use for B2B (5.1), B2C internet usage (4.8), Firm level technology absorption (4.7) and, in particular, PCT patents application per million population (23.5) scores show a relatively good position of Hungary. At the same time the Extent of staff training (3.4) is very weak and the Capacity for innovation (3.1) is unacceptably low for such a relatively developed country, as Hungary.

These findings reflect well to the DESI's Integration of the Digital Technologies pillar components and show that the business level digital technology ICT use in Hungary is weak as compared to the EU countries.

4. New technology start-ups in Hungary

The digital entrepreneurship ecosystem is very important for the emergence of new technology based businesses. To get an accurate picture of the new tech startup industry we would need to look at the size of this business sector. However, getting accurate and reliable data is problematic. An additional problem is that even if data is available, cities rather than countries are considered as suitable units of analysis. (Global Startup Ecosystem Report 2017). The most reliable or informative data source, EUROSTAT, provides data on high technology enterprises in aggregate form, not distinguishing between new ventures in general and new technology enterprises. However, these aggregate data do provide important information about the size and the magnitude of the high tech sector in a country. (Table 10).

Table 10: The High technology enterprise number and average turnover in the EU countries (2014)

Country	High technology Enterprises (HTE)		Average turnover of HTE	
	HTE/1000 population	HTE ranking (25)	Average turnover in million Euros	Turnover ranking (20)
Austria	2.17	13	1.54	8
Belgium	2.57	12	1.75	4
Bulgaria	1.45	21	*no data*	*no data*
Croatia	1.42	22	0.71	16
Cyprus	*no data*	*no data*	*no data*	*no data*
Czech Republic	3.30	6	0.68	17
Denmark	2.75	10	2.37	3
Estonia	3.04	7	0.86	13
Finland	1.79	16	4.08	1
France	2.16	14	1.56	6
Germany	1.47	20	2.82	2
Greece	1.15	23	0.72	15
Hungary	3.74	4	0.65	18
Ireland	*no data*	*no data*	*no data*	*no data*
Italy	1.75	17	1.33	9
Latvia	2.79	9	*no data*	*no data*
Lithuania	1.73	18	0.40	22
Luxembourg	3.46	5	*no data*	*no data*
Malta	*no data*	*no data*	*no data*	*no data*
Netherlands	5.05	2	1.09	11
Poland	2.02	15	0.50	21
Portugal	1.47	19	0.86	12
Romania	0.93	25	0.63	19
Slovakia	2.74	11	0.77	14
Slovenia	4.31	3	0.61	20
Spain	1.14	24	1.63	5
Sweden*	5.44	1	1.31	10
United Kingdom	2.85	8	1.55	7

*Swedish data are from 2013; Source: Eurostat
http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=htec_eco_ent2&lang=en
http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=htec_eco_sbs2&lang=en

Looking at Hungary's position, a contradictory picture emerges. On the one hand, Hungary ranks 4th in the EU in terms of the number of HTE per 1000 capita, following Sweden, the Netherlands, and Slovenia. On the other hand, the average size of the Hungarian HTE ventures based on the turnover is relatively small, placing Hungary in the bottom of the list ranking below Slovenia and Romania. As larger firms are believed to be more competitive, a large number of small high technology businesses are not really advantageous for a country (Szerb and Ulbert 2009).

To estimate the relative importance of new technology businesses, we rely on four datasets. First, we use GEM adult population data to calculate the share of new medium and high technology businesses in TEA (Total Early Stage)[5] entrepreneurship. Non-regular, internet based startup data are

[5] TEA = Total Early Phased Activity is the share of population who are currently an owner-manager of an established business, i.e., owning and managing a running business that has paid salaries, wages, or any other payments to the owners for more than 42 months (Reynolds et al. 2005)

available from startupranking.com and AngelList. A startup measure is calculated as the average number of new startups based on startupranking.com and AngelList standardized by the population size. Since we have no information about the reliability of these data, it should be viewed with precaution. The fourth dataset is based on a well-known yearly survey of Deloitte about the fastest growing technology businesses. Moving from a relatively large number of technology startups to a more restricted circle of high growth ventures and finally, to the unexceptionally rare unicorns means moving from the average businesses toward the more competitive opportunity-startups, i.e.: the Kirznerian type of businesses. At the end of the road there are the innovative, high growth Schumpeterian type of startups having inproportionally high effect on the region or country where they operate (Nightingale and Coad 2014, Szerb et al 2017).

Table 11: Medium and high-tech young firms in the EU countries (as percentage of TEA businesses, 2011-2015 average) and the number of start-ups

	Percentage of TEA businesses		Number of startups per million*	
Country	**%**	**Rank (26)**	**Per million capita**	**Ranking**
Austria	9.32	5	18.01	16
Belgium	6.01	19	21.77	14
Bulgaria	2.93	26	13.75	20
Croatia	6.05	17	15.83	18
Cyprus	no data	no data	20.94	15
Czech Republic	6.79	11	8.52	24
Denmark	12.78	1	27.05	10
Estonia	6.01	18	83.94	1
Finland	6.09	16	41.04	4
France	12.48	2	12.16	22
Germany	8.54	9	12.45	21
Greece	5.89	20	9.63	23
Hungary	6.20	15	16.76	17
Ireland	9.23	7	41.06	3
Italy	6.74	12	8.02	25
Latvia	6.53	14	31.12	7
Lithuania	5.44	22	27.68	8
Luxembourg	9.96	4	49.75	2
Malta	no data	no data	32.04	6
Netherlands	6.57	13	27.24	9
Poland	4.16	25	6.36	27
Portugal	4.29	24	22.52	13
Romania	4.61	23	7.31	26
Slovakia	5.61	21	6.26	28
Slovenia	9.24	6	25.67	12
Spain	8.26	10	15.66	19
Sweden	10.95	3	26.15	11
United Kingdom	9.07	8	37.12	5

*This is a combined number from the number of startups from startupranking.com and AngeList standardized by the population; Source: GEDI dataset, https://www.startupranking.com/countries ; https://angel.co/companies?company_types

First, we show the position of the EU countries with respect to the frequency of the medium and high technology businesses as the percentage of the TEA businesses. Table 11 also contains the startup data that is calculated based on startupranking.com and AngelList.

According to Table 10, Hungary occupies the 15th place in the EU. 6.2% of TEA businesses belong to the medium and high technology sector. This share is about half compared to Denmark and Sweden, although Hungary is ahead of other developed countries like Finland (16 place) or Belgium (19).

Startup Ranking and AngelList typically collect information on technology oriented, high growth startups, albeit, not necessary belonging to the high tech category. So these numbers cannot be compared to the GEM related data. Moreover, GEM data are representative in the 18–64 years population but we have no information about the overall size of the startups that is provided by startupranking.com and AngelList. Therefore, it is more appropriate to view the different variable values independently and compare only the ranking. With respect to startup density, Estonia occupies the first place ahead of Luxembourg, Ireland and Finland. Similar to the GEM based share of medium and high tech businesses, Hungary can be found in the middle of ranking, residing on the 17th place out of the 28 EU countries. Interestingly, large EU countries like Spain, France, Germany and Italy are in the last third of the ranking together with smaller Southern and CEE countries, like Czech Republic Greece, Romania, Bulgaria, Poland and Slovakia.

Technology Fast 500, conducted by Deloitte Touche Tohmatsu Limited (DTTL), provides a ranking of the fastest growing technology, media, telecommunications, and green technology public and private companies in all continents. The Europe, Middle East & Africa (EMEA) Technology Fast 500 award winners are selected based on percentage fiscal year revenue growth over four years. In order to be eligible for Technology Fast 500 recognition, companies must own proprietary intellectual property or technology that is sold to customers in products that contribute to a majority of the company's operating revenues. Companies must have base-year operating revenues of at least €50,000 EUROS, and current-year operating revenues of at least €800,000 EUROS. Additionally, companies must be in business for a minimum of five years, and be headquartered within Europe, Middle East & Africa (https://www2.deloitte.com/global/en/pages/technology-media-and-telecommunications/articles/emea-apply-now-technology-fast-500.html)

Below we report the numbers and the density of the fast growth new technology (FGNT) businesses in the EU based on the Deloitte technology Fast 500 EMEA reports for the 2014-2017 years. (Table 12)

Table 12: Number of EU companies in Deloitte Tech500 EMEA ranking, 2014-2017

Country	2014	2015	2016	2017	2014-2017 average	FGNT 2014-2017/million capita	FGNT ranking (25)
Austria	3	1	2	1	1.75	0.20	20
Belgium	18	15	22	20	18.75	1.65	5
Bulgaria	0	2	1	5	2	0.28	19
Croatia	4	8	3	6	5.25	1.26	7
Cyprus	no data	no data	no data	no data	no data	no data	no data
Czech Republic	2	5	6	5	4.5	0.43	15
Denmark	9	4	0	0	3.25	0.57	11
Estonia	1	0	0	1	0.5	0.38	16
Finland	24	17	23	23	21.75	3.96	2
France	86	87	94	97	91	1.36	6
Germany	32	26	23	24	26.25	0.32	18
Greece	0	1	1	0	0.5	0.05	24
Hungary	9	6	3	3	5.25	0.53	12
Ireland	8	18	7	13	11.5	2.41	4
Italy	6	7	10	8	7.75	0.13	21
Latvia	0	0	0	1	0.25	0.13	22
Lithuania	3	3	1	7	3.5	1.22	8
Luxembourg	no data	no data	no data	no data	no data	no data	no data
Malta	no data	no data	no data	no data	no data	no data	no data
Netherlands	42	49	54	49	48.5	2.85	3
Poland	15	13	15	25	17	0.45	14
Portugal	4	5	3	8	5	0.48	13
Romania	7	12	3	4	6.5	0.33	17
Slovakia	3	6	4	4	4.25	0.78	10
Slovenia	0	0	1	0	0.25	0.12	23
Spain	1	0	1	1	0.75	0.02	25
Sweden	45	37	50	48	45	4.54	1
United Kingdom	69	72	70	96	76.75	1.17	9

Source: Deloitte homepage, https://www2.deloitte.com/global/en/pages/technology-media-and-telecommunications/articles/technology-fast-500-emea.html

While France and the United Kingdom have the highest number of FGNT businesses, the much smaller Netherlands and Sweden, have more numerous FGNTs than Germany. There are only a few FGNTs in the large Southern European countries, Spain and Italy. When we standardize the FGNT numbers by the population, smaller countries – besides Sweden and Netherlands – emerge like Finland (2nd), Ireland (4th) and Belgium (5th) and Croatia (7th). It is also a surprise that Estonia, performing very well in other respects of new tech startups and ecosystems, ranks only 16th. Hungary ranks 12th out of the 25 EU countries. However, Hungary has the largest number of FGNTs in 2014, if we calculated the ranking based on the average of 2015-2017 data, Hungary would be only the 18th in the EU.

Deloitte also has a TOP50 ranking only for the CEE countries (Table 13)

Table 13: Number of EU member country companies represented in Deloitte Tech50 CEE (2014-2017)

Country	2014	2015	2016	2017	2014-2017 (sum)
Bulgaria	1	2	1	2	6
Croatia	4	8	6	8	26
Czech Republic	3	5	7	5	20
Estonia	1	0	0	1	2
Hungary	10	4	4	2	20
Latvia	0	0	0	1	1
Lithuania	3	2	3	6	14
Poland	17	12	17	19	65
Romania	6	10	4	3	23
Slovakia	3	5	5	2	15
Slovenia	0	0	1	0	1

According to Table 12, Poland, the largest country by far in the CEE region, dominates the CEE ranking followed by Croatia and Romania. Hungary is only fourth in the CEE region, based on the total number of FGNTs. It is also clear that Hungary's achievements are fading, since half of the 20 FGNTs are from one year 2014. In all probability, the high number of FGNTs in that specific year is a result of the European Union's support pumping up the venture capital market in Hungary. However, this effect cannot be seen in the later years.

Looking at the various indicators on medium and new tech businesses, startups and new technology high growth ventures, Hungary ranks around the 15–18 place among out the 28 EU countries. In two cases, density of high technology firms and fast growing new technology businesses, Hungary ranks 4th and 12th, respectively. However, these rankings are not supported by the other indicators, so we posit Hungary in the third best quartile of the countries.

Altogether, Hungary is performing better in terms of the number or the density of new tech businesses as compared to the digital or the entrepreneurship ecosystems, where Hungary belongs to the fourth, worst quartile of the EU countries.

5. The entrepreneurial and digital ecosystem of new technology businesses in Hungary based on expert survey results

In this section, we present our expert survey results. We carried out this survey to obtain better indications on specific characteristics of the Hungarian entrepreneurial ecosystem and to shed light on how Hungarian "new tech" firms perceive institutional strengths and weaknesses.

The survey on the entrepreneurial ecosystem of Hungarian "new tech" firms was designed similarly to the GEM National Expert Survey (Reynolds et al 2005). In the survey, we distinguished between eight, partially overlapping, topics related to the entrepreneurial as well as to the digital ecosystem. The survey includes 61 question items. The respondents could express their opinion on a seven level Likert-scale. The survey contained two additional options for "do not know" (8) and "no answer" (9), but we handle these options as missing values in the analysis. All of the questions are focused on characterizing the Hungarian situation on a stand-alone basis, not in comparison to other countries.

The topics and the number of question items are as follows:

1. General questions about the emergence and application of new technologies in Hungary (9 items)
2. Regulatory environment including ownership rights, access to information, taxation, start-up regulation and labour market regulation (7 items)
3. Financing, including angel finance, venture capital, equity, credit, government supports and crowdfunding (8 items)
4. Human capital and education (7 items)
5. Support, including incubation, accelerators, spin offs, meetups, government, chambers, etc. (11 items)
6. The use of digital capabilities and digital application (7 items)
7. The potential support of new technologies (8 items)
8. Regional and spatial aspects (3 items)

Our experts form a heterogeneous group ranging from entrepreneurs managing a "new tech" firm; professionals of entrepreneurship digitalization; government and NGO officials, and academics dealing with entrepreneurship and digitalization. The language of the survey was Hungarian. Altogether 43 persons have answered, 29 of them have filled out the questionnaire online and 14 on paper. Following a testing period in December 2016, the first wave of the survey was in September 2017 (19 respondents) and the second wave was in December 2017 (24 respondents). Out of them there were 15 entrepreneurs, 12 academics, 10 consultants and independent experts, and 6 government and NGO officials.

The creation of the questionnaire was supported by a 90 minute round table discussion in December 2016. Altogether, 20 experts (members of different government and NGO organizations, academics and entrepreneurs) attended the discussion. Some questions, two weeks prior to the roundtable discussion, were sent out to utilize the expert's opinion. In the following section, we present the main findings from the survey. Note that, under the term "new tech firms", we mean firms both creating and/or using new technologies.

5.1. The emergence and application of new technologies in Hungary

In the first group of questions, we asked about the application of new technologies in the business sector in general (Table 14). Our experts evaluated the Hungarian practice above the average (4.55) on a seven point Likert scale. Establishing a new technology business is neither difficult nor easy (4.02). Although Hungarian firms have a relatively good access to the global technologies (4.81), they apply (3.28) or adopt (3.26) them to a lesser extent. Foreign Direct Investment (FDI) and foreign owned firms are believed to play a major role to bring the new technologies to Hungary (5.28). Moreover, foreign partners also have a positively influence on their Hungarian partners regarding the use new technologies (5.86). Domestic strategic partners have a less important influence on the Hungarian new technology firms (4.72), their effect is similar to cluster partnership (4.72–4.95)

Table 14: Expert survey answers about the emergence and availability of new technologies in Hungary (1-7 point Likert scale)

Questions	Average
Nowadays, it takes a short time to start a new technology business in Hungary.	4.02
It is easy to get an access to globally new technologies in Hungary.	4.81
There are many domestic firms use globally new technologies.	3.28
Domestic firms adopt the newest technology in large numbers.	3.26
Foreign Direct Investment (FDI) contributes significantly to bring globally new technologies to Hungary.	5.28
Foreign strategic partners positively influence domestic new technology firms.	5.86
Domestic strategic partners positively influence domestic new technology firms.	4.72
In Hungary, clustering in the same industry has a positive effect on the operation of the new technology firms.	4.95
In Hungary, clustering in the different industries has a positive effect on the operation of the new technology firms.	4.73
Average	*4.55*

Source: Data collected from the expert survey.

Our roundtable discussants also highlighted that Hungarian businesses vary significantly in terms of the use of new digital technologies. An indicator of the deficiency of the overall Hungarian digital entrepreneurship ecosystem is the move of some successful new tech start-ups to the United States (Prezi, LogMeIn, UStream).

5.2. The effect of regulation and legal environment on new technology firms

Government regulation and the legal environment are believed to influence the establishment and the operation of new technology businesses. Overall, Hungary's performance is below average (3.55) (Table 15). Looking at the survey items separately, the guarantee of property rights (4.43) and easy access to vital business information (4.03) are judged to be above average. The government's performance (3.48), the overall level of taxation (3.55) and the general startup regulation (3.51) received below average scores. The negative effect of the changes in the taxation system received the lowest score of 1.6, assigning it to the worst performing category. Labor market regulation is performing slightly above the average (4.12).

Table 15: Expert survey answers about the regulatory environment of the new technology firms in Hungary (1-7 point Likert scale)

Questions	Average
In Hungary, the guarantee of property rights affects positively the number of new technology firms.	4.43
In Hungary, the guarantee of the access to information vital to business decision making affects positively the number of new technology firms.	4.03
In Hungary, the overall quality of the government affects positively the number of new technology firms.	3.48
In Hungary, the level of taxes and fees affects positively the number of new technology firms.	3.55
In Hungary, the changes of the taxation system affect positively the number of new technology firms.	1.60
In Hungary, the overall regulation of the start-up procedure affects positively the number of new technology firms.	3.51
In Hungary, the ease of hiring and firing regulation affect positively the number of new technology firms.	4.12
Average	*3.53*

Source: Data collected from the expert survey.

5.3. The effect of finance on new technology firms

Sufficient finance is a core prerequisite for new technology businesses that need money for R&D, new technology amendment and firm growth. The average score for finance is below average (3.58), almost the same as the regulatory environment (3.53). There are three types of finance that score above average (4.0): Debt funding (4.19), government subsidies (4.40) and venture capital (4.19). These findings reflect well to the changing policy priorities of the Hungarian government. The majority of the subsidies and direct financial support come from the Structural and Investment Funds of the EU through the Economic Development and Innovation Operational Programme (GINOP – in Hungarian).

At the same time, the availability of informal funds (3.0), IPOs (3.0) and business angels (3.22) are well below the average score indicating weaknesses in the Hungarian financial system. Crowdfunding (2.76), a relatively new source for new technology businesses, associated with the emergence of digital technologies, is also relatively weak.

Table 16: Expert survey answers about the financing environment of the new technology firms in Hungary (1-7 point Likert scale)

Questions	Average
In Hungary, there is sufficient equity funding available for new technology firms.	3.93
In Hungary, there is sufficient debt funding available for new technology firms.	4.19
In Hungary, there are sufficient government subsidies available for new technology firms.	4.40
In Hungary, there is sufficient funding available from informal investors (family, friends and colleagues) who are private individuals (other than founders) for new technology firms.	3.00
In Hungary, there is sufficient funding available from professional Business Angels for new technology firms.	3.22
In Hungary, there is sufficient funding available from venture capitalists for new technology firms.	4.15
In Hungary, there is sufficient funding available through initial public offerings (IPOs) for new technology firms.	3.00
In Hungary, there is sufficient funding available through private lenders' funding (crowdfunding) for new technology firms.	2.76
Average	*3.58*

Source: Data collected from the expert survey.

Roundtable discussants also noted problems related to capital accumulation. They also highlighted a relative oversupply of state subsidies (like JEREMIE programme) compared to the lack of eligible start-up firms. It seems that private venture capital remained low and the so-called hybrid (private–public) forms of venture capital fell behind the anticipated results.

5.4. The effect of human capital and education on new technology firms

Human capital and education seems to be amongst the strengths of entrepreneurial and digital ecosystems in Hungary (see previous sections). The findings from our survey suggest otherwise, however: the average score of Human capital and education category is 3.31; lower than that of financing or of the regulatory environment. The economically active population does not possesses the necessary skills to establish or operate a new tech business (2.88) and the education system is inadequate in terms of preparing students for a future with digitally technology dominated jobs (2.56). There also appears to be a lack of experts possessing technological skills (2.33). In Hungary, hiring technological experts is exaggerated by a significant brain drain (1.81). Two items received higher than average scores: availability of top managers (5.32) and scientific researchers (4.76) with digital qualification.

Table 17: Expert survey answers about the effect of human capital and education on the new technology firms in Hungary (1-7 point Likert scale)

Questions	Average
The Hungarian economically active population possesses the necessary skills and competences to establish and effectively run a new technology firm.	2.88
The Hungarian economically active population possesses the necessary "creative capital" to establish and effectively run a new technology firm.	3.52
The domestic education system effectively prepares students for future workplaces dominated and lead by technologies.	2.56
In Hungary, the brain drain, the leave of those that are the best and have the highest expertise to foreign countries, is NOT significant.	1.81
In Hungary, it is easy to reach and hire experts having special technological knowledges and skills.	2.33
In Hungary, the availability of top managers having qualification in digital technologies has an influence on the new technology firms.	5.32
In Hungary, the availability of scientific researchers having qualification in digital technologies has an influence on the new technology firms.	4.76
Average	*3.31*

Source: Data collected from the expert survey.

5.5. The effect of outside support on new technology firms

Outside support from various governmental organisations, quasi-governmental organisations and NGOs could help new technology firms. In this respect, the average score of the overall support is 3.86, a little bit below the average, 4.0 score. Chambers received the lowest score out of the eleven titles (2.78). Governmental and quasi-governmental agencies are also evaluated as being below the average, including entrepreneurship support centres (3.29) and specific government programmes (3.60). Business and technology incubators as well as accelerators are also believed to perform below the average (3.67–3.76). However, there are five areas where the support scores are above the average, but none of them reaches the score 5. These are co-working places (4.22), university spin-offs (4.28), pitch events (4.29), meet-ups (4.33) and business idea competitions (4.62). A common characteristic of these organisations is that they are not related or directly connected to the government.

Table 18: Expert survey answers about the effect of the different supports on the new technology firms in Hungary (1-7 point Likert scale)

Questions	Average
In Hungary, business incubators provide effective support for new technology firms.	3.67
In Hungary, technology incubators provide effective support for new technology firms.	3.69
In Hungary, accelerators provide effective support for new technology firms.	3.76
In Hungary, pitch events provide effective support for new technology firms.	4.29
In Hungary, business co-working possibilities provide effective support for new technology firms.	4.22
In Hungary, university spin-offs provide effective support for new technology firms.	4.28
In Hungary, special government programs provide effective support for new technology firms.	3.60
In Hungary, business idea competitions provide effective support for new technology firms.	4.62
In Hungary, local and countrywide chambers provide effective support for new technology firms.	2.78
In Hungary, entrepreneurship support centers provide effective support for new technology firms.	3.29
In Hungary, meet-ups provide effective support for new technology firms.	4.33
Average	*3.86*

Source: Data collected from the expert survey.

5.6. The effect of the use of digital capabilities and applications on new technology firms

Whilst we have substantial data on the digital infrastructure, less is known about the use and application of this infrastructure. Our experts evaluated the digital application of the Hungarian businesses (5 items) and the digital capabilities of the individuals (3 items). The Hungarian digital capabilities and application practice received an above average score of 4.26. All item score averages, but one, are also over the 4.0, average score. It seems that the use of digital application, ERP (4.40), of social media (4.21), of online selling (4.64), and of cloud computing services (4.54) increases the creation and the successful operation of Hungarian new technology businesses. The use of e-invoices (3.80) is believed to have smaller influence.

Individuals' digital capabilities including the use of online banking (4.19), buying online (4.10) and the use of social media (4.27) are moderately important for the successful start of a new technology firm.

While these survey items serve to measure the importance of the digital application frequency and digital capabilities in the creation and operation of new technology firms, DESI indicators provide additional details about the use of the frequency of these digital tools (see Chapter 3. 2.1. Table 7). According to the DESI indicators, Hungarian firms perform well below to the EU average in all aspects of digital use.

Table 19: Expert survey answers about the effect of the use of digital capabilities on the new technology firms in Hungary (1-7 point Likert scale)

Questions	Average
Those Hungarian firms are capable to create or to absorb new technologies that use business ERP systems.	4.40
Those Hungarian firms are capable to create or to absorb new technologies that are able to issue e-invoices.	3.80
Those Hungarian firms are capable to create or to absorb new technologies that use two or more social medias in their business operation.	4.21
Those Hungarian firms are capable to create or to absorb new technologies that are able to sell their products or services online.	4.64
Those Hungarian firms are capable to create or to absorb new technologies that use cloud computing services in their business processes.	4.57
Those Hungarian persons are capable to start new technology businesses who frequently use online banking services.	4.19
Those Hungarian persons are capable to start new technology businesses who frequently buy online.	4.00
Those Hungarian persons are capable to start new technology businesses who frequently use the social media.	4.27
Average	*4.26*

Source: Data collected from the expert survey.

5.7. Potential supporters of new technologies

While the previous survey items aimed to evaluate the existing Hungarian situation and practice, the present questions intend to investigate who should support and finance the new technologies? Our experts' opinion is divided as regards to who should be the most important supporter of new technologies. Interestingly, direct government support received the lowest score (4.19) followed by public research institutions (4.46) and higher education institutions (4.56). The experts believe that the business sector should play a more important role in new technology creation than other institutions. Within the business sector, SMEs are the believed to play the least important role (4.70), followed by foreign multinationals. Global (5.09) and domestic (5.10) start-ups should play a more important role in new tech support. Experts give the highest score for domestic large firms (5.51), so they should dominate in the support and finance of new technologies.

Table 20: Expert survey answers about the effect of the potential supporters of the new technology firms in Hungary (1-7 point Likert scale)

Questions	Average
Primarily, the government should support technological development and technology investment.	4.19
Primarily, the higher education institutions should support technological development and technology investment.	4.56
Primarily, the public research institutions should support technological development and technology investment.	4.46
Primarily, the foreign multinationals should support technological development and technology investment.	4.79
Primarily, the domestic large firms should support technological development and technology investment.	5.51
Primarily, the global start-up businesses should support technological development and technology investment.	5.09
Primarily, the domestic start-up businesses should support technological development and technology investment.	5.10
Primarily, the domestic small- and medium sized businesses should support technological development and technology investment.	4.70
Average	*4.80*

Source: Data collected from the expert survey.

5.8. Some regional aspects of new technology firms

Many countries face a problem of increasing regional inequalities. The survey findings indicate that the experts believe that new technology firms appear in those regions where the workforce possesses digital skills and digital literacy is high (6.08). Universities are believed to play a moderate role in decreasing regional inequalities via the creation and support of new technology firms (4.32). However, most of our experts do not believe that lagging Hungarian regions have adequate economic and social environment to attract new technology firms (1.81).

Table 21: Expert survey answers about the regional aspects of the new technology firms in Hungary (1-7 point Likert scale)

Questions	Average
Domestic , lagging regions have such an economic/social environment that could support the local appearance of new technology firms	1.81
Domestic, countryside university centres have such an economic/social environment that could support the local appearance of new technology firms.	4.32
New technology firms appear higher probability in those regions that have a workforce with high level of digital literacy as compared to those regions hat lack a workforce with digital literacy.	6.08

Source: Data collected from the expert survey.

5.9. Summary of the survey

We can calculate the overall average of Hungary's new tech entrepreneurship ecosystem by averaging the scores of the six main topics – New technology emergence; Regulatory environment; Financing; Human capital and education; Support; The use of digital capabilities and applications. The overall score average is 3.71. Our overall impression from all the answers that the experts provided is

that the Hungarian entrepreneurship ecosystem has many aspects that need improving to become favourable for the emergence of new technology firms. There were only two categories where Hungary score exceeded the 4.0 – middle score in the 1–7 point Likert scale –, these are the New technology emergence (4.55) and The use of digital capabilities and applications (4.26). All the other categories show Hungary's moderate performance in particular in Human capital and education (3.31), Regulatory environment (3.53), Financing (3.58), and Support (3.86). As we have plenty of relevant and reliable data from various, we did not ask questions about the physical infrastructure that is Hungary's relatively strong factor. However, even taking into account the physical infrastructure, it seems probable that the overall 3.71 score would still stay below the neutral point.

6. Summary and conclusion

In this closing chapter, we summarize the theoretical framework of our analysis and the basic findings of the analysed indices and the expert survey. Furthermore, we compare our survey findings with the findings of the previous chapters to identify the strengths and the weaknesses of the Hungarian entrepreneurship and digital ecosystems influencing new technology firm creation and operation. Finally, we enumerate the most pressing bottlenecks in the way of development of the Hungarian digital entrepreneurship.

In this case study, we evaluated the state of the new tech entrepreneurial ecosystem in Hungary. The health of the new tech entrepreneurial ecosystem is especially important as new technology oriented firms are believed to be important drivers of economic growth and job creation via the facilitation of technological change and innovation (Audretsch 1995, Colombo and Grilli 2010). According to Brown and Mason (2014), "Promoting new technology-based firms is the cornerstone of technology entrepreneurship policies in advanced industrial economies." (p. 773) Entrepreneurship, and in particular its role on fostering innovation, is now seen as being key to the new EU smart growth and development agenda as well.

The most recently emerging digital entrepreneurship ecosystem approach is looking for the emergence of new technologies at the intersection of entrepreneurial and digital ecosystems (Autio et al 2017, Nambasian 2017, Sussan–Acs 2017). Sussan and Acs (2017) define the digital entrepreneurship ecosystem as "the matching of digital customers (users and agents) on platforms in digital space through the creative use of digital ecosystem governance and business ecosystem management to create matchmaker value and social utility by reducing transactions cost." (Sussan–Acs 2017, p. 63). We have found this definition of digital entrepreneurship a suitable theoretical framework for our study.

Hence, according to our theoretical framework, the digital entrepreneurial ecosystem is in the intersection of the entrepreneurial and digital ecosystems. Research on the entrepreneurial ecosystem (EE) considers the emergence of productive entrepreneurship as a result of actors and factors within a focal territory (Acs et al. 2014). EE includes different attributes that increase entrepreneurship and support economic growth: cultural attributes as attitudes and history; social attributes like social network and capital as well as skilled employees among others; and material attributes that include institutions (Spigel 2017). These factors create a supporting background for innovative firms and motivate nascent entrepreneurs in order to start-up their own venture. In discussing the abilities of nations to innovate technology is the central issue.

Today, modern societies live in the area of information or digital technology. Digitalization and digital tools support the exploitation of entrepreneurial opportunities by restructuring functions and

relationships, decreasing the “distance” between product or service providers and consumers as well as driving generativity (Autio el at. 2017). The introduction of technological development is an important driver of recognizing emerging opportunities and this process might lead indirectly to entrepreneurial activity as well (Autio et al. 2013). The use of digital technologies affects entrepreneurial processes and outcomes, as they become more fluid, flexible and ubiquitous. Furthermore, digitization has an impact on the agents itself, since in case of tech-firms the entrepreneurial activity become less predefined and more distributed (Nambisan et al. 2017, Nambisan 2017). The concept of digital ecosystems (DE) describes a system within the included entities (like agents, institutions, organizations) and their interrelations that focus on supporting each other in order to expand their utility, benefits and promote information sharing among them (Li et al. 2012, Sussan–Acs 2017).

As a synthesis of the two concepts, Sussan and Acs (2017) have introduced the concept of the digital entrepreneurship ecosystem as “the matching of digital customers (users and agents) on platforms in digital space through the creative use of digital ecosystem governance and business ecosystem management to create matchmaker value and social utility by reducing transactions cost.” (Sussan–Acs 2017, p. 63). There is strong evidence that investing in the digital infrastructure is beneficial for the economy. Nevertheless, in the framework of digital entrepreneurship ecosystem, the implication for policy, is that in order to make the economy stronger and more dynamic a country should invest in not only the digital infrastructure but also the entrepreneurial ecosystem. Participating in the digital economy is not the same as having broadband internet access. Although it has a crucial role, there are other factors that influence the evolution of the digital economy: regulations that create an adequate business climate; digital skill in order to facilitate the use of these technologies; and institutions that support these processes (Peña-López 2016). Adaption, technology absorption and diffusion digital technologies, solutions and tools play a vital role in the intensity of digital entrepreneurship ecosystem as well.

As there are no direct indicators of digital entrepreneurship, we examined the two involved ecosystems separately.
To ensure a comprehensive view on the Hungarian entrepreneurial ecosystem where new technology businesses operate, first, we reviewed the Hungarian GEI (Global Entrepreneurship Index) scores. The distinctive characteristics of the GEI can be summarized as the followings (Szerb et al 2016b):

1. entrepreneurship is a multifaceted phenomenon that requires a composite indicator ;
2. the indicator should capture the quality aspects of entrepreneurship;
3. both the individual efforts/capabilities and the environmental/institutional aspects of entrepreneurship are important;
4. the different aspects/components of entrepreneurship constitute a system where the interrelation of the elements is vital;
5. entrepreneurship policy should be formulated from a systems perspective by providing a tailor-made policy mix that fits to a particular country’s entrepreneurial profile rather than providing a one size fits approach.

The GEI pyramid has three sub-indices that comprise the GEI super-index, measuring entrepreneurship at the country level. The three sub-indices (attitudes, abilities and aspirations) consist of fourteen pillars. All pillars contain an individual and an institutional variable component. Taking the system’s perspective, GEI takes into account the connection between the individual and the institutional factors.

Unlike in the case of the system of entrepreneurship where we have a dominant index (GEI), there is no leading indicator of digital ecosystems. In the European Union, the most widely used composite indicator is the Digital Economy and Society Index (DESI 2017). Another often used indicator is the World Economic Forum's Network Readiness Index (NRI) (2016). Next to these two prominent composite indicators, there are some other country level indicators that capture important dimensions of digitalization, namely the Digital Country Index (DCI), the Evolution Index (DEI), the Digital Tax Index (DTI) and the Digital Money Index (DMI). Next to assessing the digital ecosystem in Hungary based on all six indices, we looked at the importance of the Hungarian new tech startup sector as well.

Finally, we have conducted an expert survey to obtain better indications on specific characteristics of the Hungarian entrepreneurial ecosystem. In the survey, we distinguished between eight, partially overlapping, topics related to the entrepreneurial as well as to the digital ecosystems. The topics and the number of question items are the followings:

1. General questions about the emergence and application of new technologies in Hungary (9 items);
2. Regulatory environment including ownership rights, access to information, taxation, start-up regulation and labour market regulation. (7 items);
3. Financing, including angel finance, venture capital, equity, credit, government supports and crowdfunding (8 items);
4. Human capital and education (7 items);
5. Support, including incubation, accelerators, spin offs, meetups, government, chambers, etc. (11 items);
6. The use of digital capabilities and digital application (7 items);
7. The potential support of new technologies (8 items);
8. Regional and spatial aspects (3 items).

Our results indicate that overall, both entrepreneurship and the digital ecosystems seem to be more restricting than supporting the emergence of new technology firms. Compared to the other EU countries, Hungary is placed in the last quarter of EU countries both in the case of the general entrepreneurship and digital ecosystems. The country's position is slightly better in the digital ecosystem. Moreover, Hungary seems to loose space in both ecosystems as compared to other EU countries. The situation appears to be better when we look at the frequency of new technology firms in Hungary. In every categorisation, from the general appearance of start-ups and new tech firms to the high growth firm categories, Hungary is classified in the third quarter of the EU countries. Some measures based entirely on the number of specific business ventures estimate Hungary's position in the first quarter.

Next, based on the analysed EE and DE measures and our expert survey, we evaluate the strength and weaknesses of the element of the Hungarian entrepreneurial and digital ecosystems. Each element will be assigned to the category of weakness or strength by using the average (neutral) scores as the division line between favourable (strengths) and unfavourable (weaknesses) categories.

1. Physical infrastructure - strength

Both the entrepreneurship and the digital ecosystem data show that Hungary is performing somewhat above the average of EU countries. Hungary's score on use of internet is the highest in the DESI indicators. However, Hungarian connectivity scores, the development of the broadband infrastructure, is slightly below to the EU average. According to the NRI, infrastructure has received a score 4.8, higher than the neutral 4.0.

2. Regulation - weakness

The overall quality of regulation is not really favourable for Hungarian new tech start-ups. The general entrepreneurship ecosystem, according to the GEI, seems to be more favourable in terms of property rights, general business regulation, taxation, and labour market regulation. However, our experts evaluated the government below average in terms of overall quality, the level of taxes and start-up regulation in the 3.48–3.51 score range. The frequent changes of the taxation system seem to be one of the major weaknesses of the Hungarian entrepreneurship ecosystem. NRI's Political and regulatory environment category score is 4.0.

3. Finance - weakness

The overall quality of the Hungarian financial system is below average according to GEI and our experts. According to our survey findings, it seems that debt financing, government subsidies, and venture capital perform relatively well. Meanwhile, equity, informal investment, angel financing and crowdfunding do not seem to offer sufficient support to Hungarian new technology firms. It is important to note that over the 2013-2016 time period, EU supported JEREMIE funding fuelled the Hungarian venture capital market.

4. New technology creation and adoption - weakness

In this case study we focused more on new technology adoption than creation. On one hand, according to GEI, Hungary performs relatively well in scientific research and technology transfer. On the other hand, DESI's Integration of digital technology dimension shows that Hungarian businesses are below the EU average in terms of all of the examined categories, including integration of digital technologies, electronic information sharing, social media, e-Invoices, cloud computing, selling online and e-Commerce turnover. Presently only Hungary's RFID scores reach the EU average score. Moreover, NRI's Business usage pillar is the weakest of the ten pillars of network readiness. However, firm level technology absorption received an above average score similar to ICT and internet use. The business usage is pulled back because of the low capacity for innovation and major weaknesses in staff training. Our experts considered the use of these digital technologies as key elements in the new technology absorption.

5. Human capital and education - weakness

While the basic skills of the Hungarian population and the education system seem to be in line with the country's level of development, the overall quality of human capital is weak when we consider the entrepreneurship and the digital aspects. Hungary's Human capital dimension is relatively good in GEI, but DESI assigns Human capital as the worst component of Hungary. Our experts' opinion echoes DESI1S findings: The population's general skills and competencies hinder the establishment of new technology firms, creative capital is missing and the school system does not prepare students sufficiently for the technology dominated world.

6. Support – neither weakness nor strength

Support is the only element of the ecosystem where we are unsure about its classification. Unlike the previous cases where we had the possibility to include other sources to evaluate Hungary's performance, for this dimension, we can rely only on the findings from our experts' survey. As described in the previous chapter, councils, the government, business and technology incubators and accelerators do not really support Hungarian new technology firms. Some other informal institutions

such as pitch events, spin-offs, co-working spaces, meet-ups and business idea competitions play a more positive role. Hungarian business top managers and scientific researchers are also helpful to new technology firms.

The survey among the group of experts makes it possible to identify the main opportunities and the threats of the outside environment. New technologies are relatively easily accessible from Hungary and foreign multinationals seem to play a very important role in transferring these technologies to Hungarian companies. At the same time, domestic and local deficiencies in the entrepreneurship ecosystem hinder the general use of these new technologies. Better clustering, strategic partnerships and networking, according to our experts, could accelerate technology and knowledge transfers. A significant brain drain and the lack of a properly trained workforce further weakens human capital and represents a clear obstacle for the future development of Hungarian new technology firms.

In summation, our results on the Hungarian entrepreneurial ecosystem signals a relatively low value of venture capital and lack of sophisticated business strategy that are believed to be vital to the emergence of high growth ventures (low Finance and Strategy institutional GEI variable). Moreover, the relatively low values of the entire attitude related individual variables suggest relatively poor basic entrepreneurial capabilities, skills and cultural support of the population. The recognition of entrepreneurial opportunities is particularly problematic even if we compare Hungary with other former socialist CEE countries. The percentage of young businesses applying a technology that is younger than five year-old is also relatively weak. Moreover, both DESI and NRI indicate that, in general, the business level digital technology usage in Hungary is well below the EU average. According to DESI, out of the Hungarian businesses 16% uses electronic information sharing (44% of the EU average) 13% use social media (65% of the EU average), 8% send eInvoices (44% of the EU average), 8 % use cloud services (61% of the EU average) and 12% of SMEs sell online (71% of the EU average). In addition, NRI shows that Extent of staff training (3.4) is insufficient and the Capacity for innovation (3.1) is unacceptably low for such a relatively developed country as Hungary.

The results of the expert survey indicate that experts evaluate Hungary's performance moderate in Human capital and education, Regulatory environment, Financing and Support. Policy makers can achieve economic growth with the highest efficiency and efficacy of resource usage, by targeting the mentioned bottlenecks in the way of the development of digital entrepreneurship in Hungary.

Finally, our research also highlights the need for a composite indicator measuring the well-being of digital entrepreneurial ecosystems.

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