

Entrepreneurial Innovations in Countries at Different Stages of Development

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Abstract

The aim of our paper is to provide a comprehensive picture of the role of innovation within the entrepreneurial ecosystem in certain countries. In this way, we propose the following research question as to what kind of interrelatedness can be observed between the innovation capability of a country and other elements of its entrepreneurial ecosystem. Ninety-five countries have been involved in our analysis, which initially have been grouped by their level of economic development and a group of transition countries has been created as well. In order to measure these relations, the Global Entrepreneurship Index (GEI) was applied. This index measures the qualitative aspects of the entrepreneurial ecosystem in a national context. The index consists of fourteen pillars covering the relevant aspects of the entrepreneurial ecosystem. Out of the pillars, there are three pillars associated with three different aspects of innovation: Technology Absorption, Product Innovation, and Process Innovation. After analyzing the pillars, we conducted a k-means cluster analysis in order

to demonstrate whether countries with the same level of development are ranked in a common group if they are clustered by the values of the three innovation pillars. Our results suggest that the quality of the entrepreneurial ecosystem reflects the level of economic development. Regarding the role of innovation, it seems that the innovation-related pillars have an important role within the entrepreneurial ecosystem. Technology Absorption is highly related to the GEI score and the level of economic development since the most developed countries have the highest values for this pillar. While the Product and Process Innovation pillars have a relatively strong relationship with GEI score as well, it seems that a couple of countries have higher pillar values in these innovation-related pillars than the position of their GEI scores would lead one to expect. This may indicate that these countries have relatively good performance in research and development, but other components of their entrepreneurial ecosystem may hamper the exploitation of the results achieved by new firms.

Keywords: entrepreneurial ecosystem; Global Entrepreneurship Index (GEI); innovation; economic development; technology absorption

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There is a general consensus that *knowledge* is the most fundamental source of the modern economy [Jaffe, Trajtenberg, 2002] and that innovation has become a “ubiquitous phenomenon” [Lundvall, 1992].

It follows from the above that the literature dealing with innovation and technological change has become enormous. This literature, on the one hand, primarily tries to answer the following fundamental question: *what role does innovation play in economic growth?* The *New (Endogenous) Growth Theory* (initiated by [Romer, 1986; Lucas, 1988; Rebelo, 1991]) tries to answer this question. Initially, it was assumed that knowledge is freely available to anyone and technological opportunities are equally available in all countries. However, it has been convincingly proved in the literature of *knowledge spillovers* that the accessibility of some types of knowledge is bounded by *geographic proximity* [Jaffe, 1989; Acs et al. 1994; Anselin et al. 1997; Varga 1998, 2000; Acs, Varga 2002; Feldman, 1999; Audretsch, Feldman, 2004; Boschma, 2005] and that an excludable or imperfectly accessible part of knowledge exists which is characterized by novel, tacit elements and it is accessible only *by interactions among agents in a system of innovation* [Dosi, 1988].

The other, vast part of the innovation literature concentrates on the identification of conditions or factors that determine *knowledge creation* (especially new technological knowledge, as it is the most valuable type of knowledge in innovation) and its *diffusion*. The pivotal question that needs to be answered here is the following: *how does technological change occur, and what are the key processes and institutions involved?* The *New Economics of Innovation* (initiated by [Nelson, 1993; Lundvall, 1988, 1992; Freeman, 1982, 1995]) tries to give an answer to this question by focusing on the *institutional arrangements* in which the innovative processes take place. Innovation economics has been influenced by different theories of innovation such as *interactive learning theories* [Lundvall, 1992] and *evolutionary theories*, most importantly the *New Institutional Economics* (NIE, initiated by [Coase, 1992, 1998; North, 1989, 1990, 1991; Williamson, 1985, 2000]). The NIE states that informal social and formal legal norms and rules (i.e. institutions) underlie economic activity and leads researchers of innovation economics to posit that the interactive, iterative, and cumulative process of learning is a *socially embedded* process, therefore it cannot be understood without taking into consideration its *institutional and cultural context* [Carlsson et al., 2002].

The *National Systems of Innovation* (NSI, or elsewhere *National Innovation System* – NIS) seemed to be a fruitful approach for the study of innovation and technical change in the economy [Edquist, 1997]. According to NSI, knowledge is the most fundamental resource in the economy, and “knowledge

is produced and accumulates through an interactive and cumulative process of innovation that is embedded in a national institutional context, and that the context, therefore, matters for innovation outcomes [Ács et al., 2014, p. 477].

Paradoxically, because of the strengthening of globalization, regional scientists, economic geographers, and innovation analysts notice that the concept of the National System of Innovation may be questionable: whereas recognition has increased that important elements of the process of innovation tend to become *regional* rather than national [Cooke, 2001]. The importance of the national level as social agreements that influence learning and technology are largely formed there is further emphasized by [Freeman, 2002; Lundvall et al., 2002]. At the same time, the sub-national level, which includes clusters and regions, has increasingly become an area of interest. National institutions may influence innovation systems at regional, sectoral, or technological levels differently, and not all institutions are national [Carlsson, 2006]. For large firms, national institutions may be more important, while for SMEs, regional institutions play a crucial role [Wixted, 2009]. All the aforementioned theories (in fact the whole innovation literature) can be integrated to develop a model of *technology-led regional economic development* by channeling those into a more general regional economic growth model [Acs, Varga, 2002]. Consequently, the concept of the *Regional Innovation System* (RIS) broke away relatively quickly [Cooke, 2001].

Meanwhile, the *system perspective* has appeared in the field of *strategic management* as well, where the so-called *business-system approach* has become very popular. The *National Business System* (NBS) examines important structural and strategic factors that affect a firm’s ability to capture a large share of the total value created by the ecosystem when organizing economic activity among their ecosystem partners [Whitley, 1994, 1996]. The fundamental difference between the two approaches is the focus of the analysis: while the NBS explains international differences in firm organization and behavior, the NSI is taking innovation as its focal point by emphasizing the limited mobility of technical competencies. However, both theoretical concepts, in spite of these differences, share the common idea that the national institutional framework appears at the center of the analysis.

In sum, we can note that economic development literature (which comprises a family of related concepts, including the National System of Innovation as well), on the one hand and the National Business System (NBS) have largely *ignored the role of entrepreneurs* [Acs et al., 2018], only referring to the ‘firm’ or ‘enterprise’ as a black box [Spigel, Harrison, 2018; Malecki, 2018] from the point of strategic management. An *entrepreneur* is the one who creates inno-

vation through new combinations of former knowledge elements and creating new value (*output*). On the other hand, the entrepreneur contributes to employment and economic growth (*outcome*) due to his/her entrepreneurial activity (establishing and organizing a firm).

Both theories ignore the fact that, in spite of the abundance of resources, the extent of access to them can be severely limited by the entrepreneur's *knowledge absorption ability*, which on the one hand refers to the personal traits of the entrepreneur and on the other, indicates the degree of his/her social embeddedness [Qian, Acs, 2013; Qian, Jung, 2017; Qian, 2018].

In recent years, the concept of the *Entrepreneurial Ecosystem* (EE, or elsewhere *System of Entrepreneurship*) has definitely become a hot topic in entrepreneurial research. The number of scientific publications dealing with this concept has spectacularly multiplied recently and the term itself has become a buzzword [Spigel, Harrison, 2018; Ritala, Gustafsson, 2018].

Briefly, the EE concept is based on what the other two concepts – NSI and NBS – have ignored: the *entrepreneur*. In contrast with the institutional emphasis of the National Systems of Innovation frameworks, where institutions engender and regulate action, *Systems of Entrepreneurship* are driven by individuals, with institutions regulating who acts and the outcomes of individual action [Acs et al., 2014]. The main feature of the EE concept is that it reflects the *multi-dimensional nature* of entrepreneurship. It assumes that a large number of different factors have an effect on entrepreneurship and emphasizes the importance of *their interrelatedness* as the main qualitative determinant of the entrepreneurial performance.

The *Global Entrepreneurship Index (GEI)* has been elaborated upon to measure this *qualitative aspect* of the entrepreneurial ecosystem in a national context [Acs, Szerb, 2011, 2012; Acs et al., 2014]. Our index is based on the theoretical considerations of the EE concept, because it reflects the *multi-dimensional nature* of entrepreneurship by combining the individual entrepreneurial feature and the contextual institutional factors. The index consists of 14 pillars that can cover many but not all relevant aspects of the entrepreneurial ecosystem. Furthermore, by calculating the index, we apply a novel methodology, the *Penalty for Bottleneck* algorithm that incorporates the *system-perspective*, consequently, the interrelation between the pillars is expressed.

An Overview of the Evolution of the EE Concept

Nine studies have been identified as exhausting reviews providing a comprehensive overview of the

entrepreneurial ecosystem published in the last few years in high impact peer-reviewed journals (see them in Table 1). These papers also formulate some critical remarks in order to draw attention to some controversial and unanswered aspects of the concept.

Despite the popularity of the EE concept, the literature underlines only a few relevant results: although the concept is very “*seductive*” [Stam, 2015, p. 1764], it is still very “*chaotic*” [Spigel, Harrison, 2018, p. 152], as it is based on only a few systematic and consistent empirical results, and has developed without any accepted clear definition or unambiguously proven theoretical framework [Stam, 2015; Mason, Brown, 2014; Motoyama, Knowlton, 2017].

The different definitions of the concept point out the divergent views on the EE concept. Despite the different definitions, the common feature of ecosystems is that they are *heterogeneous*. The main advantage of the EE concept that it can reflect the *multi-dimensional nature* of entrepreneurship. It is assumed that a huge amount of different agents and factors have an effect upon entrepreneurship and *their interrelatedness* is the main qualitative determinant of entrepreneurial performance. However, researchers still do not know what the most important determining factors are or how these factors can be identified. It is now clear that ecosystems are *complex* systems, therefore they cannot be copied or simply adapted for other systems [Neck et al., 2004] and cannot be reproduced elsewhere because the development of an ecosystem is shaped by many *unpredictable events* (external and internal shocks). Therefore, one of the basic features of the ecosystems that they are sensitive to *initial conditions* [Roundy et al., 2017]. These conditions, besides the aforementioned general rules, cause the uniqueness of every ecosystem. However, many authors point out that studies do not provide a sufficient explanation about the evolution of the ecosystems. Recording those factors that presumably influence ecosystems does not offer useful knowledge since the importance of the factors can change over time. Therefore, if we want to understand how an ecosystem works as a system, causality among other factors should be explained.

There is also a consensus among researchers that the *entrepreneur* is the key player in the creation and operation of the ecosystem. The other players are more likely to be so-called ‘*feeders*’ [Cavallo et al., 2018], that is, a person who supports the ecosystem or provides different resources. At present, the examination of the *relationships between actors* is a central issue in ecosystem research [Zhang, Guan, 2017]. This is the area where the least progress has been made over the past 25 years [Roundy et al., 2017]. Some researchers mention the lack of a *holistic approach* suggesting that all relevant factors should be taken into account in measuring ecosystems. Others point out to the undesirable phenomenon of the holistic approach and they presume that each factor has

its own relative weight [Roundy et al., 2017]. This uncertainty can only be mitigated by exploring the causal relationship between the influencing factors [Stam, Spigel, 2016; Spigel, Harrison, 2018].

Several researchers suggest applying the *process approach* instead of identifying different factors influencing the ecosystems. Two processes can be identified here: the process of generating resources and the flow of resources between different actors. Initially, we can assume that only a few links exist among the actors, they rely only on some resources, and operate without a supportive business culture. However, early entrepreneurial success can reinforce a positive social attitude towards entrepreneurship. Consequently, new resources accumulate within the region, the skills of the local workforce increase, new companies, human and financial resources appear increasingly frequently. All this contributes to the evolution of a positive entrepreneurial culture, which offers new impetus for the processes. In order to analyze these processes, some researchers have recommended *network analysis* as a potential methodology to explore the relationships between the actors [Roundy et al., 2017, 2018; Roundy, 2019].

The identification of the appropriate level of ecosystems is also an important issue. The local nature of the phenomenon is clear [Stam, 2015]. While ecosystems could have boundaries, these borders are not too sharp and remote. The main problem is to identify the distinctive criteria of belonging to an ecosystem based on the notion that ecosystems are *open systems*, as they can attract resources from inside and outside. *Multi-scalar analysis* seems to be a proper tool to be able to understand these local-global relationships of ecosystems [Alvedalen, Boschma, 2017].

Ultimately, these review studies summarize the problematic issues of the entrepreneurial ecosystem and try to point out the “white spots” that require further research. The Global Entrepreneurship Index can offer a solution for some of these “white spots” by identifying the most important constituents and most hindering bottlenecks of the ecosystem, while taking into consideration the connection of the elements as well.

GEI: Measuring the Performance of the Entrepreneurial Ecosystem

While earlier analyses often focused on single indicators such as startup-rates or Total Early-phased Entrepreneurial Activity (TEA), more recent entrepreneurial research has shifted to a more systemic and multidimensional understanding of entrepre-

neurship at the national level. Based on the inconsistencies of the definition, measurement, and the policy domain of entrepreneurship, the *Global Entrepreneurship Index* (GEI) was developed to measure country level entrepreneurship [Acs, Szerb, 2011, 2012; Acs et al., 2014].

The GEI is an annual index that measures the health of entrepreneurial ecosystems at the country level and ranks the performance of 137 countries against each other. The index is based on the theoretical concept of the *National System of Entrepreneurship* that “(...) is 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] that requires a complex measure. Instead of using an output related quantitative approach of entrepreneurship, a proper measure should focus on the *quality aspects* of entrepreneurship. The GEI includes both the individual efforts and capabilities and the environmental and institutional aspect of entrepreneurship as well as the fact that these different components constitute a system where the relationship between the elements is vital.

The first version of the GEI was initially called the *Global Entrepreneurship and Development Index* (GEDI) and has been followed by yearly reports since 2011. The GEI has gone through many smaller changes since its introduction and was extensively reviewed and renewed in 2016 [Acs, Szerb, 2016]. Our composite index proposes five levels of index building. This includes the GEI super index¹ measuring entrepreneurship at the country level, the three sub-indexes (*Entrepreneurial Attitudes, Entrepreneurial Abilities, and Entrepreneurial Aspirations*), 14 pillars, 28 variables, and 49 indicators. All pillars were created by using an individual and an institutional (contextual) variable component (Table 2). The GEDI methodology collects data on the entrepreneurial attitudes, abilities and aspirations of the local population and then weights these against the prevailing social and economic “infrastructure” [Acs et al., 2018]. Entrepreneurial attitudes reflect the attitudes of the adult population toward entrepreneurship. Entrepreneurial abilities include some of the important characteristics of entrepreneurs that determine the extent to which new start-ups will have the potential for growth. Entrepreneurial aspirations refer to the distinctive, qualitative, and strategy-related nature of the entrepreneurial activity [Acs et al., 2014].

The aim of our paper is to provide a comprehensive picture on the role of innovation within the entre-

¹ Acs et al. [Acs et al., 2018] provide a detailed description of the contents of the pillars, their variables and indicators as well as the methodology and calculation in the Technical Annex of latest version of GEI: https://thegedi.org/wp-content/uploads/dlm_uploads/2017/12/2018-GEI-Technical-Annex.pdf

Table 1. Literature Review of Works on EE

Author(s)	Title	Journal	Year of publication	Reference
Zoltan Acs, Erik Stam, David Audretsch, Allan O'Connor	The Lineages of The Entrepreneurial Ecosystem Approach	Small Business Economics	2017	[Acs et al., 2017]
Janna Alvedalen, Ron Boschma	A Critical Review of Entrepreneurial Ecosystems Research: Towards a Future Research Agenda	European Planning Studies	2017	[Alvedalen, Boschma, 2017]
Angelo Cavallo, Antonio Ghezzi, Raffaello Balocco	Entrepreneurial Ecosystem Research: Present Debates and Future Directions	International Entrepreneurship Management Journal	2018	[Cavallo et al., 2018]
Elizabeth Mack, Heike Mayer	The Evolutionary Dynamics of Entrepreneurial Ecosystems	Urban Studies	2016	[Mack, Mayer, 2016]
Edward Malecki	Entrepreneurship and Entrepreneurial Ecosystem	Geography Compass	2018	[Malecki, 2018]
Philip Roundy, Beverly Brockman, Mike Bradshaw	The Resilience of Entrepreneurial Ecosystems	Journal of Business Venturing Insights	2017	[Roundy et al., 2017]
Philip Roundy, Mike Bradshaw, Beverly Brockman	The Emergence of Entrepreneurial Ecosystems: A Complex Adaptive Systems Approach	Journal of Business Research	2018	[Roundy et al., 2018]
Ben Spigel, Richard Harrison	Toward a Process Theory of Entrepreneurial Ecosystems	Strategic Entrepreneurship Journal	2018	[Spigel, Harrison, 2018]
Erik Stam	Entrepreneurial Ecosystem and Regional Policy: A Sympathetic Critique	European Planning Studies	2015	[Stam, 2015]

Source: compiled by the authors.

preneurial ecosystem in the involved countries. In this way, we propose the following research question: *what kind of interrelatedness can be observed between the innovation capability of a country and the other elements of its entrepreneurial ecosystem?*

In order to answer this question, the GEI and its three innovation-related pillar values were investigated in this paper. Since GEI is an annually calculated index, here, we applied the average values for 2012–2016 to filter out yearly variations and potential sampling errors. First, we analyze the connection between GEI scores and the level of development. Second, to have a deeper insight into the role of innovation within different ecosystems, we compare the three GEI sub-indexes and the three innovation-related pillars of GEI (technology absorption, product innovation, and process innovation) (Table 3). The *Technology Absorption* pillar reflects the technology-intensity of a country's start-up activity combined with a country's capacity for firm-level technology absorption. The *Product Innovation* pillar captures the tendency of entrepreneurial firms to create new products weighted by the technology transfer capacity of a country. Finally, the *Process Innovation* pillar refers to the use of new technologies by start-ups combined with the potential of a country to conduct applied research.

Although the latest version of the GEI report contains 137 countries, our investigation applies average data of a five-year period. Therefore, some countries have been excluded due to missing data so our analysis includes altogether 95 countries. Countries are classified based on their level of economic development as *resource-, efficiency- and innovation-driven* economies (see the list of countries in Table 4). The first group (19 countries) involves countries whose GDP per capita is in the lowest third. Their economies are based mostly on the exploitation of different natural resources. Efficiency-driven countries have a moderate level of economic development (42 countries). They show a higher level of economic development compared to resource-driven economies. Innovation-driven countries (34 countries) represent a relatively high level of economic development, as their economies operate relatively efficiently compared to the other groups. Their development path is based on innovation and new products mostly. This suggests that innovation may have a more important role in those countries' entrepreneurial ecosystem, who have higher level of development. A fourth group is a special cluster that has been created involving post-socialist transition countries² (16 countries). Most of its members belong to efficiency-driven economies, a few members

² "Transition" refers to those countries whose political and economic systems changed from the socialist political system and planned economy to a democratic political structure and market economy.

Table 2. The Structure of the Global Entrepreneurship Index (GEI)

Sub-indexes	Pillars	Variables (individual/institutional)
Attitudes sub-index	Opportunity perception	<i>Opportunity recognition</i>
		Freedom and property
	Startup skills	<i>Skill perception</i>
		Education
	Risk acceptance	<i>Risk perception</i>
		Country risk
	Networking	<i>Know entrepreneurs (knowent)</i>
		Connectivity
	Cultural support	<i>Carrier status (carstat)</i>
		Corruption
Abilities sub-index	Startup opportunities	<i>Opportunity motivation</i>
		Tax governance
	Technology absorption	<i>Technology level (techsect)</i>
		Technology absorption
	Human capital	<i>High education</i>
		Labor market
	Competition	<i>Competitors</i>
		Competitiveness and regulation
Aspirations sub-index	Product innovation	<i>New product</i>
		Technology transfer
	Process innovation	<i>New technology</i>
		Science
	High growth	<i>Gazelle</i>
		Finance and strategy
	Internationalization	<i>Export</i>
		Economic complexity
	Risk capital	<i>Informal investment</i>
		Depth of the capital market
<p><i>Note:</i> Individual variables are highlighted in italics, while institutional ones in bold.</p> <p><i>Source:</i> compiled by the authors.</p>		

are innovation-driven countries (Czech Republic, Estonia, Slovakia, and Slovenia) and only one member can be considered a resource-driven country (Kazakhstan).

Results: Analyzing the Innovation’s Role in National Entrepreneurial Ecosystems

First, we analyzed the relationship between GEI and the innovation-related pillar scores. We conducted a correlation analysis between the GEI super index and its three innovation-related pillars. The re-

sults suggest that all coefficients are relatively high (strong-medium) and indicate the relationship between the pillars of the entrepreneurial ecosystem. Only small differences among the coefficients of the innovation-related pillars can be observed (Table 5).

In order to obtain a deeper understanding of the role of innovation within the entrepreneurial ecosystem, the aforementioned four groups of the countries were compared to each other by the scores of innovation GEI pillars³. The values of innovation pillars in the four groups were compared to each other (Figure 1). The resource-driven countries

³ While GEI and its sub-index scores are measured on a 0 to 100 scale, a 0 to 1 scale is applied in the case of the pillars.

Table 3. The Innovation-related Pillars of GEI

Pillar	Components of individual variables	Components of institutional variables
<i>Technology Absorption</i>	Technology Level: Percentage of the nascent and young firms that are active in technology sectors (high or medium) (Source: Global Entrepreneurship Monitor)	Firm-level technology absorption capability (Source: World Economic Forum)
<i>Product Innovation</i>	Percentage of the nascent and young firms offering products that are new to at least some customers (Source: Global Entrepreneurship Monitor)	A complex measure of innovation including investment in research and development (R&D) by the private sector, the presence of high-quality research institutions, collaboration in research between universities and industry, and the protection of intellectual property. (Source: World Economic Forum)
<i>Process Innovation</i>	Percentage of the TEA businesses using new technology that is less than five years old on average (including one year) (Source: Global Entrepreneurship Monitor)	A complex measure of national conditions of science including Gross domestic Expenditure on Research & Development (GERD) as a percentage of GDP, the quality of scientific research institutions, and the availability of scientists and engineers. (Sources: World Economic Forum and Eurostat)

Source: compiled by the authors.

have the lowest values for all three pillars. However, this group is relatively closer to the other clusters in product innovation than in the case of the two pillars. A similar trend could be observed in the case of efficiency-driven countries. The values of *Technology Absorption* and *Process Innovation* pillars are higher than those of resource-driven countries, but these are relatively low compared to the value of *Product Innovation*. Innovation-driven countries have the highest innovation pillar scores compared with the other groups. In our case, the transition countries have moderate scores in *Technology Absorption* and *Process Innovation*, albeit they are higher than the values of resource- and efficiency-driven groups. In the case of *Product Innovation*, the same trend can be observed in other groups. The value of transition countries is almost equal to the value of efficiency-driven countries, but it lags behind the score of the innovation-driven group.

We compared the GEI and its pillar scores of certain countries in each of the four groups (Table 6). *Resource-driven* countries are mostly in the lowest third of the sample. *For them, innovation seems to be a hindering bottleneck.* This is the case in Botswana and Kazakhstan since their GEI scores are relatively high-

er than their innovation pillar scores. India suggests a slightly different pattern since its *Technology Absorption* score is one of the lowest in the whole Asian region, which may indicate the underdeveloped industry structure of the economy. However, the *Product* and *Process Innovation* pillars imply that India has a relatively strong performance in innovation.

Efficiency-driven countries have moderate GEI scores compared to the other groups and their pillar values suggest a mixed picture. It can be observed that all of the involved countries demonstrate outstanding performance in *Product Innovation*, but the position of the two other innovation pillars lag behind. *Technology Absorption* seems to be one of the bottlenecks in the Chinese entrepreneurial ecosystem. The *innovation-driven countries* have the best GEI scores within the whole sample which suggests that their entrepreneurial ecosystems and their components demonstrate a relatively good performance. However, a few outlier pillars can be observed in their case as well, as it is suggested by Australia's position in *Product Innovation*. Our special group, the *transition countries* also indicate a mixed picture, since there are relatively large differences in the performance of the entrepreneurial ecosystem despite hav-

Table 4. Countries according to their Level of Development

Type of economy	Countries
Resource-driven countries	Algeria, Angola, Bolivia, Botswana, Burkina Faso, Cameroon, Ethiopia, Ghana, India, Kazakhstan, Libya, Malawi, Nigeria, Pakistan, Philippines, Senegal, Uganda, Vietnam, Zambia
Efficiency-driven countries	Argentina, Barbados, Belize, Bosnia and Herzegovina, Brazil, Bulgaria, Chile, China, Colombia, Costa, Rica, Croatia, Ecuador, Egypt, El Salvador, Georgia, Guatemala, Hungary, Indonesia, Iran, Jamaica, Jordan, Latvia, Lebanon, Lithuania, Macedonia, Malaysia, Mexico, Morocco, Namibia, Panama, Peru, Poland, Romania, Russia, Saudi, Arabia, South, Africa, Suriname, Thailand, Trinidad and Tobago, Tunisia, Turkey, Uruguay
Innovation-driven countries	Australia, Austria, Belgium, Canada, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hong Kong (China), Ireland, Israel, Italy, Japan, Korea, Luxembourg, Netherlands, Norway, Portugal, Puerto Rico, Qatar, Singapore, Slovakia, Slovenia, Spain, Sweden, Switzerland, Taiwan, United Arab Emirates, United Kingdom, United States
Transition countries	Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Estonia, Georgia, Hungary, Kazakhstan, Latvia, Lithuania, Macedonia, Poland, Romania, Russia, Slovakia, Slovenia

Source: compiled by the authors.

Table 5. The Results of the Correlation Analysis between the GEI Score and Three Innovation Pillars

	GEI score	Technology Absorption	Product Innovation	Process Innovation
GEI score	1			
Technology Absorption	0.869	1		
Product Innovation	0.724	0.601	1	
Process Innovation	0.761	0.778	0.659	1

Source: compiled by the authors.

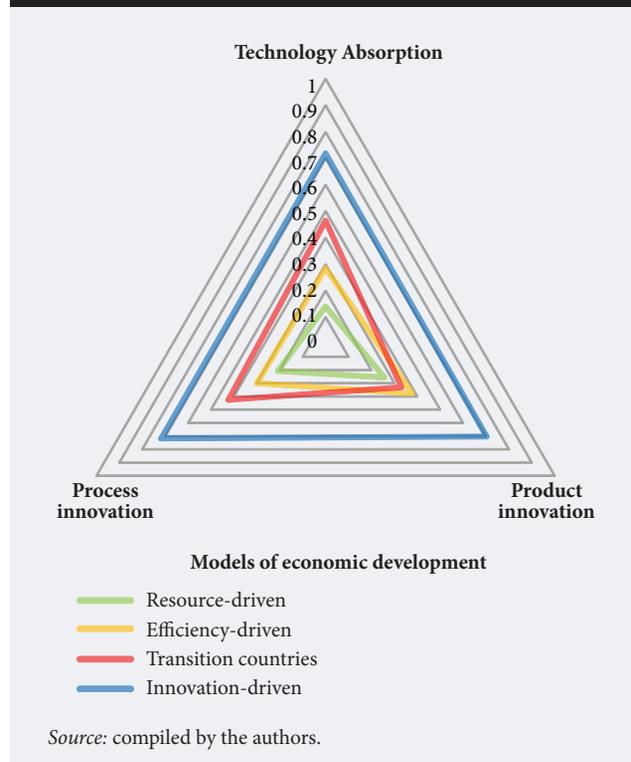
ing the same level of GDP per capita. It can, however, be observed across the sample that the *Product Innovation pillar has a much lower position than other innovation pillars and GEI scores*. This suggests that *Product Innovation is a general bottleneck in the entrepreneurial ecosystem of transition countries*, and it may indicate to the low performance in research and development at private firms in transition countries.

Finally, we conducted k-means cluster analysis to demonstrate whether countries with the same level of development are ranked in a common group if they are clustered by the values of the three innovation pillars. We ran the cluster analysis with different configurations and tested⁴ them. At the end, we selected the solution with four groups (Table 7, Table 8).

Cluster 1 involves about the half of the countries. Its members are only *resource- and efficient-driven countries*. This group has the lowest values in all of the innovation pillars and according to the GEI score. This low value can be explained by the lack of basic conditions for innovative capacities. However, the score of entrepreneurial attitudes is relatively high compared to the other sub-index values. *Cluster 2* is a quite mixed group in terms of the level of economic development. Its Aspirations sub-index value is relatively high compared to the two other sub-indexes and its score in *Product Innovation* is significantly higher than the values of other innovation pillars. Besides the score of Product Innovation pillar, the values of the High Growth pillar contribute to the relatively high sub-index score. Indeed, a couple of efficiency-driven countries like China or Turkey have an outstanding score in Product Innovation, even their overall GEI scores represent only a moderate entrepreneurial ecosystem. *Cluster 3* represents the opposite trend. Its *Technology Absorption* and *Process Innovation* scores are relatively high, but the *Product Innovation* value is relatively low. Although there is not too much variation in the economic performance of *Cluster 2* and *3*, the role of innovation in these groups seems to be quite dif-

ferent. *Technology Absorption* and *Process Innovation* refer to the high-tech firms and employment in high tech and knowledge intensive sectors, as well as the technology level of firms and the availability of scientists. While *Product Innovation* indicates the number of patents. It may mean that countries in *Cluster 2* focus rather on research and development, but the results of this effort cannot be exploited by new and productive firms. On the other hand, *Product Innovation* seems to be a bottleneck in countries of *Cluster 3*. *Cluster 4* involves only innovation-driven countries, which are the most developed ones. Their innovation pillar values are relatively in balance, and it which that innovation does not serve

Figure 1. The Values of GEI Innovation Pillars of Country Groups Based on Varying Levels of Economic Development



⁴ Three different tests have been run: Calinski-Harabasz pseudo F-test, analysis of variance (ANOVA), and Bartlett test.

Table 6. Country-Level Comparison within the Development Groups (Values)

	Resource-driven countries			Efficiency-driven countries			Innovation-driven countries			Transition countries		
	Botswana	India	Kazakhstan	Chile	China	Turkey	Australia	Switzerland	United States	Estonia	Hungary	Russia
GEI	34.3	26.3	30.0	59.0	35.9	45.0	74.9	78.9	82.5	56.0	39.4	24.7
1. Opportunity Perception	0.753	0.288	0.272	0.925	0.132	0.399	0.957	0.732	0.875	0.828	0.314	0.133
2. Startup Skills	0.276	0.198	0.427	0.894	0.184	0.688	1.000	0.688	1.000	0.657	0.335	0.353
3. Risk Perception	0.635	0.385	0.132	0.751	0.509	0.250	0.705	0.922	0.936	0.620	0.406	0.273
4. Networking	0.393	0.125	0.547	0.770	0.461	0.390	0.580	0.563	0.521	0.515	0.338	0.419
5. Cultural Support	0.760	0.184	0.213	0.719	0.299	0.414	0.769	0.680	0.838	0.540	0.364	0.150
6. Startup Opportunities	0.384	0.292	0.369	0.684	0.250	0.365	0.867	0.925	0.753	0.567	0.438	0.215
<i>7. Technology Absorption</i>	0.232	0.045	0.114	0.504	0.200	0.490	0.847	0.939	0.852	0.664	0.519	0.276
8. Human Capital	0.408	0.310	0.791	0.577	0.419	0.336	0.931	0.836	1.000	0.485	0.471	0.683
9. Competition	0.365	0.626	0.239	0.433	0.300	0.361	0.594	0.950	0.983	0.615	0.269	0.185
<i>10. Product Innovation</i>	0.204	0.644	0.215	1.000	0.878	0.925	0.560	0.828	0.804	0.569	0.278	0.151
<i>11. Process Innovation</i>	0.146	0.574	0.167	0.301	0.647	0.402	0.772	0.856	0.922	0.681	0.441	0.310
12. High Growth	0.510	0.187	0.554	0.702	0.607	0.797	0.651	0.599	1.000	0.586	0.456	0.379
13. Internationalization	0.273	0.288	0.303	0.480	0.252	0.391	0.675	1.000	1.000	0.697	0.748	0.066
14. Risk Capital	0.131	0.144	0.329	0.608	0.756	0.762	1.000	1.000	1.000	0.333	0.342	0.221
GDP per Capita	15 271	5578	23 509	22 160	12 765	21 871	43 881	56 395	51 884	26 772	23 946	24 732

Note: Innovation-related pillars are written italics. The better a country performs in a certain pillar, the darker the shade of green.
 Source: compiled by the authors.

as a bottleneck in their entrepreneurial ecosystem. In summary, it can be concluded that innovation has an important role in the entrepreneurial ecosystem, but the intensity of this role can be very varied among countries.

Conclusion

The aim of our paper was to examine the role of innovation within the national Entrepreneurial Ecosystem. In this way, we aimed to uncover the differences in innovation performance of the selected

countries. The GEI index and its three innovation pillars (Technology Absorption, Product Innovation, and Process Innovation) were applied for this investigation. Altogether 95 countries were involved in our analysis. Countries were initially grouped by their level of development and one special group was created that involved transition countries.

Our results suggest that the quality of the entrepreneurial ecosystem reflects the level of economic development. Innovation-driven countries have the highest GEI scores. Besides the high level of GEI scores, their pillar values seem to be relatively balanced and

Table 7. Groups of Countries according to their Cluster Membership

Cluster 1	Algeria, Angola, Argentina, Barbados, Belize, Bosnia and Herzegovina, Botswana, Brazil, Bulgaria, Burkina, Faso, Cameroon, Costa, Rica, Ecuador, Egypt, El Salvador, Ethiopia, Georgia, Ghana, Indonesia, Iran, Jamaica, Kazakhstan, Libya, Macedonia, Malaysia, Mexico, Namibia, Nigeria, Pakistan, Panama, Peru, Philippines, Puerto Rico, Romania, Russia, Saudi Arabia, Senegal, Suriname, Thailand, Trinidad and Tobago, Uganda, Uruguay, Vietnam, Zambia
Cluster 2	Bolivia, Chile, China, Colombia, Cyprus, Guatemala, Hong Kong, India, Jordan, Lebanon, Malawi, Morocco, Poland, Qatar, South Africa, Turkey, United Arab Emirates
Cluster 3	Croatia, Czech Republic, Estonia, Greece, Hungary, Latvia, Lithuania, Norway, Portugal, Slovakia, Slovenia, Spain, Tunisia
Cluster 4	Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Israel, Italy, Japan, Korea, Luxembourg, Netherlands, Singapore, Sweden, Switzerland, Taiwan, United Kingdom, United States

Source: compiled by the authors.

Table 8. Clustering of Countries by their Innovation Pillar Values

	Cluster 1	Cluster 2	Cluster 3	Cluster 4
Number of Members	44	17	13	21
Technology Absorption	0.199	0.287	0.615	0.831
Product Innovation	0.233	0.744	0.384	0.798
Process Innovation	0.208	0.437	0.541	0.824
Attitudes	27.5	36.6	42	61.3
Abilities	25.2	34.7	45.6	67.9
Aspirations	21.7	43.8	45.8	67.5
GEI score	24.8	38.4	44.5	65.6
GDP per Capita	12 928	25 133	27 607	46 345

Source: compiled by the authors.

this points to the high quality of the entrepreneurial ecosystem. Despite having a similar level of economic development, the efficiency-driven countries have rather heterogeneous entrepreneurial ecosystems. They have moderate performance in their GEI scores. The resource-driven countries involve the lowest level of development and have the lowest GEI scores. Most of the pillar values are in the lowest third of the sample as well, only a few pillars represent a higher position than the GEI score. The transition countries show the most variegated picture in the entrepreneurial ecosystem due to the very different development paths of these countries since the 1990s. Not any pillar or group of pillars (included innovation-related pillars) have a dominant role in these countries, but the pillar scores in these countries are significantly below the potential performance determined by the level of economic development. According to the GEI scores, Baltic countries and a few Central European countries (Slovenia, Czech Republic, and Slovakia) have rather successful development paths.

Regarding the role of innovation, it seems that the innovation pillars have an important role within the entrepreneurial ecosystem. *Technology Absorption* is highly related to the GEI score and level of economic development since the most developed countries have the highest values for this pillar. The *Product and Process Innovation* pillars have a rela-

tively strong relationship with the GEI score as well. However, it seems that a couple of countries have higher pillar values in these than their GEI scores might suggest (like China, Turkey, or India). This may indicate that these countries have relatively good performance in research and development, but other components of their entrepreneurial ecosystem hamper the exploitation of the results by new firms.

Although GEI serves as an adequate basis for discovering a country's entrepreneurial ecosystem, it has to be noted that the GEI three sub-indexes of attitudes, abilities, and aspiration, their 14 pillars, 28 variables, and 49 indicators only partially capture the National System of Entrepreneurship, which limits its general use for policy purposes. Besides the analysis with the application of GEI, further case studies and empirical research might be useful in order to investigate those strengths and weaknesses that were identified in detail.

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