Innovation Ecosystems in the Context of Economic Development: A case study of Kraków, Poland

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Abstract:

The aim of this article is to provide a comprehensive overview of the innovation ecosystem, which remains a fragmented concept, and to analyse its role in the economic development of states. The objective is achieved by first, drawing on the existing literature and theoretical framework that concerns innovation ecosystems, and by subsequently analysing the nexus between these entities and the economic development of states. The main contribution this paper makes to scholarly debate on innovation ecosystems is in attempting to link theoretical assessments with empirical observations. By drawing on the case study of the innovation landscape in Kraków, Poland, this paper offers a first-hand insight into the role of local actors and mechanisms determining the performance of the ecosystem based on primary research. As such, the study attempts to review specific stages of innovation development and the unique role of start-ups and SMEs within the ecosystem. By crossing through historical, economic and social contexts, the study embarks on a multidisciplinary as well as "causes-of-effects" approach. The different roots of the Polish innovation ecosystem are discussed, yet not failing to address the future prospects for innovation in the country. Finally, the study attempts to structure Poland's start-up experience as a guide by discerning the actors and mechanisms that drive a healthy ecosystem. In such a context, the Polish experience can be informative for CEE countries where start-up ecosystems exist at the nascent stage.

Keywords: innovation ecosystem, technology, economic development, Poland, start-ups, small and medium size enterprisess

Introduction

Although innovation ecosystems as a concept is increasingly difficult to define due to the various fields and contexts in which these entities can be analysed, it is necessary to provide a somewhat provisional definition that can serve as the basis for further discussion. While the scholarly debates and relevant literature focus on the specific elements of innovation ecosystems as well as their comparative characteristics, the aim of this article is to combine existing findings in order to produce a comprehensive overview that will serve as a guidebook to this multi-faceted concept.

First, it ought to be noted that the definition of innovation ecosystem as a concept has been subject to evolution, and whether we look at it over a number of years or at a specific point in time, the general understanding of innovation ecosystem has been changing. A significant shift in its conceptualisation occurred in the first decade of the 21st century. Prior to the 2000's, innovation ecosystems were perceived as rather static systems whose existence depended to a large extent on their governing body, the more contemporary conception describes these entities as dynamic systems with a self-governing mechanism (Smorodinskaya, Russell, Katukov, & Still, 2017). It therefore becomes possible to provide the first element of a provisional definition by accepting that innovation ecosystems are dynamic by nature.

Another important contribution to our understanding of how innovation ecosystems operate was made by Antti Hautamäki and Jari Oksanen. In their attempt to explain the emergence of

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innovation ecosystems, they linked the appearance of these entities to the imperative of structural change. They explained that different national, regional and local actors are nowadays exposed to a constantly evolving global competitive environment. This ongoing process puts strain on these actors insofar as technological advancement is propelling the shift from manufacturing to the services. In order to meet the demands of a technology-oriented environment, actors need to undergo major structural changes. The most effective way to manage these changes is by engaging in the creation of an innovation environment. As such the aforementioned perspective of Hautamäki and Oksanen adds an element of rationality that is pertinent to innovation ecosystems. According to the authors' definition, the development of innovation ecosystems can be seen as a rational and logical response to the structural changes occurring within the economy (Oksanen & Hautamäki, 2014, p. 2). This argument becomes further substantiated in other scholarly works, where authors claim that in, "…the age of non-linear innovation and digital technologies, innovation can be better nurtured within a special, innovation-conducive environment" (Smorodinskaya et al., 2017). Therefore, the rational aspect of innovation ecosystems is asserted in claiming them to be the most efficient ways of meeting technological demands. As these authors further elaborate, such an innovation-conducive environment is designated for the "co-creation of value through collaboration." By introducing the concepts of "non-linear innovation" and "value co-creation," Smorodinskaya et al. (2017) assessed the most prominent characteristics that account for the unique dynamics of innovation ecosystems. Although the idea of the co-creation of value is further explained as "an active, creative and social process, based on collaboration between producers and users," repetitive interactions and the formation of relationships remain visible among all actors within an ecosystem. When examined closely, collaboration further implies that "networked actors must rely on a common vision, strategy, common identity, and joint obligations" for the purpose of co-creating innovations (Smorodinskaya et al., 2017, p. 5248). What should be noted with respect to value co-creation is that its processes are centred predominantly on the end-users, culminating precisely in the creation of innovation for customers. Regarding the question of who the other beneficiaries of the value creation process are, an important contribution in addressing this research gap is offered by Paavo Ritala and Pia-Hurmelinna-Laukkanen (2009), who remark that collaboration between actors is one source of value creation. Yet, competing firms engaging in collaboration is seen as another type of vital activity insofar as it leads to the process known as "value capture," which by contrast to value creation is beneficial exclusively for the firms involved. When competing actors engage in collaboration in order to create new products or to improve existing ones, they work towards the common goal of increasing the size of the market or creating new markets. With the size of the market increasing, the number of benefits available for allocation increases as well. It is therefore in this process, known as "coopetition", that firms are allowed to pursue their own profit from innovation-related competition, and therefore to capture value from innovation (Ritala & Hurmelinna-Laukkanen, 2009, p. 821). When combining these abovementioned findings, it can be concluded that due to its networked structure and various cooperation and coopetition processes among the actors, innovation ecosystems can be described as networks that create important incentives through value creation and value capture, and are effectively more sophisticated than other forms of production.

A further aspect contributing to the ambiguity of innovation ecosystems as a research subject is the etymological source of the concept as well as the prospective differences between innovation ecosystems and regular innovation systems. In order to address disparities arising between the two, it is vital to look at the typology offered by Martin Fransman in his new book *Innovation Ecosystems: Increasing Competitiveness* (2018). One of the author's crucial contributions to the analysis of the concept is in juxtaposing it with business ecosystems and innovation systems. By distinguishing *business ecosystems, innovation systems* and *innovation ecosystems*, Fransman creates a somewhat comprehensive analytical framework through which it becomes possible to better understand innovation ecosystems. For the purpose of comprehending the difference between systems and ecosystems, the following section will be devoted to examining its origins. As such, business ecosystems, which remain the etymologically remote category, will be addressed later in this paper.

According to Bengt-Åke Lundvall, the concept of an innovation system should be seen predominantly as a "synthesis of analytical results produced by scholars" (Lundvall, 2016, p. 226). While the concept of a *national system of innovation* (NSI) can be originally linked to the works of the British economist Christopher Freeman, who coined the term in 1987 in response to Japan's success in accelerating technical progress and its innovation policy, it is his strong interest in innovation that should be analysed in greater detail. As one might observe, Freeman was deeply convinced by the power of innovation in shaping the global economy. As he brilliantly remarked, innovation is not a stand-alone phenomenon, and in order to bring economic profit, it needs to be supported by institutions. It is therefore the presence of institutions that enable waves of innovation to create unique opportunities for less advanced countries. While institutions in leading countries are responsible for previous waves of innovation, they are consequently slower to adapt to the new waves, and the less advanced countries emerge as more apt at developing new institutions. Therefore, by riding on the new waves of innovation, following countries can catch up with their more advanced counterparts. Inspired by Japan's success in technological catch-up, Freeman decided to search for a more robust and comprehensive concept that would explain Japan's performance. In his book, "Technology, policy and economic performance: Lessons from Japan," published in 1987, Freeman coined the concept of *national innovation system* and subsequently defined it as "the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies" (Freeman, 1987, p. 1).

In addition to the pioneering work of Christopher Freeman, Bengt-Åke Lundvall (2016) also acknowledges the contribution of different economists to the concept of innovation systems and the history of innovation research. As he asserts, some of the foundations of the modern interpretation of the innovation system was established in the work of Adam Smith and his "Wealth of Nations," wherein he introduced two modes of innovation based on experience and on science. Nevertheless, Smith's hallmark ideas of free trade and liberal economy as prerequisites for technical progress were criticised by other authors, including the German economist Friedrich List. In striking contrast to Smith, List saw government intervention as indispensable from the achievement of technological advances (Lundvall, 2016, p. 228). On the other side of the spectrum, crucial insights into the role of technology have been offered in Karl Marx's "Das Capital." His view of technology as a powerful actor shaping society and the economy was reassessed through his empirical observations. According to him, productive forces and production relations are vital insofar as they imply the need for societal and organisational change in order to benefit from new technologies.

As Lundvall claims, the greatest contribution to the concept of national systems of innovation comes from the works of Joseph Schumpeter, who he claims to be "the founder of modern innovation research" (Lundvall, 2016, p. 230). In his books, "Theory of Economic Development," and "Capitalism, Socialism and Democracy," Schumpeter offers two distinct views on the source of innovation. In his first work, the ultimate source of innovation is the individual entrepreneur, who propels economic dynamics by introducing innovations to the market and by creating enterprises. This view is somewhat challenged in the second book, where Schumpeter deems innovation to be created by the big companies and their R&D teams. Although different, these two modes of innovation have been widely accepted and promulgated by other scholars. More importantly, however, they enabled a classification of national systems as being dominated by one or the other of the two modes (Schumpeter, in Lundvall, 2016, p. 230).

In addition to coining the concept of a *national system of innovation*, another substantial contribution was made by Christopher Freeman in conceptualising innovation. As he remarks, innovation is not a linear but rather an interactive process and does not result directly from the R&D stage. This idea has been further reaffirmed my modern scholars who extended its applicability to the recent concept of the innovation ecosystem. As they claim, while production within a regular system can be characterised by the linear development of goods and services, in innovation ecosystems this process is occurring in a non-linear manner. The linear mechanism is replaced by the horizontal and vertical interactions among the actors that make up their network structure. Therefore, one could argue it is ultimately the non-linear structure and collaboration in producing innovations

that distinguishes regular systems from ecosystems (Smorodinskaya et al., 2017, p. 5248). When placed in a broader perspective, these remarks seem to direct the discussion towards the main subject of this paper; that is, the development of innovation ecosystems.

As mentioned previously in this paper, Fransman's typology offers an interesting lens to look at the concept of innovation ecosystems. According to the author, the origin of the concept can be found in the previously mentioned *national innovation systems and business ecosystems*. As Fransman argues, while the concept of the innovation ecosystem draws significantly on the other two frameworks, it focuses more on the role of innovation as an endogenous process and explains how innovation happens. This claim seems to be well substantiated in the definition offered by Fransman, when he explains that innovation happens through the interactions among interdependent players and processes, and that more successful players will launch subsequent rounds of innovation leading to the constant evolution of the innovation ecosystem (Fransman, 2018, p. 62). More importantly, however, Fransman warns against the many possible ways that innovation ecosystems can be conceptualised, when he claims them to be, "the conceptual constructs that serve the purpose of their creators." This observation seems to support the claim made at the beginning of this paper about the issues arising from the unsuitability of the concept to fit a single definitional framework.

In order to achieve a comprehensive analysis of innovation ecosystems, it is necessary to address relevant ambiguities that impair one's understanding of this concept. As such, this paper will aim to address analogies between innovation ecosystems and natural ecosystems and to explain how these networks operate. Although the two concepts seem to be etymologically related, focusing solely on such an analogy can lead to serious omissions. First, as some scholars assert, one of the most fundamental differences between an innovation ecosystem and a natural ecosystem is the purpose of producing innovation in the case of the former. They further assert that while innovation ecosystems are "designed, engineered systems" that have "a purpose, or teleology," their ecologic counterparts lack these traits (Oh, Phillips, Park, & Lee, 2016, p. 4). According to one interpretation, it is therefore the presence of the purposeful actions of each participating actor that accounts for the main difference. Moreover, in contrast to the natural ecosystems that are local, innovation ecosystems have no geographical constraints and can be characterised by the presence of cross-world links that are essential for their functioning. A different point of view on the relationship between natural and innovation ecosystems is offered by Paavo Ritala et al. (2013). According to them, modern business ecosystems as well as innovation ecosystems share their common origin with natural ecosystems wherein the interdependence of all organisms and their co-evolution creates an important link with modern ecosystems. Furthermore, his remarks seem to point out to the existence of a certain hierarchy in the classification of the ecosystems, with the natural ecosystems as the structural model of interconnection and co-evolution, followed by business ecosystems and finally by the recent concept of innovation ecosystems (Ritala, Agouridas, Assimakopoulos, & Gies, 2013, p. 248).

Establishing the links between natural ecosystems and the aforementioned counterparts would not be possible without examining the work of James F. Moore whose insights provide a deeper and more rigorous understanding of the analogies between biological ecosystems and business milieu. In his article *Predators and Prey: A New Ecology of Competition*, published in the Harvard Business Review in 1993, Moore sets out important parallels between the co-evolution of species in the natural ecosystem and the co-evolution of actors within a business ecosystem. By drawing on the definition of co-evolution provided by anthropologist Gregory Bateson in his book *Mind and Nature*, Moore argues that, the "process in which interdependent species evolve in an endless reciprocal cycle" is akin to the dynamics that govern the business ecosystem wherein "companies coevolve capabilities around a new innovation: they work cooperatively and competitively to support new products, satisfy customer needs, and eventually incorporate the next round of innovations" (Bateson, as cited in Moore, 1993). Another important analogy is made by Moore when he notices that both types of ecosystem have their beginnings in disorganised or even a "random collection of elements" that become structured within time. As he asserts, while in natural ecosystems "species spring from the natural resources of sunlight, water and soil nutrients," the emergence of the business ecosystem also necessitates in the initial "swirl of capital, customer interest, and talent

generated by a new innovation" (Moore, 1993). Finally, the last element of a successful business ecosystem – innovation – is the one that has been reasserted and further developed by Moore in his book *The Death of Competition: Leadership and Strategy in the Age of Business Ecosystems* published in 1996. Here, the author engages in a discussion on the importance of innovation for the business ecosystem and the co-evolution of the companies operating within it. According to the conceptualisation set out in his work, innovation can be seen not only as a necessary prerequisite for the business ecosystem to emerge, but it also enables the ecosystem to evolve when companies engage in launching the next round of innovations (Moore, as cited in Fransman 2018, p. 40) According to Moore, coevolutionary interactions between players of the ecosystem including customers, market representatives, suppliers, companies and stakeholders that are intentionally referred to as "primary species," drive the dynamic of the ecosystem (Moore, as cited in Fransman, 2018, p. 42). As a matter of fact, the above-stated strong analogy between modern ecosystems and their biological counterparts is further reiterated in other scholarly works. Marco Iansiti and Roy Levien, in the article "Strategy as Ecology" published in Harvard Business Review in 2004, offer a similar lens for understanding the concept of business ecosystems, as they assert both business networks and biological ecosystems can be characterised by "a large number of loosely interconnected participants that depend on one another for their effectiveness and survival" (Iansiti & Levien, 2004, p. 5). They add, in business ecosystems, "firms interact with each other in complex ways and the performance of each firm is dependent on the health and performance of the whole" (Iansiti & Levien, as cited in Fransman, 2018, p. 46). When put in a broader context, the healthiness of each ecosystem determines the fate of its participants by allowing them to flourish or to suffer. In the same vein, the authors emphasize the importance of the mutually dependent relationships between actors within an ecosystem, and the fact that these relationships assign unique meaning to the actors. An example of such valuable interdependence, as they claim, could be observed among companies, products and technologies of a business network, which would lose their meaning without such relationships being in place. As the authors insist on the strong parallels between business networks and biological ecosystems, the argument about the role of co-dependence and relationships is equally valid for the species within a natural system. Furthermore, as Iansiti and Levien point out, the presence of such relationships between actors is determined externally by the overall state of the system and is rarely affected by individual participants. Iansiti and Levien delve even further into the analogies between biological systems and networks of business entities and offer an even more robust explanation in their argument. They claim one of the common characteristics between the two systems is the presence of crucial hubs that regulate ecosystem health. While in business ecosystems this role is served by the keystone organisations that "provide a stable and predictable set of common assets that other organisations use to build their own offerings" and "that connect network participants to one another," biological keystones are the organisms whose decline or absence could negatively impact a variety of other organisms. This logic is best reflected by drawing on the example of sea otters, which effectively regulate coastal ecosystems by consuming sea urchins. While an overgrown population of sea urchins could lead to a decrease in organisms important in maintaining the food web, sea otters emerge as the keystone and benefit the sea community as a whole (Iansiti & Levien, 2004, p. 5).

Theorising innovation ecosystems

Once it has been concluded that innovation ecosystems can be best described as collaborative networks, what makes such a conceptualisation more complex is the fact that there exist various types of collaborative networks. Therefore, it becomes necessary to distinguish among the different types of such networks in order to prevent serious omissions from occurring when the concepts are used interchangeably. The first type, regional innovation clusters are based on a peculiar functional model that makes them distinguishable from other networks. The processes that govern regional clusters can be best described as interactions occurring among three participating groups: companies, research centres and authorities. The three groups correspond to the three respective helices, make up the *Triple-Helix* model of knowledge. Originally coined by Etzkowitz and Leydesdorff, the triple-helix model offers a conceptual perspective on the trilateral networks that exist between university, industry and government, and which together lead to a functioning

national innovation system (Etzkowitz & Leydesdorff, as cited in Carayannis & Campbell, 2009, p. 206). Yet, if one decides to assess the role of the determining value of the knowledge and technology from external actors in a socially assigned hierarchy, it is vital to look at the more advanced *Quadruple Helix* model. Unlike the former, the quadruple helix model acknowledges the role of the media as the fourth actor indispensable in shaping the public interest in knowledge and innovation and is thus responsible for driving the "innovation culture" within the state (Carayannis & Campbell, 2009, p. 206).

While regional innovation clusters are defined as "geographically localised agglomerations of collaborating firms and organisations," on some occasions these entities can embark on collaboration with counterparts in different geographical locations leading to the formation of another type of networks known as the global value chains (GVC). These collaborative webs can be described as more advanced forms of the regional innovation systems, with the actors dispersed across countries and territories. Moreover, as these actors are interdependent and work within a common project of producing goods and services, their functional arrangement enables more robust production and marketing processes in several countries (Smorodinskaya et al., 2017, p. 5249). The third type of the collaborative networks are digital innovation ecosystems – "a dynamic collective of interdependent actors and the resources they draw on to innovate with digital technology" (Wang, 2019, p. 5). A digital innovation, which is at heart of these ecosystems, should be understood as "a product, process or business model that is perceived as new, requires significant changes on the part of adopters, and is embodied in or enabled by IT" (Fichman et al., 2014, p. 333, as cited in Wang, 2019, p. 2). The functioning of digital innovation ecosystem is possible thanks to digital platforms, which enable customers to connect with each other and exchange value by making transactions. These online platforms enable the creation of an interface for producers, suppliers and customers that operate within the network, and whose interactions lead to the co-creation of value. As such, digital innovation ecosystems can be put into a broader category of platform-based ecosystems. Interestingly, an even more far-reaching conclusion can be made with regard to digital technologies and their qualities. Due to their special role in reducing the costs of coordination by "making process and product innovations programmable, sensible, and searchable," many innovation ecosystems should be seen as digital innovation ecosystems (Wang, 2019, p. 4).

Another substantial contribution to the understanding of the concept of innovation ecosystems in the literature was made by Dr. Deborah J. Jackson, from the National Science Foundation. Jackson's definition of innovation ecosystems is of critical importance to the current conceptual framework insofar as it constitutes one of the most lucid and comprehensive interpretations of this term. As explained by Jackson, innovation ecosystems are "the complex relationships that are formed between actors or entities whose functional goal is to enable technology development and innovation" (Jackson, 2011). Such definition introduces two important elements. First, it implies the complexity of interactions that are occurring among the actors within an ecosystem, and more importantly, it addresses the pivotal question about the purpose of such a system by asserting that innovation is its final objective. Moreover, Jackson's definition contains universal elements, which reappear in other attempts at defining innovation ecosystems across the research field. One of these universal elements is the distinction between material resources and human capital that together make up the totality of the ecosystem. While material sources consist of the technical equipment and funding necessary for the research, the human capital encompasses the actors that take part in the innovation production including institutional staff, researchers and industry representatives (Jackson, 2011). Another significant distinction by Jackson is introducing the notion of the research and commercial economies (Oh et al., 2016). These two notions are critical to the understanding of the innovation ecosystem as one organism whose overall performance depends on the individual performance of the actors. Some scholars put additional emphasis on the role of the universities within an ecosystem. They point to the underestimated potential of the universities, whose performance is most often evaluated upon their efficiency in producing knowledge. Yet universities, as it turns out, have a wider capacity that reaches beyond plain research-production and exploration. Their role is especially important for regional ecosystems. In addition to research-production, universities also perform various other functions such as "consulting local industry,

delivering policy advice and informing general public debates, providing highly trained and educated graduates for regional and national labor markets" (Bramwell Hepburn, & Wolfe, 2012, p. 7). These functions undoubtedly facilitate the process of knowledge transfer while emphasizing the appeal of universities in promoting regional economic growth. Therefore, it can be theorised that in its ideal form, a university will advance regional innovation by "generating and attracting the talent that underpins academic and applied excellence" as well as, by "supporting local firm-based R&D" and "entrepreneurial activity at the local level" (Bramwell et al., 2012, p. 7). Moreover, as the universities develop essential links with local businesses and cooperate with governmental authorities, they also have the power to shape the balance in the labour market. This is possible thanks to the insight universities have into labour market information, which provides them with the type of programmes that should be developed to meet market demand (OECD, 2007, p. 15).

Nexus between innovation ecosystems and economic development

In his comparative research on the innovation systems in capitalist economies, including the United States and Japan, Richard Nelson (1988) provides crucial insights into the mechanisms of technological change in these countries. He specifically emphasizes three elements, which make innovation ecosystems in capitalist countries proceed in different ways to Soviet economies. Building on the case of the United States, Nelson points out the privatisation of new technology, presence of rivalrous sources of new technology and reliance on market forces to choose among the innovations offered by different firms. In the opposing camp are scholars who claim that by contrast to the capitalist approach, centrally planned economies are more apt at generating new technology since they treat it predominantly as a public good. In order to address these contrasting claims, Nelson engages in an in-depth discussion on the balance of between public and private aspects in the capitalist innovation systems. While depicting technology as partially a public good, Nelson does not fail to affirm the role of inherently private incentives in spurring innovation. He subsequently points to the public use of innovation that makes it widespread. In addition to the healthy equilibrium between the private and public sphere in capitalist countries, Nelson also praises its institutional design, which effectively regulates the profit incentives by establishing a property rights framework. As he further notices, institutions stimulate action through private incentives and make innovators more aware of the market opportunities, while benefiting from the low costs of privatising knowledge. The vital role of universities has also been reasserted by Nelson in describing them as a "repository of public scientific and technological knowledge." As he further remarks, in the United States "university science, engineering and science-based industries grew together" (Nelson in Dosi at al., 1988, p. 320).

Nelson also notices that certain areas of academic knowledge, such as biology and computer science, may be more important sources of ideas and techniques for industry than others. Finally, Nelson does not fail to contrast the university-industry connection in the United States with the experience from Japan, where "generic cooperative research" is conducted together by the firms leaving no place for the active role of universities (Nelson in Dosi at al., 1988, p. 321). Interestingly, Nelson abstains from judging which approach is more effective. Regarding government support for R&D, the author underlines the existing differences in the role of government across different countries. By drawing on the case of Japan, where industrial policy has been coordinated by the Ministry of International Trade and Industry (MITI), he points out the lack of such a coordinating mechanism in the US. Instead, US government involvement in R&D has been rather selective. As he asserts, contrary to what is commonly believed, a significant amount of government research support comes from government agencies "with particular applied missions, which are seeking to build a scientific understanding to advance those missions" (Nelson in Dosi at al., 1988, p. 322). As such, one could argue about the predictability of such a scheme wherein significant support is channelled only to the academic fields crucial for technical advance.

Once the main mechanisms of the innovation system in capitalist countries have been discussed, it is now possible to delve into the meaning of these entities for economic development. Starting from the basic assumption, one could argue that links between innovation ecosystems and economic growth can be described as rather straightforward. Innovation and technology that is

contained in the products and services foster a positive environment for enhanced productivity and efficiency (World Economic Forum, 2015, p. 54). The process of how innovation becomes a carrier of economic growth can be explained based on the relationships between economic input and output. According to the traditional approach, increasing input is key to obtaining a more satisfying output. This logic, however, loses its appeal when juxtaposed with the alternative solution of innovation. By implementing innovation in the form of enhanced goods, services, and methods and processes, it becomes possible to obtain more outputs from the same number of inputs. As such, emerging technologies can serve as the vehicles for bridging technological gaps and for hastening the process of catching-up for actors that have been lagging behind technological leaders (Minshall, 2017). Furthermore, one important aspect of innovation ecosystems that is often underestimated is that these entities enable the creation of ideas not only in the R&D scientific field. By their very presence, innovation ecosystems "encourage collaboration, connectivity, critical and creative thinking, diversity, and confrontation across different visions and angles" (World Economic Forum, 2015, p. 54). Therefore, it is no exaggeration to conclude that due to its structure, innovative ecosystems act as catalysts for the generation of all kinds of ideas, thus being able to create innovation directly as well as indirectly. Although it is indisputable that ideas that result in product innovation drive economic growth and development, there exist some important prerequisites to this process. Consequently, the importance of the ideas in an innovation ecosystem stems from their suitability to be translated into products and services, which in turn can be later introduced to the market. Nevertheless, this stage emerges as the most problematic one. Some ideas become tangled in the processes that occur between production and commercialisation, and which impair further product innovation. An example of such processes are the marketing activities that are responsible for branding a product. Due to the risks associated with the introduction of the product into the market, it is ultimately the role of the company to decide whether it is willing to bear such risks. The role of marketing, however, is to shape the size of the risks through their impact on the differentiation and appeal of the product. Depending on the effectiveness of their actions, companies decide whether they want to take the risk and turn an innovation into a product.

Another type of barrier that impedes product innovation emerges directly from the process of transferring knowledge from university to industry. Although the existing conducive environment of an innovation ecosystem creates the basis for the collaboration between the two sides, the inherently different objectives of universities and industry cannot be ignored. While the primary objective of the university is to provide knowledge and to produce human capital, the actions of industry and companies are dictated by market efficiency. The issue of different priorities becomes further exacerbated by "organisational cultural differences" (Pavitt, 2003, as cited in Bramwell et al., 2012). According to Pavitt, such differences are especially visible in the pace with which these entities operate as well as in their attitude to meeting deadlines. From one point of view, it could be argued that universities tend to operate at a slower pace than the dynamic realm of companies. Yet the question of the orientation of the two areas is not related to pace of operation but rather to the type of innovation sought by these actors. As such, it is necessary to make another distinction between incremental and radical innovations. While incremental innovations offer moderate improvements to existing products and services, they do not cause significant change to the status quo. Radical innovations by contrast are breakthrough discoveries that change all aspects of products and services. It could be reasoned that the different types of innovation sought by universities and industry respectively can impede collaboration between them. It may also be assumed that market orientation, understood as "the organizational culture that most efficiently creates the necessary behaviours for the creation of superior value for customers" and which is customer-centric and market-driven, is more present within companies than universities (Lewrick et. al, 2015, p. 240). Yet, any reasoning that does not include the risks for both actors can lead to serious fallacies. It should be noticed that companies can be more interested in incremental innovation because it allows them to better mitigate risk. Universities, by contrast, are better predisposed to embrace the risks associated with radical innovations, which are at the same likely to lead to crucial discoveries. Other factors that may cause potential problems with effective technology transfer include the publication of the research results. As such, potential clashes between universities and businesses can arise when universities decide to publish the results of

their research. If this is the case, the idea of patent filling and licensing becomes counterproductive for businesses that want exclusive rights to the products and services (See Figure 1. p. 20).

Another category of financial obstacles to successful knowledge has been introduced by Dr. Jackson and termed the "Valley of Death." As she claims, this concept relates to situations where technologies that deserve attention and increased funding are not further elaborated due to a lack of funds. As she explains, the valley of death is "the gap between basic research funded largely by government and commercial development funded by industry" (Jackson, 2011, p. 6). Jackson's concept is therefore helpful in understanding why increased government investment in research and development (R&D) does not always translate into more innovation or more marketable products. Conversely to what can be expected, such extensive funding cannot mitigate the others risks in the process, which are related to the effectiveness of the company's commercialisation practices (European Commission, 2009, p. 24). As a matter of fact, the research economy and commercial economy are financially supplied by different sources. Because of the prevailing tendency among investors to compare the risks and benefits of investing in innovation, the product development process is frequently abandoned. This has been the case especially when the risks associated with unproven and pre-commercial technologies are perceived by private investors as simply too high (European Commission, 2009, p. 24).

Regarding the role of external factors that affect university-industry transfer, it needs to be mentioned that size of the firms can become a determinant of such collaboration. It will not be surprising that large firms tend to be more inclined towards collaboration with universities, as they are more willing to invest in the research and development, and more capable of adopting the new technologies (Arvanitis, 2005, as cited in Bramwell et al., 2012). The type of the industry in which a given company operates can also affect the knowledge transfer. Certain industries are more likely to create a conducive environment for a partnership with universities than others. Various perspectives can be offered in this regard. While some authors see "engineering technology, business and financial studies, mathematics and computing" as sectors that create more context for cooperation, others claim that sectors related to "chemicals, machinery and electrical equipment" have a stronger record in collaborating with the universities (Hughes, 2011, as cited in Bramwell et al., 2012).

When analysing the growing interest of governments in building innovation ecosystems, it is necessary to first look at the traditional approaches, which offer an important insight into why innovation ecosystems emerged as a preferred alternative for economic development. As already mentioned, actors within economies, including businesses and industries, have been struggling to meet market demand driven by rapid technological change. While this set of disruptive processes was initiated during the transition from the Industrial Era to the Information Era, the situation became further exacerbated by the Great Recession (Bennett, 2018). The actors within the economy were challenged not only by transformation but also by the forces of the Great Recession, which only enlarged the technological gap and pushed them further from meeting their objectives. As technological advancement occurred to be the fastest growing phenomenon during the transition to the Information Era, it soon became clear where the actors had to concentrate their efforts. What could be noticed in the transition to the technology-driven, knowledge-based economy is the special homogenizing power of this technological phenomenon. The emergence of new, non-linear and networked forms of production has equally affected all pre-existing types of economies including developed, developing and those in the process of transition. It visibly altered their industrial policies by replacing vertical hierarchies with horizontal ones and by introducing collaborative governance within a network (Smorodinskaya et al., 2017, p. 5251).

Drawing on the previously presented findings, it can be stated that innovation ecosystems were created with the purpose of mitigating the difficulties of the transition to a technology-driven economy. Nevertheless, this statement would be incomplete if it failed to acknowledge the negative effects that are pertinent to the technology-oriented approach. As a matter of fact, rapid technological change is accompanied by inherent consequences of producing inequality between geographic regions as well as workers. The growth of the technological sectors led to the unequal

dispersion of businesses with the majority of them being gathered in certain metro regions. The same logic applies to workers who are not employed in the tech sector in the metro regions and who face higher inequality. Therefore, an innovation ecosystem is a tool for the more equal redistribution of wealth created by technology advancement. In this sense, these collaborative networks can be seen as a response not only to the demand for technological transition but also the externalities created by technology itself. Especially appealing in this regard is the idea of building start-ups, which enable the distribution of global technology that otherwise would be concentrated within certain geographical locations. Because of their instrumental role, start-up ecosystems are often claimed to be a vehicle by which regions and citizens can take advantage of technological change. Regarding these new findings, a following analogy can be made that the economic growth of regions is only possible if it is paralleled by investments in a start-up ecosystem.

Despite the aforementioned qualities of the start-up ecosystem, the beneficial role of start-ups remains a subject for scholarly debate. Critics of the concept often point out the limited applicability of start-ups, arguing that these entities can only exist in developed countries, where they can enjoy the availability of all the necessary resources. As these critics remark, the lack of support from the local government as well as bureaucratic and financial barriers in developing countries impede the potential for entrepreneurship activities (Benkeroum, 2018). The opponents of this critique argue that the biggest opportunities for start-ups are presented in underdeveloped countries, as well as those where entrepreneurship is a recent phenomenon (Didar, 2015). According to this school of thought, most powerful incentives are born among the poorest populations that have a genuine intention in leveraging their country and contributing to its prosperity. Although start-ups in developing countries will lack key components such as early-stage funds, collaborative-work spaces, venture capital or access to mentoring, it does not imply their imminent failure. The idea of building a start-up ecosystem continues to intrigue as it allows for the two-dimensional action of meeting the technological demands and mitigating the inevitable inequalities. In addition to creating jobs and employment, which lead to economic growth, start-ups create a milieu for entrepreneurship (Didar, 2015). Arriving entrepreneurs in turn import new ideas thus contributing to innovation and competition. More importantly, however, start-ups engender economic dynamism, having a significant impact on the cities in which they operate.

Innovation landscape in Poland: case study of the Kraków innovation ecosystem

In order to gain a better insight into the innovation mechanisms driving the Polish innovation scene, qualitative methods were applied to gain factual background information. Semi-structured interviews were conducted with four actors operating within the Polish innovation ecosystem, with three of them concentrated in the city of Kraków. In addition, analysis of internal documents and unpublished materials as well as publicly available reports and information on those organisations was used as a secondary source for drawing conclusions from this case study. The case study analysis was performed in line with Robert's Yin case study method (1994). Actors were chosen on the basis of the sectors in which specialize, whereby each of them corresponds to the one area of three-sided Triple-Helix model of knowledge transfer. Respondents were drawn from government, industrial and academic sectors. Moreover, they were chosen based on their performance within the Polish ecosystem as well as their range of operation. The start-up company, Brainly, the Hubraum incubator and Jagiellonian University Innovation Center located in Kraków have been the main representatives of the city ecosystem, with each of them cooperating on national as well international levels and Kraków being an entry point for the wider CEE region. With their offices divided between Eastern and Western Europe as well across the Atlantic, these actors create an additional knowledge base for research as they make it possible to derive conclusions through a comparative approach. Moreover, the wide range of activities performed by these actors provides insight into the key areas of innovation in Poland. As such, the main aspects that were addressed in the interviews and secondary source analysis include the venture capital market, university-industry technology transfer, the business culture of start-ups and structural impediments to innovation.

According to professors Amnon Frenkel and Shlomo Maital, post-socialist societies in Central and Eastern Europe tend to have outstanding levels of human capital cultivated by high standards of education (Frenkel & Maital, 2014, p. 64). These countries have traditionally been leaders in maths, science and technology and centres of the most skilled software programmers in the world (Szabo, 2013). In the case of Poland, which is home to one of the world's oldest universities, the role of academia remains crucial. It creates a pool of talented and well-educated inventors and creators that may one day enter the innovation scene (Rogowski, 2013). Moreover, the case of Poland can be seen as unique compared to other countries insofar as the beginnings of innovation have been instigated not only by the rich human capital but also by specific socio-political and historical factors.

The roots of entrepreneurship in Poland date back to the Second World War and the following period under communist rule in Poland. The sequence of these historical events has been meaningful for the entrepreneurial trajectory of the country. While the most prominent and educated individuals making up the country's human capital were lost during the war, the subsequent wave of communism purged entrepreneurial spirit by banning all sorts of individual endeavours. Personal incentives were further frustrated when the government nationalised businesses run by the remaining intellectual elite. While on the one hand, these events have undoubtedly caused irreparable damage to society and the prosperity of its people, it is no exaggeration to say that at the same time they had a galvanizing effect on the rest of the population (Krzysztofiak, 2017). The restrictions imposed by communist rule had an adverse effect on people who became even more creative in their attempts to overcome political and economic constraints by setting up small commercial activities and building networks. These early practices of entrepreneurship in Poland have become especially significant during the years of economic transition. It was not until the period of the Polish market opening up to Western trade that small businesses created by entrepreneurs acquired a new role as mediators in importing foreign products to Poland. What needs to be noticed in this regard is the vital role played by these entrepreneurs in building the national wealth of the country, which stands in stark contrast to other post-communist countries, where national wealth was built mainly from state assets. In the following years, the country's accession to the European Union initiated a series of economic and social reforms that created favourable economic conditions and shaped the economic landscape of the country. As a result of these reforms and financial incentives received to consolidate its EU membership, Poland experienced increasing entrepreneurship with the creation of new companies and start-ups over the last decade (Krzysztofiak, 2017). Furthermore, funding worth 10 billion euros received from the EU budget provided a significant boost for entrepreneurship and competitiveness, paving the way for the Polish start-up scene.

While the beneficial role of the small and medium-sized enterprises within the ecosystem has been frequently questioned insofar as SMEs have fewer linkages to universities than large companies and are less likely to contribute their funds to the R&D, in the case of Poland, such criticism loses its appeal. Small and medium-sized enterprises became important assets for Central and Eastern European transition economies, becoming the only available alternative for the social and economic development in these countries under communist rule (Krzysztofiak, 2017). In Poland especially, the vital role of SMEs has been seen in the aftermath of the decentralisation of the economy and the creation of new jobs. In the 1990s, the Polish economy consisted of the state, cooperative and private sectors. While the state and cooperative sectors prevailed over the private in terms of assets and employment, private farms remained a dominant form of agriculture, making up 70% of the farming areas. Moreover, economic reforms, which started in 1989 and were paralleled by the political transformation, contributed to the rapid growth of the SME sector. Only a small number of legislative regulations that were passed were directed towards SMEs. In 1988, the Act on Business Activity was the only document determining the development of this sector. The new legislation not only focused on SMEs, but it also allowed entrepreneurs to act without any government obstacles. In 1989, another boost to the sector was provided through the removal of major administrative barriers for private firms entering the market. As such, conducive conditions for SMEs were created in the aftermath of economic decentralisation and paved the way for the entrepreneurship explosion in the country.

At the end of the 90s, as much as 45% of Polish GDP was created by the SME sector with only 24% of GDP being from large companies. Another important indicator of the role of SME's in the Polish economy was evidenced by the number of people employed in the sector. In 1999, 7 out of 11.4 million people employed in the economy were working in SMEs (Hyz, 2008, p. 5–7).

While SME's continue to retain a significant role in the economic growth of Poland, their development has been suffering from stagnation in recent years due to insufficient financial assistance. This has been especially visible in Polish firms financing innovation either from their own resources or by relying on bank financing (Czerniak & Stefański, 2015). Regarding government programmes designed to support the SME sector in Poland, EU financial assistance and the EU Cohesion Policy are of great importance to the sector (Gwizdała, 2017, p. 46). EU structural funds received in the years 2007–2013 led to the remarkable development of SMEs. What needs to be noticed in this regard is that interest and assistance from the European Union in SMEs can be seen as a response to the economic and structural realities – 99% of the companies within the European Union fall within the category of small and medium-sized enterprises, which in turn provide 85% of all new jobs. It will therefore be no exaggeration to say that SMEs are the backbone of Europe's economy (Gwizdała, 2017, p. 46).

The next stage in the European Union's assistance, implemented through 2014–2020, was expected to result in even higher levels of innovation among Polish SMEs. As a part of the new financial framework for the years 2014–2020, the funding allocated to the Polish SME sector was equal to 15.7 billion euros. One of the most important tools used to implement the European strategy by enhancing the competitiveness and sustainable growth of micro-enterprises is the Competitiveness of Enterprises and Small and Medium-sized Enterprises (COSME) with a budget of 2.2 million euros (Gwizdała, 2017, p. 53–54). According to evidence presented in the interim evaluation of the programme between 2014–2016, COSME has reached the expected results, such as the number of SMEs benefiting from debt financing. It has also facilitated SME access to EU funds through the introduction of new flexible rules as well as through funding in the form of grants and credit guarantees. Currently, the largest programme offered by the European Union to SMEs is the Horizon 2020 with a budget of approximately 80 billion euros. The programme for the first time enables SMEs to apply for grants of up to 2.5 million euros jointly with business coaching and acceleration services. Yet, only 5% of the programme budget went to the EU-13 Member States including Poland. This becomes in fact an important indicator of innovation gaps that exist in Central and Eastern European countries. Other barriers for Polish SMEs in Horizon 2020 include "weak visibility and internationalisation" as well structural challenges related to legal provisions (Walczyk-Matuszyk, 2017).

When discussing the role of start-ups within the Polish ecosystem today, it would be recommended to start from providing a somewhat provisional definition of this concept that reflects how these entities are perceived within national boundaries. In the context of the Polish ecosystem, a start-up can be defined as "a business carried out in order to generate new products and services in conditions of high uncertainty and with no more than 10 years of market presence" (Deloitte, 2016). Although the maturity of the start-up ecosystem in Poland is rather average when compared to other Western countries, Poland is indeed a good example of a young start-up ecosystem with significant potential for growth. Evidence indicates the fact that the age range of start-up founders in Poland remains stable through the years with the highest percentage being founded by people aged 30 years (Polish Start-ups Report, 2018, p. 17). Moreover, according to the findings of the World Bank report from 2017, Poland is globally recognised as one of the most start-up friendly ecosystems with regard to administrative conditions and taxation laws. It can further be estimated that three Polish cities, Warsaw, Kraków and Poznań, offer better conditions for starting up a business than cities such as Moscow, Sydney, London (Haponiuk, 2017). What accounts for the attractiveness of Poland as a start-up location, is its conducive environment. The cities of Kraków, Wrocław and Warsaw emerge as the epicentres of innovation in Poland, with Kraków being the most technology oriented. The country's interest in expanding the innovation and start-up scene has been equally reflected in passing supportive legislation. In order to achieve a flourishing start-up environment, it is imperative to implement regulations that will foster innovation and

entrepreneurial activity in the first place. This objective seems to be actively pursued by the Polish government as the institutional conditions and legal regulations have been successively created in Poland. The current government appears to embrace a more galvanizing approach especially in the areas of tax relief, financing R&D, as well as the broad facilitation of the innovation process. Recent increases in tax relief for R&D is just one of the government steps aiming to boost innovation in the country (Zachariasz-Podolak, 2018). Allowing companies to make a double deduction of the expenditure related to Research and Development has not only increased the perception of Poland as an innovation friendly milieu, but also increased the actual number of companies using such incentives.

In addition to the tax incentives and financing, one of the most essential factors driving the success of start-ups in the market is the presence of acceleration programmes (Szmigiel, 2018, p. 22). In 2016, the Polish government announced the *Start in Poland* (SIP) programme with a budget of approximately $800 million to support start-ups (Krzysztofiak, 2017). According to the Ministry of Development, the main objective of this programme is to provide companies with assistance in areas such as business acceleration, long-term development and international expansion (Ministry of Economic Development, 2017, p. 20). Regarding the prospective results of the programme, it is expected that in the next seven years over one thousand high-tech companies will be developed in Poland and will enter foreign market competition (Barszcz & Tarlecka, 2016). According to predictions, such increased investment in the start-up infrastructure will help the Polish economy to expand while making development more dynamic. Moreover, the *Start in Poland* programme has been launched in tandem with the project *Scale Up*, calibrated to provide support to accelerators and hence to enable the growth of start-ups. The main objective of the accelerators is to combine "start-up potential with the experience and resources of large corporations," and to "build relationships between start-up founders and those responsible for innovations in large companies" (Szmigiel, 2018, p. 24). Participation in an accelerator therefore emerges as an excellent opportunity for a start-up insofar as it offers workshops and training, supervision of experts and mentors, coaching, and more importantly, access to investors and clients (Serwatka, 2018, p. 77). The role of an accelerator within the ecosystem can be addressed using the example of *Hubraum*, located in the city of Kraków. In addition to the acceleration programme, Hubraum also serves the role of an incubator for telecommunications corporation, Deutsche Telecom. With its three offices in Berlin, Kraków and Tel Aviv, it effectively fosters innovation transfer and creates business opportunities for all participants. Hubraum provides start-ups with "financing, space to work, consulting mentors and experts, and access to Deutsche Telekom's resources," including resources and a customer base (Serwatka, 2018, p. 71). Support offered by Hubraum is directed towards a wider audience with the office in Kraków being the entry point for early-stage start-ups in Central and Eastern Europe. While it could be expected that the needs and expectations of entrepreneurs in this part of Europe could be different when compared to those based in Berlin and Western Europe, what connects start-ups in both regions is the need for technological solutions. Edge computing, and narrowband Internet of Things are among popular solutions Hubraum offers its partners (See Figure 1). More importantly, however, Hubraum combines features of an accelerator and incubator in one. While traditionally accelerators tend to focus on mentoring and workshops, incubators usually provide office workspace including meeting rooms and technical equipment (Serwatka, 2018, p. 75). What makes Hubraum prominent in this regard is that it offers all of the aforementioned benefits to its partners.

While the Polish start-up scene has been concentrated in the cities of Warsaw, Kraków, Poznań, Wrocław and Gdańsk, what makes Kraków special in this regard is that it simultaneously remains the second largest R&D centre, academic base and technological hub in the country (Department of Economic Development, p. 7). Considerable potential in scientific research and higher education is reflected in the number of well-educated young people that make up the rich human capital of this area. What further accounts for the attractiveness of Kraków as a location with high technological investment potential is the high concentration of technology and industrial parks in this city. The Kraków Technology Park (KTP) remains the most modern IT park in Poland that has also been enjoying the status of the special economic zone within the region. It is also the city's largest technology incubator, which has a wide array of benefits available to its investors

including investment grounds, rental office areas and tax exemptions (The Polish Agency for Enterprise Development, 2011, p. 15). KTP has been successful in accommodating more advanced firms that specialise in Information and Communication Technology (ICT), while at the same time remaining an accelerator for over 60 start-ups (Krzysztofiak, 2016). Fostering conditions for the development of technology firms in Kraków seem to be equally reflected in the large number of business service centres. There are over 100 business service centres that operate in the city including internationally recognised companies, such as Cisco, Google, Shell, Capgemini, HSBC, Philip Morris International, IBM and Lufthansa Global Business Services (Department of Economic Development, p. 10).

As previously noted in this paper, the active participation of universities in knowledge transfer crucial for a prosperous ecosystem. The implications of this are visible in the vital cooperation between universities and businesses based in Kraków, which participate in the transfer of knowledge from academia to industry by launching academic incubators and creating technology transfer centres (TTC). Among the most successful academic incubators in Kraków is The Jagiellonian Center of Innovation (JCI) launched by the Jagiellonian University. The centre offers support for innovative research projects in field of life science, including biotechnology, pharmacy, nanotechnology, by providing start-ups with up to $273,000 of early-stage funding in exchange for minority stakes (Chen, 2015). Regarding the role of technology transfer centres, The Center for Innovation, Technology Transfer and University Development (CITTRU) at the Jagiellonian University is the leader in patent-filing. Among CITTRU's main responsibilities is the marketing of innovation and research, support for academic entrepreneurship, and most importantly, the legal protection of discoveries offered to scientists and PhD students in the form intellectual property rights (The Polish Agency for Enterprise Development, 2011, p. 57). Entrepreneurial incentives to students are offered also by the AGH University of Science and Technology, which remains a leading Polish university in the field of modern technologies. The university provides incentives for its students under the umbrella of the AGH Academic Incubator of Entrepreneurship. Thanks to the incubator, the university can provide students with direct help in establishing and running their own businesses. Over one hundred firms have been established thanks to the AGH incubator, while around 2,000 individuals have benefited from its assistance. Moreover, the permanent cooperation of the university with industrial companies such as IBM, CEMEX, Comarch, and Valeo, facilitates job-market entry for students enabling them to pursue a future career in these companies (Jezierska & Szewczyk, 2014, p. 31).

Table 1. Local actors in the innovation ecosystem in Kraków

Actors	Findings
Start-up company	**Brainly** is currently the world's largest learning platform for students, parents, and teachers, rallying more than 100 million users each month. The company users include students attending prestigious schools in the United States as well as those located in the most remote communities in South America and Asia. The company set a record of Polish fundraising by collecting $39 million from the international investment market in several rounds.
Jakub Piwnik - Communications Director at Brainly	Venture industry in Poland and in the CEE region as a whole is still young compared to the VC industries of Western Europe and the United States. As such, a comparison of the foreign VC funding received in Poland to that in other parts of Europe is not recommended. Foreign financing should be expected to remain proportional to the maturity of Poland's VC market. While data presented in the Polish Start-ups 2018 Report reveal that only 30% of the surveyed start-ups in Poland have an employee stock option plan (ESOP), it should be noticed that ESOP practice in the country is inherently linked to the very specific business culture of the start-ups. In Poland, where the entrepreneurial spirit and mindset are still developing, launching a start-up company is perceived as a risky activity.
Start-up incubator	**Hubraum** is Deutsche Telekom's tech incubator with campuses in Berlin, Kraków and Tel Aviv. Hubraum sparks innovation transfer and creates business opportunities for both sides by offering access to the customer base of Deutsche Telekom and providing its technological solutions of low-power wide-area (LPWA) networks, edge computing, and narrowband Internet of Things (NBIoT).
Manager of Hubraum, preferred to stay anonymous	The type of support provided by incubators to start-ups can include business partnership with access to the company's customer base, technological support in the form of technological solutions or both. As such, expectations of start-ups and entrepreneurs based in Poland and the CEE region will not be necessarily different compared to Western Europe. It is frequently observed that incubator partners share the common denominator of looking for specific technologies and sharing similar values.
University Innovation Center	**The Jagiellonian Center of Innovation** established in 2004 by the Jagiellonian University in Kraków has been actively providing a wide range of services to entrepreneurs and scientists engaged in life sciences. In 2013, JCI extended its offer to include contract research carried out in JCI's owned laboratories and clinical trials conducted in JCI's dedicated Clinical Trials Center.
Dr. Łukasz Kutrzeba – Business Development Director at Jagiellonian Center of Innovation	Some of the obstacles to effective collaboration between universities and industries in the process of technology transfer can be traced to the size of the projects that are being commissioned to academia. While smaller projects are frequently downplayed by universities due to other pertaining priorities, large projects by contrast entail high cost and lead to abnormal market prices. Publication of research results can also become an issue when universities decide to maintain their rights to publication. As such, it becomes vital to observe the inherently different interests of these actors. While the universities may be interested in the number of publications, companies seek to use research results to enhance their market competitiveness.
Sebastian Szczepaniak – Founder of Foundation Work Nations; co-organiser of Start-Up Europe Week	One of the main problems with the development of the Polish ecosystem is not the lack of financing but rather the structural impediments, which make the acquisition of such financing difficult. While the funds are usually directed towards large cities, a more decentralised distribution of the EU public funding directed towards entrepreneurs and innovators in smaller cities is needed. Moreover, while the lack of an entrepreneurial mindset persists in Poland, acquiring entrepreneurial and leadership skills is further complicated by the current education system and unfit curricula.

Source: Elaborated by the authors based on empirical study materials.

Drawing on the various aspects of the Polish innovation ecosystem addressed by the respondents, it becomes possible to distinguish between the most fragile areas that impair innovation processes and to summarise future innovation prospects in the country. As such, insufficient venture capital, which is frequently cited as the main determinant of the lower number of start-ups in Poland compared to Western Europe, should be seen through the wider lens of venture market maturity. When seen in this context, the level of foreign venture funding in Poland should be seen as proportional to its relatively young VC market. With venture capital being only one of the factors responsible for the level of entrepreneurship activity in the country, more attention should be given to the development of entrepreneurial and leadership skills, which are neglected in current teaching curricula. In order for Poland to compete internationally, the entrepreneurship mindset needs to be shared on a larger scale. While in the West, business schools focused on developing time-management skills and abstract thinking are a common phenomenon, in Poland the path of pursuing entrepreneurial knowldege is not widespread and remains within personal initiative of persons who desire to acquire such skills. Moreover, the structural impediments related to EU public funding further exacerbate the obstacles faced by entrepreneurs in smaller cities, who find such funds difficult to acquire.

Another important area that can effectively impede innovation can be seen in the collaboration between universities and industry. Here, however, it becomes possible to discern obstacles to such collaboration that are of a universal nature and that can be extended to a wide range of ecosystems. According to the crucial insight provided in the interviews, the process of university-industry technology transfer can always be complicated by the inherently different objectives of these entities. While universities seek to use research results to increase the number of publications, this objective seems to stand in stark contrast to the motives of companies, which seek exclusive rights to the results to enhance their market competitiveness. Therefore, without compromise, innovation transfer between the two sectors can become a difficult task, making the triple-helix model of cooperation hard to implement.

Finally, some of the determinants of innovation in Poland identified here, including its young venture capital market, centralised EU public funding and especially obstacles to university-industry knowledge transfer could be deemed as issues of universal nature, thus representing important areas of fragility for other CEE countries and their ecosystems.

Conclusion

Innovation ecosystems as a concept can be difficult to define, as there are multiple contexts in which it can be analysed. The literature review in this paper also confirms the fragmentation surrounding the concept. Despite the persistent difficulty in defining and describing innovation ecosystems, certain characteristics and trends have been discerned here. This then made it possible to somewhat systematise the definition of the concept and conclude that innovation ecosystems are collaborative networks that create important incentives for customers and firms through the processes of cooperation as well as coopetition. This then led to the further acknowledgement that innovation ecosystems can be important vehicles in the process of transitioning to a technology-driven economy and that externalities created by technology itself can be neutralised through innovation. The special role of innovation in bridging existing technological gaps has also been acknowledged.

Due to the observed etymological ambiguity surrounding the concept of innovation ecosystems, recognising the similarities and differences between natural ecosystems and modern ecosystems was at the core of this research. While specific traits such as the interdependence of all organisms and their co-evolution point to crucial analogies between the two concepts, strong scholarly arguments accounting for the differences were also reviewed. In the second part of the study, the links between innovation ecosystems and economic development were reinforced by depicting start-up ecosystems as vehicles for regional growth and the milieu for entrepreneurship. This observation was further applied to the experience of Poland, where SMEs were the main engine for

economic growth in the post-communist transition period. The conducive environment existing in Poland, including administrative conditions, favourable legislation, and the high concentration of R&D centres in several Polish cities and the active participation of universities all seem to point to the fact that although young, the start-up ecosystem in Poland has significant potential for growth. The empirical part of the paper focused on the ecosystem in Kraków, making it possible to identify the mechanisms driving the national ecosystem. Conclusions derived from the qualitative research were subsequently applied to identify the main areas of current fragility.

According to experts, the future prospects of innovation ecosystems in Poland depend on the effective implementation of reforms in two strategically important areas – the local capacity and international connections. Polish start-ups should focus on meeting competition and concentrate their efforts "on industrial complementarity to other important global innovation hubs" (Buompane, as cited in Krzysztofiak, 2017). Another area for improvement is communication and cooperation among innovation stakeholders in various regions, including central and local governments as well as corporations. As experts claim, reform in this sector will facilitate better access to foreign markets as well as greater ability to benefit from new innovation and industrial practices (Buompane, as cited in Krzysztofiak, 2017). To conclude, the future priorities for the Polish innovation ecosystem should aim for a more open culture among Polish start-ups and their competitiveness on foreign markets, especially on the European market. The current approach is therefore seen as detrimental due to the start-ups being overly introspective. The Polish start-up ecosystem needs a strategic shift from local to global thinking with a more welcoming attitude towards different business cultures. In the same manner, more attention should be paid to networking and interconnecting with other markets, especially the Unites States and Europe. Until progress is made in these areas, it is likely that Polish start-ups will continue to lag behind their counterparts in Western Europe.

Another area that should be seen as a future source of potential is the remuneration of start-up employees. It is currently difficult for Polish start-ups to compete with international corporations for the best employees, not only because of the existence of more attractive wages abroad, but also because of stock option plans (ESOPs) widely used by international competitors. One of the explanations for this issue is offered based on the specific culture of trust among start-ups. In Poland, where the risks inherent in launching a start-up are frequently estimated as higher than the potential benefits, the trust aspect becomes further complicated. The fact that Poland has a rather weak record of successful start-ups adds to these fears and makes the employee stock option plan an unpopular solution (See Figure 1.)

Due to the very specific environment in which the Polish ecosystem evolved, it would be an injustice to compare it to its more mature and developed European counterparts. Social and cultural factors intertwined with the historical legacies in Poland have resulted in the low level of trust and cooperation skills. These factors have certainly influenced the mindset of the entrepreneurs, perhaps making them more reluctant to benefit from external sources of financing. When combined, these characteristics account for the rather weak social capital in Poland, implying different evaluation criteria than those used in the case of the United Kingdom and Sweden. While the United Kingdom has been traditionally a destination for specialists and entrepreneurs from all over the world, favourable start-up conditions in Sweden are shaped by local culture, thus resulting in high levels of social trust (Szmigiel, 2018, p. 22). Therefore, these differing realities impede an evaluation of the Polish start-up ecosystem and make objective comparison a difficult task.

As the fragility of the innovation ecosystem in Poland stems mainly from its low level of development, it is possible to produce a set of comprehensive recommendations to address some of these issues. Regarding the future of the start-up ecosystem in Poland, the cultivation of a culture of entrepreneurship and education in entrepreneurial activity should be given more priority. Moreover, this objective seems to be further substantiated by the findings of the Polish 2018 Start-up Report. The report identifies several deficiencies in the Polish education system, including the lack of an entrepreneurship curriculum centred on cultivating time management, decision-making

and leadership skills. In the same vein, the authors of the report point out missing critical thinking skills and interdisciplinary learning which, as they claim, are at the heart of Anglo-Saxon societies. These observations seem to align with the account of primary actors in the ecosystem in Kraków, including the founders of start-ups and incubators (see Figure 1). Another aspect highlighted in the report relates to the need for more structural change in aligning with the investment trends. While the top recipients of funding from Polish VCs operate in analytics, business intelligence and Internet of Things (IoT), these sectors do not correspond to European trends. As a matter of fact, European VCs in 2017 and the first half of 2018 were oriented towards deep tech, fintech and health tech start-ups, thus leaving the leading sectors of Polish start-ups largely unpopular for attracting foreign VCs. If the observed disparity between the preferences of Polish and European investors is not addressed, the Polish start-up market will find it increasingly difficult to acquire foreign funds, perhaps locking some start-ups in a development trap. Another hurdle to further development of the Polish innovation scene are the acceleration programmes, which tend to target newly created start-ups and SMEs, while entirely ignoring those start-ups that have failed to develop. While such failed start-ups remain largely neglected, they should be seen as important sources of potential and should be provided second-chance assistance (Szmigiel, 2018, p. 24).

Based on the evidence presented here, it can be concluded that it is indispensable for Poland to create a more open business culture, which will allow a margin for error for entrepreneurs and offer reinvigoration mechanisms to failed start-ups. Another area that needs more attention is improving the process by which Polish companies employ foreigners. Currently, most foreign employees in Polish start-ups come from outside the European Union, especially Ukraine, United States and United Kingdom. While the process of employing foreigners has been up driven by the *Poland Prize Programme*, which offers a simplified visa route and administrative help to start-ups, implementation of more robust visa policies is necessary to enable the hiring process on a larger scale. Yet, the future of the Polish ecosystem can be seen in a positive light. While prior to 2016, cooperation between medium and large enterprises and start-ups was rather scarce, thanks to the *Scale Up* incentive, recent years have been marked by a rising number of such partnerships. It is vital to observe Poland's success in regional development, with the Małopolska Region being currently one of the fastest growing regions in Poland and Europe. In 2015, Małopolska was awarded the title of European Entrepreneurial Region 2016 by the European Committee of the Regions. While formerly this distinction has been awarded to regions in Western Europe, which far exceed Poland's GDP, unique dynamics between universities, businesses and entrepreneurs in Małopolska enable the region to compete on the European scene. Kraków, the capital of the region, has been the most prominent example of the dynamism necessary for a healthy innovation ecosystem. Considering the combination of the R&D activities at its universities, successful companies and high percentage of pro-active people interested in modern technology, the Kraków start-up community can be seen as a vehicle for regional development. The Kraków experience could therefore be extended especially to those countries that seek to create a friendly environment for business and to attract foreign investors. Therefore, by juxtaposing these observations with the conclusions derived from the qualitative research, it is possible to create a guide for the countries across the CEE region. While the findings of this case study prove that structural impediments to the innovation ecosystem in Poland persist, the same obstacles can be encountered by CEE countries which, despite high levels of human capital, enjoy low levels of entrepreneurial skills and face centralised EU public funding. If the success of this region was to be mimicked and repeated in other regions of Poland, it will be logical to presume that a healthy regional ecosystem is an essential prerequisite for a healthy innovation ecosystem. As such it seems vital for other CEE countries to concentrate their approach on building and proliferating regional start-up ecosystems.

This study has several limitations. First of all, as a qualitative study it may suffer from some biased interpretation of the case study materials, although by following scholarly procedures, the authors tried to minimize this effect. Additionally, taking into account the contextual nature of the information presented, the findings might be better applicable to post-Soviet countries that share similar socio-economic conditions and historical paths. Thus, a future direction for research might stem from testing whether a similar innovation ecosystem structure as employed in Poland may be relevant and beneficial for countries in other regions, even also outside the

EU (i.e. lacking substantial monetary support for start-up and innovation development from EU funds) and functioning under different socio-economic conditions.

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