CHAPTER 4

SUPPORTING THE INCLUSIVE GROWTH OF ECOSYSTEMS IN THE CONTEXT OF THE DIGITAL TRANSFORMATION

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ABSTRACT

In this chapter we investigate which of the elements of the entrepreneurial ecosystem model have been crucial to contribute to economic growth and inclusiveness in the examined regions, selected to illustrate the diversity of employment models and levels of technological development. An important lesson from the research is that the technological transformation (may) lead to augmentation in some cases, but to substitution in others. Second, technologies are shaped socially. The history and the long-term matter and thus, the institutional shaping should take its time and perhaps there is no need for constant changes, but of consistent and long-term policy. Beyond this more general takes, on the basis of this analysis are formulated policy recommendations.

Keywords: *Digital Transformation, Entrepreneurial Ecosystems, European Union, Regions, Inclusive Growth*

1. INTRODUCTION

Since the publication of the work of Frey and Osborne (2013/2017), the debate about the future of work has become a trending topic, leading to the publication of hundreds or even thousands of books and articles[1]. For about a decade, the dominant discourse in this debate has been about the jobs' destruction and the end of work. Following the 2013 analysis of Frey and Osborne, who claimed that 47% of the jobs in the USA are at an imminent risk of automation, multiple academic authors and consultancy companies reports developed complex methodologies in order to predict the jobs and professions that will disappear. The major assumption within this stream has been that understanding that the technologies will substitute human labour and thus, make work redundant.

[1] For example, more than 10 000 results appeared on www.amazon.com for the search future of work (last accessed on the 5 February 2023)

However, in 2023 or ten years after the publication of the paper of Frey and Osborne, instead of witnessing the end of work, there is increasing evidence that employment levels in the developed world have never been so high (Eurostat, 2023[2]). The development of the debate provided arguments and evidence that technologies are not deterministic (Warhurst et al., 2020; Kornelakis et al., 2022; see also Perez' chapter 3 in this volume) and something more, they can be shaped by various policies and actors. Something more, in parallel to the job destruction, there are different processes taking place at the same time, including the job creation, job shift, and job change (Degryse, 2016). In this context a more nuanced approach to the digital transformation impacts has been needed, and this has been precisely the BEYOND4.0 approach.

In this context of technological change (or even technological revolution, see Chapter 3 of Perez in this volume), it has been interesting to analyse what exactly was happening in the different European regions. While different approaches and disciplines have tried to address the impacts of the digital transformation at regional level, our methodological choice was to use the perspective of Stam and Spiegel (2016) on the entrepreneurial ecosystem, defined as a "set of interdependent actors and factors that are governed to enable productive entrepreneurship within a particular territory". In the framework developed by these two authors, ten elements play a role in creating value through entrepreneurial activity: formal institutions, culture, physical infrastructure, demand, networks, leadership, finance, talent, knowledge & support services/intermediaries (Figure 1). Among the advantages of this approach have been the comparability among regions and the idea that the elements in an ecosystem are substitutable in such a way that there is no one "best way", but different possible pathways to a high-performing entrepreneurial ecosystem (Schrijvers, Stam and Bosma, 2021; see also chapter 1 in Oeij et al., August 2022).

More precisely, we have been interested in the impact of the digital transformation on the functioning of ecosystems, on inclusive growth, and the respective implications for the future of work. In this context, it has been important to investigate which of the elements of the entrepreneurial ecosystem model have been crucial in order to contribute to economic growth and inclusiveness in the examined regions, selected to illustrate the diversity of employment models and levels of technological development. That is why, in BEYOND4.0, we have selected several of these regions and within these regions looked at leading sectors, leading focal companies and business networks. The examples examined in the chapter are part of the empirical work, conducted in the framework of BEYOND4.0

[2] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Employment_-_annual_statistics#Employment_in_2021_compared_with_the_EU_target

project. More precisely, between 2021 and 2022 we carried out twelve regional case studies (Dhondt et al., January 2022) and 30 company case studies (Oeij et al., August 2022).

This chapter deals with the analysis of good examples and concludes with policy recommendations, developed on the basis of the empirical analysis.

2. IDENTIFYING THE ECOSYSTEMS

In the context of BEYOND4.0 there could be observed that some regions can record growth over long periods, while other regions have experienced decline. That is why we have been interested to understand why. For this, we would like to understand which ecosystem elements support inclusive economic growth at the regional level in the context of the digital transformation. The entrepreneurial ecosystems include a variety of actors, e.g. companies, regional/local governments, educational institutions, research bodies, funds and other financial players, and other stakeholders, that constitute regional networks. In each region, we have analysed two entrepreneurial ecosystems, one incumbent, and one emerging. Under incumbent entrepreneurial ecosystems we understand ecosystems existing for a long period of time that have shaped the economic development of a particular region, for example the emblematic cases of the steel industry in the Rhine/Ruhr region in Germany or the automotive industry in the West Midlands in the United Kingdom (Jaguar – Land Rover). The term emerging entrepreneurial ecosystem (Dhondt et al., 2022) refers to an ecosystem that still is in the process of being formed, hence not yet fully mature, and is created around/related to a specific theme or industry (e.g., in health, food, biotech, or pharma), or applies to new industries (e.g., smartphones, solar panels, wind farms, digital health devices). Emerging business ecosystems can be – but not necessarily are – characterised by a high number of growth-oriented start-ups.

BEYOND4.0 sought collaboration with scholars from Utrecht University for quantitative tools to measure the development of the ecosystems in general. They participated with a complex analysis, based on regional statistics in order to propose a classification of entrepreneurial ecosystems, based on the specific configurations of the ecosystem elements (Schrijvers et al., 2021).

To achieve a deeper understanding the ecosystem dynamics and mechanisms that might lead to growth, in the case of BEYOND4.0 we conducted qualitative research based on cases studies. The in-depth interviews as part of the qualitative data collection covered both 'incumbent' and 'emerging' ecosystems in six countries: Finland, Bulgaria, Germany, the United Kingdom, Spain, and the Netherlands. In total, we have studied eight different regions (namely two different (NUTS) regions in Finland and Germany) and fourteen ecosystems (six incumbent with two double cases and six emerging). This analysis allowed

a better understating of the relationship between the technology embedded in a particular sector and the development of the respective region. The shaping of the technologies has taken place in the context of the ecosystem, where in some cases the different stakeholders collaborated, but in other the efforts have been dispersed.

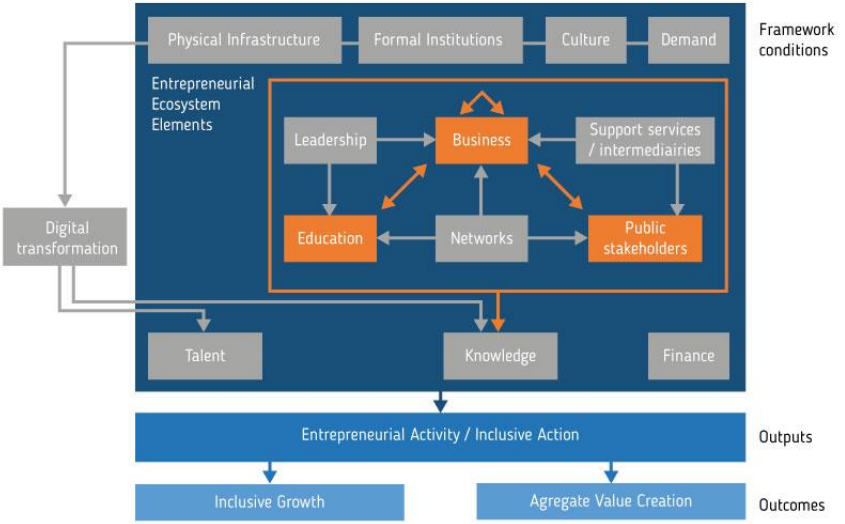

Figure 1: The elements of the ecosystem. Source: Dhondt et al. 2022, p.9[3]

The examined ecosystems differ in terms of the technology deployment (See Table 1). Four of the entrepreneurial ecosystems are at the centre of the digital transformation. The mobile technology sector of Oulu, Brainport and the ICT ecosystem in Sofia are major players in developing and application of digital technologies. The Sofia region is supplying ICT services to the whole of Europe and North America.

[3] Dhondt et al., 2022, p. 9. https://beyond4-0.eu/storage/publications/egional%20report:%20entrepreneurial%20ecosystems%20in%20six%20European%20countries/BEYOND4.0_D4.1_Regional%20report_six_countries-PC-18429.pdf

Table 1: BEYOND4.0 incumbent entrepreneurial ecosystems and description of major changes in the business ecosystem

BEYOND4.0 region	Dominant business ecosystem	Change 2010-2022
Salo, Finland	Mobile technology	The Nokia business ecosystem collapsed in 2011. The region shows a strong decline. After 2018, Valmet started with battery production, using Industry 4.0 technologies (robotisation, IoT)
Oulu, Finland	Mobile technology; Wood Processing	The region experiences the replacement of Nokia business ecosystem by the emerging ICT ecosystems and incumbent wood processing. Both new sectors develop new avenues with Industry 4.0 technologies (IoT, informatisation).
Sofia, Bulgaria	ICT sector	The continuous growth of ICT, branching out. This is not an industry sector, but the focus is on supplying industrial ICT solutions to the whole of Europe and North America. In this sense, they are driving Industry 4.0 efforts.
Duisburg, Germany	Steel sector	The sector experiences a steady decline of heavy steel, continuing restructuring. The new solutions lie in integrating digital solutions in the production systems.
Dortmund, Germany	Steel sector	The steel business ecosystem is not dominant anymore, new business ecosystems are on the rise.
Zuidoost Noord-Brabant, Netherlands	Advanced manufacturing	Advanced manufacturing has taken over the role as the dominant business ecosystem. This sector is at the core of the Dutch Smart Industry (or Industry 4.0).
Basque Country, Spain	Machine tool	This sector is also slowly declining, but still the most important business ecosystem in the region. The machine tool is representative of Industry 4.0 in Spain.
West Midlands, United Kingdom	Car manufacturing	This is a slow declining sector, but still the most important business ecosystem in the region. Car manufacturing uses a great degree of robotisation and other Industry 4.0 technologies.

Source: Dhondt et al. 2022, p.11

On the other hand, the Basque machine tool incumbent entrepreneurial ecosystem and the German Steel ecosystem see themselves mainly as consumers of digital technologies, as does the automotive ecosystem in the West Midlands in the United Kingdom. In all these ecosystems companies are far in automation, but digital technologies do not transform production systems. The level of adoption of these technologies depends very much on the concrete companies. The different uptake of these technologies is also reflected in the impact on the business models used in the ecosystems.

The analysis of the employment effects of the digital transformation (on the basis of EU LFS data[4]) have demonstrated that between 2008 and 2020 some ecosystems have recorded significant growth (as illustrated by the ecosystems in Sofia, Brainport and Oulu with respectively 78%, 23% and 10% or employment growth – See Figure 2). In other ecosystems (such as the steel in Germany or the mobile phones in Salo), the existing technologies, combined with the digital tools have led to job destruction. In other words, in parallel to the substitution advanced by Frey and Osborne (2013) there could be an augmentation pathway, i.e., technology enabling employees to do their work better. Logically, the question would be why? The examination of the respective ecosystems allows differentiating cases where their elements and actors collaborate versus cases where efforts have been dispersed (Figure 2).

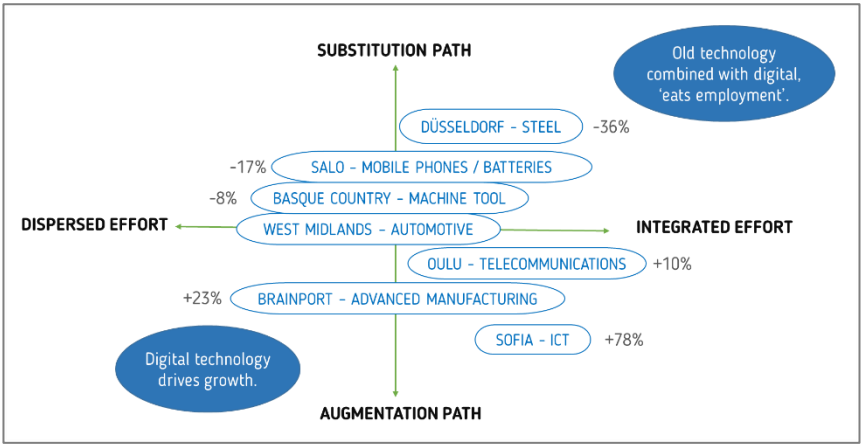

Figure 2: Employment effects of the Digital Transformation. Source: Steven Dhondt and Vassil Kirov (26 November 2021), Peaking behind the curtain. Organisation, technology

[4] European Union Labour Force Survey, available at: https://ec.europa.eu/eurostat/web/microdata/european-union-labour-force-survey

and policy in the 21st Century. Presentation for Technequality Scientific Conference, Brussels/Online

3. IDENTIFYING THE ELEMENTS SUPPORTING THE DEVELOPMENT OF THE ECOSYSTEMS

Going beyond the employment effects, during the project the researchers have analysed the situation in the ecosystems. More precisely, they have been interested to identify what elements of the ecosystem supported their development. The qualitative research allowed also to go beyond the classification and that is why respondents at regional or company level have been asked to formulate their opinion about the most important elements.

The synthesis analysis of the regions in terms of the ten elements indicates some important issues to be considered, as visible in Table 2. The respondents' opinion pointed out five important ecosystem's elements to be considered necessary and/or sufficient conditions of productive growth. These are as follows: talent, networks, finance, infrastructure, and formal institutions, and they are examined below in this section.

Table 2: Summary of the results of the qualification of the six entrepreneurial ecosystems (1=present, 0=absent): comparison of BEYOND4.0-results (BEY) to study by Utrecht University (UU) (Schrijvers, 2020) (blue text = difference in evaluation between UU and BEYOND4.0- team)

	Finland: incumbent IEE (Salo & Oulu)		Bulgaria: ICT IEE (Sofia)		Spain: Machine tool IEE (Basque Country)		Germany: Steel IEE (Duisburg)		UK: automotive IEE (West Midlands)		Netherlands: Brainport IEE (East North-Brabant)	
	BEYOND4.0	UU	BEYOND4.0	UU	BEYOND4.0	UU	BEYOND4.0	UU	BEYOND4.0	UU	BEYOND4.0	UU
Formal institutions	Strong institutional context, but locally focused (exclusive)	1	Insulated IEE, not supported by institutional environment	0	Strong institutional context, well developed network and attitudes	1	Diminishing institutional support for traditional IEE	1	Strong institutional context, with complete coverage of support	1	Half directed institutional context, not focused on entrepreneurship	1
Entrepreneur-ship culture	Strongly developed in the two regions. Trust in entrepreneurship.	1	IEE is strongly entrepreneur focused	0	Strongly developed and supported	0	Fractured entrepreneurial culture mainly driven by anchor company	1	Traditional entrepreneurial culture, R&D and MNC driven	0	Collaborative culture, trusting relations	1
Physical and IT infrastructure	Strongly developed, multimodal	1	Developed through airport and IT connection	0	Strongly developed, multi-modal	1	Strongly developed, multi-modal	1	Strongly developed, multi-modal	1	Strongly developed, multi-modal	1
Demand	Markets are global, not building on local demand. For new products, local demand is important.	0	Only focus on international markets	0	Markets are global, not building on local demand	1	Markets are global, also building on local and national demand	1	Markets are global, not building on local demand	1	Markets are global, not building on local demand	1
Finance / financing	Broad financial support for start-ups, for scale-ups it is less sufficient	1	International and EU funding mainly, with issue of corruption	1	Well-developed and strongly funded financial system	0	Funding is at risk for making the necessary transition(s)	1	Well-developed, strongly funded financial system (cause: Brexit)	1	Well-developed and strongly funded financial system, not dependent on local funding	1

	Finland: incumbent IEE (Salo & Oulu)		Bulgaria: ICT IEE (Sofia)		Spain: Machine tool IEE (Basque Country)		Germany: Steel IEE (Duisburg)		UK: automotive IEE (West Midlands)		Netherlands: Brainport IEE (East North-Brabant)	
	BEYOND4.0	UU	BEYOND4.0	UU	BEYOND4.0	UU	BEYOND4.0	UU	BEYOND4.0	UU	BEYOND4.0	UU
Talent	Mixed picture for education levels: tight for high levels, abundant for low skills	1	Strong supply of talent	0	Strong supply of talent and system to support it	1	Supply of talent is in a turmoil, with dwindling supply to the IEE	1	Strong supply of talent	1	Supply of talent is average, mainly by extraordinary demands	1
(New) Knowledge	Mixed situation with excellent knowledge supply in Oulu, less so in Salo	1	Local optima, but overall, not strong knowledge position	1	Strong knowledge system support for EES	1	System dominated by anchor company, limiting innovation direction	1	Strong knowledge system support for EES	1	Strong knowledge system support for EES	1
Services by Intermediaries	Strongly developed in Oulu, average for Salo	1	Strongly developed network of intermediaries	1	Strongly developed network of intermediaries	1	Strongly developed network of intermediaries , focused on Anchor co.	1/0	Strongly developed network of intermediaries	1	Strongly developed network of intermediaries, not limited to region	1
(Social) Networks	Well networked regions	1	Starting network development	0	Very strong, historical networks in the IEE	1	Very strong, historical networks in the IEE, dominated by Anchor company and partly EU focuses	0/1	Well networked region, but conflicting interests	1	Very strong, historical networks in the IEE	1

	Finland: incumbent IEE (Salo & Oulu)		Bulgaria: ICT IEE (Sofia)		Spain: Machine tool IEE (Basque Country)		Germany: Steel IEE (Duisburg)		UK: automotive IEE (West Midlands)		Netherlands: Brainport IEE (East North-Brabant)	
	BEYOND4.0	UU	BEYOND4.0	UU	BEYOND4.0	UU	BEYOND4.0	UU	BEYOND4.0	UU	BEYOND4.0	UU
Leadership	Anchor company driven leadership	1	Entrepreneur driven leadership with foreign influence limiting clear local visions	0	Sector associations driven leadership	1	Anchor company driven leadership	0	Dispersed leadership, through OEM and networks	1	Business leadership	1

Source: Dhondt et al. 2022,pp.51-52

Talent

Talent is an essential element for the development of productive ecosystems, and this was underlined by our respondents in all the cases (Table 2). All ecosystems mention the availability of qualified personnel as a factor contributing to the current success.

An interesting example has been the case of Sofia, where we have studied the development of the ICT-sector from 2008 until today. As it could be seen from fig. 2, the employment in the sector has nearly doubled during the last decade. In this case the deployment of digital technologies has not affected employment negatively. On the contrary, digital technologies supported the augmentation path. The nature of the sector has also changed: from a fast re-engineering of hardware (See Focacci & Kirov 2021), to price-based competition for orders in the context to execution of very simple operations in software outsourcing in early post-communism for the same client offers, the sector companies increasingly collaborating as specialists in a global market. This has been supported by emerging network organisations. In this case, technology is not destroying jobs, but rather supporting the companies in specializing, and the employees to develop their skills sets in the context of companies' labour markets. The abundant supply of software engineers (talent) has been the major reason for the long-term growth of this ecosystem. The fact that on average ICT employees are paid up to four times the average salary in Sofia has made the sector really attractive, at a difference of other Balkan countries where youth trained in IT still tend to emigrate, searching better jobs elsewhere. However, in order to fully understand the situation, the talent should be contextualised. While at a general level countries like Bulgaria could not be "suspected" to succeed in ICT, because of the low level of IT skills (DESI index data[5] or RIS 2021 data[6] show an extremely low (normalised) score for digital skills in the overall population), on the other hand, the position for IT specialists far exceeds the position of all other regions in Bulgaria and even in Europe. Moreover, the talent has been mobilised also because of the development of other factors, as explained in the following sections, networks, finance and infrastructure. The emerging networks and the improving financial situation in the sector helped to keep talent in in the IT-intensive region of Sofia but in a context of increasing digital divide.

Talent in terms of skills, training, and education has been featured also in the context of the machine tool ecosystem within the Basque country, Spain. In this case, the Machine tool institute (IMH) and the network of vocational training centres have been able to supply the necessary skills, being deeply rooted in the territory, particularly due to the proximity

[5] The Digital Economy and Society Index (DESI), available at: https://digital-strategy.ec.europa.eu/en/policies/desi
[6] Regional Innovation Scoreboard 2021, available at: https://ec.europa.eu/research-and-innovation/en/statistics/performance-indicators/european-innovation-scoreboard/eis

of the educational centres to the companies. In addition, aspects such as up-skilling and re-skilling through master studies or specialisation courses in digital technologies are gaining importance in this region (Dhondt et al., 2022:107). At a difference of most of the examined ecosystems, counting on the development of local talent, In the Dutch case local stakeholders developed a strategy to attract international talents and helping in this way the ecosystem to outperform other regions in the world. The region requires an ongoing supply of very highly skilled (international) employees, because at present in the Netherlands there is a 'war on talent' in the context of a tight labour market for high-tech employees and where less than half (44.2%) of secondary or medium vocational education students (in South Brabant) opt for a technological profile in 2019.

Networks

Social networks are considered by respondents as a very important element in most ecosystems. More specifically, most ecosystem respondents refer to 'triple' or 'quadruple helix' types of networks between businesses, government, education/research, and society. As clarified by Oeij et al. (2022), many respondents stress the need for cooperation/collaboration (much less so, competition) between businesses within the region/ecosystem. This could refer to vertical cooperation in supply chains but also to horizontal forms of cooperation within and across supply chains. Examples are found in the Dutch ecosystem in the East of North-Brabant (Netherlands) and in the United Kingdom ecosystem in the West Midlands. The situation in Sofia is related to the fact that the ICT-industrial network operates as an insulated network from its broader environment. The broader network development will be a factor for the future.

According to the studies of Kangas and Karonen (Chapter 7 in this volume) and Dhondt et al. (2022:109), there has been a strong collaboration between the company Nokia and the University of Oulu. This collaboration was based on a long-term relationship and previous initiatives, such as the "Technology Village", that was established in 1982, when the city of Oulu, the University of Oulu, and a number of shareholder companies established Oulun Teknologiakylä. The purpose of this joint venture was to gather top technology experts in Oulu and accelerate the ongoing transformation of the economic structure in the region. The overarching theme was to launch an image of Oulu as a knowledge and competence centre for the Finnish electronics industry. The more developed collaboration began in the late 2010s. Gradually, on the basis of this collaboration, Nokia, the University of Oulu, the research institute VTT and new ICT-based enterprises started cooperating and formed a growing and innovative new economic ecosystem that successfully unified research, development, designing, manufacturing, and selling around electronics and mobile technology. As a result of this cooperation, one can point to the example of Technopolis (https://technopolisglobal.com/about-us), which today has 16 campuses that host 1,500

companies and 45,000 employees in six countries within Europe thereby helping to build communities.

In the Bulgarian case in Sofia, compared to a few years ago, companies have started to collaborate instead of only competing one another. Specialisation of companies and upgrade in value chains increased collaboration and partnerships developed based on specific competencies. In addition, the size of the companies stimulated them to collaborate in order to take together bigger orders. But collaboration has not only been developing among companies. The newly created state or municipal institutions also supported this collaboration. The newly created State Agency for Science and Innovations started creating interconnections between business, state and regional institutions and scientific organisations. On the other hand, the local government in Sofia nominated a vice-mayor in charge of the digital transformation in order to facilitate the communication between the ecosystem and public authorities. Clearly, a positive role in this process played the availability of EU funding that stimulated interactions among the stakeholders in the ecosystem

For the Basque country machine tool ecosystem, clustering became crucial. The fact that AFM Cluster, the organisation that represents the interests of Advanced Manufacturing in Spain, is located in Gipuzkoa in the Basque Country,-shows the importance of this industrial activity in the region. Founded more than 70 years ago, this cluster includes has an R&D research institute helping member companies in adapting and adopting new digital technologies, collaborating with the network of vocational education and training actors such as the IMH. As whole, the Basque Country has many employed in knowledge-intensive sectors and shows relatively high innovation expenditures. Public support drives most of the knowledge spillovers. Even if companies do drive several types of spillover, the guidance of major programmes is crucial to achieving the necessary new ideas.

In the Dutch case of the emergent ecosystem in aviation maintenance, the social network is supported by educational institutions. Cooperation and the existing network within the region of West North-Brabant were seen as very important–many network meetings. Parties are not open/transparent and hardly ever work together. It is very difficult for new parties to enter. In fact, there are three separate sub-ecosystems (logistics, maintenance and new materials) (Dhondt et al., 2022:122).

Finance

BEYOND4.0 research revealed that finance is an ecosystem element considered more important by the respondents than suggested in Schrijvers et al. (2021). There has been a strong emphasis on public financing of investments by national and EU levels in the ecosystem in some regions, with the German steel ecosystem as a prime example.

The Bulgarian ecosystem explicitly mentions EU funding as the main source of Finance. National funding is under development and not yet at the level of the other EESs. As showed by the research, the EU funding can play an important role in filling the gaps related to the finance as illustrated by the case of Sofia, where about 350 million euros have been invested through the JEREMIE programme[7] in the last 12 years. The launched by EU money venture capital funds made financing available and well used and helped private funding to be attracted.

For the Finnish ecosystem, research revealed that their companies increasingly rely on private actors that provide financing options for investment. However, the support has been perceived as insufficient for particular segments: scale-ups have difficulty finding sufficient support to grow. Within the Digital emergent entrepreneurial ecosystem, start-ups have had no major problems in obtaining capital for the start-up, but again, there is insufficient funding to scale up the activities. That is why, in many cases, the start-up company was sold to foreign investors instead of being further developed by its founders. In the digital health ecosystem, there has not been any major problem in obtaining capital for the start-up ideas. In addition to private funding, the City of Oulu also has been able to provide financial support, in parallel to various national and EU-level research funds, that have been available.

In the Basque (Spanish) ecosystem, autonomy in designing and implementing the region's industrial policy has offered companies a variety of flexible options for financing. In Spain, the presence of private equity firms, including in this ecosystem, has been gaining importance. Companies such as EASO Ventures and BERRI UP served as accelerators that showcase new funding sources. Additionally, access to new funding sources has been strengthened through accelerator programmes at both regional and sub-regional levels. In the regional sphere, the Basque Government maintains a line aimed at the areas of intelligent specialisation of the territory where, specifically and through the BIND4.0 programme, it favours the attraction of innovative business ideas and their acceleration.

In the Dutch case, aerospace is a traditional sector, depending on a lot of public funding. Without such funding, there would not have been an ecosystem, because payback period for investments is long, so subsidies and credit are essential. Furthermore, it is difficult to find new financing because of the long payback times and inflexible long-term contracts and closed innovation systems (defence). There is a need for more ambitious plans to attract financing. Local funders are reluctant to fund national projects.

[7] https://www.eib.org/en/publications/jeremie-a-new-way-for-using-eu-structural-funds-to-promote-sme-access-to-finance-via-holding-funds

Furthermore, the elements of Formal institutions and Physical infrastructure are considered 'necessary' (but not sufficient) conditions for the success of ecosystems. This is not the outcome of the Utrecht University-research (Schrijvers et al., 2021), where no condition was considered 'necessary'[8].

Infrastructure

Regarding the element of physical (and ICT) infrastructures, respondents from all regions/ecosystems are stating that the multimodal physical infrastructure (road, rail, waterways, air) is sufficiently well-developed in the region, even if most regions indicate congestion problems. With respect to ICT infrastructure, there also seems a consensus among the six countries that this is up to standard. One exception is that for the Dutch Aerospace ecosystem, where access to a landing strip and related facilities at the nearby, is a crucial factor for the existence of the ecosystem. The private companies are in the good graces of the Defence partner to get access to the facilities.

Oulu (Finland) has always been a region in constant economic transition, yet with a strong industrial basis to build on including big international operating companies. The Port of Oulu is the largest port in Northern Finland, and important for the global exports of final products. Railways and road transport are particularly important for domestic logistics. In Oulu, telecommunications facilities are good, and the anchor company Stora Enso has some own logistic systems to deliver products to the global markets. The main reason for Nokia's location in Oulu was the availability of suitable labour for production and the specialized electronics industry. This was driven by the University of Oulu's Faculty of Technology, its collaboration on the production of electronic measuring equipment for industrial purposes and an overarching goal of building an electronics industry hub in Oulu.
The Basque Country is well connected with other regions in Spain and internationally via road and (high speed) rail networks. The Basque Country has three airports and two important commercial maritime ports. According to the Digital Economy and Society Index of the Basque Country (which measures connectivity, human capital, use of internet services, integration of digital technology and digital public services), the region stands out as a leader among the EU countries as a whole.

For some ecosystems (e.g. the Ruhr region in Germany), there is an explicit mention of the geographical advantages of where the region is located, with respect to access to

[8] This is probably due to the fact that the scores of these elements are calculated relative to the EU median. In general, the level of these elements is measured at a high statistical level in Europe, which is why scoring above the EU median is not necessary to have a good ecosystem.

trimodal transport options via water, road and rail. For the Sofia region, the software activities are local but with strong connections to the international clients or mother firms. The international airport is supportive of this purpose. The whole region may be evaluated as having a less supportive infrastructure. The ecosystem has less need for intermodal infrastructure support to optimise its performance.

Formal institutions

Formal institutions matter for how the ecosystem functions and what kind of output it produces (Stam, 2015). This element is often only mentioned by respondents as a 'hygiene factor': the interviewees in the ecosystems do not consider it a very important element, and this is likely related to the fact that the quality of the formal institutions is generally up to standard in the regions in the study. We already saw from Schrijvers et al. (2021) and other analysis (Focacci & Kirov, 2021) for the Bulgarian ecosystem that this element is problematic for companies. The BEYOND4.0-information shows that businesses have to deal with an institutional environment in which corruption and unsupportive public policy play an important role. The businesses in this Bulgarian incumbent ecosystem manage to 'circumvent' the negative impacts of this context. The companies (and other stakeholders) operate as insulated from their institutional context and are able to do that because of the international firms that dominate this IEE. These companies do not want to get entangled in these local issues. However, these phenomena are a major barrier to the ecosystem development. Respondents agree that the development of the ecosystem is taking place despite the formal institutions, not because of the institutions and their support. A limiting factor is that Bulgaria is also a centrally governed country, which does not allow regional support systems.

The reverse is the case for the Dutch IEE, in which there is already significant institutional support. From the discussions with the interviewed companies, it would seem that less support for entrepreneurship seems available in the future. The comments from the Dutch Brainport region were that they found too many impediments in the institutional environment (e.g., much insistence on new environmental rules (PCBs) and putting a lot of risk on management) to support entrepreneurship.

The Finnish incumbent ecosystems have been focused locally. In this sense, the stakeholders have not been prepared to support the industrial networks attract more international talent. The anchor company Stora Enso and Nokia comply with national regulations and tax policies. At the local level, there is constant communication with the municipality, which tries to take into account Nokia's wishes. Oulu infrastructure has been supportive of the company. Telecommunication facilities are good, and the company has some logistic systems of its own to deliver products to the global markets. The government

is not very flexible when it comes to employment-based immigration. The visa processes are too slow and prevent hiring a highly skilled labour force from abroad.

The Basque Country scores relatively well on the Quality of Government; with an index score of 63.3 in 2019, the Basque Country counts as best performing region, above national and EU levels. The region continues to be one the main actors in the development of the examined ecosystem, as it drives programmes for professional education (IMH), for research, for funding and for strategic programmes to support the machine tool sector.

4. FROM PROJECT FINDINGS TO POLICY RECOMMENDATIONS

To understand the future, there is a need of a larger perspective related to technology, more than just task perspective. Growth in Europe is dependent on how regions use the opportunities to conquer new markets and develop new products/services. The same technology can have different uses and be adapted into different products and services. There are different scenarios, a region can be resilient or turn into an economic disaster and that is why a social and policy shaping is needed to ensure socially inclusive outcomes, especially in the context where the digital transformation has been exacerbated by the Covid-19 pandemic.

The question here is to what extent the research on ecosystems could provide useful policy recommendations. An important lesson from the research conducted in the framework of BEYOND4.0 is that the technological transformation (may) lead to augmentation in some cases, but to substitution in others. From this perspective, regions should be careful about the support and development of ecosystems and sectors with a potential to grow.

Second, technologies are shaped socially. This means that there is a space for regulation at different levels and by different actors/institutions. The history and the long-term matter and thus, the institutional shaping should take its time and perhaps there is no need for constant changes, but of consistent and long-term policy.

The importance of the ecosystem approach, understood as collaboration between varieties (of relevant stakeholders) also underlines the collaboration efforts and the need to "expand" the list of the collective actors/groups that are benefitting from the transformation following the appropriate policies at various levels.

Beyond this more general takes, on the basis of this analysis there are number of policy recommendations:

Preparing, attracting and preserving talent

As mentioned above, the respondents in our research share the opinion that talent availability has been the main explanation for entrepreneurial success. Something more, performance of the ecosystems can be explained to access to sufficient talent (Dhondt et al. 2022). However, the different ecosystems have provided different ways of tackling the talent issue. The two major pathways have been to develop talent locally or to attract talent internationally. In the case of the Brainport ecosystem, there has been a lot of policy support to attract international talent. In the case of Sofia, the talent has been meaning the existence of pool of labour force with excellent IT skills that allow companies to understand and integrate the newest digital technologies. This pool has been developed domestically, but in the future companies might need also international talent. In this context, the stakeholders of the European ecosystems should focus on a dual strategy of developing local talent and attracting talent from other regions and countries.

Boosting networks: a long-term mission

The other important ecosystem element has been the development of networks and networking that can facilitate the collaboration between the actors of the ecosystem. In this perspective, the creation of conditions that could support the collaborative efforts is essential. This could take different forms, but should be based on a long-term consistent effort. As illustrated by the case of Sofia, the programming of European and national funding programmes could include as a precondition the involvement of the crucial ecosystems' stakeholders. In addition, regional and local authorities and governments could create arenas (discussions, forums and so on) where ecosystems stakeholders can meet discuss, know better each other and build trust in the long-term.

Crafting conditions and building on knowledge

The research has been showing that there is no need to manage the digital transformation (Dhondt et al. 2022: 98). Instead, the attention should be stimulating companies to invest more in the adoption of technology and the application of new business models. The creation of knowledge goes hand in hand with the development of talent. The creation of new knowledge could involve universities and research centres on the one hand and companies on the other. In this perspective, networking is crucial and initiatives of local authorities and the municipal Sandbox in Sofia, can certainly help. But beyond networking, the development of knowledge requires targeted investment in key technologies that are part of the smart specialization of the respective regions. And here European policies could help those EU regions that lag behind in the development of knowledge economy.

Developing Infrastructures is needed also in the context if the digital transformation

The BEYOND4.0 research has clarified that the infrastructure has been a necessary element for the successful development of entrepreneurial ecosystems. For certain, in the context of the digital transformation, digital infrastructure has become a crucial element for success. The availability of fast and reliable internet has been pointed out as a precondition for the development of the Bulgarian ICT ecosystem. But other infrastructure elements may play also a role in order to connect companies and clients. Regarding the element of physical (and ICT) infrastructures, respondents from all regions/ecosystems are stating that the multimodal physical infrastructure (road, rail, waterways, air) is sufficiently well-developed, even if most regions indicate congestion problems. Concretely, within the ecosystem perspective, regional authorities should analyse well what are the concrete needs of the companies in order to target efforts and investments there. Sometimes, such efforts do not require substantial finance; there could be an optimization of the public transport network to allow employees to get easier to particular office areas or development of concrete transport connections that could ease business exchanges of the ecosystem with international partners.

Formal institutions – competence and rule of law

The formal institutions could support the development of entrepreneurial ecosystems; even if there have been ecosystems that developed despite the formal institutions. But the expectations of the actors have been that institutions at various levels should support the relevant ecosystems. However, the development of formal institutions is not only in the hands of regions. But on the other hand, the research has showed that formal institutions could have diverse role within the same country. And something more, institutional innovations could be developed. In this respect European regions should stay curious and sensitive about such institutional innovations that can inspire other.

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