DIGITALIZATION AND PLATFORMIZATION IN ROMANIA BASED ON THE DIGITAL PLATFORM ECONOMY INDEX 2020

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Abstract

This article examines the Romanian digital platform economy. In particular, it discusses how this novel paradigm could help Romania adapt to new technological and structural conditions and participate in the upcoming industrial-digital revolution. It intends to investigate the bottlenecks in the country's platform economy. Moreover, it compares the health of the digital entrepreneurial ecosystem with that of neighbouring countries. So that Romania may achieve sustainable growth, it suggests ways to enhance the platform economy framework. The methodology and data analysed in the study are based on the Digital Platform Economy Index 2020. It combines 61 indicators from different sources in 24 variables, twelve for the digital environment and twelve for the entrepreneurial ecosystem. These variables comprise the twelve pillars. Providing a basis for comparison, they are a crucial component of the model. Lastly, the four sub-indices and the main super-index are calculated. Platform economies such as Romania lack technology transfer, financial facilitation and digital literacy, according to the research. Demand side issues, such as fewer companies operating online and utilizing cloud technologies and low consumer online purchases, inhibit the introduction of new online businesses and technologies. Digitalization of industrial processes is not a trend in Eastern European countries. It is important to note that the study is limited by using macro-level indicators. With no platform-specific examples, it generalizes the concept of the digital economy. As a study topic, the digital platform economy presented in this article is an emerging field of research.

Implications for Central European audience: This article identifies the bottlenecks in the digital platform economy in Central and Eastern European countries. Particularly, it emphasizes the necessity to improve digital literacy, the number of multi-sided platforms networking, as well as technological transfer pillars of the platform economy. It also compares several cross-country dimensions of the digital platform economy. The author theoretically proves the importance of changing business models and embracing digitization in order to move towards a platform economy. In addition to describing what platform economies are and what they are not, the article also discusses how platforms can be combined with traditional firms to maintain a constant economic growth rate.

Keywords: platform economy; digitalization; entrepreneurship; ecosystem
JEL Classification: L26, N70, P27

Introduction

The COVID-19 crisis affected almost every country on Earth, wrecking economies and the way of doing business and also slowing down their economic convergence. However, the secluded Romanian economy succeeded in a remarkable comeback after the pandemic, achieving a 6.3% GDP growth in 2021 (OECD, 2022). Romanian productivity growth rates are currently two-thirds that of the OECD average, although regularly exceeding the OECD average. Despite OECD economists' advice to resurrect productivity growth, enhance the rule of law and speed up structural changes and infrastructure development, these proposals are not easy to adopt. Their implementation is much more ambiguous. Therefore, why is Romania's growth path so obscure, and how can we make sense of the global industrial revolution currently underway? According to Baumol (1986), some countries often experience a quick rise in productivity and real GDP. However, this rate may be followed by cycles of deindustrialization and declining productivity, and this trend was also seen globally over the last two decades. Technological revolutions are mostly to blame for this phenomenon of expansion. The term "techno-industrial revolution" refers to rapid and unprecedented technological change, as well as the ability to manufacture more and better items more efficiently (Perez, 2010; Rifkin, 2011).

Considering the First Industrial Revolution, some believe Great Britain began adopting new technologies abruptly, but this is not the case. The First Industrial Revolution began with a thought revolution and widespread printing. The value of information transmission and how-to-do publications was well recognized (Polk, 2018). The telephone, radio and television revolutionized communication throughout the twentieth century's Second Industrial Revolution. After a few decades, people were able to communicate and absorb information from all over the world. Huge advancements in manufacturingwere made possible by the arrival of a new energy source, oil. The Second Industrial Revolution established economic marketplaces and significantly transformed conventional economics, boosting productivity in the process (Rifkin, 2017). Although some sources refer to the third revolution as the Fourth Industrial Revolution, this was not the case for many countries. It is a never-ending revolution that is more about the application of digital technology and its confluence with other industries (Johnson & Markey-Towler, 2020).

In Romania, the subject of this study, the First Industrial Revolution started at the end of the 19th century, when the farming industry was modernized, and industries such as textiles and manufacturing were built. Nevertheless, the Romanian growth and industrialization process experienced a period of stagnation between World War I and World War II, followed by a period of recovery (Fischer-Galati, 2019). A period of rapid industrialization and urbanization occurred in Romania during the Second Industrial Revolution. As a result of the development of new industries, such as oil and gas, electricity and heavy machinery, the country's economy became more diversified. In addition, new roads, railways and ports were built to improve the country's transportation system. The country's communist government put in place a number of economic and industrial policies meant to modernize and industrialize the country. The country's planned communist economy also helped this period of industrial growth (Turnock, 1970; Fischer-Galati, 2019; Săgeată et al., 2021).

First and foremost, we must recognize that not all growth depends on new technologies and that industrialization did not play a significant role in the recent convergence (Rodrik, 2021).

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The capacity of enterprises to absorb existing information and technologies may be one of the reasons behind developing countries' rapid growth (Aghion & Jaravel, 2015). This is also confirmed by Próchniak (2011), who notes that the development of information and communication technologies, as well as human capital and an excellent financial system, are all necessary components of healthy growth in CEE countries. Productivity growth occurs when products become more efficient and less expensive, resources are better deployed, and improved manufacturing processes are used to raise the value of worker labour (Brynjolfsson & Saunders, 2009). The benefits of network flexibility, innovation and learning should not be overlooked in the drive for efficiency and growth through ecosystem exertion (De Meyer & Williamson, 2020).

Over the last few years, the methods in which we communicate, connect, work and generate value in the economy have altered radically (Kenney & Zysman, 2016). This is also known as the Internet of things technology, as it connects intelligent devices, autonomous automobiles, sensors and automated manufacturing that continuously generates data. Over time, advancements in the Internet have made these connections easier and more affordable (Evans & Schmalensee, 2016). Recently, the term "digitally enabled business, political and social activities" was coined by Kenney and Zysman (2016). However, what makes this industrial revolution superior to the previous one? How can we protect the privacy and security of data, avoid cybercrime and terrorism, and avert informational feudalism? How to construct emergent platform ecosystems that attract users and generate revenue? What kind of control and value capture system do platform models require? In the course of this digital revolution, Romania has actively participated, and it has seen an increase in the number of IT and software companies, as well as growth in the service sector. Furthermore, the country has invested significantly in technology, including high-speed internet, mobile networks and cloud computing, which have contributed to increased business efficiency and productivity. As the digital ecosystem develops, Romania's position as a regional leader in digital-based industries is strengthened (Pîrvu & Zamfirescu, 2017; Stăncioiu, 2017; Suciu et al., 2021; Vrabie, 2022).

The objective of this article is to illustrate why a digital ecosystem is vital for growth and how it can assist Romania and its neighbours in adjusting to new technological and organizational conditions and participating in a new industrial-digital revolution. The research gap results from a shortage of published material on the digital entrepreneurship environment and platform economies. Additionally, the responsibilities of users, agents, digital contextual variables and infrastructure on a two-sided platform market still need to be clarified. The present study demonstrates why a new entrepreneurship ecosystem metric is necessary and why relying primarily on manufacturing is not the best strategy. Growth is contingent not just on technology but also on how we employ or defy it.

In the next section of the research, the topic of entrepreneurship in Romania is explored, as well as the importance of having a large number of high-growth firms capable of digitization. The benefits of an entrepreneurial ecosystem are then discussed in the second subsection, as well as why digital technologies and businesses would benefit from being a part of a digital ecosystem. Later in the chapter, we will discuss the potential benefits of platform economies and existing indices of digital ecosystems. The methods describe the structure, computation and importance of an index that measures digital ecosystems. Next, the research explores

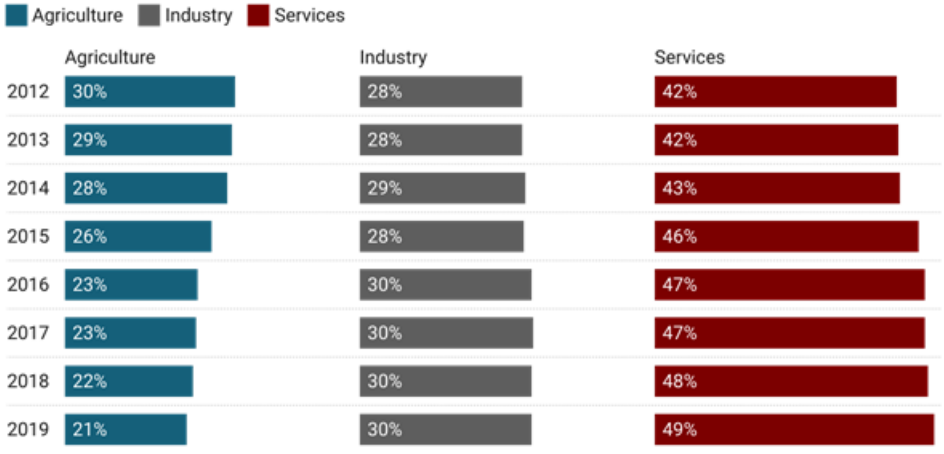
the results, policy suggestions and conclusions that support the importance of this field of study.

1 Literature Review

1.1 Romanian entrepreneurship situation

The Romanian economy has grown steadily during the last few years despite complicated periods. Topping off at 7.3% real GDP growth in 2017 before plummeting to -3.6% in 2020, it magically recovered to 6.3% GDP growth at market prices in 2021 (Eurostat, OECD). It has been forecast that yearly GDP growth will remain at or above 4.5% in 2022 and 2023, but the current political situation can change this forecast. The services, trade and information technology industries have consistently added the most value to growth, while agriculture and construction have slowed. This favourable phenomenon is a result of rising internal demand and the ability of local enterprises to deliver high-quality products. However, despite the fact that Romania's real GDP per capita has increased from $10,000 in 2008 to $12,000 after more than 12 years, the country remains the second most deficient in the European Union, after Bulgaria, according to World Bank statistics.

Figure 1 | Romanian employment by economic sector, in percentage



Source: own elaboration, based on World Bank data (2022)

Despite a downward trend in unemployment until 2019, when it fell to 3.9%, according to the World Bank, this figure has since risen to 5.03% in 2020. However, a low unemployment rate says nothing about the workforce composition in industries, the complexity of those economic activities, or their tendencies. In Figure 1, one can observe that the role of agriculture as one of the primary employing industries has decreased constantly, while the role of services has increased. The importance of services for future growth has been neglected, despite their critical role in creating jobs, lowering transaction costs, as well as transforming a product into a service. We must emphasise that emerging economies' proportion of services trade has increased, which is a usual pattern during the transition to a developed economy (WTO, 2019).

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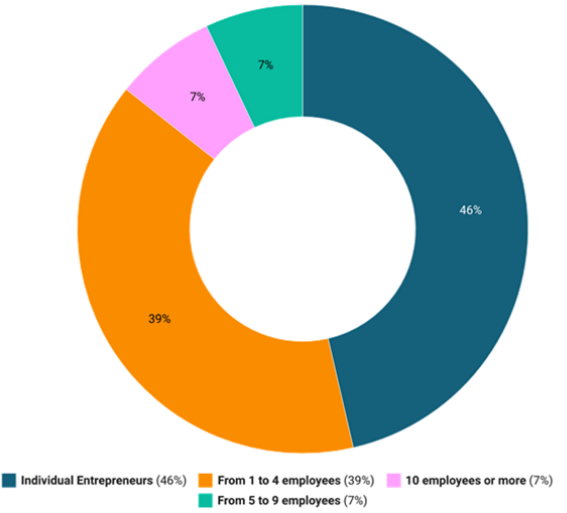
Figure 2 | Size distribution of Romanian companies, 2019



Source: own elaboration, based on Eurostat data

One of the believed reasons why a country can achieve such a fast level of growth is by having a large number of young entrepreneurs. Thus, having favourable institutions supporting entrepreneurship would lead to a high number of flourishing high-growth firms. This could lead to a transition to a market economy and higher levels of development (Lafuente et al., 2016). Currently, Romania is experiencing a period of economic growth higher than the EU average. Economic expansion in recent years has been correlated with an increase in the number of businesses, yet individual entrepreneurs account for the lion's share of the business population. Individual entrepreneurs accounted for 46% of all firms in 2019, followed by micro-businesses, with one to four employees, accounting for 39% of all firms. Both groups of businesses with five to nine employees and those with more than ten employees each make up roughly 7%, maintaining their business population at a consistent level since 2012. However, since the bulk of local businesses are small and unproductive, this is a problem for healthy business dynamics. Another concern is that international corporations provide a sizable portion of the business output, approximately 75%, according to the World Bank.

Moreover, attempting to assist local enterprises has proved ineffective since their production has declined. Additionally, the industrial sector's export share of companies with 20 or more employees is meagre, at roughly 32%, compared to more than 50% in practically all other Eastern European countries. Large firms are more productive and export more than small businesses, whereas small businesses are less productive and export less (OECD, 2022).

Table 1 | Size distribution of Romanian companies

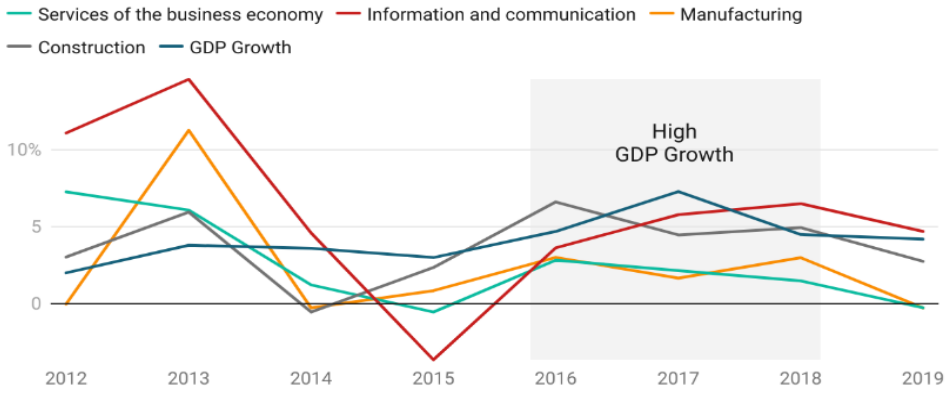
Firm size	2012	2013	2014	2015	2016	2017	2018	2019
Individual entrepreneurs	291,580	333,275	341,817	341,556	344,917	327,456	338,357	347,147
1 to 4 employees	248,379	249,508	251,810	252,236	268,211	301,573	304,211	294,065
5 to 9 employees	53,601	54,240	50,398	49,252	50,540	50,928	51,594	52,526
10 employees or more	53,765	52,960	52,117	52,064	53,720	53,824	54,064	54,523

Source: own elaboration, based on Eurostat data

However, this may be the case for developed countries. Nevertheless, specialization in specific technologies and industries and digitization of certain industries can have a greater impact on the economy than the simple entry of new firms where workers lack knowledge and skills for the newly created jobs. Digital networks have already been shown to have a significant impact on the economic performance of Romanian SMEs (Rivza et al., 2019). According to Mateus (2016) and the Digital Economy and Society Index (DESI), Romania is in the group of countries that is catching up with the digital economy when compared with the EU average. However, we should not overlook the fact that entrepreneurial motivation remains largely determined by environmental factors and regional differences in Romania (Nicolae et al., 2016).

Moreover, small firms may be well supported by different policies and grants that would drive employability and firm entry figure but not necessarily growth (Lafuente & Rabetino, 2011). In Figure 3, we can see the Romanian net business growth or company dynamics, and we can see that the number of ICT businesses increased, which was more or less in line with GDP growth. However, growth in manufacturing firm numbers was also noted.

Figure 3 | Romanian net business population growth, in percentage



Notes: Services of the business economy except activities of holding companies.

Source: own elaboration, based on Eurostat data

Nevertheless, if Romania wants to take part in the exchange economy experiment, the *Homo economicus* mentality has to be transformed into actors acting cooperatively. This cooperative business model will alter future market conditions and institutions, leading the

complex, impersonal exchange to political stability and ripping off the economic benefits from technology (North, 1971). The self-interest principle is consistently violated in this economic system, as long-term growth is achieved through social rather than individual technological creativity (Henrich et al., 2001). Economies of scale are no longer dependent on the size or structure of individual businesses but can be grasped at the ecosystem level (De Meyer & Williamson, 2020). On the other hand, the sharing economy and IoT are built on an open, distributed and collaborative architecture that enables peer-to-peer connections, thereby removing the middleman from the value chain. Research shows that it is insufficient to support a single sector of the economy in order to sustain growth. Instead, it is necessary to foster a collaborative environment in which various sectors can gain innovation and productivity (Campos & Root, 1996; Acs et al., 2021). Recent studies mention that the information technology industry increases both productivity and value added. While manufacturing has increased productivity and generated value, new technologies have contributed little, and there is considerable value to be discovered in new technologies.

1.2 Digital technologies and their ecosystem

From car-sharing and house-sharing to advertising, television and the music industry's transformation, digitalization, including artificial intelligence, market platforms and big data, is disrupting numerous industries, and no industry is immune (De Meyer & Williamson, 2020; Prahalad & Krishnan, 2008). However, there is a business strategy that can keep the incumbents and entrants in harmony. This can be accomplished by fostering a wholesome entrepreneurial ecosystem. The latter is defined as a network of interdependent organizations and individuals that work cooperatively to accomplish a goal in a particular environment (Sussan & Acs, 2017). The entrepreneurial ecosystem emphasizes the role of the place and contextual factors for entrepreneurial dynamics, but also national economic productivity (Wurth et al., 2022; Acs et al., 2017). In comparison to a system, an ecosystem is composed of both living and non-living elements (Acs et al., 2017). Collaboration with ecosystem actors and partners can result in the addition of new capabilities and knowledge that enable lean transformation and innovation. However, in conventional business economics, entrepreneurs are not taught how to encourage businesses to collaborate and exchange value (Evans & Schmalensee, 2016). This type of related cooperation can resolve complex integrated problems and requirements distinct from those associated with simple production activities. In an ecosystem where knowledge and capabilities are widely disseminated, one company cannot meet the requirements of customers as their needs and preferences keep changing. The ecosystem structures assist in bringing these capabilities and knowledge together, allowing them to interact and learn from one another while retaining some of the actor autonomy (De Meyer & Williamson, 2020).

Ecosystem strategies have been shown to benefit not just platform operators or e-commerce businesses but also traditional industries such as manufacturing and energy, which have been affected by ICT advancements. Ecosystems have characteristics such as collaborative innovation, product and service sharing, and knowledge. Although ecosystems are evolving around two-sided platforms, the ecosystem leader is the primary actor facilitating efficient information flows and the assessment of needs and capacities. When participants enter the platform, the knowledge exchange between parties is highly structured, as are joint learning and innovation opportunities and the flexibility to cooperatively reconfigure value proposals.

That is why, in the absence of a leader (orchestrator), a self-coordinating platform struggles to combine all potential knowledge and capabilities (Lang et al., 2019). At the same time, the primary purpose of a leader is to foster trust between contributors and users, determined by perceptions of collective identity, legitimacy and institutional work (Gawer & Cusumano, 2014).

Digital ecosystems, in the case of super platforms, combine knowledge from more than five, albeit not sometimes ten industries. Additionally, participants from both emerging and developed economies will be present (Lang et al., 2019). However, even if the platform is managed remotely, the regional embeddedness, production factors, infrastructure and geographical dimensions of the ecosystem remain critical for its efficiency (Acs et al., 2009; Acs et al., 2021). The distinction between a two-sided platform and an ecosystem type of platform is that the former is more focused on matching. In contrast, the latter can also facilitate the establishment of an environment conducive to complementary innovations (Gawer & Cusumano, 2014). These are referred to as network-centric innovations. Regarding governance arrangement, platforms are more concerned with interface governance, whereas ecosystems are more concerned with formation of interconnections (Adner, 2017).

Despite the numerous benefits of ecosystems, they come in various forms that depend on industrial and digital capabilities for adoption. The Boston Consulting Group classifies them as digitizer networks, platforms, and super platforms (Lang et al., 2019). The advanced product capabilities and limited digital capabilities make a digitizer network more promising for undersized industries. This way, advanced hardware or software can be added to a product, offering desired features to the customer and promoting product stickiness. On the other hand, this type of ecosystem is limited to tens or hundreds of contributors, which eliminates information redundancy and maximizes the value added by each contributor. Perhaps this contribution to efficiency explanation is given by those who claim that small systems are creative. However, this may be true up to a certain level as creativity may remain cloistered in small, disconnected teams. From a small to a medium-sized system, the level of connectivity grows, and cohesion between those groups takes place, leading to creativity (Uzzi & Spiro, 2005). Currently, the Internet is a unified global network and digital infrastructure for voice, video and data exchange, but it has the potential to evolve into new ecosystems. Network effects enable previously unimaginable scaling capabilities. In an ecosystem, they can boost the value of products and services on both the demand and supply sides. To boost their innovation and efficiency, businesses should be able to access and reconfigure resources from around the world and locally from other big and small firms in real time (Prahalad & Krishnan, 2008). The global network of resources creates a new environment of competition and opportunity. However, a too-big network can dissuade firms from investing or entering the ecosystem because sharing the costs also implies sharing the profits (Gawer & Cusumano, 2014). We cannot develop a standardized measurement for all ecosystems because each has its own unique structure and characteristics. Additionally, distinct patterns will exhibit unique growth, shape and self-organization at each system scale, and collaboration norms will differ (Root, 2020). However, a benchmarking perspective and a comparison of index scores between countries can provide critical insights into which pillars to develop (Szerb et al., 2019).

According to the European Commission's digital economy evaluation, Romania ranks worst among EU member states in terms of digital performance. This was determined using the DESI (Digital Economy and Society Index). As illustrated in Table 2, Romania not only lacks

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the potential to integrate digital technology into the economy but also has limited access to digital public services.

Table 2 | Digital Economy and Society Index, breakdown

DESI breakdown		2018	2019	2020
Romania	Human capital	7.50	7.55	7.90
	Connectivity	10.49	10.85	12.06
	Integration of digital technology	4.50	4.98	5.50
	Digital public services	3.17	3.68	4.49
Bulgaria	Human capital	7.99	8.31	8.18
	Connectivity	7.78	8.14	8.55
	Integration of digital technology	4.22	4.52	4.83
	Digital public services	10.88	11.74	12.86
Czechia	Human capital	10.96	11.27	11.66
	Connectivity	8.27	9.01	9.28
	Integration of digital technology	7.72	8.33	9.37
	Digital public services	11.47	12.50	13.48
Slovakia	Human capital	10.95	11.06	10.65
	Connectivity	8.23	8.48	9.58
	Integration of digital technology	6.54	6.70	6.90
	Digital public services	10.61	11.42	12.54
Hungary	Human capital	9.80	9.78	9.76
	Connectivity	9.01	9.73	12.18
	Integration of digital technology	4.82	5.11	5.29
	Digital public services	9.80	10.65	11.27

Source: own elaboration, based on DESI and Innovation Scoreboard

1.3 Platform economy

The capacity to produce new goods, rapidly prototype, imitate, scale up new products and perform aftersales maintenance is still essential for manufacturing economies. However, we observe how digital technologies perform the functions of connecting R&D, production and the customer, which undermines numerous learning opportunities due to the absence of physical knowledge exchange in manufacturing firms (Steinfeld, 2004). Countries can continue to innovate and grow by maintaining manufacturing capacity and improving the quality of their entrepreneurial ecosystems. However, this digitalization phenomenon decreases costs, increases global integration and modularizes production processes. The

architecture of production processes shifts from an internal system structure to external firms clustered in distinct "ecosystems" upon which both large and small firms rely for innovation and production (Locke & Wellhausen, 2014). In the case of platform businesses, geographical boundaries do not limit firms' ability to connect with the best suppliers and customers while avoiding the pressures associated with connecting with only local actors. This model can bring together millions of users and agents and local knowledge (Sussan & Acs, 2017). It provides small businesses with access to larger markets around the world. At the same time, an amalgamation of platform partakers can result in the formation of an ecosystem. Production ecosystems, both physical and digital, provide firms with innovation capabilities. Rochet & Tirole (2003) define a platform as a transaction mediator where the value is generated by the interaction between pairs of end-users.

Szerb et al. (2022) define this type of business as one that can match one group of users (people, buyers, contributors) with another (suppliers, companies, stakeholders) by lowering connection costs and time. The primary distinction from traditional markets is the presence of network externalities, which enables interaction between both sides of the market via a common platform (Rochet & Tirole, 2003). The platform serves as a core in a complex system of interactions, and governance is carried out via a central position and a variety of pricing models, access preferences and incentives (Adner, 2017).

The research of Goldfarb & Tucker (2019) mentions that the digitalization of the economy will affect the costs regarding searching, replication, transportation, tracking and verification of products. However, platform business models primarily facilitate user matching while being aided by advancements in digitalization but also innovation in information and communications technologies (ICT) (Acs et al., 2021). Without these advancements in ICT and digital infrastructure, platform businesses may never be invented, as this is a two-sided market (Sussan & Acs, 2017). Platforms are a mix of complex mixtures and intercommunications of "software, hardware, operations, and networks" (Kenney & Zysman, 2016, p. 7). This business model applies to various industries, including software, gaming, portals and streaming media, payment systems, advertising, and Internet networks (Rochet & Tirole, 2003). Despite the enormous leapfrogging opportunities presented by multi-sided platforms for low-medium developed countries, we can still observe a tendency in these efficiency-driven economies to focus on retail platforms, service-providing platforms, or work mediation platforms with low innovation. Most of these actions are "matchmaker" businesses whose primary objective is to connect customers and pedlars (Acs et al., 2021). In contrast, a tendency towards platforms for platforms and platforms for digital tools development has been seen in innovation-driven economies. However, it is only a matter of time before less-developed countries' IT capability accumulation and creativity expand.

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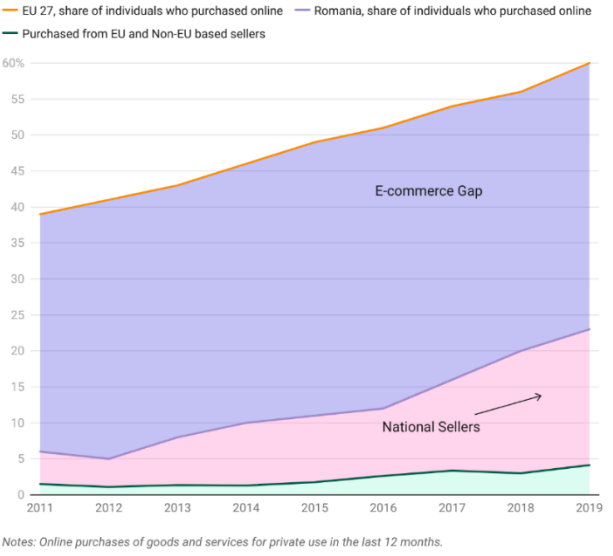
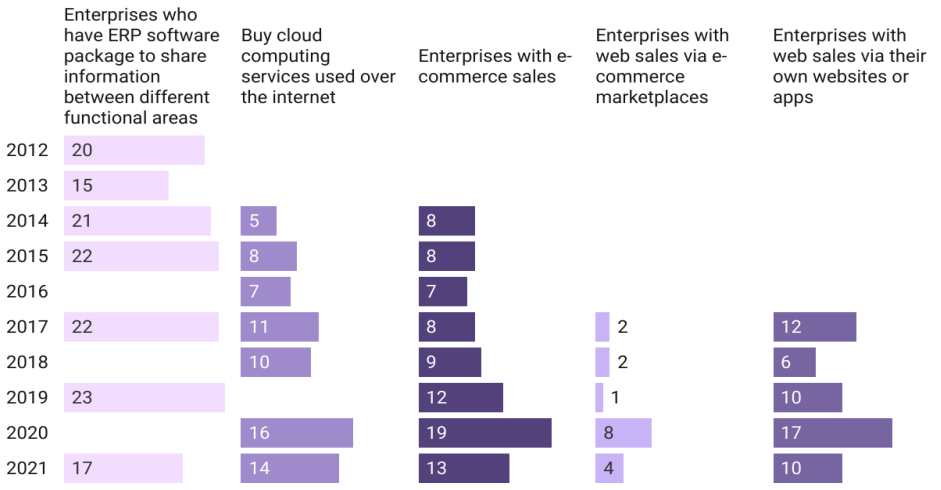
Figure 4 | Romanian e-commerce sales compared to EU level



Source: own elaboration based on Eurostat data

Additionally, their pricing models are dissimilar due to the fact that platforms vary in function and arrangement. More recently, the sharing economy and the IoT is taking over some other types of industries. However, this paradigm should avoid capturing all the dimensions of an industry or having the yearning to change all industries, and ecosystems should not be a solution to all business problems. Figure 4 shows that the share of firms selling on digital platforms is relatively low; only 19% of all organizations engage in e-commerce, compared to 70-80% in highly developed countries. Without ERP (enterprise resource planning) software, Romanian businesses may struggle to generate new data and optimise their organizational and manufacturing processes. By moving to cloud platforms, the physical expenses of organization and access would be reduced, and this characteristic of Romanian enterprises is also low, as illustrated in Figure 5.

Figure 5 | Romanian enterprises on digital markets, in percentage



Notes: Enterprises using different types of digital functions, serving also as the supply side of the digital platforms.

Source: own elaboration based on Eurostat data

We cannot overlook the platform network effect for growth, which states that the value produced by a network increases exponentially as the number of nodes (members) increases arithmetically (Kelly, 1998). This is not true for businesses that are not networked, where the effect is linear. When businesses began to use the Internet to connect to global networks of suppliers and customers, they created new challenges for established business models, ushering in the globally networked production paradigm (Steinfeld, 2004).

1.4 Digital ecosystem indices

Up to this point, several indices aimed at measuring the digital ecosystem have been developed. However, they all differ in terms of their structure and objectives. As an example, the DiGiX index measures the degree of digitalization in 99 countries, but it only includes 18 indicators under five dimensions (regulation and government adoption, infrastructure, enterprise adoption, affordability and user adoption). Even though this measurement is based on an attractive methodological style and broad approach, it does not clearly distinguish a platform from a physical entrepreneurial ecosystem or the interaction between them as this is a key attribute of an ecosystem (Cámara, 2018).

On the other hand, the DESI, despite being a more comprehensive and inclusive index for society, still does not include the platform indicators in the measurement and the interaction between individual and institutional factors. This indicator is developed since 2014, and it includes 4 dimensions (human capital, connectivity, integration of digital technology, and digital public services). This index represents the most human-centred type of digital technology ecosystem. The use of so many indicators in an index, however, results in making the measurement too general and turning it into a "measurement of everything" (European Commission, 2018).

In a manner similar to the DESI, the DEI (Digital Evolution Index) provides a data-driven assessment of the progress of the digital economy. The initial application covered 60 countries and combined more than 100 indicators. There are four major dimensions to these indicators: supply conditions, demand conditions, institutional environment, and innovations and change. The innovation dimension includes aspects such as entrepreneurship, technology, funding ecosystems, disruptive forces and a start-up culture (Chakravorti et al., 2015; Chakravorti & Chaturvedi, 2017).

2 Methodology

Without a doubt, the consequences of the technological revolution on the collapse of tech businesses and stocks have not been exaggerated (Hobijn & Jovanovic, 2001). As we can see now, they have challenged established business models and how they create value (Cairncross, 2002). Additionally, businesses interact more, form partnerships and outsourced manufacturing, spreading risk and entering new markets together with incumbents (Cairncross, 2002). In this networked, complexly connected world, we must extend individual-level views incorporating the complexities of higher levels considering the dynamic interactions and changes of individuals and actors (Root, 2020). The paradigm in this article connects persons and agents to the environment. The latter is composed of infrastructure and institutions and takes the form of a platform-based ecosystem. A macro level of analysis, factors and policy decisions can be seen at the national level in this study. The reason for this is that regional and individual-level policies do not take into account contextual and institutional factors, and decisions regarding digital policies are taken at the national level. In comparison to the DESI (Digital Economy and Society Index), the proposed DPE (Digital Platform Economy) index is focused on platformization, contrasting with the EU DESI, which focuses on the usage and employment of digital technology (Szerb et al., 2022).

As previously said, the platform-based ecosystem is formed of four dimensions: on the demand side, there is the user who establishes digital user citizenship (DUC). In contrast to Szerb et al. (2022), the second dimension is the supply side, which comprises app developers and various agents (digital technology entrepreneurship, DTE), rather than users being the demand and supply side. The third dimension is represented by digital multi-sided platforms (DMPs), which serve as an orchestrator between users and agents, as well as between innovative and economic activity. The fourth component is the digital technology infrastructure (DTI), which refers to the regulations that govern digital technology activities.

Measuring the digital economy environment is not straightforward, but the DPE index aims to capture the interaction of various sectors of the economy, which is why it also incorporates other complicated indices that reflect the state and performance of the digital platform economy to a greater or lesser extent.

Table 3 | DPE Index composition

Variables	Pillars	Sub-indices		Pillars	Variables
Networking agents	Networking	Platform	Digital technology infrastructure	Digital access	Digital access institutions
Networking users					Digital access Digital technology
Matchmaking agents	Matchmaking			Digital freedom	Digital freedom institutions
Matchmaking users					Digital Freedom Digital technology
Financial facilitation agents	Financial facilitation			Digital protection	Digital protection institutions
Financial facilitation users					Digital protection Digital technology
Digital adoption agents	Digital adaptation	Digital technology entrepreneurship	Digital user citizenship	Digital literacy	Digital literacy institutions
Digital adoption Digital technology					Digital literacy users
Technology absorption agents	Technology absorption			Digital openness	Digital openness institutions
Technology absorption Digital technology					Digital openness Digital technology
Technology transfer agents	Technology transfer			Digital rights	Digital rights institutions

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Technology transfer Digital technology					Digital rights Digital technology

Source: own editing based on Szerb et al. (2022)

The structure of the DPE index, as defined by Szerb et al. (2022), is shown in Table 3. Its first components are 61 indicators drawn from a variety of sources. The indicators are combined to generate the 24 variables listed in Table 3, twelve for the digital environment and twelve for the entrepreneurial ecosystem. These variables comprise the twelve pillars. They are critical components of the model but also provide a basis for comparison. Finally, the four sub-indices and the main super-index are calculated.

The index calculation methodology is the penalty for bottleneck (PFB) methodology created by Acs et al. (2011). This methodology is distinct from the others in that it makes the premise that a system's operation is contingent on its weakest component or variable. As a result, they recommend that this bottleneck be addressed first, owing to its effect on other system indicators.

In the study, this penalty function originating from Ács et al. (2014, p. 484) is employed:

$$h_{(i),j} = \min\ y_{(i),j} + \mathrm{a}\left(1 - e^{-\mathrm{b}\left(y_{(i)j} - \min y_{(i),j}\right)}\right) \quad (1)$$

where $h_{\mathrm{i,j}}$ is the modified, post-penalty value of the pillar *j* in the country *i*,

$y_{\mathrm{i,j}}$ is the normalized value of the index component *j* in the country *i*,

$y_{\min}$ is the lowest value of $y_{\mathrm{i,j}}$ for the country *i*,

i = 1, 2,……n = the number of countries,

j = 1, 2,…….m = the number of pillars,

0 ≤ a, b ≤ 1 are the penalty parameters, the basic setup is a = b = 1.

The data and methodology were collected and processed by Szerb et al. (2022). This article applies the study to Romania and benchmarks it against its Eastern European counterparts.

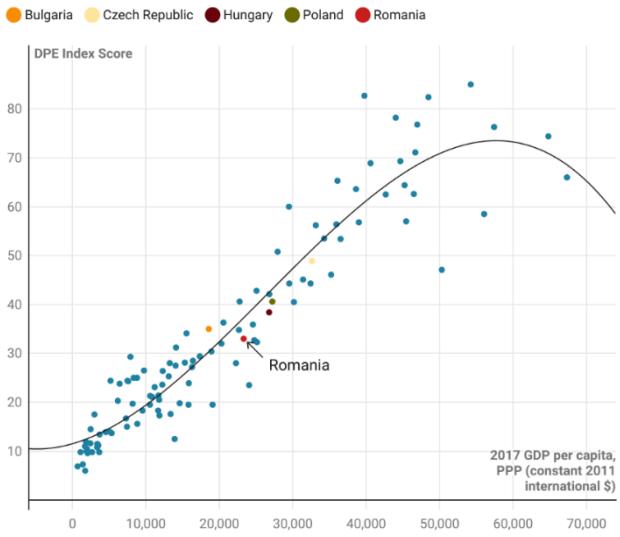
3 Analysis Results

3.1 Digital Platform Economy Index

Throughout the COVID-19 pandemic, digital platforms and businesses flourished significantly, mainly in the delivery, accommodation and work-related services sectors (Bădoi, 2020). However, this platformization movement was somewhat muted in countries such as Romania, which are still in the process of transitioning from old corporate models to digital ones. This approach also entails advocating for supportive legislation, infrastructure and financial incentives to make the digital transition (Pînzaru et al., 2017). Therefore, can Romania participate in the new platform economy with its current endowments, and what are the current obstacles? This new paradigm will necessitate a reassessment of operational processes, as well as the required digital competencies and value creation models. It is worth

noting that the platform economy does not just mean new marketplaces but also new techniques of internal end-to-end digitalization, data-sharing schemes, crowdsourcing and virtual cooperation.

Figure 6 | Digital Platform Economy Index



Source: own elaboration based on Szerb et al. (2022), DPE index score

Despite being aware of the available technologies to digitize their equipment and processes, a slight improvement in the SMEs' technological innovation has been made, and little movement in the knowledge economy (Gheorghe, 2020). We used the DPE index to assess the backdrop for both the physical and digital economies and to identify areas of interaction between the two.

When we look at the DPE index score, we see that Romania has a score of roughly 33, which is below the trend line. Romania underperforms when compared to other countries at the same income level. When we compare the DPE to the DESI score from Rivza et al. (2019), we see that these two measures are significantly correlated, with Romania consistently ranking worst in Europe. In comparison, countries such as Bulgaria outperform the trend at that income level. The research could not discern a link between short-term improvements in the business environment, platform economy and Romania's extraordinary growth.

Table 4 | Digital Platform Economy sub-indices, Romania

Country	Digital technology infrastructure	Digital user citizenship	Digital multi-sided platform	Digital technology entrepreneurship
Romania	35.48	35.73	29.95	30.77

Notes: The maximum score for sub-index performance is 100.
Source: own elaboration based on Szerb et al. (2022)

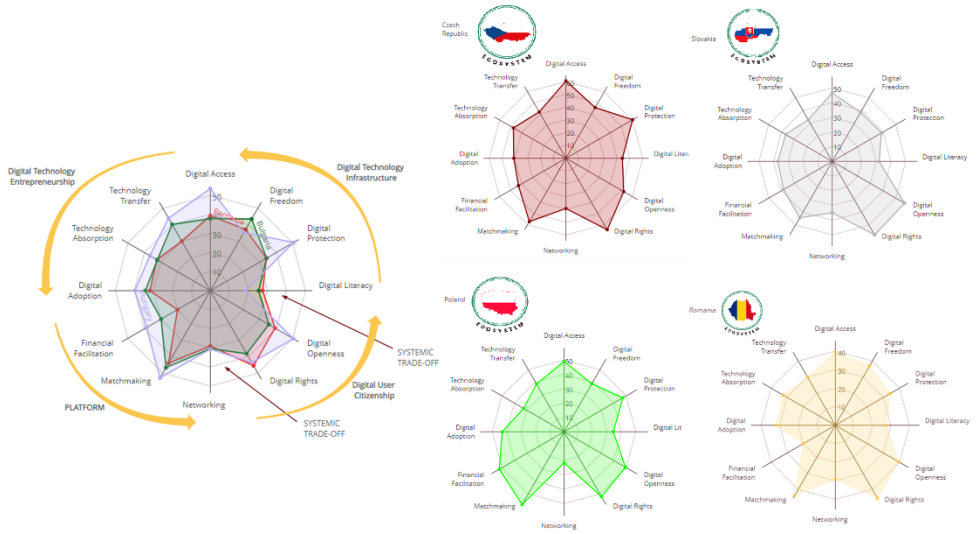
Digital multi-sided platforms are critical for the interaction of actors in a platform economy. More precisely, through cross-side network effects, actors can extract value and innovate, as

well as experiment, integrate, exchange and receive feedback on their products (Helfat & Raubitschek, 2018; Song, 2019). Romania should focus primarily on this aspect of the platform economy, which is concerned with actor interaction and trust. Despite past research demonstrating how platforms may benefit sectors, platforms vary in their functionality and the way they add value, whether it is a sales platform or a co-creation platform (Hänninen et al., 2018). As discussed previously, industries such as hospitality and health and social work have undoubtedly profited from these types of platforms. Romania has expanded both the supply and demand sides of the market, according to the sub-indices, but the platform environment and firm adoption capacity for this sort of business model are still underdeveloped.

Looking at the twelve pillars of Romania's digital platform economy, we can see three major blockages. The first is digital literacy, which implies citizens' capability to use digital technology and connect with them on digital platforms. In Eastern European countries, we can see this as a common trade-off. This may be explained by the poor educational standards in these countries. The second bottleneck is networking. Despite the developed user side of the pillar, the agent side, as observed previously, is weaker mainly by the use of ICT by businesses but also by business-to-consumer connection. As a result, improvements in product digitalization, bringing the product to a platform, and growing online sales and consumer contact, are critical. When compared to wealthy countries, making digital skills a central part of schooling curricula and organizing lifelong learning schools will help close the literacy gap (McKinsey Global Institute, 2016).

Financial facilitation is the last evident bottleneck of the Romanian platform economy, as seen in Figure 7. The pillar refers to the availability of online financial payment mechanisms as well as funding for platform support and matchmaking (Szerb et al., 2020). When comparing Romania to its Eastern European counterparts, we can see that it has the most bottlenecks and ranks last in the region.

Figure 7 | Digital Platform Economy Index, pillar analysis



Source: own editing based on Szerb et al. (2022), DPE index score

Pillars such as digital literacy and networking must be addressed in all countries' platform environments. The role of digitization and digital technologies in entrepreneurship has been little analysed (Song, 2019). However, it may not be very sensible to study these two aspects of entrepreneurship separately. We argue that no digital environment can succeed without first establishing a physical entrepreneurship ecosystem. Furthermore, no platform economy can exist without the acceptance of digital technologies and the creation of a digital ecosystem. We can see that Romania is primarily struggling to build its entrepreneurial ecosystem.

Nevertheless, how can Romania reach such high levels of growth without a robust ecosystem? The explanation is that those exploitable industries that are difficult to disrupt are providing the value that contributes to the GDP. Manufacturing and agriculture are non-information-intensive industries with low research costs, limited scalability, limited user variety and little information asymmetry (Parker et al., 2016). Increased total factor productivity in particular industries can lower prices and raise demand, keeping firms competitive (Varga et al., 2013). A robust competitive environment will also encourage new firm development and job creation.

Table 5 | Digital and entrepreneurship components scores

Pillars/sub-indices		Pillar/sub-index score	Entrepreneurship ecosystem score	Digital ecosystem score
DTI	Digital access	39.4	57.3	64.2
	Digital freedom	37.1	55.3	56.4
	Digital protection	34.1	57.3	55.9
Digital technology infrastructure		**35.5**		
DUC	Digital literacy	27.5	45.2	55.9
	Digital openness	39.3	64.4	61.0
	Digital rights	45.4	59.3	63.5
Digital user citizenship		**35.7**		
DMSP	Networking	29.0	49.9	50.2
	Matchmaking	43.9	56.4	56.4
	Financial facilitation	20.0	39.0	42.1
Digital multi-sided platform		**29.9**		
DTE	Digital adoption	31.8	53.8	51.9
	Technology absorption	32.4	49.7	53.5
	Technology transfer	30.0	48.5	53.3

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Digital technology entrepreneurship	**30.8**		
Digital Platform Economy Index	**33.0**	**54.3**	**54.2**

Source: own elaboration based on Szerb et al. (2022).

As seen in the previous figures, there is a low likelihood of entrepreneurs pursuing ICT and IoT-related ventures in Romania. These include data security, cloud platforms, networking management solutions, etc. (Giones & Brem, 2017). This element is essential to connect to digital platforms and engage in experimentation and innovation. Given that digital ecosystems are always growing and constructing in the shape of a playground, it may be premature to determine what works and does not work, as well as which actors and roles should be updated (Westerlund et al., 2014). However, unless we assess the effectiveness of specific ecosystem components and the overall performance of the ecosystem, we will be unable to modify existing rules and frameworks (Vogel, 2013). Together with digital multi-sided platforms, these two sub-indices are the weakest in Romania, but a lack of development in this market segment is evident in the majority of Eastern European countries. At the same time, these countries require digitization and the proper use of technology and components of production on a platform to boost their efficiency (Lafuente et al., 2016).

Table 6 | Cross-country comparison of digital platform indices and sub-indices

Country	Digital technology infrastructure	Digital user citizenship	Digital multi-sided platform	Digital technology entrepreneurship	Digital Platform Economy Index
Czechia	54.05	52.34	45.94	43.23	49
Hungary	42.61	34.93	38.10	37.87	38
Poland	42.41	42.53	40.69	36.70	41
Slovakia	40.80	46.88	38.88	35.43	40
Bulgaria	37.62	32.63	34.87	34.95	35
Romania	35.48	35.73	29.95	30.77	33

Source: own elaboration based on Szerb et al. (2022).

3.2 Policy suggestions to improve DPE scores by 10%

Perhaps one of the most critical components of the examination is the integration of research and policy in the design of new strategies. According to studies conducted by Sinozic et al. (2015) on evidence-based policymaking in a Turkish region, private investment support, increased R&D expenditures, a stronger position in EU knowledge networks and investments in human capital can all contribute to the growth of underdeveloped regions. In Romania, there is a similar trend towards improving policy for the platform economy. If one wants to improve the performance of the digital platform economy by 10%, approximately 60% of the input effort should be directed towards upgrading the digital multi-sided platforms. The financial facilitation pillar should receive the most attention, as it will drive not only matchmaking start-ups but also easier exchange transactions on the platform and user involvement. As indicated previously, increasing investments in the networking pillar is

necessary to facilitate business-to-business connections while also allowing actors to access new technologies and engage in knowledge exchange. Approximately 14% of the effort should be directed towards this pillar. However, investments in R&D alone cannot guarantee high GDP growth. Hence, additional efforts should be directed towards human development or digital-technological skill augmentation.

Consequently, 21% of the effort should be directed towards the digital literacy pillar. However, we must emphasize that present investments in labour education will yield the best effects at least five years after they are made. One critical pillar that needs improvement is technology transfer, which encompasses identifying and exploiting new opportunities resulting from emerging technologies. We need to include product digitization in certain branches of the economy and cross-industry digital projects here. Recently, the Romanian government announced a €1.9 billion COVID-19 recovery plan to upgrade the public sector's information technology and, in particular, to ensure the development of citizens' high-speed internet connections. This is a central objective following the failure of COVID-19 information initiatives (CER, 2021).

Table 6 I Required pillar improvements in case of 10% DPE score enhancement

Pillar	Required increase in pillar	Percentage of total new efforts
Digital access	0.00	0%
Digital freedom	0.00	0%
Digital protection	0.00	0%
Digital literacy	0.06	21%
Digital openness	0.00	0%
Digital rights	0.00	0%
Networking	0.04	14%
Matchmaking	0.00	0%
Financial facilitation	0.13	46%
Digital adoption	0.01	4%
Technology absorption	0.01	4%
Technology transfer	0.03	11%
Sum of additional resources	28.0	

Source: own calculation based on Szerb et al. (2022)

Conclusions

Measuring the platform economy and entrepreneurship ecosystem can be a critical, evidence-based benchmarking tool. It can aid policymakers in evaluating which contextual characteristics of the economy demand improvement, but it requires an understanding of actor interaction mapping. This should take the quantity and quality of actors into account, as well as their collaboration, innovation and competitive pressure. The economy's future is

digital, and the process of digitalization will result in a more platform-based economy. In this study, we measured the digital platform economy of Romania and compared it with its neighbouring countries. While the Romanian platform economy has a number of advantages, including high customer Internet penetration and university graduation rates, attracting and retaining talent will be challenging in a digital environment. Reddy et al. (2020) also noticed the significance of digital literacy for growth. However, capacity of sectors to digitize must be strengthened, as well as firms' adoption of new high-tech breakthroughs and entry into online marketplaces. Trust in government institutions, as well as inter-business trust, are key components of a platform ecosystem as corporate finance is vital, as our data reveal. Diversifying finance in Romania into decentralized finance would aid growth, as banks have failed to stimulate growth by monopolizing the money supply. as the nature of assets has shifted significantly away from tangible to immaterial. Additionally, the amount of corruption is considerable, making policy execution difficult. Corruption and finance as constraints to growth were also proven to be significant in the study by Ullah (2020). Manufacturing and services expanded in recent years, although this was primarily due to the importation of low-cost resources and technologies rather than a sustained transformation of products and processes. The above observations clearly illustrate the gaps in the Romanian digital ecosystem and provide answers to the research question regarding the importance of ecosystems for economic growth, as well as the need for actors to improve their capacities.

It is also important to switch from product thinking to platform thinking since this model of business generates and analyses a greater amount of data, stimulates innovation through collaboration, and is much more scalable and can reach a wider market than traditional models, as also mentioned by Parker et al. (2016). In platform thinking, emphasis is placed on creating thriving ecosystems benefiting developers, users, partners and platform owners (Parker et al., 2016). Additionally, the opportunity to create value by growing platforms on platforms or the efficiency of matching workers with tasks should not be overlooked (Kenney & Zysman, 2016). Digital currencies and blockchain technologies have the potential to significantly improve the quality of interaction between ecosystem actors and how they create value and innovate. A positive relationship between the digital platform economy with gross domestic product indicates the possibility of countries catching up if there is a healthy ecosystem. Through platforms and digitalization, less developed rural regions may also be able to maintain their viability through both domestic and cross-border product sales, as well as increased net turnovers of SMEs (Rivza et al., 2019).

Despite Romania's exceptional growth in recent years, only a small portion of this success can be attributed to a robust entrepreneurial environment and a digitisation process. This conclusion is supported by only imperceptible improvements in the DESI, which measures a country's digital performance. Romaina being Europe's second least inventive country and having the lowest platform economy index in coevolution with the DESI (2021) leads us to believe that the country's phenomenal growth is being fueled by a focus on discrete labour- and capital-intensive industries rather than a synergy between them (European Commission, 2021). We can note, however, that changes in total factor productivity bring the greatest value to the majority of industries. We did not observe an increase in the use of IoT technology or online sales, but a small percentage of the rural population and enterprises engage in e-commerce. Without a well-defined strategy for prioritizing industries, restructuring existing enterprises, digitising products, and connecting demand and supply via the Internet, Romania risks falling into the middle-income trap or worsening inequality. This will show an inability to

cut marginal costs and increase productivity, which is a necessary condition for networked, sharing, platform economies to thrive (Rysman, 2009). Numerous alternatives exist, one of which is to promote e-commerce operations via interactive websites. Finance digitization of SMEs, but also of production, while boosting collaboration across firms in IoT, robots and artificial intelligence are also essential. Compared with Eastern European peers, Romania has the weakest digital ecosystem, while Czechia and Poland are at the top. They are ranked at the top due to the quality of their platforms and technological endowment. Romania has the opportunity to improve its cloud-based technologies and ERP systems, as well as the use of the Internet for adult education.

By 2025, the Internet of Things is expected to generate $11.1 trillion in annual revenue, according to McKinsey Global Institute (2015). A large portion of this value-added comes from manufacturing, hospitals and agricultural settings. Educating the public on how to use digital technologies and interact with online markets is also crucial since it creates market demand, which is necessary for the platform or digital marketplace to attract new players. Additionally, financial tools are required to aid in the acceptance, innovation, and platform interaction of new technologies. To sustain the country's progress, Romanian policymakers should prioritise knowledge absorption and adoption of new technologies, as these activities contribute a greater percentage of the value than the invention of new technologies. In other words, Romanian businesses and residents should invest heavily in capacity building.

The results of this research, as well as the platform measurement applied, will help policymakers identify the bottlenecks of their platform economy. This will enable them to decide which pillars and dimensions to correct first to be able to participate in the speedy knowledge economy. To date, most studies have measured the economy through the physical prism, and few have taken into account the digital and platform dimensions. Combining a physical entrepreneurial environment with a digital platform economy to answer the question why this measurement is superior to previous methods is a distinctive aspect of this study. Additionally, it provides a more straightforward method of systematically comparing the economies of different countries. In reality, the limitation of this study lies in the incapacity to evaluate differences in platformization and digitization strategies for different countries and different types of platforms over time. In addition, a regional approach to measuring the digital ecosystem would bring to light the inequalities within each country's digital business environment.

As this study focuses more on the environment and systemic factors of the digital platform economy, future research should focus more on quantifying the digital platform economy as well as assisting economies in transitioning to the platform environment and new business models.

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References

Acs, Z. J., Braunerhjelm, P., Audretsch, D. B., & Carlsson, B. (2009). The knowledge spillover theory of entrepreneurship. *Small Business Economics*, 32(1), 15–30. https://doi.org/10.1007/s11187-008-9157-3

Acs, Z. J., Rappai, G., & Szerb, L. (2011). Index-Building in a System of Interdependent Variables: The Penalty for Bottleneck. *GMU School of Public Policy Research Paper No. 2011-24*. https://doi.org/10.2139/ssrn.1945346.

Ács, Z. J., Autio, E., & Szerb, L. (2014). National Systems of Entrepreneurship: Measurement issues and policy implications. *Research Policy*, 43(3), 476–494. https://doi.org/10.1016/j.respol.2013.08.016.

Acs, Z., Szerb, L., & Autio, E. (2017). The Global Entrepreneurship Index. In Z. Acs, L. Szerb, & E. *Autio, Global Entrepreneurship and Development Index 2016* (pp. 19–38). London: Springer International Publishing. https://doi.org/10.1007/978-3-319-63844-7_3.

Acs, Z. J., Song, A. K., Szerb, L., Audretsch, D. B., & Komlósi, É. (2021). The evolution of the global digital platform economy: 1971–2021. *Small Business Economics*, 57(4), 1629–1659. https://doi.org/10.1007/s11187-021-00561-x.

Adner, R. (2017). Ecosystem as Structure: An Actionable Construct for Strategy. *Journal of Management*, 43(1), 39–58. https://doi.org/10.1177/0149206316678451.

Aghion, P., & Jaravel, X. (2015). Knowledge Spillovers, Innovation and Growth. *The Economic Journal*, 125(583), 533–573. https://doi.org/10.1111/ecoj.12199.

Baumol, W. J. (1986). Productivity Growth, Convergence, and Welfare: What the Long-Run Data Show. *The American Economic Review*, 76(5), 1072–1085.

Bădoi, D. (2020). Ocuparea pe platformele digitale în contextul crizei COVID-19: Studiu de caz asupra personalului de livrare. *Revista Calitatea Vieții*, 31(2), 188–207. https://doi.org/10.46841/RCV.2020.02.05.

Boston Consulting Group. (2019, January 16). Emerging Art of Ecosystem Management. Retrieved from https://www.bcg.com/publications/2019/emerging-art-ecosystem-management

Brynjolfsson, E., & Saunders, A. (2009). *Wired for Innovation: How Information Technology Is Reshaping the Economy*. Cambridge and London: The MIT Press.

Cairncross, F. (2002). *The company of the future: How the communications revolution is changing management*. Boston: Harvard Business School Press.

Cámara, N. (2018). DiGiX 2018: A Multidimensional Index of Digitization, BBVA Research.

Campos, J. E., & Root, H. (1996). *The key to the Asian miracle*. Washington DC: Brookings Institution Press.

CER, 2021. Romania 33, Centre for European Reform. Retrieved April 23, 2022, from https://policycommons.net/artifacts/2206279/romania-33/2962641/.

Chakravorti, B., & Chaturvedi, R. S. (2017). *Digital Planet 2017: How Competitiveness and Trust in Digital Economies Vary across the World*. Medford: The Fletcher School, Tufts University.

Chakravorti, B., Tunnard, C., & Chaturvedi, R. S. (2015). Where the Digital Economy Is Moving the Fastest. *Harvard Business Review*, 19,1-7.

De Meyer, A., & Williamson, P. J. (2020). *Ecosystem edge: Sustaining competitiveness in the face of disruption. Stanford*. California: Stanford University Press.

European Commission. (2018). Digital Economy and Society Index 2018 Report: Shaping Europe's digital future. Retrieved from https://digital-strategy.ec.europa.eu/en/library/digital-economy-and-society-index-2018-report

European Commission. (2021). Digital Economy and Society Index 2021: Shaping Europe's digital future. Retrieved from https://digital-strategy.ec.europa.eu/en/library/digital-economy-and-society-index-desi-2021

Evans, D. S., & Schmalensee, R. (2016). *Matchmakers: The New Economics of Multisided Platforms*. Boston, Massachusetts: Harvard Business Review Press.

Gheorghe, G. I. (2020). The Development of Intelligent Industry in Romania. *International Journal of Modeling and Optimization*, 10(6), 178-184. https://doi.org/10.7763/IJMO.2020.V10.767.

Gawer, A., & Cusumano, M. A. (2014). Industry Platforms and Ecosystem Innovation: Platforms and Innovation. *Journal of Product Innovation Management*, 31(3), 417–433. https://doi.org/10.1111/jpim.12105.

Giones, F., & Brem, A. (2017). Digital Technology Entrepreneurship: A Definition and Research Agenda. *Technology Innovation Management Review*, 7(5), 44-51.

Goldfarb, A., & Tucker, C. (2019). Digital Economics. *Journal of Economic Literature*, 57(1), 3–43. https://doi.org/10.1257/jel.20171452.

Hänninen, M., Smedlund, A., & Mitronen, L. (2018). Digitalization in retailing: Multisided platforms as drivers of industry transformation. *Baltic Journal of Management*, 13(2), 152–168. https://doi.org/10.1108/BJM-04-2017-0109.

Helfat, C. E., & Raubitschek, R. S. (2018). Dynamic and integrative capabilities for profiting from innovation in digital platform-based ecosystems. *Research Policy*, 47(8), 1391–1399. https://doi.org/10.1016/j.respol.2018.01.019.

Henrich, J., Boyd, R., Bowles, S., Camerer, C., Fehr, E., Gintis, H., & McElreath, R. (2001). In Search of Homo Economicus: Behavioral Experiments in 15 Small-Scale Societies. *American Economic Review*, 91(2), 73–78. https://doi.org/10.1257/aer.91.2.73.

Hobijn, B., & Jovanovic, B. (2001). The information-technology revolution and the stock market: Evidence. *American Economic Review*, 91(5), 1203-1220. https://doi.org/10.1257/aer.91.5.1203.

Fischer-Galati, S. (2019). Romania's development as a Communist state. In *Romania in the 1980s* (pp. 4-16). Routledge.

Johnson, N., & Markey-Towler, B. (2020). Economics of the Fourth Industrial Revolution: Internet, Artificial Intelligence and Blockchain (1st ed.). New York: Routledge.

Kelly, K. (1998). *New rules for the new economy: 10 radical strategies for a connected world*. New York: Viking.

Kenney, M., & Zysman, J. (2016). The Rise of the Platform Economy. *Issues in Science and Technology*, 32, 61–69.

Lafuente, E., & Rabetino, R. (2011). Human capital and growth in Romanian small firms. *Journal of Small Business and Enterprise Development*, 18(1), 74–96. https://doi.org/10.1108/14626001111106442.

Lafuente, E., Szerb, L., & Acs, Z. J. (2016). Country level efficiency and national systems of entrepreneurship: A data envelopment analysis approach. *The Journal of Technology Transfer*, 41(6), 1260–1283. https://doi.org/10.1007/s10961-015-9440-9.

Lang, N., von Szczepanski, K., & Wurzer, C. (2019). The emerging art of ecosystem management. Boston Conulting Group, 1-20.

Locke, R. M., & Wellhausen, R. L. (2014). *Production in the Innovation Economy*. Cambridge, MA: The MIT Press.

McKinsey Global Institute. (2016). Digital Europe: Pushing The Frontier, Capturing The Benefits. New York: McKinsey Company.

McKinsey Global Institute. (2015). The Internet of Things: Mapping the value beyond the hype. Retrieved from https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/the-internet-of-things-the-value-of-digitizing-the-physical-world

Mateus, A. (2016). DESI/I-DESI Digital Economy and Society Index. European Commission, Brussels.

North, D. C. (1971). Institutional Change and Economic Growth. *The Journal of Economic History*, 31(1), 118–125.

Nicolae, M., Ion, I., & Nicolae, E. (2016). Regional differences in entrepreneurial perceptions and implications for the Romanian competitiveness policy. *Management & Marketing*, 11(1), 394–409. https://doi.org/10.1515/mmcks-2016-0005.

OECD (2022), OECD Economic Surveys: Romania 2022, OECD Publishing, Paris, https://doi.org/10.1787/e2174606-en.

Parker, G. G., Alstyne, M. W. V., & Choudary, S. P. (2016). *Platform Revolution: How Networked Markets Are Transforming the Economy and How to Make Them Work for You*. New York: W. W. Norton & Company.

Perez, C. (2010). Technological revolutions and techno-economic paradigms. *Cambridge Journal of Economics*, 34(1), 185–202. https://doi.org/10.1093/cje/bep051.

Pînzaru, F., Anghel, L., & Mihalcea, A. (2017). Sustainable management in the new economy: Are Romanian companies ready for the digital challenge? In Zanele, N., & Thabang, M. (Eds.), IGMLG 2017 – Proceedings of the 5th International Conference on Management, Leadership and Governance (pp. 346-352). Saint Petgersburg, Russia.

Pîrvu, B. C., & Zamfirescu, C. B. (2017). Smart factory in the context of 4th industrial revolution: challenges and opportunities for Romania. In *IOP conference series: Materials science and engineering*, 227(1), 012094.

Polk, W. R. (2018). Crusade and jihad: The thousand-year war between the Muslim world and the global north. New Haven and London: Yale University Press.

Prahalad, C. K., & Krishnan, M. S. (2008). The new age of innovation: Driving cocreated value through global networks. McGraw-Hill.

Próchniak, M. (2011). Determinants of economic growth in Central and Eastern Europe: The global crisis perspective. *Post-Communist Economies*, 23(4), 449–468. https://doi.org/10.1080/14631377.2011.622566.

Reddy, P., Sharma, B., & Chaudhary, K. (2020). Digital Literacy: A Review of Literature. *International Journal of Technoethics*, 11(2), 65–94. https://doi.org/10.4018/IJT.20200701.oa1.

Rifkin, J. (2011). *The third industrial revolution: How lateral power is transforming energy, the economy, and the world*. New York: Palgrave Macmillan.

Rifkin, J. (2017). *The Zero Marginal Cost Society: The Internet of Things, the Collaborative Commons, and the Eclipse of Capitalism*. New York: St. Martin´s Press.

Rivza, B., Kruzmetra, M., Gudele, I., & Foris, D. (2019). Digitalization as an essential growth factor contributing in SME development (experience of Latvia and Romania). *Agronomy Research*, 17(1), 261-270. https://doi.org/10.15159/AR.19.030.

Rochet, J.-C., & Tirole, J. (2003). Platform Competition in Two-Sided Markets. *Journal of the European Economic Association*, 1(4), 990–1029. https://doi.org/10.1162/154247603322493212.

Rodrik, D. (2021). Prospects for global economic convergence under new technologies. In Paper presented at the Brookings Institution's Global Forum on Democracy and Technology.

Root, H. L. (2020). *Network Origins of the Global Economy: East vs. West in a Complex Systems Perspective.* Cambridge: Cambridge University Press.

Rysman, M. (2009). The Economics of Two-Sided Markets. *Journal of Economic Perspectives*, 23(3), 125–143. https://doi.org/10.1257/jep.23.3.125

Săgeată, R., Mitrică, B., & Mocanu, I. (2021). Centralized Industrialization in the Memory of Places. Case Studies of Romanian Cities. *Societies*, 11(4), Article 4. https://doi.org/10.3390/soc11040132

Sinozic, T., Bergman, E. M., & Moran, N. (2015). Evidence-based policy research to inform the European Neighbourhood Policy framework: Five recommendations for Europe and its neighbours. *The International Spectator*, 50(3), 88-102.

Song, A. K. (2019). The Digital Entrepreneurial Ecosystem—A critique and reconfiguration. *Small Business Economics*, 53(3), 569–590. https://doi.org/10.1007/s11187-019-00232-y.

Steinfeld, E. S. (2004). China's Shallow Integration: Networked Production and the New Challenges for Late Industrialization. *World Development*, 32(11), 1971–1987. https://doi.org/10.1016/j.worlddev.2004.04.003.

Suciu, C., Handra, A. D., Rada, A. C., & Uțu, I. (2021). Industrialization 4.0-The digital revolution which redefines production. *Annals of'Constantin Brancusi'University of Targu-Jiu. Engineering Series* (4).

Sussan, F., & Acs, Z. J. (2017). The digital entrepreneurial ecosystem. *Small Business Economics*, 49(1), 55–73. https://doi.org/10.1007/s11187-017-9867-5.

Stăncioiu, A. (2017). The Fourth Industrial Revolution 'Industry 4.0'. *Fiabilitate Şi Durabilitate*, 1(19), 74-78.

Szerb, L., Lafuente, E., Horváth, K., & Páger, B. (2019). The relevance of quantity and quality entrepreneurship for regional performance: The moderating role of the entrepreneurial ecosystem. *Regional Studies*, 53(9), 1308–1320. https://doi.org/10.1080/00343404.2018.1510481.

Szerb, L., Somogyine Komlosi, E., Acs, Z. J., Lafuente, E., & Song, A. K. (2022). The Digital Platform Economy Index 2020. Cham, Germany: Springer International Publishing.

Turnock, D. (1970). The Pattern of Industrialization in Romania. *Annals of the Association of American Geographers*, 60(3), 540–559. https://doi.org/10.1111/j.1467-8306.1970.tb00740.x.

Uzzi, B., & Spiro, J. (2005). Collaboration and Creativity: The Small World Problem. *American Journal of Sociology*, 111(2), 447–504. https://doi.org/10.1086/432782.

Ullah, B. (2020). Financial constraints, corruption, and SME growth in transition economies. *The Quarterly Review of Economics and Finance*, 75, 120–132. https://doi.org/10.1016/j.qref.2019.05.009.

Varga, A., Járosi, P., Sebestyén, T., & Basar, M. (2013). Detailed Policy Impact Model. Report of the SEARCH FP7 Project.

Vogel, P. (2013). Building and assessing entrepreneurial ecosystems. In Presentation to OECD LEED Programme Workshop on Entrepreneurial ecosystems and Growth-oriented entrepreneurship, The Hague, 7.

Vrabie, E. (2022). What is holding Romania back from growing tech unicorns locally? Retrieved April 23, 2022, from https://therecursive.com/what-is-holding-romania-back-from-growing-tech-unicorns-locally/.

Westerlund, M., Leminen, S., & Rajahonka, M. (2014). Designing Business Models for the Internet of Things. *Technology Innovation Management Review*, 4(7), 5-14.

World Bank. (2022). Employment in industry (% of total employment) (modeled ILO estimate) [Data set]. Retrieved from https://data.worldbank.org/indicator/SL.IND.EMPL.ZS

World Trade Organization (2019). *World Trade Report 2019: The future of services trade*. Switzerland: World Trade Organization.

Wurth, B., Stam, E., & Spigel, B. (2022). Toward an Entrepreneurial Ecosystem Research Program. *Entrepreneurship Theory and Practice*, 46(3), 729–778. https://doi.org/10.1177/1042258721998948.

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