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Andrea Szalavetz

Digital entrepreneurs in factory economies

1. Introduction

Digital entrepreneurs[1] are perceived as being innovative in the Schumpeterian (1934) sense. Their offerings rely on, embody, or are embodied in digital technologies (Lyytinen et al., 2016) that bring about a multiplicity of new product-service combinations and revolutionise the patterns of value-adding activities. Consequently, digital entrepreneurs are considered to have a transformative impact. Their activities disrupt some industries, rendering them obsolete, create new ones, and transform the business practices and models of actors in related industries (Vial, 2019). Note that since digital technologies are general-purpose ones, practically all industries are 'related'.

Digital entrepreneurial ventures have a large potential impact not only in a technological sense but also in an economic one: their high growth potential is demonstrated by the rapidly growing number of digital technologies-based unicorns.[2] Given this double impact, it is no surprise that digital entrepreneurship is currently deemed of paramount importance to economic development (Nambisan et al., 2019).

Digitalisation is expected to herald a new era in entrepreneurship (Nambisan, 2017) not only in advanced economies, although the development benefits of digital technologies are not evenly distributed (World Bank, 2016). Yet, digital entrepreneurship may become a new, qualitative source of economic growth, intensifying the catching up of countries that are prepared to exploit the much-praised capacity of digital technologies, namely that they 'democratise innovation and entrepreneurship' (e.g. Aldrich, 2014; Nambisan, 2017[3]).

However, in line with the scholarship which posits that not all entrepreneurs are equal (e.g. Henrekson and Sanandaji, 2019; Lafuente et al., 2019), and furthermore, there are non-negligible differences among digital entrepreneurs themselves (e.g. Sussan and Ács, 2017; von Briel et al., 2018), it is essential to explore the features of digital entrepreneurs also outside the centres of digital technology production. Uncovering the differences between advanced economies and less developed ones in the features and prospects of digital entrepreneurs may extend our understanding of the differences in the potential of these agents to become levers of growth and upgrading.

Complementing a large body of studies focusing on the nature and implications of digital entrepreneurship in advanced and in high-performing emerging economies (e.g. China), there is an emerging literature analysing the features and the practices of digital entrepreneurs at economic peripheries, in particular in Africa (e.g. Graham, 2019).

[1] Digital entrepreneurs are considered in this chapter in a narrow sense of 'digital technology entrepreneurs' (Giones and Brem, 2017).
[2] 'Unicorns' denote companies valued at $ 1 billion or more: https://www.cbinsights.com/research-unicorn-companies.
[3] For a review and a comprehensive critique of this view see: Dy (2019).

By contrast, there is scarce empirical evidence on the specifics of digital entrepreneurs in Central and Eastern European dependent market economies (CEE).[4]

The purpose of this chapter is to address this gap by drawing on insights gathered from interviews with twelve Hungarian digital entrepreneurs operating in the automotive technology ecosystem. We analyse the particularities of digital entrepreneurs in CEE, that is, whether the surveyed companies display the features described in the academic literature on digital entrepreneurs. This allows for considering the impact of digital entrepreneurship on the dependent position of the region, specifically, whether these important agents of innovation represent a strategic opportunity to shift CEE economies to a relatively higher-road trajectory of economic development. Can digital entrepreneurs enable these countries to break out of the dependent model?

The rest of this chapter is structured as follows. The introductory section is followed by a brief review of the literature on the specific features of digital entrepreneurs. Subsequently, the method of empirical data collection is outlined, and the empirical findings are presented. The final section discusses the findings and concludes with some propositions regarding the ways of interpreting and improving the developmental outcomes of these particular species of companies.

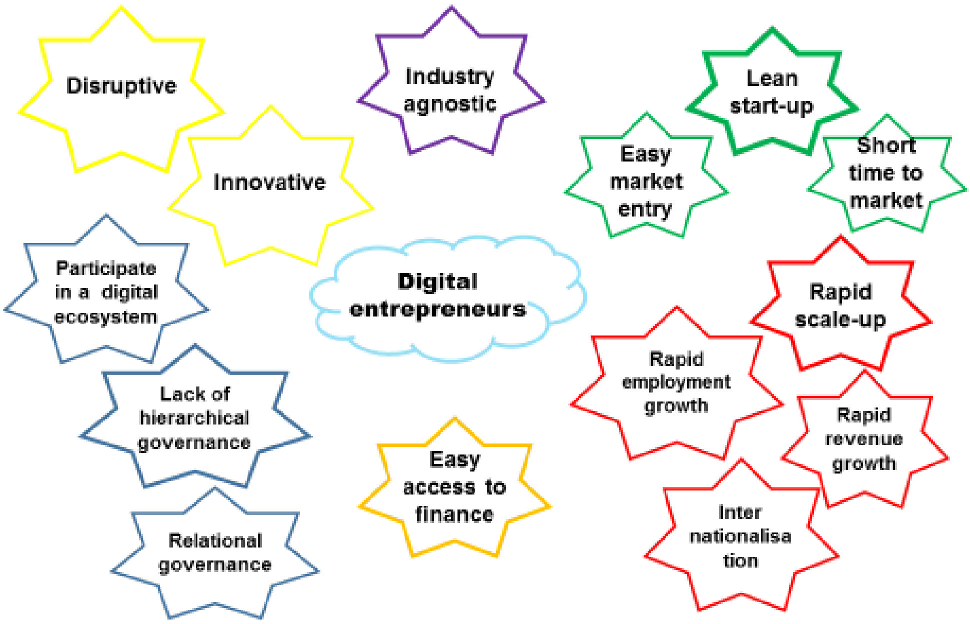
2. Digital entrepreneurs: a particular species driving high-road development

Digital entrepreneurship is defined as the setting up of entrepreneurial ventures with offerings (products, services or product–service systems) that embody, or are embodied in or enabled by digital technologies (Lyytinen et al., 2016). Prior research associates digital technology-based new ventures with knowledge-intensive, Schumpeterian entrepreneurship, and postulates that these companies have a high growth potential (Henrekson and Sanandaji, 2019; Huang et al., 2017; Lassen et al., 2018). The activity of digital entrepreneurs is expected to bring about meaningful economic gains in terms of innovation, productivity, growth, and employment (Lafuente et al., 2019).

Scholarly analyses list a number of additional distinctive characteristics that apply to digital entrepreneurs (Figure 1).

[4] A notable exception is Skala (2019). See also a companion paper prepared in the framework of this project (Szalavetz, 2020).

Figure 1: Characteristics of digital entrepreneurs



Source: Author's compilation based on her survey of the literature

Besides the two most common catchwords (Schumpeterian and disruptive) referring to their innovativeness, important distinctive features of digital entrepreneurs include a 'lean start-up' mode of market-entry[5] (Blank, 2013; Ries, 2011), and a higher-than-the-average speed of scale-up (Autio and Cao, 2019; Huang et al., 2017). In Nambisan's (2017: p. 1035) wording, digital technologies allow entrepreneurial processes to "unfold in a *non-linear fashion across time and space*." (italics added).

Since digital technologies allow for a low-cost experimentation with entrepreneurial ideas, entry barriers are lower and market entry is easier while the time to market is shorter for digital than for conventional entrepreneurs (Autio and Cao, 2019, Nambisan, 2017).

Digital entrepreneurs' rapid internationalisation is facilitated by digital technologies themselves. Digital infrastructures and platforms bridge distance, and enable a larger than the average market reach. Moreover, if the number and needs of users or customers escalate, they can be met without adding proportionately more resources (Zhang et al., 2015). Consequently, the value created and appropriated by entrepreneurs can grow rapidly—this is referred to by Nambisan (2017) as the non-linearity of digital entrepreneurs' growth.

Scaling-up is also enabled by digital entrepreneurs' relatively easy access to finance. Digital entrepreneurs are claimed to overcome resource constraints and obtain funding for their expansion relatively easily, for two reasons. Firstly, because they are able to harness digital technologies that reduce the information asymmetries hindering conventional lending processes (Estrin et al., 2018). Secondly, because they are major beneficiaries of the intensifying interest of 'BigTech' companies (the best capitalised, largest technology companies) in financial services provision (Frost et al.,

[5] Instead of entering the market with a product deemed 'perfect', as a result of large-scale upfront development, lean start-ups would launch 'minimum viable products' or offerings that are intentionally incomplete (Nambisan, 2017), and rely on customers' feedback for further development.

2019), and are recipients of corporate venture capital investment by large, established, non-digital firms trying to integrate digital offerings in their core products.[6]

Digital entrepreneurs are considered industry agnostic (Autio and Cao, 2019), targeting customers in virtually any sector. This substantiates the claim that digitalisation has transformed the nature and degree of openness in innovation and entrepreneurship (Nambisan et al., 2019). Compared to conventional start-ups, it is easier for digital entrepreneurs to acquire large established companies as customers, since these latter need to adapt to the 'digitalisation imperative' to streamline their operations, improve their processes, and create new business models (Crittenden et al., 2019). Additionally, digital entrepreneurs can benefit from strong public incentives supporting their growth, among others, by subsidies for the adoption of new digital solutions.

Over and above being integrated in particular value chains, the business environment for digital entrepreneurs can rather be described as a digital ecosystem, i.e. a network of interdependent and collaborating organisations that use digital infrastructure to create value jointly (Sussan and Ács, 2017; Valdez-de-Leon, 2019).

Another noteworthy feature characterising digital entrepreneurs is that their inter-organisational exchanges are characterised either by *relational governance* based on trust, collaborative problem solving, and information sharing (Gereffi et al., 2005), or by *ecosystem governance*, in which the rules of participation and the distribution of revenues among the partners are clearly established.[7] Compared to the captive or hierarchical governance modes characterising the transactions of physical product suppliers or manufacturing subsidiaries in factory economies, this feature suggests that local digital entrepreneurs rely on a high level of technological knowledge for their integration in global value chains and that their contribution involves knowledge-intensive, high value-adding activities.

3. Research design, data collection and analysis

Since digital entrepreneurship by domestic-owned actors in factory economies is a nearly uncharted territory of academic research (Szerb et al., 2018), this chapter employs an exploratory research design, based on corporate interviews, to obtain insights on the ways digital entrepreneurs exploit the specifics of cyber technologies (Eisenhardt, 1989).

Business press articles and reports by management consultancy firms abound in success stories describing the evolution of some highly-valued digital empires. Although the Global Unicorn Club contains barely any companies from peripheral factory economies,[8] local observers, also in 'low/moderate performer' dependent market economies, find it relatively easy to identify a couple of local high-flying, entrepreneurial companies specialised in today's paradigm-changing, digital technologies.

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[6] For example, Sandler (2017) provides a survey of the top venture capital investment providers in the automotive technology sector, and shows that there are several established OEMs among them.

[7] Being embedded in digital ecosystems, i.e. in loose networks of digitally connected and interacting organisations *that are not managed by a hierarchical authority* (Valdez-de-Leon, 2019) characterises an increasing number of digital entrepreneurs.

[8] In August, 2019 the 'Club' had 393 members, with U.S. and Chinese unicorns accounting for the dominant majority of listed companies. The new member states of the European Union were represented by one firm from Estonia and one from Malta.

The context of this study is Hungary, a typical dependent market economy (Farkas, 2011, 2016) in which both innovation performance (European Innovation Scoreboard, 2018) and business digitalisation performance are particularly weak.[9]

The sample was selected on the basis of two criteria. The selected companies were (1) domestic-owned entrepreneurial ventures specialised in the provision of digital solutions, and (2) involved in supplying automotive companies. The context of one single industry, the digital automotive technology ecosystem, was selected in an effort to homogenise the sample – at least partially. The automotive industry proved to be a good choice, since the digital intensity of value-adding activities is among the highest in automotive value chains (Calvino et al., 2018). Furthermore, given Hungary's strong specialisation in this industry[10] and the dominance of foreign-owned manufacturing units, this industry exemplifies Hungary's dependent market economy status, and its exposure to the developments in the automotive industry and to the strategic decisions of lead companies.

The method of purposeful sampling (Patton, 1990) has been applied, and companies whose cases seemed promisingly information-rich were chosen. This was made possible by the author's database of a collection of business press and technology press articles describing the achievements of Hungarian companies in terms of digital transformation and digital innovations.[11]

Twelve domestic-owned entrepreneurial ventures were interviewed between January and April, 2019. Interviews lasted 90 minutes on average, and were guided by an interview protocol consisting mainly of open-ended questions to facilitate exploration. The questions were organised around three topics: the history of the venture; its business strategy; and the factors enabling its integration in the highly-concentrated automotive value chains. The empirical data obtained during the interviews have been analysed in two papers. The main focus of this book chapter is the specifics of the surveyed firms, their offerings, and their business strategy, while a companion paper (Szalavetz, 2020) is concerned with the factors enabling the integration of digital solution providers in automotive value chains.

The qualitative data obtained from individual interviews have been analysed content-wise, involving the identification of the key commonalities that facilitate interpretation. Analysis was conducted using standard within-case and cross-case analysis techniques (Eisenhardt 1989). We applied the constant comparative method for data analysis (Glaser, 1965), collecting and analysing data simultaneously. This allowed us to cross-check the emerging patterns in subsequent interviews, and/or contrast interviewees' remarks with those gained in prior interviews.

4. Results

To set the context, we first asked about the specifics of the surveyed firm's products and/or solutions. We asked our interviewees to recount the history and how their

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[9] According to the business digitalisation pillar of the composite Digital Economy and Society Index, Hungary scores the second lowest in EU28, ahead only of Romania (DESI, 2018). Hungary's position in international rankings of entrepreneurial capabilities is also much lower than those of its CEE counterparts. (Hungary was 50th in the 2018 edition of the Global Entrepreneurship and Development Index. By contrast, Poland was 30th, Slovakia: 36th, and the Czech Republic: 38th (Ács et al., 2018, pp. 28-29.).

[10] This industry accounted for more than a quarter (27.1%) of total manufacturing production in 2018 (Source: author's calculation from Central Statistical Office data).

[11] See companion paper (Szalavetz, 2020) for details.

offerings had been developed. The interviews had been preceded by a compilation of secondary source data (press releases and business press articles about the company, public profit and loss accounts, and notes to the financial statement). These documents disclosed important basic data on the firms in question, and were useful also in terms of triangulating interview information. The basic data of the surveyed firms are summarised in Table 1.

Table 1: Overview of sample firm characteristics (data for 2018)

No.	Product	€	Employment	Year of foundation	Interviewee
1	A self-driving software stack. A simulation solution for testing autonomous vehicles (purpose-built virtual representation of the environment allowing to recreate problems in vehicles' environments so that simulation and validation exercises can be carried out). A power-efficient hardware IP core to accelerate artificial intelligence-based self-driving software deployment that solves the problems associated with the currently excessively high power consumption of the hardware that accelerates AI-based automated driving solutions. A highway autopilot solution for autonomous driving in highways.	~5m	182*	2015	Marketing officer
2	Business intelligence: provision of big data, data visualisation and analytics-based solutions of company-specific problems; strategic consulting relying on data science approaches.	9.5m	136	2006	Communications officer
3	Connected car vehicle-to-everything (V2X) solutions: a software stack allowing for V2X communication to be integrated in on-board units or roadside units.	~1m	29	2012	Technology officer
4	Integrated digital ergonomics system, i.e. a motion digitising and evaluating device that captures, measures, records, and analyses data related to assembly workers' motion, to be used for ergonomic analyses and testing.	~7k	4	2014	Managing director
5	Engineering services♦: development and implementation of production tracking systems, barcode and RFID solutions for production logistics and warehousing, self-developed real-time location system.	3.9m	31	1990	Business unit manager
6	Engineering services♦: development and implementation of visual inspection solutions (camera-based or 3D scanning based) for quality control in manufacturing production; industrial software development e.g. traceability systems, MES.	766k	10	2015	Founder
7	An immersive virtual reality system, i.e. a 3D educational and virtual collaboration platform to be used (among others) by students specialised in automotive engineering or to be applied for training new employees in automotive companies. Furthermore, this platform integrates various online collaborative tools, connecting	101k	2	2013	Founder

	multiple users: used e.g. in new product development.				
8	Development, manufacturing, deployment and commissioning of custom-tailored production machinery combined with smart solutions. Analysis and solution of specific technological problems related to customers' product and process development and engineering activities. R&D in the field of simulation methods and finite element analysis.	7.1m	51	2002	Founder
9	Engineering services♦: development and deployment of cyber-physical production systems (CPPS), robotic system integration, development of CPPS-based functional solutions (e.g. quality control, process automation, production monitoring and optimisation, etc.). R&D on collaborative robots, development of demonstration use cases of collaborative robots.	5.5m	46	1991	Business develop ment manager
10	Conceptual design and implementation of customised special-purpose machinery for factory automation; system integration services (robotics, computer vision, measurement system, data acquisition and processing).	508k	14	2012	Founder
11	Design and implementation of cyber-physical systems and analytics solutions for manufacturing companies. Consultancy about the ways and methods of digital transformation and implementation of smart factory solutions. Data-driven and AI-powered business process reengineering and optimisation, solution of technological problems.	67k	2	2013	Founder
12	An industrial Internet of Things (IIoT) platform for smart factories, based on big data technologies and machine learning. The platform is capable of implementing machine-learning-powered process optimisation. The platform supports smart factory applications. Design and implementation of smart factory solutions on the basis of this platform.	~25k	10	2017	Founder

€ = net sales in EUR (the exchange rate used for conversion from HUF was 319) k = thousand, m = million, employment = number of employees, MES = manufacturing execution system

* In addition to 182 employees in Hungary, the company has dozens of employees abroad.

♦ Engineering services include assessment of the customer's processes, identification of bottlenecks, conceptual design of a solution, procurement, deployment, installation (commissioning), and in some cases service and maintenance of system-specific hardware e.g. machinery, or track and tracing infrastructure, cameras, sensors, or other data capture tools, user interfaces, and other system components, together with the development and deployment of the related software e.g. reporting algorithms, mobile applications, and system integration services.

The detailed descriptions in Table 1 highlight that the offerings of the sample companies show a great diversity, reflecting the multiplicity of entrepreneurial opportunities stemming from conceivable product–service combinations. Notwithstanding this diversity, some commonalities allowed for the classification of sample companies into two groups. Based on the accounts of the interviewees, in Figure 2 we have grouped the solutions of the surveyed firms into a 2x2 matrix according to the hardware/software-intensity and customer-specificity of the given solution. Hardware-intensity is obviously considered in a relative sense, since the solutions of all companies are highly software-intensive or in a broader sense, intangibles-, and knowledge-intensive.

Figure 2 reflects that the distribution of the sample is skewed, since the dominant majority of the companies create and deliver custom-tailored digital solutions (industrial cyber-physical product–service systems). These technology providers integrate digital technologies in customers' production / business systems to enhance the efficiency of, and the value of data generated by, customers' production / business processes. By contrast, the companies in the bottom left quadrant (BLQ) offer productised (rapidly scalable) digital solutions.

Figure 2: The classification of sample companies' products & solutions

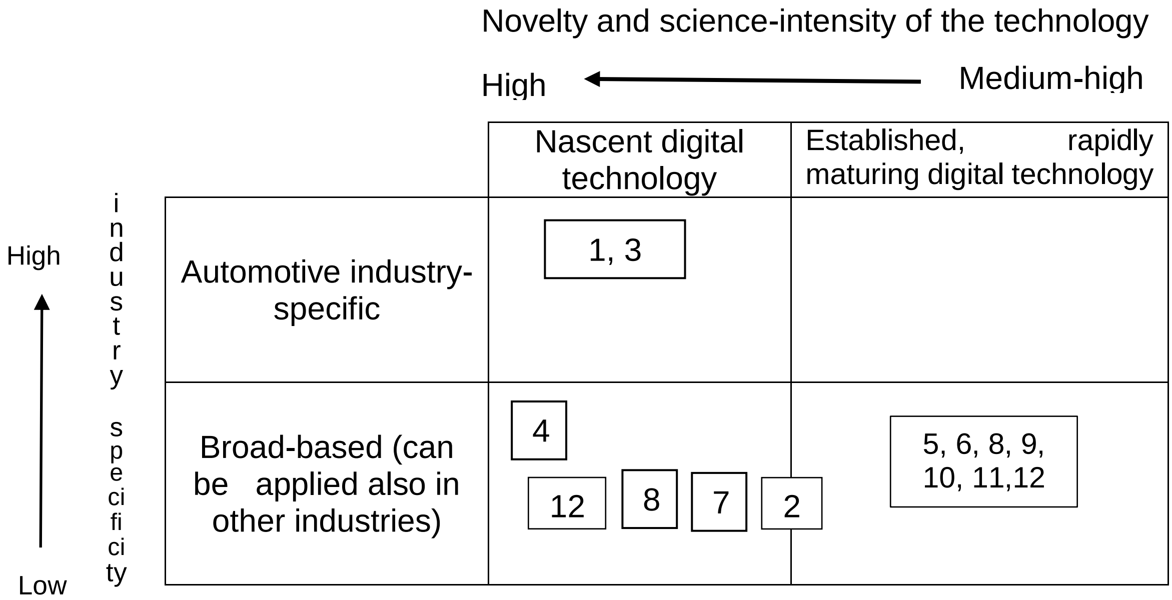
	Productised solutions	Custom-tailored digital solutions
Hardware-intensive		4, 5, 6, 8, 9, 10
Software-intensive	1, 3, 7	2, 11, 12

Although it is challenging even for technical experts to determine the technological novelty of specific solutions, in order to guide our analysis, we have grouped the solutions of the surveyed firms also according to the novelty of the technology (Figure 3). In categorising individual solutions, we relied both on the opinion of the managers interviewed and the concepts on technological novelty outlined in the literature.[12]

On the one hand, Figure 3 confirms the claim that (most) digital entrepreneurs are industry agnostic: their solutions can be used by customers in any sector (Autio and Cao, 2019). The customer portfolios of most of the surveyed firms are not limited to automotive industry actors, nevertheless, automotive companies represent a large share of their customers. This demonstrates the pioneering status of the automotive industry in the field of digital transformation.

[12] In order to determine novelty, Abernathy and Clark (1985), for example, analyse the capacity of an innovation to influence the established production system and customer base, classifying innovations as incremental or radical. Radical innovations make existing production systems obsolete, destroy the value of existing expertise, demand new procedures, and/or create new markets. In a similar vein, Tushman and Anderson (1986) classify technologies as competence enhancing or competence destroying— the latter case is characterised by a higher degree of novelty. Other scholars in the innovation literature rely on the concepts of (a) technological uncertainty, e.g. regarding the means to accomplish certain tasks (e.g. Fleming, 2001), and (b) familiarity and previous experience with the product and process technologies employed to create the desired new product or solution. In this latter sense, Henderson and Clark (1990) consider a technological invention radically new if, compared to existing technologies/solutions, it is based on different scientific and engineering principles.

Figure 3: Some additional features of sample companies' products & solutions[13]



On the other hand, Figure 3 also suggests that the offerings of the majority of the firms in the sample are neither disruptive nor radical innovations based on nascent technology. The solutions of the firms in the bottom right quadrant (BRQ) of the matrix rely on already existing, and rapidly maturing, digital technologies, e.g. cyber-physical systems, factory automation, simulations, digital twins, and analytics. These technologies are applied in company-specific combinations and enable adopters' digital transformation to achieve improvements in their existing production systems and/or to solve particular technological or business problems.

Irrespective of the fact that the deployment of smart factory-specific digital technologies requires extensive software development and systems integration capabilities, these solutions no longer convey *nascent* technologies. Smart factory-specific or 'industry 4.0' solutions are becoming more and more mature and established. Considering that the term 'industry 4.0' was officially introduced less than a decade ago, in 2011, at the Hannover trade show, this reflects the acceleration of technology innovation cycles.

As the following interview excerpt demonstrates, the entrepreneurial strategies and practices of BRQ companies have not changed, they have simply *grown digital*.

[13] Companies 8 and 12 are represented in multiple quadrants. This refers to different products/activities. For example, besides designing and implementing custom-tailored and smart solutions embedded in special machinery, No. 8 is also engaged in the solution of product development related technical problems, and conducts basic research to develop material science-specific simulation methods – used by global automotive companies aiming at reducing the weight of selected components. No. 12 is specialised in basic research-intensive IIoT development, which is represented in the bottom left quadrant of the matrix. Additionally, No. 12 designs and implements industry 4.0 projects for Hungary-based manufacturing companies (mainly automotive ones). This latter activity is classified in the bottom right quadrant of the matrix. Note that the custom-tailored individual solutions of the companies in the bottom right quadrant are highly heterogeneous also in terms of the technological and R&D capabilities required to design and implement the given solution.

"The activities we perform have not changed radically, we simply integrated digital technologies both in our activities and in our offerings" (No. 5, 6, 9)

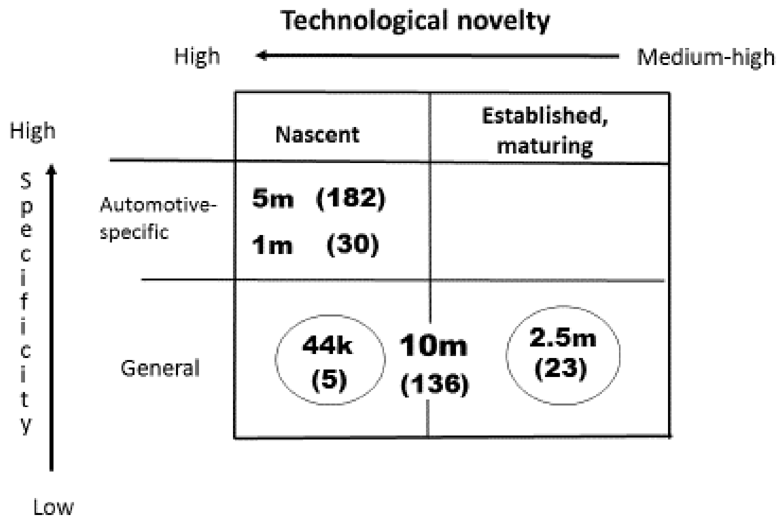
Notwithstanding that these offerings have no 'transformative' impact, i.e. they are not expected to bring about creative destruction, they are evidently innovative in a Schumpeterian sense, representing 'new product–service combinations', and/or "reform[ing] or revolutioni[sing] the pattern of production by exploiting […] an untried technological possibility for producing […] existing commodities in a new way" (Schumpeter, 1943, p. 132).

By contrast, the offerings of the companies in the 'nascent technology' column can be regarded as radical novelties. Interview data confirmed that these *born digital* companies introduced their offerings in the market as lean enterprise-specific, incomplete, 'minimum viable products' (Ries, 2011). The solutions of this group of companies are at different stages of R&D and commercialisation, and all have undergone continuous evolution ever since the first versions were introduced. Although the managers interviewed (No. 1, 3, 4, 7, and 12) have all underscored that their offerings require several years of further development, the 'still incomplete' products of these companies are generating, in some cases, revenues that are already non-negligible.

Investigating the association between the novelty of the technology and business performance, our data indicate that there is no meaningful relationship between these variables (Figure 4). For example, although the offerings of the companies in the BLQ of the matrix (No. 4, 7 and 12—the IIoT platform in this latter case) represent radical novelty, the impact of these companies in terms of revenues is lower than that of the companies in the BRQ.[14]

[14] Note that a simple comparison of turnover data without considering the cost of goods sold may provide a distorted picture. This item may be quite large in the case of companies supplying smart factory solutions together with systems integration services, since it may include purchased special purpose machinery.

Figure 4: Turnover (€) and (employment), 2018



Note: Circled data are averages

More importantly, the growth performance of nascent technology companies does not unambiguously validate the assumption that digital entrepreneurial ventures have a high growth potential. The level of an 'adequate' performance in terms of revenues can barely be determined in the case of nascent technology companies, whose offerings represent radical novelty while it is also hard to fathom how long it takes to reach the tipping point, after which sales performance 'explodes' – this is highly heterogeneous across digital entrepreneurs. Nevertheless, it is clear that the turnover data of companies 4, 7, and 12 (note that this latter is a very young company) leave a lot to be desired.[15]

One reason for their failure to scale is that they have not been able to overcome the usual financial constraints faced by entrepreneurs. Although several companies obtained either venture capital investment or research grants, the managers interviewed considered the low level of external funding as one of their main obstacles to growth.

Companies 1, 2 and 3, are the only ones to represent a textbook case of Schumpeterian, high-impact, rapidly growing digital entrepreneurs, specialised in nascent technology, and offering born-global products.

As for entrepreneurs specialised in hard-to-scale, custom-tailored digital solutions, the main determinant of growth is, in principle, their business development capability. However, as the following interview excerpt illustrates, business development was not an issue for the companies in the right-hand column of Figure 2, since demand for their offerings was growing rapidly.

"There is such a high demand for our specialised expertise in digital engineering services provision that we do not have to make substantial investments in business development – we have more assignments than what we can reliably accomplish." (No. 8)

[15] This finding is consistent with the literature on business gazelles and high-impact firms (e.g. Ács, 2011), positing that the average high-impact firm is not a new start-up.

Nevertheless neither have these companies experienced a rapid growth: growth in their cases has been rather moderate, albeit sustained. The main bottleneck limiting growth in this latter group was the lack of skilled software developers and engineers, exacerbated by the fierce competition for talent both from the better-capitalised local subsidiaries of global companies and from foreign labour markets.

The employment data of the companies in the sample also seem disappointing, especially in the light of the literature emphasising the strong positive impact of entrepreneurship on job creation (see survey in Haltiwanger et al., 2013). The companies in the sample had, on average, been operating for ten years in 2019, even so, only two of them have more than 100 employees. The average number of employees is 43 across the sample, and without the two outliers it is only twenty.[16]

Interviews have revealed that the market orientation of the surveyed firms is closely related to the specifics of their offerings. The providers of production-related digital services or product-service systems have not internationalised[17]: they have remained local, targeting Hungary-based manufacturing firms—that were in most cases the local subsidiaries of global companies.[18] Companies 2 and 4, and those in the BLQ of Figure 2 offering productised solutions, are predominantly export-oriented. Some of the exporting companies have even established sales offices in the Silicon Valley and in emerging Asian economies.

Regarding the governance modes characterising the transactions of the surveyed companies, our interview information confirms the prevalence of relational governance. Relational governance is justified in cases, where the planning and the implementation of custom-tailored digital solutions require close collaboration between technology providers and adopters. This collaboration is based on trust and the sharing of knowledge between the two parties. Solution provision is not a one-off activity: the technology providers demonstrate their capabilities, build trust, and accumulate knowledge about the customers' problems in the course of the initial projects. Subsequent assignments by the same contractors are usually broader and deeper. Another explanatory factor of the prevailing mode of governance is the uniqueness of knowledge, which precludes price-based competition and hierarchical governance.

"It's a kind of joint experimentation with our main customer to improve our offering further. It is not a market-based transaction, where price matters." (No. 4)

"It is not the price of our services that matters. What matters is achieving the trust of prospective customers, so that they believe in our capabilities, that we can solve their problems." (No. 2); [It's not the price of our services, but] "what matters is being involved in internationally funded research projects." (No. 9)

Ecosystem governance was relevant in the cases of two companies in the sample (No. 1 and 3) and occasionally (in some projects) also for Nos. 8, 9, and 12.

[16] Note that instead of hiring new employees, several small companies (with fewer than 10 employees) would from time to time resort to independent contractors (freelance software developers) providing software development services to accomplish specific projects. They would do so because orders were volatile. Consequently, company-level employment data do not precisely reflect the real employment impact of these ventures.

[17] This finding is consistent with the Polish experience, see the chapter in this book by Gwosdz et al.'s (2020).

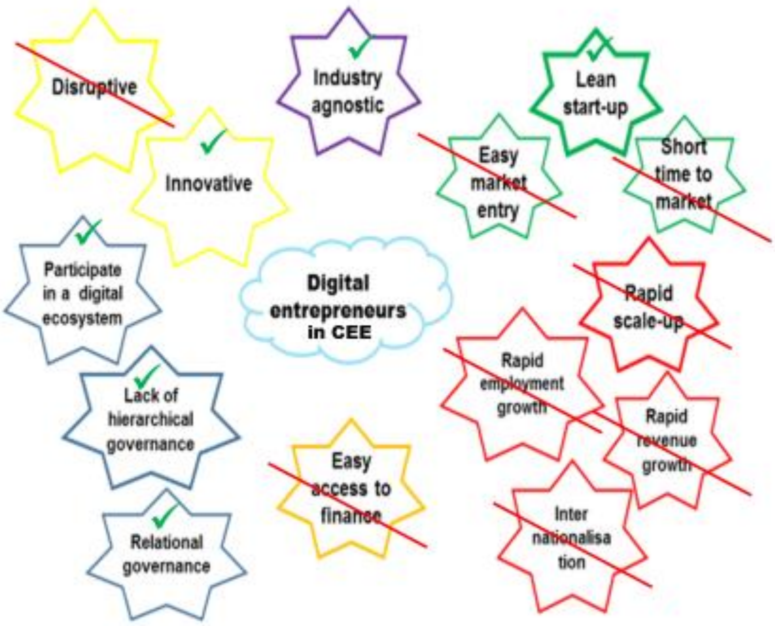
[18] No. 2 is an exception: it offers business intelligence services, supporting business management rather than solving production-related technological problems. Its customers are mainly international, including some Fortune 500 companies.

"We collaborate with our future customers in a number of research and demonstration projects funded by foreign stakeholders, research funds, local municipalities, or EU-programmes. A non-negligible share of our revenues stems from these collaborations. You see, our competitiveness is based on the reputation we have built so far. Our [ecosystem] partners *trust* that we are able to contribute." (No. 1 and 3)

Discussion and policy implications

From these results we can conclude that the specifics of the surveyed digital entrepreneurs do not fully and unambiguously conform to those described in the literature (Figure 5).

Figure 5: Results



Indeed, the offerings of most of the surveyed companies proved to be 'industry agnostic' while the governance mode characterising their transactions is relational or ecosystem-based, and not hierarchical. Half of the firms in the sample have, indeed, introduced 'still incomplete' products, to be further developed according to customers' feedback, which confirmed the lean enterprise-specific mode of digital entrepreneurs' market entry. On the other hand, the custom-tailored solutions offered by the other half of the sample have also attained ready-to-launch form following an iterative process of joint fine-tuning by the teams of both the vendor and the customer. In that sense, the examples of the surveyed firms would all confirm the 'lean start-up' feature characterising digital entrepreneurs.

However, although the companies in the sample are all innovative in a Schumpeterian sense, their offerings were disruptive only in few cases. Instead of a 'transformative impact', the solutions of the companies in the right-hand column of Figure 2 have enabled the adopters to perform their traditional core activities more efficiently than previously.

Instead of an explosive growth, most companies have experienced only a more or less modest increase in revenues and employment. For most, access to finance has proven to be one of the key obstacles to scaling-up.

Furthermore, contrary to the alleged rapid internationalisation of digital entrepreneurs, the majority of the surveyed companies—those in the BRQ of Figure 3—have remained local.

Most of the differences we identified are related to the specifics of the offerings. Note that companies with productised offerings were under-represented in the sample while the providers of customised digital solutions for manufacturing plants were over-represented. Further research is required to determine, whether the distribution of digital entrepreneurs is significantly different in dependent market economies from that of advanced economies, in terms of a higher-than-the-average share of entrepreneurs offering production-related digital solutions to the local manufacturing subsidiaries of global companies. Intuition suggests that this is the case, however, the small size of the sample does not allow for general conclusions in this respect.

From another perspective, it is obvious that, in a country where innovation and business digitalisation performance are weak, and labour productivity and entrepreneurial performance are low, all kinds of digital entrepreneurs matter, not only the high-impact ones that display explosive growth. Whether their products are disruptive or not, digital entrepreneurs play a crucial role in improving these performance indicators. They contribute to local technology upgrading, since the adoption of digital technologies improves adopters' productivity and competitiveness. Consequently all kinds of digital entrepreneurs – not only high-growth ventures with disruptive offerings based on radical innovation – can assist dependent market economies' efforts to progress towards a high-road trajectory of economic development. The surveyed companies should be acknowledged as drivers of productivity- and innovation-driven, high-local-value-added, qualitative development.

Nevertheless, in the dependent market economies of CEE, the extent to which digital entrepreneurs generate economic gains for their countries of origin is dwarfed by that of efficiency-seeking foreign direct investment in export-oriented manufacturing. For example, the performance of even some high-flying companies in the sample appears insignificant in comparison with that of traditional automotive subsidiaries.[19]

Altogether, local digital entrepreneurs are, currently, barely able to improve the dependent position of CEE economies: their number and economic impact are too small to bring about the required qualitative shift in the development trajectories of these countries. Digital entrepreneurship could become a statistically more significant source of GDP growth only where two conditions are fulfilled. On the one hand, a critical mass of digital entrepreneurs is indispensable: their number needs to increase rapidly. On the other, digital entrepreneurs need to be able to access the inputs necessary for their growth, in terms of finance, business development know-how, and adequately skilled labour.

Our results call for a fostering of digital entrepreneurship, as an avenue to qualitative economic development and upgrading. This demands no radical policy innovations: traditional policy instruments[20] are required, promoting the accumulation of digital competencies and subsidising investments that increase companies' digital maturity. This latter promises to kill two birds with one stone: in addition to improving

[19] In 2018, the turnover of Magyar Suzuki was higher than that of No. 3 by a factor of 2,000, and that of a relatively smaller local automotive subsidiary, Hankook Tire, by a factor of 700. (Source: author's calculation from data of the TOP 50 Hungarian non-financial companies, HVG, 25th July, 2019.)

[20] At the same time, the experiences of the surveyed companies also call for new policy mechanisms, e.g. accelerator programmes that foster the scaling-up and the internationalisation of digital ventures offering productised solutions.

technology adopters' total factor productivity, it also offers new business opportunities to local digital entrepreneurs.

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