
Editorial: Technology adoption over the stages of entrepreneurship

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Abstract: The role of technology in shaping the emergence, nature, and outcomes of entrepreneurship has emerged as a key research agenda. Recent research in entrepreneurship and innovation shows that technology matters. However, how, when, and which technology matters for entrepreneurship is much less clear, as a variety of new technologies (e.g., business analytics, social media technology, mobile applications and development, cloud computing, internet of things, machine learning, artificial intelligence) are available across industries and regions and may be introduced and adopted at different stages of entrepreneurship: (1) pre-stage (latent and nascent entrepreneurship), (2) early-stage (emergent entrepreneurship), and (3) late-stage (growth entrepreneurship). This special issue examines the role and impact of technology adoption over the stages of entrepreneurship. Taking a dynamic capability view, we develop a theoretical framework on the role of technology adoption over the stages of entrepreneurship, focusing on three domains of (technological) capabilities used by entrepreneurs – strategic, managerial, and operational. We state that an alignment of these three domains is likely to facilitate the creation and leverage of digital capabilities of entrepreneurs, providing guidance to answer the questions on what technology to adopt, when to adopt it, and how to adopt it.

Keywords: technology adoption; entrepreneurship; dynamic capabilities, digital capabilities; technological capabilities.

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1 Introduction

A growing number of studies in technology and entrepreneurship emphasise the role of context (Autio et al., 2014; Welter et al., 2019) for both the transition from latent to emergent entrepreneurship and entrepreneurial growth (Audretsch et al., 2022a, 2022b). Technologies, including an increased digitalisation, thereby shape regional entrepreneurial dynamics (Belitski and Desai, 2016; Nambisan et al., 1999, 2017) as well as the emergence of digital entrepreneurial ecosystems (Song, 2019; Sussan and Acs, 2017). Although studies demonstrate that institutional characteristics remain relatively constant over time (Stuetzer et al., 2018), in recent decades, the digitalisation of entrepreneurial activities has added to the volatility in entrepreneurial transition (Caiazza et al., 2020) at various stages of entrepreneurship (Audretsch et al., 2022a, 2022b). The digital transformation of entrepreneurs and their communities has created new forms of entrepreneurship (Nambisan, 2017; Sahut et al., 2021) and has shaped entrepreneurial trajectories across Europe and globally (Audretsch and Belitski, 2021; Autio et al., 2018; Göcke et al., 2022). Consequently, recent studies have called for exploring in more detail how technologies, including digitalisation, not only directly affect entrepreneurial outcomes but also entrepreneurial trajectories, including entrepreneurial aspirations (Estrin et al., 2013), entrepreneurial orientation (O'Shea et al., 2005), and growth rates of entrepreneurs (Nambisan et al., 2019).

The role of technology in shaping the emergence, nature, and outcomes of entrepreneurship has emerged as a key research agenda. Recent research in entrepreneurship and innovation shows that technology matters (Autio et al., 2018), in line with an extensive literature on information systems and information technology

governance on the effect of technological change on firm performance and society (Grant, 1991; Khalil and Belitski, 2020). However, how, when, and which technology matters for entrepreneurship is much less clear, as a variety of new technologies (e.g., business analytics, social media technology, mobile applications and development, cloud computing, internet of things, machine learning, artificial intelligence) are available across industries and regions and may be introduced and adopted at different stages of entrepreneurship: (1) pre-stage (latent and nascent entrepreneurship), (2) early-stage (emergent entrepreneurship), and (3) late-stage (growth entrepreneurship). Heterogeneity both in the technology and in entrepreneurship outcomes invalidates a ‘one-size-fits-all’ approach to understanding this relationship and presents a ripe and relevant research agenda (Nambisan et al., 2017). Some technologies may play a more decisive role at the nascent stages of entrepreneurship (e.g., cloud computing, social media, big data analysis) when resources and skills are limited. Other technologies such as the internet of things, artificial intelligence, or blockchain may facilitate further the exploration of opportunities for emergent entrepreneurs and established firms, i.e. growth entrepreneurs (Autio and Rannikko, 2016). Given that ‘entrepreneurship’ itself is a heterogeneous phenomenon, there may be different responses to technology adoption depending on the entrepreneur’s motivation and stage of emergence (Audretsch et al., 2015).

The collection of papers in this special issue aims to answer the question of how, when, and which technologies should be developed and adopted by entrepreneurs over the different stages of entrepreneurship, considering also changes in technologies over time. For pre-stage entrepreneurship, technologies enable fast access to information and networks as well as the validation of business ideas and concepts. For early-stage entrepreneurship, technologies enable the transition from a startup to a scaleup by reducing transactions costs and lifting research limitations. For late-stage entrepreneurship, new technologies can support further the exploration of market opportunities and can facilitate growth and access to new markets. In doing so, the papers in the special issue examine the role of technologies that enable the pipeline of entrepreneurs from those considering an opportunity (latent and nascent entrepreneurs), those who are already acting on the market (emergent entrepreneurs), those who have developed their market and further exploit existing opportunities (growth entrepreneurs) (Audretsch and Keilbach, 2008) as well as those who went beyond entrepreneurial aspirations (Estrin et al., 2013).

The remainder of this paper is structured as follows. The subsequent section develops a theoretical framework on the role of technology adoption over the stages of entrepreneurship, followed by a description of the papers included into the special issue. A final section concludes, highlighting fruitful future avenues of research.

2 Theoretical framework

Adding the digitalisation perspective to the dynamic capability view (DCV) helps to explain how entrepreneurs enter the market using digital technologies (Helfat, 2000; Helfat and Peteraf, 2003). The analysis of the digitalisation of entrepreneurial capabilities thereby relates to both dynamic and operational capabilities. Helfat and Peteraf (2003, p.1007) thus note that “a dynamic capability in the form of research and development may enter the renewal stage as new techniques for conducting R&D become available. A firm also may redeploy an R&D capability from one market to another market”.

Moving across different stages of the entrepreneurial life cycle thus requires entrepreneurs to operate and develop three domains (Tallon and Pinsonneault, 2011): (1) the strategic domain, (2) the managerial domain, and (3) the operational domain. These three domains do not exist in a vacuum, but consist of a set of inter-related elements (Santoro et al., 2019). Distinguishing between individual attributes therefore requires the analysis of several interrelated domains and characteristics within an entrepreneurial firm.

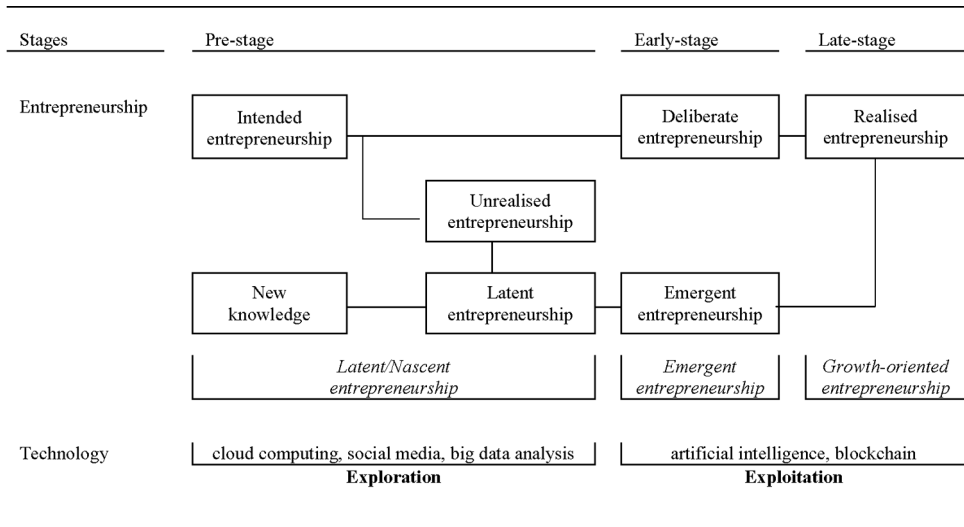
The *strategic domain* of digital capabilities consists of the strategic alignment between business and digital operations and strategy as well as value delivery (Li et al., 2016). A strategic alignment ensures a link between the business and IT objectives for entrepreneurs, where value delivery represents providing value from optimising the different digital expenses, digital infrastructure, and data sharing (within the organisation and its external parties). Aligning growth and digital strategies is essential to realise the full value from technology by entrepreneurs and improve value creation (Coltman et al., 2015; Cunningham et al., 2018). In particular, the strategic domain of entrepreneurship is able to integrate both business and digital aspects, constituting a key alignment dimension, which will further lead to strategic choices on business and digital strategy. The *managerial domain* of digital capabilities consists of management structures and processes. Management structures represent entrepreneurial skill levels and the availability of e-competences as resources (Merindol and Versailles, 2020). Management structures may include an IT department and a Chief Information Officer (CIO), which both can affect management governance. The managerial domain further includes risk management and agility (Somsing and Belbaly, 2017) towards software development (Lee and Xia, 2010), enabling higher resilience and agility to shocks (Korte and Hüsing, 2015). The *operational domain* of digital capabilities finally enables the integration of transaction-oriented and standardised data on products, customers, and external partners within and outside entrepreneurial firms.

Effective strategic alignment of all three domains by considering the way entrepreneurs make decisions on developing or adopting a technology to move forward on the entrepreneurial lifecycle includes considering the availability and cost of external and internal resources used to strengthen a dynamic entrepreneurial capability (Bantham et al., 2003; Somsing and Belbaly, 2017). Adopting Teece et al.'s (1997) concept of dynamic capabilities as well as drawing on Nambisan et al.'s (2019) approach to linking digital technologies to value creation and value capture, we state that an alignment of the three domains (strategic, managerial, and operational) of technology is likely to facilitate the creation and leverage of digital capabilities of entrepreneurs, providing guidance to answer the questions on what technology to adopt, when to adopt it, and how to adopt it.

Prior research suggests that the concept of dynamic capabilities can explain why some entrepreneurs are more successful in adopting new technologies and in establishing competitive advantages in markets than others (see Helfat, 2000; Helfat and Raubitschek, 2000; Teece, 2007; Khalil and Belitski, 2020). Entrepreneurs who consider an opportunity of starting a business and entering a market (latent and nascent entrepreneurs) and those who have already entered a market and continue to grow (emergent entrepreneurs) (Audretsch et al., 2022a, 2022b) will need to cultivate their dynamic capabilities at different levels to create novel products (Deeds et al., 2000). The DCV thereby suggests that dynamic capabilities propel entrepreneurs to cope with the rapidly changing digital landscape with a fast-growing digital infrastructure at any stage of the entrepreneurial life cycle (Audretsch and Belitski, 2017; Nambisan et al., 2017).

The adoption of new technologies creates entrepreneurial opportunities and enables a pipeline of entrepreneurs from those considering an opportunity (latent and nascent entrepreneurs), those who are already acting on the market (emergent entrepreneurs) as well as those who have developed their market and further exploit existing opportunities (growth entrepreneurs) (Audretsch and Keilbach, 2008; Audretsch et al., 2021). Figure 1 illustrates the role of technology adoption, with the example of some specific technologies over the three distinct stages of entrepreneurship: pre-stage, early-stage, and late-stage.

Figure 1 Technology adoption over the stages of entrepreneurship



3 Papers in this special issue

Papers in this special issue broaden our understanding of the three domains of (technological) capabilities used by entrepreneurs – strategic, managerial, and operational – shedding light on the role of technology development and adoption at different stages of entrepreneurship and across different institutional, cognitive, and geographical contexts (Boschma et al., 2015).

The first paper titled ‘Relationship between firm total factor productivity and performance: case of the Czech high-tech industry’ by Dvouletý and Blažková (2022) emphasises the importance of the operational domain of technology for entrepreneurs, discussing the role of total factor productivity for firm performance. The study thereby demonstrates the significance of firms in high-tech industries in relation to the country’s economic growth and national competitiveness. Studying the financial performance of 267 Czech high-tech companies over the years 2002–2018, the study empirically assesses the relationship between total factor productivity and financial performance to enrich the ongoing discussion on the determinants of high-tech enterprises’ success. Controlling for other firm characteristics such as company age, size, legal form, capital structure as well as sectoral and regional affiliation, the authors find that firm performance is significantly dependent on total factor productivity.

The study by Stojkovski et al. (2022) titled 'Equipment as a service and the role of technology: the transition towards usage-based business models' focuses on the lifetime of a venture, investigating how technological advances open opportunities to explore new ways for profit generation, highlighting both the managerial and operational domain of technology. This study describes the managerial decision to switch towards entirely new business models (BMs). Equipment as a service is thereby one of the most drastic examples of technology-enabled business model innovation (BMI) in the field today. The paper introduces novel knowledge on this phenomenon through an in-depth exploratory qualitative study with 26 interviews in four relevant stakeholder groups. Drawing on BMI theory, it clarifies (1) why firms move towards usage-based BMs, (2) what the main usage-based BM archetypes are, and (3) how shifting to these archetypes impacts BM components and innovates the BM. The study shows that technology takes on a key driving role in the transition towards usage-based BMs, opening up new routes for adaption by established as well as young firms.

The third paper by Johansson and Karlsson (2022) titled 'Information technology and high-impact entrepreneurship' presents the strategic and managerial domain of the DCV and develops a conceptual framework for analysing the role of information technology in the formation of high-impact entrepreneurship. Entrepreneurial decision-making is contextualised in the setting of competent teams, and where its role in economic growth is modelled as part of a minimum set of actors necessary for the generation of innovative output – so-called collaborative innovation blocs. By departing from a collective of actors, rather than the individual entrepreneur, transactions costs are shown to become central for understanding the antecedents and conditions for high-impact entrepreneurship as core strategic decisions are often based on asymmetric information and bounded rationality. Subsequently, this also implies a central role for information technology in facilitating the processes that precede high-impact entrepreneurship through its ability to bridge or reduce information asymmetries. Based on the framework, the development of information technology is hypothesised to particularly favour new entrepreneurs with growth ambitions, new firm entry, and high growth firms by accelerating the creation and allocation of knowledge.

The fourth paper by Civera et al. (2022) titled 'The importance of team diversity for academic spinoff performance' examines the role of team diversity as a strategic capability for entrepreneurs, affecting the performance of academic spinoffs. Building on the upper-echelon theory, the authors argue that different forms of diversity, namely profile diversity, cognitive distance, CEO non-duality, and the presence of a non-academic CEO may positively affect the early performance of academic spinoffs. The papers' hypotheses are tested on a sample of 307 Italian academic spinoffs founded between 2010 and 2014. The results support the positive role of diversity in enhancing growth, but only for innovative academic spinoffs. The presence of a non-academic CEO is the only diversity measure that plays a direct positive role, regardless of company technological features, highlighting the importance of both the strategic and managerial domain of technology.

The fifth paper titled 'An exploratory study of high-performance computing technology adoption over the stages of entrepreneurship' by Cunningham et al. (2022) examines how and when technology adoption occurs over the stages of entrepreneurship, focusing on both operational and managerial aspects of the DCV. High performance computing (HPC) includes infrastructure and applications that are used for complex computational problems and can involve supercomputers and linked clusters. HPC can

contribute to industry and firm competitiveness, particularly for SMEs. Against this background, there remains a limited understanding of how and when technology adoption occurs over the stages of entrepreneurship. In addressing this deficit, this exploratory study identifies how and when technology adoption occurs over the stages of entrepreneurship. The paper's contribution is twofold. First, it develops a taxonomy of HPC with respect to the how and when of technology adoption. Second, it identifies three categories of technology adoption – emergent imitators, early adopters, and growth assimilators across two stages of entrepreneurship – emergent and late-stage.

The sixth paper by Bock and Dilmetz (2022) titled 'The indication of creativity and its effect on the probability of success of crowdfunding projects' emphasises the growing importance of crowdfunding as a fundraising option, strategically creating financial capabilities for entrepreneurs. The authors state that alongside traditional forms of financing, crowdfunding resulted in an emerging stream of literature, examining the mechanisms for increasing the probability of success of crowdfunding propositions. A significant part of this literature thereby focuses on the examination of signals that entrepreneurs can provide to reduce information asymmetries. This paper extends this research by investigating the proactive communication of the creativity within crowdfunding projects as a potential signal for success. Using 39,718 campaigns from Kickstarter, the authors investigate the occurrence of words associated with creativity and the resulting influence on the probability of success. The results show that the proactive communication of the creativity of the projects can have a positive influence on the probability of a successful fundraising campaign. The paper also provides evidence that the communication of creativity can be influenced by other signals, depending on the context in which these signals are used, emphasising the relevance of the strategic domain of technology.

The seventh paper titled 'Corporate social responsibility as a driver of digital innovation in SMEs: the mediation effect of absorptive capacity' by Stock et al. (2022) analyses how SMEs can achieve higher levels of digital innovation despite their lack of resources. This paper embraces all three domains of technology for entrepreneurship and uses a dataset consisting of 520 German SMEs, proposing and testing a model in which corporate social responsibility (CSR) is an enabler of knowledge-sharing and supports SMEs in acquiring resources needed for digital innovation development. The authors find empirical evidence for a positive mediation effect in which absorptive capacity functions as a feature linking CSR to an SME's digital innovation output, which is in line with managerial and operational domains of technology. The study shows that CSR can be used as a strategic instrument when aimed at outperforming competitors. In sum, this study helps to explain the relationship between CSR and an SME's digital innovation, thus presenting far-reaching implications for SME research and the emerging scholarly debate on digital innovation in resource-constrained organisations.

The eighth paper by Bruckner et al. (2022) titled 'Crowdfunding and entrepreneurial failure: Why do overfunded startups collapse?' describes the role of technology in enabling fundraising for entrepreneurship. It examines the use of technology within the strategic and managerial domain to achieve crowdfunding success, discussing also factors of entrepreneurial failure. Especially failure after massive overfunding via crowdfunding is underexplored. This study therefore uses a qualitative narrative approach to investigate how massive overfunding in crowdfunding threatens entrepreneurial activity. It presents the findings as a taxonomy of failure causes on the environmental, firm, and individual levels based on cases that failed after receiving massive overfunding. The framework

challenges established thinking on resources and financing as measures of entrepreneurial success by providing in-depth insights into processes leading to failure despite available resources. Practically, this serves as a reference for backers aiming to safely invest via crowdfunding and for startups to avoid common pitfalls of overfunding.

4 Future research

This special issue contributes to the literature on entrepreneurship by theorising and discussing the role of technology adoption at different stages of the entrepreneurial life cycle, focusing on the digitalisation perspective of dynamic capabilities for latent, emergent, and growth-oriented entrepreneurship. It also extends academic knowledge on how different technologies can be developed and used by small businesses and entrepreneurs to generate and enhance their absorptive capacity, raise funding, improve productivity, or advance growth and networks. The empirical evidence points towards the importance of developing infrastructure to adopt and use technology, embracing the three-legged concept of strategic, managerial, and operational domains of technology used by entrepreneurs (Li et al., 2016; Lin and Wu, 2014; Loasby, 2010). This also supports previous findings on the DCV (Ray et al., 2004), which indicate that resource management is key to improving performance in entrepreneurial firms.

There are several limitations in the field that could guide future research. Firstly, given that quantitative data is limited and is often cross-sectional, future research may expand the use of mixed-methods approaches as well as aim to create longitudinal data. At the same time, using panel data would provide more robust estimations and more significant insights into how changes in digitalisation mechanisms affect growth. Secondly, research findings often rely on perceptual data (Nakayama and Sutcliffe, 2005). Entrepreneurs may be unable to identify managerial actions based on such results. Thirdly, while mixed-method approaches (Rocco et al., 2003) prove useful, further data collection and analysis is required with more responses across different industries, markets, regions, and other forms of institutional context (see Cunningham et al., 2017). This approach will help validate the theoretical framework using multi-country and multi-dimensional studies and shed more light on the importance of the relationship between the three domains. Future studies may look into various classification methods from both strategic management and IT disciplines. Moreover, further research on understanding the moderating and mediating effect of the operational domain of digitalisation is required. The strategic and operational domain have the highest impact on entrepreneurship growth and entrepreneurial opportunity identification out of the three domains, hence also call for more research in this field.

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