Exploring the impact of digital transformation on technology entrepreneurship and technological market expansion: The role of technology readiness, exploration and exploitation

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Title Page (WITH AUTHOR DETAILS)

Exploring the Impact of Digital Transformation on Technology Entrepreneurship and Technological Market Expansion: The Role of Technology Readiness, Exploration and Exploitation

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Jerome Couturier (PhD) Jerome is a Professor of strategy and management at ESCP Europe, based in Paris and London. He lectures in Business Strategy, International Management, Business Transformation and Innovation to EMBAs, Masters and in various executive programmes across Europe. Jerome is an active member of the Health Management & Innovation research centre at ESCP. His work and research concentrate on enterprise and business transformation, strategic agility, strategy execution, and more generally on growth strategies. He is author of articles, policy papers, and co-author of the internationally acclaimed book “How to Think Strategically – Your Roadmap to Innovation and Results”, published by the Financial Times Masters’ series. Prior to joining ESCP Europe and starting 3H Partners, Jerome worked with McKinsey & Co and A.T. Kearney. He is a board member and non-exec director in several companies. Jerome holds a PhD in physics of semi-conductors from Ecole normale supérieure, an MBA from Insead, and lives in Paris with his wife Paulina and his two daughters Clarisse and Marie.

LETTER TO EDITORS AND REVIEWERS

REVISED PAPER: JOBR-D-20-01395R2

Dear editors-in-chief,

We are very grateful for the thoughtful comments and suggestions provided by you and the reviewers of our manuscript: " Exploring the impact of digital transformation on technology entrepreneurship and technological market expansion: The role of technology readiness, exploration and exploitation”. We have benefitted a great deal from the feedback. Thus, very re-submit our accepted paper by reviewers and guest editors for the consideration of editor in chief.

Sincerely,
Authors

REV #1

Reviewer #1: Thank you for your hard work, I am pleased with the result and how you have addressed all my previous comments.

REV #2

Reviewer #2: Thank you for the opportunity to review the revised version of your manuscript. I think that, after the review process, the paper has been improved and I am pleased to recommend it for publication.

Our Response

Thank you for your comments and suggestions during the review process of our paper. We think, the quality of our paper is now much improved after addressing your comments.

Exploring the impact of digital transformation on technology entrepreneurship and technological market expansion: The role of technology readiness, exploration and exploitation

Abstract

The objective of this research is to addresses the effects of digital transformation on value creation through the study of technology entrepreneurship and technological market expansion. This is particularly important since both of these concepts are part of the dynamic capabilities that help in embracing digital innovation at a national level. Relevant data from 28 European countries representing development indicators and ease of doing business over a timeframe of 7 years from 2009 to 2015 were analysed to formulate and investigate a new perspective of digital entrepreneurship driven by the concepts of digital transformation and entrepreneurship. To do this, digital transformation has been broken into three categories, namely technology readiness (e.g. ICT investments), digital technology exploration (e.g. research and development) and digital technology exploitation (e.g. patents and trademarks). This research identifies several significant relationships between such constructs, which contribute to the literature and provide key implications for business management and practitioners.

Keywords: Digital transformation, technology entrepreneurship, market expansion, technology readiness, technology exploration, technology exploitation.

1. Introduction

The last decade has seen the emergence of a diverse set of digital technologies, platforms and infrastructures that have changed the way we live and work. Organisations from both the private and public sectors and almost all industries have been driven to explore –and often have had no choice but to adopt, cutting-edge technology and its applications. This process has frequently involved the transformation of key business operations, thus affecting processes, products and services as well as management structures and concepts. In particular, the concepts of innovation and entrepreneurship have been transformed in significant ways, which is having broad organisational and policy implications (Yoo et al., 2010). Exploration, integration and exploitation of new digital technologies have thus become one of the biggest challenges for businesses and society in the current environment, with no sector or organisation considered to be immune to its effects. Thus, the term *digital transformation* is used today to signify the transformational or disruptive implications of digital technologies for businesses (Nambisan et al., 2019; Matt et al., 2016) and society. Digital transformation is a concept not limited to particularly innovative businesses, digital start-ups or high-tech giants. It is a process that embraces companies of all sizes, operating in the most diverse industries (Warner & Wäger, 2019), as well as their stakeholders.

The effects of digital transformation on value creation at national level become key to developments in this field, particularly when studied through the lens of the dynamic capabilities that help in embracing digital innovation, such as technology entrepreneurship and technological market expansion lens (Han, 2019; Bouwman et al., 2018; Quinones et al., 2013; Holotiuk & Beimborn, 2018). However, despite its relevance for scholars and practitioners, the concept of digital entrepreneurship and developments in the entrepreneurship domain, in their relation to digital transformation, have received limited attention in the literature (Kraus et al., 2018; Sadraei et al., 2018). This research has therefore been set to study the effects that digital transformation may have on value creation through the study of technology entrepreneurship and technological market expansion, both of which are part of the dynamic capabilities that help in embracing digital innovation (Thrassou et. al., 2019; Garousi Mokhtarzadeh et al., 2020; Sukumar et al., 2020). To achieve this aim, the research defines the relationship between digital transformation and entrepreneurship through the concepts of digital technology readiness, digital technology exploration and digital technology exploitation, studying the interrelationship between these concepts at a national level.

This study focuses on the analysis of key indicators related to a panel of 28 European countries for a timeframe of seven years from 2009 to 2015. By analysing data from over half of the total number of countries in Europe, our findings are informed by a large percentage of the countries recognised by scholars and policymakers as highly entrepreneurial and innovation-driven nations (Groth et al., 2015). Since the nature of the data is longitudinal, this research adopts the methodology employed by Jafari-Sadeghi (2019) and employs a panel data analysis. To test developed hypotheses, following the literature (e.g., Richard & Daria, 2006; Ross, et al., 2015; Su et al., 2015), we use static panel data synthesis, comparing fixed-effects versus random-effects analysis. In this regard, the research relies on four databases as its source of data such as World Bank including World Development Indicators (WDI) and Ease of Doing Business Index (EDBI), Organisation for Economic Co-operation and Development (OECD) and Global Entrepreneurship Monitor (GEM).

Our research identifies a significant number of relationships between the concepts of digital transformation and entrepreneurship, which will inform policymakers in their efforts to create the environment that supports the technological market expansion and technology-driven entrepreneurship at a macro-level. Those relationships include not only technology readiness factors such as ICT investments, education and access to technology, but also digital technology exploration (e.g. research and development) and digital technology exploitation (e.g. patents and trademarks).

To achieve its aim, the remainder of this paper is structured as follows: in the following section, the concepts of technology entrepreneurship and technological market expansion are explored in their relationship with technology readiness and technology exploration and exploitation, and a theoretical framework is outlined; section 3 provides details of the methodological approach to the collection and analysis of data for the testing of the hypotheses; the results are presented and discussed in sections 4 and 5 respectively, while section 6 outlines the conclusions of the research.

2. Theoretical background

Digital transformation and entrepreneurship

A wide range of factors influences the ability of an organisation or a sector to embrace a digital transformation strategy. These range from purely business factors (Hamburg, 2019) to a more comprehensive view of the problem which covers, for example, the level of competitive pressures, technology readiness or the nature of its regulatory environment (Scott, 2007). A review of the literature, however, points to technology and its adoption as the key drivers of digital transformation (Zhu et al., 2006; Andriole et al., 2017).

As their context evolves, digital technologies, platforms and infrastructures continue to open opportunities for the creation of new businesses, and for branches of existing businesses to shift from offline to online environments. This has led to the emergence of *digital entrepreneurship* as a new form of entrepreneurial activity (Niemand et al. 2017; Cenamor et al., 2019; Jafari-Sadeghi et al., 2020). It is then plausible to argue that digital transformation opens a range of opportunities for entrepreneurial activity that, in turn, has been found to lead to value creation at local, regional and national levels (Ahmad and Seymour, 2008; Minniti, 2008). Having reviewed the literature on digital entrepreneurship, Kraus et al. (2018) concluded that digital transformation has indeed led to a shift in the way in which entrepreneurs conduct their business activities, reflected in six broad subjects covered in the literature: digital business models; digital entrepreneurship process; platform strategies; digital ecosystems; entrepreneurship education; and social digital entrepreneurship. Paradoxically, Kraus et al. (2018, p. 21) conclude their study by arguing that "*research on digital entrepreneurship is still in its infancy*", which led us to study the relationship between the concepts of entrepreneurship and digital transformation. Our study of the dynamic capabilities that help in embracing digital innovation is in line with the view of digital entrepreneurship by the European Commission (2005, p. 1):

> *Digital entrepreneurship embraces all new ventures and the transformation of existing businesses that drive economic and/or social value by creating and using novel digital technologies. Digital enterprises are characterised by a high intensity of utilisation of novel digital technologies (particularly social, big data, mobile and cloud solutions) to improve business operations, invent new business models, sharpen business intelligence, and engage with customers and stakeholders. They create the jobs and growth opportunities of the future.*

The use of concepts related to digitisation and digital transformation at national level help understand digital entrepreneurship and the attention it has received from the perspective of different disciplines (Sahut et al., 2019) including information systems (Du et al. 2018); innovation (Nambisan et al. 2018); management and business (Lanzolla et al., 2018); policy Nambisan et al. 2019); and strategy (Autio et al. 2018). Moreover, literature confirms that the level of technological development assists businesses in expanding their market (e.g. Brodie et al., 2007; Yang & Chan, 2020). For instance, Petersen et al. (2002) argue that the internet and evolution of technology have enabled firms to reduce their cost for searching new market opportunities, allowing them to constantly expand their market. In another research, Mimoun et al., (2017) investigates the complex innovative activities in marketing expansion of ventures in the service sector and highlight that although it is risky, technological innovation has a significant impact on expanding market. This is particularly important for small entrepreneurial firms since they are known by leveraging their technological capabilities to tackle their lack of resources (Loane et. al., 2007; Matejun, 2016; Sadeghi & Biancone, 2018, Boudlaie et.al., 2020).

Through the concepts of Information technology readiness, Information technology exploration and Information technology exploitation, the links between digital transformation and entrepreneurship as well as technology market expansion will be explored, as described in the remainder of this section.

Digital technology readiness

Parasuraman and Colby (2015) define technology readiness as the people's propensity to embrace and use new technologies for accomplishing goals, both at home and the workplace. According to Nugroho (2015), in discussing the acceptance of new technology the Technology Acceptance Model (Davis, 1989) gives attention to individual-level factors, with focus on perception as the basis for deciding about the adoption of information technology. Readiness can also be measured using the Technology Readiness Index (TRI) developed by Parasuraman and Colby (2015). In their views, technology readiness is comprised of four dimensions: optimism, innovativeness, discomfort, and insecurity. Optimism and innovativeness contribute positively to technology readiness, while discomfort and insecurity inhibit technology readiness, and individuals can express both positive and negative feelings toward technology simultaneously. Regardless of the mechanism used for its measurement, the readiness of the digital technologies that can drive digital transformation is subject to two key factors: availability of the technology and the ability of individuals to use it for improved performance. Porter (1985) studied the strategic role of ICT investments in the process of developing new competitive advantages and strategic renewal, supporting successful firm performance development, which has led to a debate on the relationship between ICT investments and performance (Dos Santos et al., 1993; Weill, 1992; Ferraris et al., 2018; Dezi et al., 2019) and suggestions that a productivity paradox (Brynjolfsson, 1993) may exist.

In a wider context, over the last two decades, scholars such as Kourilsky and Walstad (2002) and Rideout and Gray (2013) have investigated the relationship between entrepreneurship, technology and education by looking at factors influencing the high-technology venture initiation decision, best sources of preparation and education as a major obstacle theme. Having asked more than 1,000 entrepreneurs what they thought most contributed to their success in starting a business, Kourilsky and Walstad (2002) found that education and internet use were some of the key factors influencing their decision to start and/or own a high-tech business. 46% of their responses pointed to education as an essential factor, while 44.8% described using the internet as essential. Crosscutting educational partnerships that carefully blend entrepreneurship education, technology content-specific education and high-technology venture experience at both the high school and college levels were recommended by Kourilsky and Walstad (2002) and later endorsed by a range of scholars including Naia et al. (2015) and Mosey et al. (2017).

Digital technology exploration

He and Wong (2004, p. 484) define exploration as a process involving "activities aimed at entering the new product and process domains", while exploitation is defined as involves "activities aimed at improving the existing product and process positions". The resource-based view of the firm (Barney, 1991) proposes that a firm's ability to create wealth is largely determined by its unique resources/capabilities. Firm success or failure is not entirely dependent upon industry structure, but rather a function of the resources and capabilities controlled by the firm, deployed by managers and developed and extended by the organisation (Schendel, 1994). To achieve the desired change in a strategic asset stock such as research capabilities there needs to be a consistent pattern of resource flows- R&D spending. Greater commitment to R&D should result in the greater internal development of discoveries as well as enhance the flow of new scientific information into the firm (Deeds, 2001).

Digital technology exploitation

The exploitation and use of digital technologies have been studied for decades, from information systems to economic-, political- and management-related disciplines where digitisation has been considered as a subject of common interest. When studying digital excellence, Böhmann et al. (2015) identified key areas that are subject to transformation when companies within a particular context seek to 'go digital'. These include, among others, customer and partner engagement, business model innovation, process digitisation and automation, and digital security and compliance, all of which involve direct interaction with their ecosystems through customer-driven and user-driven strategies (Sadeghi et. al., 2018). From a wider, ecosystem perspective, this is perceived by many as 'performing the tasks that are critical for success' (Akram et al., 2014) leading to a focus on behaviours that lead to economic success, with patents and trademarks as typical examples emerging from businesses. Intellectual property as a formal institution impact of entrepreneurial activities of individuals through providing new incentive frameworks for deciding to start a new business (Eckhardt & Ciuchta, 2008). For example, obtaining the patent right gives researchers an advantage in using their patent to launch a startup company (Czarnitzki, et al. 2016). In this regard, Shane (2001) highlights that those independent entrepreneurs can leverage intellectual property to tackle their inadequate asset. Simultaneously, entrepreneurial firms are expected to respond to the new challenges of digital transformation with significant investment in intangible capital.

3. Hypotheses development

Informed by its theoretical framework, this research considers that investments in information and communication technologies to be used by business and in raising the ability of individuals to use such technologies have a positive effect on digital entrepreneurship and an expansion of the technological market that drives digital transformation. ICT investments will be considered as a combination of the availability of information and communication technologies and their connectivity to support their business processes, and the adult education required for the adoption and effective operation of such technology. Hence, we assert the following hypotheses:

> ***$H1_a$.*** *ICT investment and usage by businesses positively influence technology-driven entrepreneurship in a country.*
> ***$H1_b$.*** *ICT investment and usage by businesses positively influence technological market expansion in a country.*
>
> ***$H2_a$.*** *In a country, the households' internet access positively influences technology-driven entrepreneurship.*

H2$_b$. *In a country, households' internet access positively influences technological market expansion.*

H3$_a$. *Adult education level in a country positively influences technology-driven entrepreneurship.*
H3$_b$. *Adult education level in a country positively influences the technological market expansion.*

Rapid market expansion within a country is often promoted by policy initiatives such as the development and/or fast spread of information technologies (e.g. computers, mobile devices) and related infrastructures (e.g. telecommunications infrastructure), thus embedding the new digital technology into the social and technological environment of the country (Dai & Xue, 2015; Mokhtarzadeh et al., 2020). Even for countries with limited infrastructure, significant efforts in technology adoption and application may lead to a significant transition in terms of information technology developments. Of course, such digital transformation strategies call for suitable macro-level policy environment changes in these countries (Murphy, 2001). When the so-called leapfrogging occurs at the national level such that the latecomers catch up with the overall development mode of the frontrunners, policy initiative supports should appear at the macro-level (Nemet, 2009). The relative amount of expenditures on information and communication technologies, as well as on research and development, have traditionally been used as an indicator of a firm's innovative activity in many industries (Scherer, 1980). Thus, we hypothesise that:

H4$_a$. *In a country, investing in R&D pulls individuals into starting a new technology-oriented business.*
H4$_b$. *In a country, investing in R&D positively impact on the technological market expansion.*

H5$_a$. *In a country, there is a positive relationship between the number of researchers engaged in R&D and technology entrepreneurship.*
H5$_b$. *In a country, there is a positive relationship between the number of researchers engaged in R&D and technological market expansion.*

H6$_a$. *In a country, there is a positive relationship between the number of technicians participating in R&D and technology entrepreneurship.*
H6$_b$. *In a country, there is a positive relationship between the number of technicians participating in R&D and technological market expansion.*

Intellectual property is deemed to be an imperative determinant to predict the propensity of individuals to not only launch a high-tech business (Laplume, Pathak & Xavier-Oliveira, 2014) but leverage it for potential market expansion. Along with patents and trademarks, scientific publications emerging from the relationship between industry and academia have been studied as an indicator of intangible capital stock (Mahlich, 2007). Therefore, we propose the following hypotheses:

H7$_a$. *In a country, there is a positive relationship between the number of patent applications and technology entrepreneurship.*
H7$_b$. *In a country, there is a positive relationship between the number of patent applications and technological market expansion.*

***H8$_a$*.** *In a country, there is a positive relationship between the number of trademark applications and technology entrepreneurship.*
***H8$_b$*.** *In a country, there is a positive relationship between the number of trademark applications and technological market expansion.*

***H9$_a$*.** *In a country, there is a positive relationship between the number of scientific and technical journal articles and technology entrepreneurship.*
***H9$_b$*.** *In a country, there is a positive relationship between the number of scientific and technical journal articles and technological market expansion.*

The theoretical model is outlined in figure 1 below.

Please insert Figure 1 here.
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4. Research method
Source of data

To test developed hypotheses, this research relies on four databases as its source of data. In this regard, World Development Indicators (WDI) and Ease of Doing Business Index (EDBI) have been taken from World Bank and other variables have been extracted from Organisation for Economic Co-operation and Development (OECD) and Global Entrepreneurship Monitor (GEM). We used WDI (2019) to collect information regarding technology exploration and technology exploitation as well as macroeconomic data (e.g., the country's GDP). OECD (2019) has been utilised to collect data related to technology readiness such as ICT investment and internet access. Furthermore, EDBI is an important source of data about business's environmental institutions such as regulations, laws, and cost of doing business, etc. (Pinheiro-Alves & Zambujal-Oliveira, 2012; Ruiz, Cabello, & Pérez-Gladish, 2018). Eventually, GEM (2019) is of the most reliable source for entrepreneurship information, hence the database has been employed to extract the regarding the value creation through entrepreneurship.

For this research, the level of data collection is the country/national level. Therefore, a panel of 28 countries in the Europe area for a timeframe of 7 years from 2009 to 2015 has been employed. The logic behind analysing a group of nations (European countries) is adapted to Xavier et al. (2012) since they suggest that it considers variations between geographic regions and economic development levels of countries. The set of 28 countries include twenty-two EU members (Belgium, Germany, Denmark, Spain, Estonia, Finland, France, Greece, Croatia, Hungary, Ireland, Italy, Lithuania, Luxembourg, Latvia, Netherlands, Poland, Portugal, Romania, Slovak Republic, Slovenia, Sweden) and six non-EU members (Bosnia & Herzegovina, Switzerland, United Kingdom, Macedonia, Norway, Russian Federation).

Measures

Entrepreneurship and market expansion

This paper is set to study the impact of digital transformation on value creation through technology entrepreneurship. Thus, we define two dependent variables: a) TEA-TECH which represents total early-stage entrepreneurship (TEA) active in the technology sector. This variable considers the technological value creation in current markets; b) Looking at future value creation, TEA-MX stands for technological market expansion activities of TEAs in the studied context.

Digital technology readiness

Regarding the concept of digital transformation, research from different contexts show that the independent variables lie on the country's level of technology readiness (e.g. Agarwal et al., 2010; Makkonen et al., 2017; Zhu et al., 2006), technology exploration (Pramanik et al., 2019; Langer and Yorks, 2018), and technology exploitation (Tajudeen et al., 2018; Åkesson, Sørensen, & Eriksson, 2018; Caputo et al., 2019). In technology readiness cluster, ICT refers to investment on information and communications technology (expressed in the natural log); INRT represents as the percentage of households who reported that they had access to the Internet; ADL-EDU talks about the level of education of adults (which can give them the ability to use minimum technology).

Digital technology exploration

technology exploration is the second important pillar of digital transformation (Pramanik et al., 2019; Langer and Yorks, 2018). In this regard, R&D-EXP stands for expenditure on research and development (as the percentage of GPD); RSCH-R&D refers to the number of researchers engaged in R&D (expressed in the natural log); and TECH-R&D represents as the number of technicians (who perform scientific and technical tasks) participated in R&D (expressed in the natural log).

Digital technology exploitation

The third pillar is technology exploitation (Tajudeen et al., 2018; Åkesson, Sørensen, & Eriksson, 2018), which includes cluster, PTNT-APP stands for the number of patent applications (expressed in the natural log); TRMD-APP refers to the number of Trademark applications (expressed in the natural log); JRL-ART represents as the number of scientific and technical journal articles (expressed in the natural log.

Control variables

Next set of measures are control variables, which include the institutional environment of countries that affect entrepreneurship such as GDP, the GDP growth rate (GDP-G), COST, TIME, and procedures (PROC) required for starting a business.

The description of all variables is presented in Table 1.

Please insert Table 1 here.

Method of analysis

Since the nature of data is longitudinal, this research adopts its methodology from Jafari-Sadeghi (2020) and employs panel data analysis. Following the literature (e.g., Richard & Daria, 2006; Ross et al., 2015; Su et al., 2015), we use static panel data synthesis and conduct fixed-effects versus random-effects analysis. The equation of fixed-effects panel data is asserted as below (E. 1):

$$Y_{i,t} = \beta_0 + \beta_1 X_{i,t} + \alpha_i + \varepsilon_{i,t}$$

(**E. 1** Fixed-effects panel data analysis)

In this equation, $Y_{i,t}$ is the dependent variable (Here *i* represent TEA-TECH, TEA-MX; and *t* shows time 2009-2015); β_0 is the intercept; β_1 is the coefficient for independent variables; X_{it} represents independent variables; α_i (i=1….n) is the unknown intercept for each entity (all the stable characteristics of countries); and $\varepsilon_{i,t}$ is the error term. Fixed-effects panel data avoids of issues regarding omitted variables. Fixed-effects panel data focuses on the discrepancy between countries and addresses the unseen heterogeneity (Hausman, 1978). Moreover, Richard and Daria (2006) and

Su et al. (2015) propose that to resolve the problem of temporarily fixed-effects, all the unobserved specifications that fluctuate in time should be included in the analysis.

Prior to hypotheses testing, the descriptive statistics and correlation matrix (Table 2) of the variables suggest that no critical correlation problem between the explicative variables has been recognised.

Please insert Table 2 here.

To check the stationarity of the panel data, we run the unit root test, in which it revealed that the unit root is confirmed for all independent and dependent variables, except for the case of RSCH-R&D within which only Harris–Tzavalis (1999) test reveals the absence of unit-roots. Table 3 represents the results of panel data stationarity test.

Please insert Table 3 here.

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5. Results

The objective of this paper is to disentangle the influence of digital transformation in technology entrepreneurship as well as technological market expansion. Taking advantage of the wealth of static panel data, we employed fixed- versus random-effect model analysis. To avoid multicollinearity problems, the relationship between dependent variables with each group of independent variables has been tested separately. In this regard, first, we explore the importance of technology readiness (H1-2-3_a and H1-2-3_b). then, we test hypotheses H4-5-6_a and H4-5-6_b in the examination and discuss the concept of a technology exploration. Finally, hypotheses H7-8-9_a and H7-8-9_b examines the impact of technology exploitation.

Technology readiness

The static analysis of the impact of technology readiness on technology entrepreneurship and technological market expansion activities has been shown in Table 4. In this vein, the result of the Hausman test suggests that the most appropriate panel data analysis for technology readiness as interacted with technology entrepreneurship and technological market expansion is the random model.

Please insert Table 4 here.

The static test indicates that ICT investment significantly contributes to technology entrepreneurship and technological market expansion. Therefore, $H1_a$ (C. 1.680, P. < 0.001) and $H1_b$ (C. 0.017, P. < 0.05) are confirmed. Our findings support $H2_a$ indicating that Internet Access has a significant and positive impact on technology entrepreneurship, as noted by the coefficient of 0.151 (P. < 0.01) while $H2_b$ (C. 0.008, P. > 0.1) cannot be supported. Regarding Adult Education, the findings for technology entrepreneurship is significant (P. < 0.001) but $H3_a$ cannot be supported since the coefficient is in the opposite of hypothesised relationship (C. -0.331). However, no significant impact has been seen for technological market expansion ($H3_b$: C. -0.013, P. > 0.1).

Technology exploration

The panel data synthesis for the influence of technology exploration on entrepreneurship and technological market expansion activities has been presented in Table 5. The result of the Hausman test proposes that the most appropriate panel data analysis for technology exploration as related to technology entrepreneurship is the random model and for technological market expansion is the fixed model.

Please insert Table 5 here.

The panel data analysis reveals that R&D Expenditure significantly has a positive on technology entrepreneurship and technological market expansion. Hence, $H4_a$ (C. 1.201, P. < 0.05) and $H4_b$ (C. 0.021, P. < 0.01) are supported. Our results suggest that Researchers in R&D has a significant and positive relationship with technology entrepreneurship, as expressed by the coefficient of 0.139 (P. < 0.05), supporting $H5_a$. However, no support has been found for $H5_b$ (C. -0.192, P. > 0.1). Further, although the impact of Technicians in R&D on technology entrepreneurship ($H6_a$) could not find support (C. -0.052, P. > 0.1), yet, the test for technological market expansion is significant (C. 0.195, P. < 0.1) that supports $H6_b$.

Technology exploitation

The final set of hypothesis testing considers the concept of technology exploitation as influences entrepreneurship and technological market expansion activities has been presented in Table 6. The Hausman test has been employed, in which it proposes that the best panel data synthesis to study the relationship between technology exploitation and technology entrepreneurship is the random model while the fixed effect model is the best analysis for technological market expansion.

Please insert Table 6 here.

The static panel data supports $H7_a$, which confirms that Patent Applications has a significant and positive impact on technology entrepreneurship, as noted by the coefficient of 1.431 (P. < 0.001) while $H7_b$ (C. 0.005, P. > 0.1) cannot be supported. The relationship between Trademark Applications with both dependent variables is significant. In this regard, $H8_a$ is supported (C. 0.121, P. < 0.05) but $H8_b$ cannot be accepted since the impact of Trademark Applications on technological market expansion is negative (C. -0.360, P. < 0.05), which is opposite to hypothesised relationship. Similarly, $H9_a$ could not find support from static analysis, the relationship between Journal Articles and technology entrepreneurship is significant (P. < 0.05) but negative (C. -0.130). However, the static panel data synthesis confirms the hypothesis $H9_b$ (C. 0.015, P. < 0.1), there is a positive relationship between the number of scientific and technical journal articles and technological market expansion.

6. Discussion

Today, there is consensus in the literature on the importance of ICT investments, internet access and adult education on socio-economic development. The relevance of each of those elements for the emergence of technology-driven entrepreneurship and the expansion of the technological market in any country has been studied by different scholars (Naia et al., 2015). Yet, the relationship between those elements as key components of the digital technology readiness of a country –essential for an effective digital transformation strategy, has not received enough attention. Having found support for hypotheses $H1_a$, $H1_b$ and $H2_a$, our results confirm the importance of ICT investment and usage by both businesses and households as drivers of technology-driven entrepreneurship and technological market expansion at a national level. This is in line with previous research informing, for example, the regional development at the European level (European Commission, 2007b). However, we found no evidence to support our hypothesis that households' internet access positively influences technological market expansion ($H2_b$). A plausible explanation for this can be that home internet access is in a large percentage of cases either a tool for access to services by the household (Lichtenstein & Williamson, 2006) or a mechanism for entertainment (Seiter, 2005). In both cases, this finding highlights the need for further research in areas such as the lack of equality of access to the Internet and its implications for entrepreneurship and social inclusion, as well the misuse of the Internet and its implications for education and wellbeing, ultimately affecting socio-economic development (Chester, 2011).

It is also important to highlight that –when perceived as part of digital technology readiness in a country, we found no evidence that adult education level in a country positively influences neither technology-driven entrepreneurship nor the technological market expansion within the country. Instead, the negative relationship between educational attainment and technology entrepreneurship ($H3_a$) highlights the findings of Oosterbeek et al. (2010) and Jafari-Sadeghi et al. (2019c), in which they argued that adults formal education decreases the likelihood of creating new businesses. This is because individuals can increase their self-awareness of their lack of enough entrepreneurial competencies as well as a better understanding of the risk of failure (Jafari-Sadeghi et al. 2019a, Jafari-Sadeghi et al. 2019c). This can influence people's decision to stay employed as opposed to starting an entrepreneurial activity that might be unsuccessful. In this regard, Oosterbeek et al. (2010) found that a higher educational level can result in realistic business opportunity recognition which plays a negative role in awareness and readiness of non-entrepreneurs toward new venture creation. In terms of digital technology exploration as a key to the digital transformation of countries, our findings confirmed that R&D and related investments have a positive effect on technological entrepreneurship ($H4_{a,}$ $H5_a$). This opens new areas for research as many countries design and engages with digital transformation strategies either at the macro policy level or sectoral level. The lack of guidance on how to design policy initiatives to fulfil these goals has been acknowledged by authors such as Dai & Xue (2015) as a major challenge, particularly by the so-called 'lagging countries'. This study highlights the need for future research on the interaction between traditional innovation policy initiatives and those focused on digital transformation and entrepreneurship. Also, our study reveals the need for research that addresses questions about the need for countries to focus more on technology transfer or on basic R&D, or the ways policy at the national level may influence policy initiatives at the level of specific industries and technologies.

Paradoxically, while both R&D investments and the number of technicians engaged in R&D positively impact the technological market expansion in a country ($H4_{b,}$ $H6_b$), our research found no evidence of a positive relationship between the number of researchers engaged in R&D and technological market expansion ($H5_b$). This confirms a nonlinear dynamic behaviour of R&D for short-term performance as opposite to long-run growth (Yuan & Nishant 2019). In this regard, the literature highlights that R&D can show fluctuations and erratic growth patterns in entrepreneurial activities as an example of short-term performance (Wälde, 2002). However, when it comes to longer-oriented period, R&D investments enable firms to maintain their technological advantages and expand their markets (Klette & Griliches, 2000). In this vein, technological diversification obtained by R&D allows firms to seek new directions of product/ service development (Di Cintio, Ghosh &

Grassi, 2017), which allows them to operate in higher growth markets and have better performance in market expansion compared to non-innovator firms (Del Monte & Papagni, 2003). Our study of relationships between digital transformation, entrepreneurship and digital technology exploitation also revealed significant results. For example, our research shows that technology entrepreneurship is positively influenced by both the number of patent applications filed ($H7_a$) and the number of trademark applications ($H8_a$) in a country. This could be explained by the fact that intellectual property regimes can assist entrepreneurs to protect their innovative ideas and 'know-how' from imitators, which creates numerous technological opportunities to start a new venture or enhance their current business (Laplume, Pathak & Xavier-Oliveira, 2014). Thus, intellectual property not only protects entrepreneurial talents and knowledge but also contributes to decreasing disproportionate information and indicating the "quality" of the enterprise as well as seeking expected returns (Czarnitzki, et al. 2016; Ardito et al., 2019; Rezaei et al., 2020)- which make a positive influence on the propensity of entrepreneurial activities within countries.

Moreover, it is inevitable to address the dual behaviour of scientific and technical journal articles, as an element of country's level of technology exploitation, where it has a negative impact on technology-driven entrepreneurship ($H9_a$) but positive influence on the technological market expansion ($H9_b$). However, the justification of the behaviour lies in the nature of research articles that take advantage of previous and current information to contribute to the future implications. Moreover, considering article authorship as an educational activity, our findings for the relationship between technology entrepreneurship and scientific/technical articles are in line with those of adults' formal education ($H3_a$). However, the positive relationship between scientific and technical journal article and (technology) market expansion stresses the function of market research on future opportunity identification and exploitation. In fact, market research (and foresight) enables businesses to envision an operating environment of challenges and opportunities and opens the competitive space to make more informed decisions about how/when/where to expand (Iden et al., 2016, Jafari-Sadeghi et al. 2019b). This confirms that in a country the higher quality and quantity of research article contributes to higher intensity of its (technological) market expansion.

Theoretical and practical contributions

Our findings –in terms of both the supported and rejected hypotheses, make significant additions to the literature that covers the different dimensions of digital transformation, thus providing important theoretical and practical contributions. For example, recent research focused on big data analytics (e.g. Rialti et al., 2020) has found that capabilities are a significant antecedent of an organisation's strategic flexibility, a relationship influenced by organisational ambidexterity. We have taken this further by studying how the concept of digital technology ambidexterity influences digital entrepreneurship –a key driver to socio-economic development at all levels. This contribution has additional implications for business research and management practice, as it informs managers who are aiming to exploit the potential of not only big data but other forms of digital technologies, technology innovations and their applications to foster strategic flexibility at organisational, sector and national levels in the new competitive contexts where businesses operate. Furthermore, as managers continuously interact with increasingly digital value chains, our approach to digital technology entrepreneurship adds to recent insights and guidelines (e.g. Caputo et al., 2019) that help practitioners understand and manage the dynamic digital infrastructure of the organisation and thus the boundaries of their business processes.

This research builds on the wealth material of digital transformation and proposes a framework which incorporates technology readiness, exploration and exploitation. Moreover, in the last decade, firms have been putting into practice actions that explore and exploit new digital technology innovations (Kraus et al., 2018), which has brought attention to the relationship between technology and individual entrepreneurship (Majchrzak et al., 2016, p. 273). Consequently, the current study contributes to the literature via stressing on the impact of technology readiness, exploration and exploitation on technology entrepreneurship and technological market expansion. However, limited progress has been made on the study of this relationship at a country level (Dai & Xue, 2015), which leads to a need for suitable macro-level policy changes (Murphy, 2001). Therefore, the final important contribution of this research is its country-level analysis.

From a wider perspective, our findings contribute to the emergence and the adoption of innovative and transformational technology-driven business models with the potential to drive development at all levels. A requirement for most organisations as a result of the current digital transformation of businesses and societies, adaptation of current business models to the new context requires a significant shift in the priorities of the business. Our findings extend the recent works of authors such as Bouwman et al. (2019) and Garzella et al., (2020) on this domain beyond the context of SMEs, to help practitioners rethink their strategy to handle the impact of digitisation and improve their performance at a time when digital transformation is challenging their business models.

Another key area of business research and practice that benefits from our findings is knowledge management, particularly in the relationship between knowledge and technology ambidexterity, and their impact on digital entrepreneurship. Given the role of ambidexterity (Cegarra-Navarro et al., 2019) and technology knowledge on empowering of citizens to engage with private businesses (Martinez-Martinez et al., 2019) and public sector organisations (Cegarra-Navarro et al., 2014), our research informs practitioners in their efforts to explore and exploit technological knowledge from different sources to overcome the strategic and operational challenges associated with digital transformation (Castagna et al., 2020; Scuotto et al., 2017).

Also in terms of practical contributions, this research has identified new facilitators of digital transformation (e.g. investments in ICT and R&D) as well as areas that do not necessarily lead to an increase of technology-driven entrepreneurship or market expansion (e.g. adult education). In achieving these aims, our study informs the efforts of European policymakers in outlining initiatives that support digital transformation strategies at the macro level, thus responding to recent calls from entrepreneurship scholars such as Kraus et al. (2018) for research that goes beyond the industry background to consider internationality aspects of digital entrepreneurship. For example, our research highlights that publishing scientific articles do not promote entrepreneurial activities in European countries, but it helps finding new markets opportunities. On the other hand, patents and trademark applications lead to higher business creation rates. This help practitioners adopting a proper strategy in country-level.

7. Conclusions

Entrepreneurship has been significantly transformed over the last decade. Key to such a transformation is the dynamics of digital technologies, platforms and infrastructures, and the way in which these have changed how value is created. As stated by Nambisan et al. (2019), research aimed at understanding the digital transformation of the economy needs to incorporate multiple and cross-levels of analysis, embrace ideas and concepts from multiple fields/disciplines, and explicitly acknowledge the role of digital technologies in transforming organisations and social relationships. In particular, it is important to explore how entrepreneurs can drive digital transformation, a phenomenon that according to Li et al. (2018) remains under- researched. By focusing on technology entrepreneurship, this paper aimed to improve the current understanding of digital entrepreneurship by exploring the influence of digital transformation not only on technology entrepreneurship but also on the technological market expansion.

To achieve our aim, digital transformation was categorised into three different clusters, i.e. technology readiness, technology exploration and technology exploitation, including three factors for each specific cluster. Hence, for the objective of this research, eighteen hypotheses were developed which were tested through panel data analysis. In this regard, comparing fixed-effects versus random-effects, a static panel of 28 countries in the Europe area for a timeframe of 7 years from 2009 to 2015 has been synthesised. Our results find thirteen significant relationships between the concepts of digital transformation and entrepreneurship, in which ten hypotheses supported and three had three revealed opposite behaviour to the relationships initially hypothesised.

Our findings make significant additions to the literature that covers the different dimensions of digital transformation. This has been achieved, first, by expanding on the contribution of recent research on the latest technologies (e.g. big data analytics) and their applications in innovative business strategy and operations, to foster strategic flexibility at organisational, sector and national levels in the new competitive contexts where businesses operate. Secondly, this research informs practitioners in their efforts to understand and manage the dynamic digital infrastructure of their organisation and thus the boundaries of their business processes as the business interacts with increasingly digital value chains. A third major contribution of this research is related to the lessons it provides for the rethinking of the business models of those businesses facing a significant shift in their priorities as a result of the current digital transformation of businesses and societies.

This research was restricted to specific perspectives. For instance, our analysis was limited to a sample of 28 nations, which may be perceived as a small-size sample. In this regard, we employed panel data analysis of 7 years that allowed for a resolution of issues related to the statistical validity of the method through inflating bootstrapping standard errors, as highlighted by Castaño, Méndez and Galindo (2016). This was also addressed by limiting the timeframe of the research to 8 years from 2007 to 2015. Thus, future research can take advantage of more recent data. Furthermore, for this research, we were limited to use secondary datasets, in which the data were taken from several resources such as World Bank databases entitled “World Development Indicator” and “Ease of Doing Business Index” as well as Organisation for Economic Co-operation and Development and Global Entrepreneurship Monitor. However, we suggest that future research focuses on a specific context and builds on primary information. We also suggest exploring whether literature could triangulate the country-level analysis with more data, perhaps also qualitative, like interviews, or company data for each country. This would allow to strengthen analysis and provide more solid contributions.

By studying the technology ambidexterity construct this research opens new avenues for research into the relationship between knowledge ambidexterity and technology ambidexterity, a correlation that can inform practitioners in their efforts to explore and exploit technological knowledge from different sources to overcome the strategic and operational challenges associated with digital transformation.

Also, in line with the findings of Kraus et al. (2018), future research could seek to expand on our findings through the study of how cultural differences (e.g. demography, psychological characteristics, entrepreneurship education, expertise and industry knowledge and networks) across countries could influence the adoption of digital entrepreneurship and why some digital strategies could not be transferred in other cultures without overcoming certain barriers.

Finally, as noted previously, we acknowledge that the concepts of technology readiness, technology exploration and technology exploitation are not the only themes that can be used for the study of the impact of digital transformation on technology entrepreneurship and technological market expansion. Technology readiness and exploration and exploitation of digital technologies are considered in this research as part of the dynamic capabilities that help businesses and societies embrace digital innovation. On these bases, such constructs provide a conceptual platform to explore connections between digital transformation and the concepts of innovation and entrepreneurship and the integration of ideas from such areas. We encourage researchers and practitioners to identify other areas that could be employed for the study of the relationships between digital transformation, technology entrepreneurship and technological market expansion. However, we hope our approach will motivate future research in this area.

References

Agarwal, R., Gao, G., DesRoches, C., & Jha, A. K. (2010). Research commentary—The digital transformation of healthcare: Current status and the road ahead. *Information Systems Research*, *21*(4), 796-809.

Ahmad, N., and Seymour, R. G. (2008). Defining entrepreneurial activity: Definitions supporting frameworks for data collection. *OECD Statistics Working Papers* 2008/01, Paris: OECD. [Available at: https://www.pairault.fr/ehess/doc/ocde_entreprise_08.pdf] [Last accessed: 16 July 2020]

Åkesson, M., Sørensen, C., & Eriksson, C. I. (2018). Ambidexterity under digitalisation: A tale of two decades of new media at a Swedish newspaper. *Scandinavian Journal of Management*, *34*(3), 276–288. https://doi.org/10.1016/j.scaman.2018.06.004

Akram, A., Bergquist, M. and Åkesson, M. (2014). Digital Visions vs. Product Practices: Understanding Tensions in Incumbent Manufacturing Firms. *47th Hawaii International Conference on System Sciences*, Waikoloa, HI, 2014, pp. 4516-4525.Allison, P. D., & Waterman, R. P. (2002). Fixed-effects negative binomial regression models. *Sociological Methodology*, *32*(1), 247–265. https://doi.org/10.1111/1467-9531.00117

Andriole, S.J., T. Cox and K.M. Khin, 2017. The innovator‘s imperative: Rapid technology adoption for digital transformation. Boca Raton, US: CRC Press.

Ardito, L., Ferraris, A., Messeni Petruzzelli, A., Bresciani, S., Del Giudice, M. (2019), “The role of universities in the knowledge management of smart city projects”, *Technological Forecasting and Social Change*, 142, 312-321

Autio, E., Nambisan, S., Thomas, L. D., & Wright, M. (2018). Digital affordances, spatial affordances, and the genesis of entrepreneurial ecosystems. *Strategic Entrepreneurship Journal*, 12(1), 72–95. https://doi.org/10.1002/sej.1266

Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of Management,* 17 (1), 99–120.

Bohmann T, Drews P, Meyer-Blankart C (2015). Digitale Exzellenz: Eine Bestandsaufnahme zur Digitalisierung deutscher Unternehmen und Beho¨rden. Research Report, Universita¨t Hamburg. https://www.soprasteria.de/docs/librariesprovider33/Studien/digitale-exzellenz-2015-sopra-steria-consulting.pdf?sfvrsn=8. Accessed 29 Feb 2020.

Boudlaie, H., Mahdiraji, H.A., Shamsi, S., Jafari-Sadeghi, V., & Garcia-Perez, A. (2020). Designing a human resource scorecard: An empirical stakeholder-based study with a company culture perspective. *Journal of Entrepreneurship, Management and Innovation*, 16(4), 113-147. https://doi.org/10.7341/20201644

Bouwman, H., Nikou, S., Molina-Castillo, F.J. and de Reuver, M. (2018). The impact of digitalisation on business models. *Digital Policy, Regulation and Governance*, 20(2), 105-124. https://doi.org/10.1108/DPRG-07-2017-0039

Bouwman, H., Nikou, S., & de Reuver, M. (2019). Digitalization, business models, and SMEs: How do business model innovation practices improve performance of digitalizing SMEs?. *Telecommunications Policy*, *43*(9), 101828.

Bresciani, S., Ferraris, A., & Del Giudice, M. (2018). The management of organizational ambidexterity through alliances in a new context of analysis: Internet of Things (IoT) smart city projects. *Technological Forecasting and Social Change*, 136, 331-338.

Brodie, R. J., Winklhofer, H., Coviello, N. E., & Johnston, W. J. (2007). Is e- marketing coming of age? An examination of the penetration of e- marketing and firm performance. *Journal of Interactive Marketing*, 21(1), 2-21.

Brynjolfsson, E. (1993). The productivity paradox of information technology. *Communications of the ACM*, *36*(12), 66-77.

Caputo, A., Ayoko, O. B., Amoo, N., & Menke, C. (2019). The relationship between cultural values, cultural intelligence and negotiation styles. *Journal of Business Research*, 99, 23-36.

Caputo, A., Fiorentino, R. and Garzella, S. (2019). From the boundaries of management to the management of boundaries: Business processes, capabilities and negotiations, *Business Process Management Journal*, 25(3), pp. 391-413. https://doi.org/10.1108/BPMJ-11-2017-0334

Castaño, M. S., Méndez, M. T., & Galindo, M. Á. (2016). Innovation, internationalisation and business-growth expectations among entrepreneurs in the services sector. *Journal of Business Research*, 69(5), 1690–1695. https://doi.org/10.1016/j.jbusres.2015.10.039

Castagna, F., Centobelli, P., Cerchione, R., Esposito, E., Oropallo, E., & Passaro, R. (2020). Customer Knowledge Management in SMEs Facing Digital Transformation. *Sustainability*, *12*(9), 3899.

Cegarra-Navarro, J. G., Garcia-Perez, A., & Moreno-Cegarra, J. L. (2014). Technology knowledge and governance: Empowering citizen engagement and participation. *Government Information Quarterly*, *31*(4), 660-668.

Cegarra-Navarro, D. Jiménez-Jiménez and A. García-Pérez. (2019). An Integrative View of Knowledge Processes and a Learning Culture for Ambidexterity: Toward Improved Organizational Performance in the Banking Sector. *IEEE Transactions on Engineering Management*. https://doi.org/10.1109/TEM.2019.2917430.

Cenamor, J., Parida, V., & Wincent, J. (2019). How entrepreneurial SMEs compete through digital platforms: The roles of digital platform capability, network capability and ambidexterity. *Journal of Business Research*, 100, 196-206.

Chester, L. (2011). The Participation of Vulnerable Australians in Contemporary Markets for Essential Goods and Services. *Journal of Australian Political Economy*, *68*, 169-93.

Czarnitzki, D., Doherr, T., Hussinger, K., Schliessler, P., & Toole, A. A. (2016). Knowledge creates markets: The influence of entrepreneurial support and patent rights on academic entrepreneurship. *European Economic Review*, *86*, 131-146.

Dai, Y., & Xue, L. (2015). China's policy initiatives for the development of wind energy technology. *Climate policy*, *15*(1), 30-57.

Davis, F.D. (1989). Perceived Usefulness, Perceived Ease Of Use, And User Acceptance, *MIS Quarterly*, 13 (3), 319-340.

Deeds, D. L. (2001). The role of R&D intensity, technical development and absorptive capacity in creating entrepreneurial wealth in high technology start-ups. *Journal of Engineering and Technology Management*, 18(1), 29-47.

Del Monte, A., & Papagni, E. (2003). R&D and the growth of firms: empirical analysis of a panel of Italian firms. *Research Policy*, *32*(6), 1003-1014.

Dezi, L., Ferraris, A., Papa, A., & Vrontis, D. (2019). The role of external embeddedness and knowledge management as antecedents of ambidexterity and performances in Italian SMEs. *IEEE*

Transactions on Engineering Management. https://doi.org/10.1109/TEM.2019.2916378.

Di Cintio, M., Ghosh, S., & Grassi, E. (2017). Firm growth, R&D expenditures and exports: An empirical analysis of Italian SMEs. *Research Policy*, 46(4), 836-852. https://doi.org/10.1016/j.respol.2017.02.006

Dos Santos, B.L., Peffers, G.K. and Mauer, D.C. (1993), "The impact of information technology investment announcements on the market value of the firm", *Information Systems Research*, 4(1), 1-23.

Du, W., Pan, S. L., Zhou, N., & Ouyang, T. (2018). From a marketplace of electronics to a digital entrepreneurial ecosystem (DEE): The emergence of a meta-organisation in Zhongguancun. China, *Information Systems Journal*, 28, 1158–1175.

Eckhardt, J. T., & Ciuchta, M. P. (2008). Selected variation: The population- level implications of multistage selection in entrepreneurship. *Strategic Entrepreneurship Journal*, *2*(3), 209-224.

European Commission. (2007a). e-Skills for the 21st century: fostering competitiveness, growth and jobs. *Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions.* COM(2007) 496. Brussels: Commission of the European Communities. Available at http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52007DC0496:EN:NOT

European Commission. (2007b). Promoting young people's full participation in education, employment, and society. *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions.* COM(2007) 498. Brussels: Commission of the European Communities. Available at http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52007DC0498:EN:NOT

Ferraris, A., Monge, F. and Mueller, J. (2018), "Ambidextrous IT capabilities and business process performance: an empirical analysis", *Business Process Management Journal*, Vol. 24 No. 5, pp. 1077-1090. https://doi.org/10.1108/BPMJ-07-2017-0201

Garzella, S., Fiorentino, R., Caputo, A., & Lardo, A. (2020). Business model innovation in SMEs: the role of boundaries in the digital era. *Technology Analysis & Strategic Management*, 1-13.

Garrido, M., Rissolai, G., Rastrelli, M., Diaz, A., & Ruíz, J. A. (2009). *Immigrant women, e-skills, and employability in Europe: The case of Hungary, Italy, the Netherlands, Romania, and Spain*. Technology & Social Change Group (TASCHA).

Garousi Mokhtarzadeh, N., Amoozad Mahdiraji, H., Jafarpanah, I., Jafari-Sadeghi, V., & Cardinali, S. (2020). Investigating the impact of networking capability on firm innovation performance: using the resource-action-performance framework. *Journal of Intellectual Capital*, 21(6), 1009-1034. https://doi.org/10.1108/JIC-01-2020-0005

GEM. (2019). Global Entrepreneurship Monitor. Retrieved January 26, 2017, from http://www.gemconsortium.org/

Gupta, A.K., Smith, K., Shalley, C.E. (2006). The interplay between exploration and exploitation. *Academy of Management Journal*, 49 (4), 693–706.

Groth, O. J., Esposito, M., and Tse, T. (2015). What Europe needs is an innovation- driven entrepreneurship ecosystem: Introducing EDIE. *Thunderbird International Business Review*, *57*(4), 263-269.

Hamburg, I. (2019). Implementation of a digital workplace strategy to drive behaviour change and improve competencies. In *Strategy and Behaviors in the Digital Economy*. IntechOpen.

Han, J. W. (2019). Promotion of Technology-based Start-ups: TIPS Policy of Korea. *Asian Journal of Innovation & Policy, 8*(3), 396-416.

Hausman, J. A. (1978). Specification Tests in Econometrics. *Econometrica, 46*(6), 1251–1271.

He, Z.L., Wong, P.K. (2004). Exploration vs. exploitation: an empirical test of the ambidexterity hypothesis. *Organisation Science*, 15 (4), 481–494.

Holotiuk, F., & Beimborn, D. (2018). Organizational Ambidexterity for Digital Innovation: The Approach of Digital Innovation Labs. *Academy of Management Global Proceedings*, (2018), 22

Iden, J., Methlie, L. B., & Christensen, G. E. (2017). The nature of strategic foresight research: A systematic literature review. *Technological Forecasting and Social Change*, 116, 87-97.

Jafari-Sadeghi, V. (2020). The motivational factors of business venturing: Opportunity versus necessity? A gendered perspective on European countries. *Journal of Business Research*, 113(May 2020), 279-289. https://doi.org/10.1016/j.jbusres.2019.09.058

Jafari-Sadeghi, V., Dutta, D. K., Ferraris, A., & Del Giudice, M. (2020). Internationalisation business processes in an under-supported policy contexts: evidence from Italian SMEs. *Business Process Management Journal*, 26(5), 1055-1074. https://doi.org/10.1108/BPMJ-03-2019-0141

Jafari Sadeghi, V. Biancone, P. P., Anderson, R. B., & Nkongolo-Bakenda, J. M. (2019a). International entrepreneurship by particular people "on their own terms": evidence of universal attributes of entrepreneurs in evolving economies, *International Journal of Entrepreneurship and Small Business*, 37(2), pp. 288–308. https://doi.org/10.1504/IJESB.2019.100109.

Jafari-Sadeghi, V., Kimiagari, S. and Biancone, P. Pietro (2019b). Level of Education and Knowledge, Foresight Competency, and International Entrepreneurship: A Study of Human Capital Determinants in the European Countries, *European Business Review*, 32(2). 46-68. https://doi.org/10.1108/EBR-05-2018-0098.

Jafari-Sadeghi, V., Nkongolo-Bakenda, J. M., Dana, L. P., Anderson, R. B., & Biancone, P. P. (2019c). Home Country Institutional Context and Entrepreneurial Internationalisation: The Significance of Human Capital Attributes. *Journal of International Entrepreneurship*, https://doi.org/10.1007/s10843-019-00264-1

Klette, T. J., & Griliches, Z. (2000). Empirical patterns of firm growth and R&D investment: a quality ladder model interpretation. *The Economic Journal*, *110*(463), 363-387.

Kourilsky, M. L., & Walstad, W. B. (2002). The early environment and schooling experiences of high-technology entrepreneurs: Insights for entrepreneurship education. *International Journal of Entrepreneurship Education*, *1*(1), 1-20.

Kraus, S., Palmer, C., Kailer, N., Kallinger, F. L., & Spitzer, J. (2019). Digital entrepreneurship. *International Journal of Entrepreneurial Behavior & Research*. https://doi.org/10.1108/IJEBR-06-2018-0425

Langer, A. M., and Yorks, L. (2018). *Strategic Information Technology: Best Practices to Drive Digital Transformation*. John Wiley & Sons.

Lanzolla, G., Lorenz, A., Miron-Spektor, E., Schilling, M., Solinas, G., & Tucci, C. (2018). Digital transformation: what is new if anything? *Academy of Management Discoveries*, *4*(3), 378-387.

Laplume, A. O., Pathak, S., & Xavier-Oliveira, E. (2014). The politics of intellectual property rights regimes: An empirical study of new technology use in entrepreneurship. *Technovation*, *34*(12), 807-816.

Li, L., Su, F., Zhang, W., & Mao, J. Y. (2018). Digital transformation by SME entrepreneurs: A capability perspective. *Information Systems Journal*, 28(6), 1129-1157.

Lichtenstein, S., & Williamson, K. (2006). Understanding consumer adoption of internet banking: an interpretive study in the Australian banking context. *Journal of Electronic Commerce Research*, 7(2), 50.

Loane, S., Bell, J. D., & McNaughton, R. (2007). A cross-national study on the impact of management teams on the rapid internationalization of small firms. *Journal of World Business*, 42(4), 489-504.

Mahlich, J. 2007. The Japanese Pharmaceutical Industry in Transition: Has Higher Research Orientation Resulted in Higher Market Value? *Asian Business Management* 6, 75–94.

Majchrzak, Ann, M. Lynne Markus, and Jonathan Wareham. "Designing for digital transformation: Lessons for information systems research from the study of ICT and societal challenges." *MIS Quarterly* 40.2 (2016). 267-277

Makkonen, M., Frank, L., & Koivisto, K. (2017). Age differences in technology readiness and its effects on information system acceptance and use: the case of online electricity services in Finland. *Bled 2017: Proceedings of the 30th Bled eConference. Digital Transformation: From Connecting Things to Transforming Our Lives, ISBN 978-961-286-043-1*.

Martínez-Martínez, A., Cegarra-Navarro, J. G., Garcia-Perez, A., & Wensley, A. (2019). Knowledge agents as drivers of environmental sustainability and business performance in the hospitality sector. *Tourism Management*, *70*, 381-389.

Matejun, M. (2016). Barriers to development of technology entrepreneurship in small and medium enterprises. *Research in Logistics & Production*, 6.

Matt, C., Hess, T., Benlian, A., & Wiesbock, F. (2016). Options for formulating a digital transformation strategy. *MIS Quarterly Executive*, 15(2), 6.

Minniti, M. (2008). The role of government policy on entrepreneurial activity: productive, unproductive, or destructive? *Entrepreneurship Theory and Practice*, *32*(5), 779-790.

Mimoun, L., Torres, L. T., & Sobande, F. (2017). When High Failure, Risky Technology Leads to Market Expansion: The Case of the Fertility Services Market. *ACR North American Advances*, 45, 773-774.

Mokhtarzadeh, N., Amoozad Mahdiraji, H., Jafari-Sadeghi, V., Soltani, A., & Abbasi Kamardi, A. (2020). A product-technology portfolio alignment approach for food industry: A multi-criteria decision making with z-numbers. *British Food Journal*, 122(12), 3947-3967. https://doi.org/10.1108/BFJ-02-2020-0115

Mosey, S., Guerrero, M., & Greenman, A. (2017). Technology entrepreneurship research opportunities: insights from across Europe. *The Journal of Technology Transfer, 42*(1), 1-9.

Murphy, J. T. (2001). Making the energy transition in rural East Africa: Is leapfrogging an alternative?. *Technological Forecasting and Social Change, 68*(2), 173-193.

Naia, A., Baptista, R., Januário, C., & Trigo, V. (2015). Entrepreneurship education literature in the 2000s. *Entrepreneurship education literature in the 2000s*, (1), 111-135.

Nambisan, S., Siegel, D., & Kenney, M. (2018). On open innovation, platforms, and entrepreneurship.

Strategic Entrepreneurship Journal, 12(3), 354–368. https://doi.org/10.1002/sej.1300.

Nambisan, S., Wright, M., & Feldman, M. (2019). The digital transformation of innovation and entrepreneurship: Progress, challenges and key themes. *Research Policy, 48*(8), 103773.

Nemet, G. (2009). Demand-pull, technology-push and government-led incentives for non-incremental technical change. *Research Policy*, *38*, 700–709. https://doi.org/10.1016/j.respol.2009.01.004

Niemand T., Rigtering C., Kallmünzer A., Kraus S., Matijas S. (2017). Entrepreneurial orientation and digitalisation in the financial service industry: a contingency approach. In: *Proceedings of the European conference on information systems (ECIS),* Guimarães, Portugal, June 5–10, 2017, 1081–1096

Nugroho, M. A. (2015). Impact of government support and competitor pressure on the readiness of SMEs in Indonesia in adopting information technology. *Procedia Computer Science*, *72*, 102-111.

OECD. (2019). Organisation for Economic Co-operation and Development. Retrieved from https://www.oecd.org/

Oosterbeek, H., Van Praag, M. C. and Ijsselstein, A. (2010). The impact of entrepreneurship education on entrepreneurship skills and motivation, *European Economic Review*. 54(3), 442–454. https://doi.org/10.1016/j.euroecorev.2009.08.002

Parasuraman, A., & Colby, C. L. (2015). An updated and streamlined technology readiness index: TRI 2.0. *Journal of Service Research*, *18*(1), 59-74.

Petersen, B., Welch, L., & Liesch, P. (2002). The Internet and Foreign Market Expansion by Firms. *Management International Review*, 42(2), 207-221.

Pinheiro-Alves, R., & Zambujal-Oliveira, J. (2012). The Ease of Doing Business Index as a tool for investment location decisions. *Economics Letters*, *117*(1), 66–70. https://doi.org/10.1016/j.econlet.2012.04.026

Porter, M. (1985). Technology and Competitive Advantage, *Journal of Business Strategy*, 5(3), 60-78, 1985.

Pramanik, H. S., Kirtania, M., and Pani, A. K. (2019). Essence of digital transformation—Manifestations at large financial institutions from North America. *Future Generation Computer Systems*, *95*, 323-343.

Quinones, G, Nicholson, B & Heeks, R. 2013. Positioning Research on Entrepreneurship in Developing Economies: A Study of Latin-American Digital Ventures. *In:* Proceedings of 3rd Conference of the International Consortium of Studies on Innovation and Entrepreneurship (ICIER) Policies to Support Entrepreneurship Rio de Janeiro.

Rezaei, M., Jafari-Sadeghi, V., & Bresciani, S. (2020). What drives the process of knowledge management in a cross-cultural setting: The impact of social capital. *European Business Review*. 32(3), 485-511. https://doi.org/10.1108/EBR-06-2019-0127

Rialti, R., Marzi, G., Caputo, A., & Mayah, K. A. (2020). Achieving strategic flexibility in the era of big data. *Management Decision*. https://doi.org/10.1108/MD-09-2019-1237

Richard, B., & Daria, T. (2006). Gravity for Dummies and Dummies for Gravity Equations. *Nber Working Paper Series*, 1–29. https://doi.org/10.1017/CBO9781107415324.004

Rideout, E. C., & Gray, D. O. (2013). Does entrepreneurship education really work? A review and methodological critique of the empirical literature on the effects of university- based entrepreneurship education. *Journal of Small Business Management*, 51(3), 329-351.

Ross, A. G., Adams, J., & Crossan, K. (2015). Entrepreneurship and the spatial context: A panel data study into regional determinants of small growing firms in Scotland. *Local Economy*, *30*(6), 672–688. https://doi.org/10.1177/0269094215600135

Ruiz, F., Cabello, J. M., & Pérez-Gladish, B. (2018). Building Ease-of-Doing-Business synthetic indicators using a double reference point approach. *Technological Forecasting and Social Change*, *131*(June), 130–140. https://doi.org/10.1016/j.techfore.2017.06.005

Sadeghi, V. J., & Biancone, P. P. (2018). How micro, small and medium-sized enterprises are driven outward the superior international trade performance? A multidimensional study on Italian food sector. *Research in International Business and Finance*, 45, 597-606. https://doi.org/10.1016/j.ribaf.2017.07.136

Sadeghi, V.J., Biancone, P. P., Giacoma, C., & Secinaro, S. (2018). How does export compliance influence the internationalization of firms: is it a thread or an opportunity? *Journal of Global Entrepreneurship Research*, 8(3), 1-15. https://doi.org/10.1186/s40497-018-0089-3

Sadraei, R., Jafari Sadeghi, V., & Sadraei, M. (2018). Biotechnology revolution from academic entrepreneurship to industrial: chemo-entrepreneurship. *Biometrics & Biostatistics International Journal*, 7(6), 546-550. https://doi.org/10.15406/bbij.2018.07.00257

Sahut, J. M., Iandoli, L., & Teulon, F. (2019). The age of digital entrepreneurship. *Small Business Economics*, 1-11

Seiter, E. (2005). The Internet Playground: Children's access, entertainment, and mis-education (Vol. 10). Peter Lang.

Schendel, D. (1994) Introduction to Competitive Organisational Behavior: Toward an Organisationally Based Theory of Competitive Advantage. *Strategic Management Journal*, 15, 1–4.

Scherer, F.M. (1980). Industrial Market Structure and Economic Performance, 2nd Edition. Rand McNally, Chicago

Scott, J. E. (2007). An e-transformation study using the technology-organization-environment framework. *BLED 2007 Proceedings*, 55.

Scuotto, V., Santoro, G., Bresciani, S., & Del Giudice, M. (2017). Shifting intra- and inter-organizational innovation processes towards digital business: an empirical analysis of SMEs. *Creativity and Innovation Management*, 26(3), 247-255.

Shane, S. (2001). Technology regimes and new firm formation. *Management Science*, *47*(9), 1173-1190.

Strasssmann, P. (1990). The business value of computers: an executive's guide, *Information Economic Press*, New Canaan, CT.

Su, L., Jin, S., & Zhang, Y. (2015). Specification test for panel data models with interactive fixed effects. *Journal of Econometrics*, *186*(1), 222–244. https://doi.org/10.1016/j.jeconom.2014.06.018

Sukumar, A., Jafari-Sadeghi, V., Garcia-Perez, A., & Dutta, D. K. (2020). The potential link between corporate innovations and corporate competitiveness: Evidence from IT firms in the UK. *Journal* *of Knowledge Management*. 24(5), 965-983. https://doi.org/10.1108/JKM-10-2019-0590

Tajudeen, F. P., Jaafar, N. I., and Sulaiman, A. (2019). External Technology Acquisition and External Technology Exploitation: The Difference of Open Innovation Effects. *Journal of Open Innovation: Technology, Market, and Complexity*, *5*(4), 97.

Thrassou, A., Vrontis, D. and Bresciani, S. (2018), “The Agile Innovation Pendulum: Family Business Innovation and the Human, Social and Marketing Capitals”, *International Studies of Management and Organization*, 48(1), 88-104.

Wälde, K. (2002). The economic determinants of technology shocks in a real business cycle model. *Journal of Economic Dynamics and Control*, *27*(1), 1-28.

Warner, K. S., & Wäger, M. (2019). Building dynamic capabilities for digital transformation: An ongoing process of strategic renewal. *Long Range Planning*, *52*(3), 326-349.

Weill, P. (1992). The relationship between investment in information technology and firm performance: a study of the valve manufacturing sector, *Information Systems Research*, 3(4), 307-333.

WDI. (2019). World Bank. Retrieved June 5, 2018, from http://data.worldbank.org/indicator/NY.GDP.MKTP.CD?locations=CA

Xavier, S. R., Kelley, D. J., Kew, J., Herrington, M., & Vorderwülbecke, A. (2012). Global Entrepreneurship Monitor Global Report. *Global Entrepreneurship Monitor*.

Yang, C., & Chan, D. Y. T. (2020). Market Expansion of Domestic Gaming Firms in Shenzhen, China: Dilemma of Globalisation and Regionalisation. *Tijdschrift voor economische en sociale geografie*. https://doi.org/10.1111/tesg.12459

Yoo, Y., Henfridsson, O., Lyytinen, K. (2010). The new organising logic of digital innovation: an agenda for information systems research. *Information Systems Research,* 21 (4), 724–735.

Yuan, X., & Nishant, R. (2019). Understanding the complex relationship between R&D investment and firm growth: A chaos perspective. *Journal of Business Research*. https://doi.org/10.1016/j.jbusres.2019.11.043

Zhu, K., Dong, S., Xu, S. X., and Kraemer, K. L. (2006). Innovation diffusion in global contexts: determinants of post-adoption digital transformation of European companies. *European journal of information systems*, *15*(6), 601-616.

Figure 1

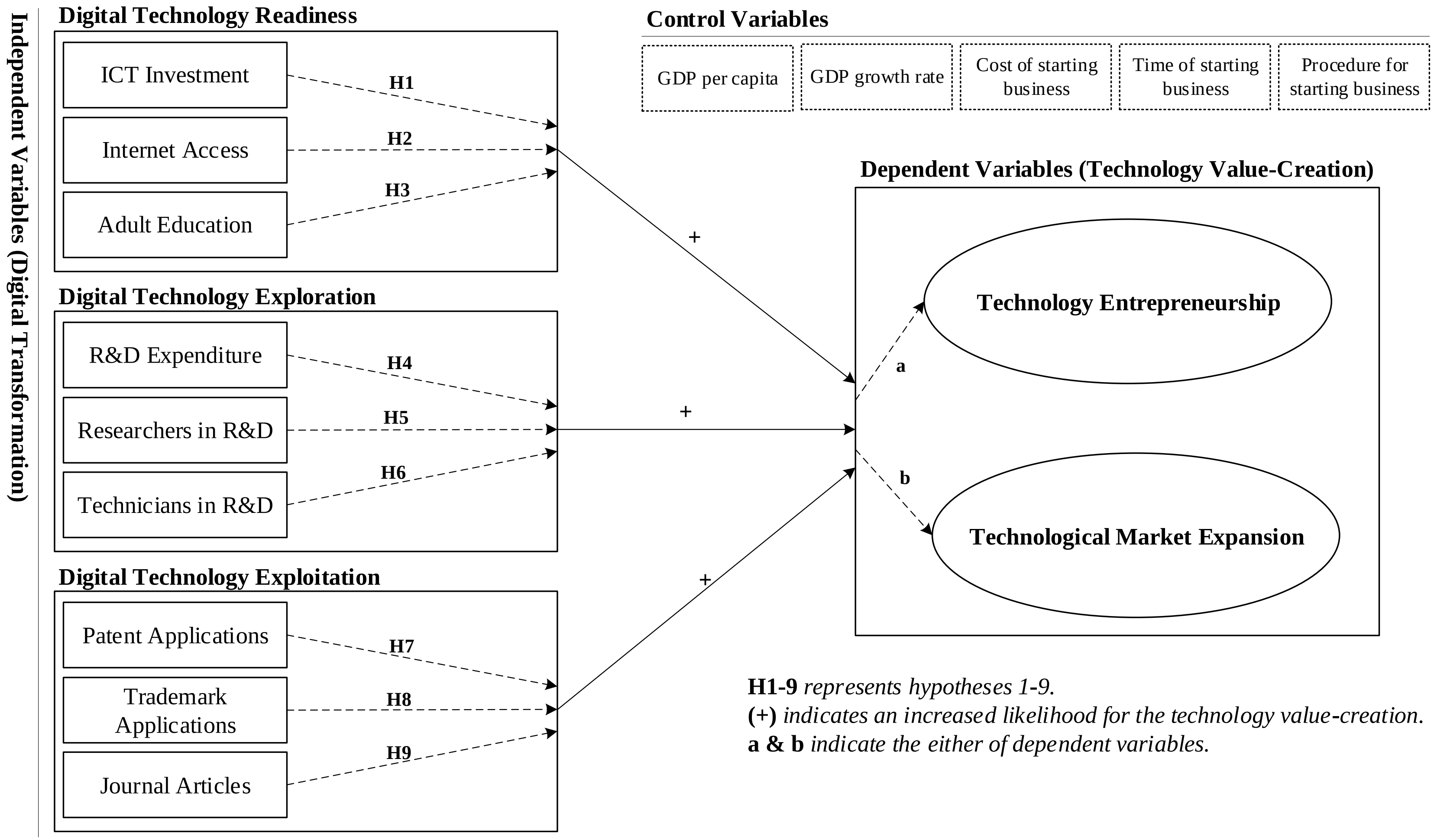

Figure 1. Theoretical Framework

Table 1

Table 1. Variables' description.

Label	Name	Descriptions	Source
TEA-TECH	Technology entrepreneurship	Total early-stage entrepreneurship (TEA) active in the (high or medium) technology sector: It represents the percentage of individuals aged 18 to 64 years who are involved in running new high or medium technology businesses.	GEM
TEA-MX	Technological market expansion	TEA and market expansion, with technology: Total early-stage entrepreneurship actively looking for market expansion in the technology sector.	GEM
GDP	GDP per capita	(Expressed in the natural log) GDP per capita is gross domestic product divided by midyear population. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products.	WDI
GDP-G	GDP growth rate	The annual percentage growth rate of GDP at market prices based on constant local currency.	WDI
EASE-COST	Cost of starting business	The cost of starting a business, as a percentage of income per capita.	EDBI
EASE-TIME	Time of starting business	The time of starting a business, as a number of days.	EDBI
EASE-PRC	Procedure for starting business	The procedure of starting a business, presenting the number of steps of starting a new business.	EDBI
ICT	ICT investment	(Expressed in the natural log) the acquisition of equipment and computer software that is used in production for more than one year.	OECD
INRT	Internet access	Defined as the percentage of households who reported that they had access to the Internet. In almost all cases this access is via a personal computer either using a dial-up, ADSL or cable broadband access.	OECD
ADL-EDU	Adult education	This indicator looks at the adult education level as defined by the highest level of education completed by the 25-64-year-old population.	OECD
R&D-EXP	R&D expenditure	(% of GDP): Gross domestic expenditures on research and development, expressed as a per cent of GDP. They include both capital and current expenditures in the four main sectors: Business enterprise, Government, Higher education and Private non-profit. R&D covers basic research, applied research, and experimental development.	WDI
RSCH-R&D	Researchers in R&D	The number of researchers engaged in R&D, as per million (expressed in the natural log): Researchers are professionals who conduct research and improve or develop concepts, theories, models techniques instrumentation, software of operational methods.	WDI
TECH- R&D	Technicians in R&D	The number of technicians involved in R&D, expressed as per million (expressed in the natural log): Technicians and equivalent staff are people who perform scientific and technical tasks involving the application of concepts and operational methods, normally under the supervision of researchers.	WDI
PTNT-APP	Patent Applications	(Expressed in the natural log) Patent applications filed through the Patent Cooperation Treaty procedure or with a national patent office for exclusive rights for an invention--a product or process that provides a new way of doing something or offers a new technical solution to a problem.	WDI
TRMD-APP	Trademark Applications	(Expressed in the natural log) Applications to register a trademark with a national or regional Intellectual Property (IP) office. A trademark is a distinctive sign which identifies certain goods or services as those produced or provided by a specific person or enterprise.	WDI
JRL-ART	Journal Articles	Scientific and technical journal articles (expressed in the natural log): Refer to the number of scientific and engineering articles published in the following fields: physics, biology, chemistry, mathematics, clinical medicine, biomedical research, engineering and technology, and earth and space sciences.	WDI

Table 2

Table 2. Correlation matrix and descriptive statistics.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Mean	6.69	0.68	10.17	0.61	5.27	17.47	6.25	73.13	74.67	23.81	1.55	7.98	6.67	5.02	8.29	9.15
Std. Dev.	3.31	0.52	0.82	4.02	6.55	17.36	2.59	10.50	13.43	14.13	0.87	0.67	0.87	2.26	0.71	1.54
Min	0.39	0.00	8.42	-14.81	0.00	3.50	2.00	42.14	18.65	6.34	0.02	5.06	3.67	0.00	7.15	5.85
Max	18.22	2.96	11.69	25.16	31.60	109.0	15.00	95.20	96.78	70.10	3.75	8.95	8.12	9.88	10.25	11.60
Correlation matrix																
TEA-TECH.**1**	1.00	-0.19	0.35	0.19	-0.21	-0.11	-0.11	0.22	0.18	-0.05	0.30	0.28	0.26	0.14	-0.04	0.17
TEA-MX.**2**		1.00	-0.38	0.06	0.13	0.17	0.11	-0.08	-0.21	0.16	-0.25	-0.34	-0.16	-0.34	-0.20	-0.42
GDP.**3**			1.00	0.06	-0.36	-0.42	-0.38	0.40	0.51	0.01	0.66	0.77	0.76	0.37	0.24	0.43
GDP-G.**4**				1.00	-0.16	0.01	-0.17	0.22	0.34	-0.23	0.02	0.03	-0.02	0.07	-0.04	-0.02
EASE-COST.**5**					1.00	0.66	0.75	-0.30	-0.37	0.27	-0.40	-0.45	-0.27	-0.06	0.07	-0.02
EASE-TIME.**6**						1.00	0.65	-0.05	-0.12	-0.01	-0.32	-0.39	-0.34	-0.14	-0.02	-0.29
EASE-PRC.**7**							1.00	-0.24	-0.35	0.25	-0.47	-0.46	-0.33	-0.05	0.14	-0.02
ITC.**8**								1.00	0.61	-0.30	0.58	0.38	0.21	0.31	0.08	0.13
INRT.**9**									1.00	-0.50	0.45	0.39	0.28	0.36	0.22	0.13
ADL-EDU.**10**										1.00	-0.12	-0.12	0.00	-0.11	-0.03	0.16
R&D EXP.**11**											1.00	0.76	0.62	0.39	0.01	0.40
RSCH-R&D.**12**												1.00	0.81	0.35	0.07	0.38
TECH- R&D.**13**													1.00	0.32	0.16	0.37
PTNT-APP.**14**														1.00	0.70	0.72
TRMD-APP.**15**															1.00	0.43
JRL-ART.**16**																1.00

Table 3

Table 3. Panel unit root tests.

	Levin–Lin–Chu (2002) – adjusted t*	**Harris–Tzavalis (1999) – rho (statistics)**	**Breitung (2000) – lambda (statistics)**
TEA-TECH.**1**	28.508$^{\square}$	-0.141$^{\square}$	-3.466$^{\square}$
TEA-MX.**2**	-17.489$^{\square}$	-0.132$^{\square}$	-4.236$^{\square}$
GDP.**3**	-8.512$^{\square}$	0.332$^{\square}$	-2.058**
GDP-G.**4**	-94.064$^{\square}$	0.162$^{\square}$	-0.328
EASE-COST.**5**	3.909	0.444***	0.772
EASE-TIME.**6**	5.189	0.695*	0.409
EASE-PRC.**7**	0.397	0.581*	-0.086***
ITC.**8**	-4.120$^{\square}$	0.633*	3.611**
INT.**9**	-8.098$^{\square}$	0.845*	5.752*
ADL-EDU.**10**	-1.268*	0.554*	4.709***
R&D-EXP.**11**	-5.774$^{\square}$	0.139$^{\square}$	2.525***
RSCH-R&D.**12**	-4.662$^{\square}$	0.542	2.488*
TECH- R&D.**13**	-9.690$^{\square}$	0.507**	0.045**
PTNT-APP.**14**	-5.870$^{\square}$	0.380$^{\square}$	0.160*
TRMD-APP.**15**	-5.785$^{\square}$	0.721*	4.359*
JRL-ART.**16**	-14.540$^{\square}$	0.685***	2.894

Coefficients (Std. Error) * $p < 0.1$. ** $p < 0.05$. *** $p < 0.01$. $^{\square}$ $p < 0.01$. For all tests, the null hypothesis is that all the panels contain a unit root.

Table 4

Table 4. Results of the static panel data analysis for technology readiness.

	TEA-TECH		TEA-MX	
	Fixed	Random	Fixed	Random
C	34.765	-9.761**	0.987	3.056***
	(29.098)	(3.886)	(3.575)	(0.931)
GDP	0.006	0.027	0.005	0.011**
	(0.079)	(0.031)	(0.015)	(0.005)
GDP-G	-0.037	-0.046	-0.003	0.002
	(0.054)	(0.030)	(0.010)	(0.006)
EASE-COST	0.147	-0.118*	-0.009	-0.005
	(0.137)	(0.064)	(0.017)	(0.012)
EASE-TIME	-0.019	0.017	-0.005	-0.001
	(0.056)	(0.023)	(0.007)	(0.005)
EASE-PRC	0.211	0.222	0.022	0.005
	(0.251)	(0.153)	(0.031)	(0.026)
ICT	-2.606	1.680□	0.014	0.017**
	(2.703)	(0.429)	(0.009)	(0.008)
INRT	0.172**	0.151***	0.014**	0.008
	(0.071)	(0.058)	(0.007)	(0.005)
ADL-EDU	-0.046	-0.331□	-0.123	-0.013
	(0.123)	(0.094)	(0.332)	(0.023)
R&D-EXP				
RSCH-R&D				
TECH- R&D				
PTNT-APP				
TRMD-APP				
JRL-ART				
R^2	0.385	0.591	0.044	0.260
F Test	1.370		5.730	
(P-Value)	0.121		0.000	
Hausman Test	(Random) 0.473		(Random) 0.296	
Observations	196	196	196	196
Groups	28	28	28	28

Coefficients (Std. Error) * p < 0.1. ** p < 0.05. *** p < 0.01. □ p < 0.01.

Table 5

Table 5. Results of the static panel data analysis for technology exploration.

	TEA-TECH		TEA-MX	
	Fixed	Random	Fixed	Random
C	24.846	-5.471	3.453	4.584□
	(27.344)	(5.078)	(3.383)	(1.004)
GDP	1.064	0.697	-0.267	-0.333***
	(1.037)	(0.452)	(0.334)	(0.101)
GDP-G	0.642	-0.287	0.116	0.065
	(1.300)	(0.779)	(0.128)	(0.085)
EASE-COST	0.159	-0.113*	-0.011	-0.007
	(0.134)	(0.063)	(0.017)	(0.012)
EASE-TIME	-0.018	0.009	-0.003	0.000
	(0.059)	(0.021)	(0.007)	(0.004)
EASE-PRC	0.228	0.298*	0.015	0.005
	(0.245)	(0.154)	(0.030)	(0.025)
ICT				
INRT				
ADL-EDU				
R&D-EXP	-1.957	1.201**	0.021***	0.020***
	(2.698)	(0.525)	(0.008)	(0.007)
RSCH-R&D	0.160***	0.139**	-0.192	-0.316**
	(0.062)	(0.056)	(0.161)	(0.128)
TECH- R&D	-1.058	-0.052	0.195*	0.285***
	(0.949)	(0.515)	(0.117)	(0.089)
PTNT-APP				
TRMD-APP				
JRL-ART				
R^2	0.325	0.576	0.186	0.385
F Test	1.450		4.870	
(P-Value)	0.084		0.000	
Hausman Test	(Random) 0.385		(Fixed) 0.000	
Observations	196	196	196	196
Groups	28	28	28	28

Coefficients (Std. Error) * p < 0.1. ** p < 0.05. *** p < 0.01. □ p < 0.01.

Table 6

Table 6. Results of the static panel data analysis for technology exploitation.

	TEA-TECH		**TEA-MX**	
	Fixed	Random	Fixed	Random
C	1.466	***-2.034***	***3.642***	3.900□
	(32.734)	***(4.908)***	***(4.013)***	(1.077)
GDP	-0.108	***0.207***	***-0.203***	-0.177**
	(0.265)	***(0.192)***	***(0.335)***	(0.086)
GDP-G	1.125	***-1.125*****	***0.244***	-0.073
	(1.364)	***(0.479)***	***(0.257)***	(0.052)
EASE-COST	2.897	***0.100***	***-0.008***	0.001
	(2.098)	***(0.246)***	***(0.016)***	(0.012)
EASE-TIME	-0.026	***0.016***	***-0.003***	-0.002
	(0.055)	***(0.021)***	***(0.007)***	(0.004)
EASE-PRC	0.320	***0.297*****	***-0.013***	0.002
	(0.258)	***(0.147)***	***(0.032)***	(0.025)
ICT				
INRT				
ADL-EDU				
R&D-EXP				
RSCH-R&D				
TECH- R&D				
PTNT-APP	-3.201	***1.431***□	***0.005***	-0.008
	(2.734)	***(0.353)***	***(0.032)***	(0.029)
TRMD-APP	0.146**	***0.121*****	***-0.360*****	-0.086
	(0.066)	***(0.056)***	***(0.167)***	(0.096)
JRL-ART	0.165	***-0.130*****	***0.015****	0.020***
	(0.134)	***(0.058)***	***(0.008)***	(0.007)
R^2	0.038	***0.678***	***0.116***	0.337
F Test	1.270		***5.320***	
(P-Value)	0.180		***0.000***	
Hausman Test	(Random) 0.684		(Fixed) 0.000	
Observations	196	196	196	196
Groups	28	28	28	28

Coefficients (Std. Error) * $p < 0.1$. ** $p < 0.05$. *** $p < 0.01$. □ $p < 0.01$.