POLITECNICO DI MILANO

School of Industrial and Information Engineering
Master of Science in Management Engineering

How Entrepreneurship Drives Economic Growth: The Role of Digitalization

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Academic Year 2018/2019

ACKNOWLEDGMENTS

There are a lot of people I want to express my thanks to, not only for the drafting of this dissertation but also for having supported me throughout my challenging and inspiring experience at Politecnico di Milano.

First of all, I want to thank my supervisor Prof. Angelo Cavallo who gave me the inspiration to choose the topic of this thesis, transmitted all his passion for entrepreneurship and, finally, constantly helped me during the period of research.

Special thanks also to my co-supervisor Dr. Sina Lessanibahri who kindly assisted me with the statistical and mathematical part of this dissertation, teaching me all the necessary techniques. Furthermore, I'd like to thank Prof. Antonio Ghezzi for having allowed me to join the research team of the "Osservatorio Startup Hi-Tech" of Politecnico di Milano and work regularly with them. For this reason, I want to acknowledge everyone in the team and, in particular, Dr. Silvia Sanasi.

Then, many thanks to all the Professors I met during my years in this University. Each of them had a great role in my professional growth. A special mention to Prof. Luca Gastaldi who gave me precious advice for the preparation of this paper.

A big thank you to all my friends inside and outside the University for having shared these years together.

Most importantly, I want to thank my whole family, especially my mother Gianna and my father Pierluigi (and also my sister Sara). Since without their support I would not have had the chance of studying in this University, most of the merit for this achievement belongs to them.

Finally, a particular dedication to Cavaliere del Lavoro Ernesto Gazzola, as well as my grandfather, who, being a productive entrepreneur since 1962, has been, is and always will be one of the most influential sources of inspiration for me.

Andrea

Abstract

While most studies have studied the impact of entrepreneurship and digitalization on economic growth separately, at our knowledge, none of them have directly investigated the combining effects of these two phenomena on economic development. Drawing upon a processual view of entrepreneurship whose phases are entrepreneurial quantity, entrepreneurial quality and entrepreneurial outcome, we propose a new measurement system of this phenomenon. Hypotheses are developed to examine the relationship between entrepreneurship, digitalization and economic growth at country-level. We test these hypotheses using a comprehensive dataset which relies on several sources. Moreover, data refer to the 28 countries belonging to European Union in 2019 in a timeframe that goes from 2009 to 2017. The empirical results generally support our hypotheses by showing that (1) entrepreneurship positively influences economic growth, (2) entrepreneurship positively influences digitalization, (3) digitalization positively influences economic growth, (4) digitalization completely mediates the relationship between entrepreneurship and economic growth. These findings contribute to our understanding of the role of entrepreneurship and digitalization in context of economic growth. Implications for policymakers and entrepreneurs are also included in the end of this dissertation.

Abstract (Italian version)

Mentre la maggior parte degli studi ha studiato l'impatto dell'imprenditorialità e della digitalizzazione sulla crescita economica separatamente, a nostra conoscenza, nessuno di loro ha studiato direttamente gli effetti combinanti di questi due fenomeni sullo sviluppo economico. Attingendo a una visione processuale dell'imprenditoria le cui fasi sono la quantità imprenditoriale, la qualità imprenditoriale e il risultato imprenditoriale, viene proposto un nuovo sistema di misurazione di questo fenomeno. Le ipotesi sono sviluppate per esaminare il rapporto tra imprenditorialità, digitalizzazione e crescita economica a livello nazionale. Queste ipotesi vengono testate utilizzando un set di dati, costruito sfruttando diverse fonti. Inoltre, i dati si riferiscono ai 28 paesi appartenenti all'Unione Europea nel 2019 in un arco temporale che va dal 2009 al 2017. I risultati empirici generalmente supportano le ipotesi di ricerca dimostrando che (1) il livello di imprenditorialità influenza positivamente la crescita economica, (2) il livello di digitalizzazione influenza positivamente la crescita economica, (3) il livello di imprenditorialità influenza positivamente la crescita economica, (4) la digitalizzazione media completamente la relazione tra imprenditorialità e crescita economica. Questi risultati contribuiscono alla comprensione del ruolo dell'imprenditorialità e della digitalizzazione nel contesto della crescita economica. Alcune implicazioni per i responsabili politici e gli imprenditori sono incluse alla fine di questa tesi.

EXECUTIVE SUMMARY

Introduction

Entrepreneurship, defined as "the pursuit of opportunity beyond resources you currently control" by Stevenson (1985, 1990, 1993), has been a prospering topic and central to the work of many scholars. The interest in this theme began at the beginning of the last century thanks to the Austrian economist Joseph Schumpeter who underlined the challenging nature of entrepreneurship towards the status quo. In more recent years, the trend of digitalization has become more and more relevant both from a business and a societal point of view. At this regard, scholars have started a productive discussion pointing out that this trend has resulted in the beginning of a process of digital transformation. Entrepreneurship, like many other fields of knowledge, has been overwhelmed by this powerful revolution. Consequently, most existing studies have introduced the phrase "digital entrepreneurship", defined, "as the pursuit of opportunities based on the use of digital media and other information and communication technologies" (Davidson and Vaast, 2010), to indicate the specific phenomenon triggered by the infusion of new digital technologies in various aspects of innovation and entrepreneurship. Furthermore, it is comprehensively acknowledged that entrepreneurial activity is one of the driving forces for a country's economic growth. It is not only a theoretical fact (Friar and Meyer, 2003; Fritsch, 2008) but it has also been empirically demonstrated in several studies (Wong et al., 2005; Valliere and Peterson, 2009; Bjørnskov and Foss, 2008). In the same way, also the level of digitalization positively affects economic development (Yousefi, 2011; Evangelista et al., 2014; Stanley et al., 2018). However, a gap exists in the current state of the research since the economic growth of a country has never been explained by its level of entrepreneurship and simultaneously analyzing its level

of digitalization. In this respect, we argue that the level of digitalization could mediate the effects of entrepreneurship on economic growth. In sum, we build a novel framework to examine the effects of entrepreneurial activity on economic growth, with a particular focus on the mediating role of digitalization (see Figure A).

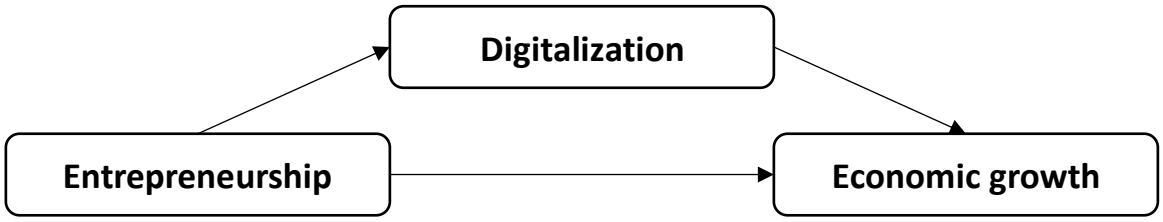

Figure A - Research Framework

Therefore, the aim of this research is to study the link between entrepreneurship and economic growth and to evaluate the role of digitalization in this relation. Through a quantitative approach based on a statistical model, we can state that entrepreneurship is positively related to economic growth and that digitalization completely mediates this relationship. Moreover, since we propose a process view of the entrepreneurial phenomenon made up of three phases, we state that only the last two phases out of three have a positive impact on economic development. These refer to the phase of scale-up and stabilization of the firm. This research gives several contributions to the theory. First of all, the recent phenomenon of digital entrepreneurship is empirically proven. Then, a new and scrupulous way to measure the phenomenon of entrepreneurship is proposed. Policymakers can take advantage of this new method to measure the entrepreneurial phenomenon. Scholars can exploit this research to take a cue to analyze more in depth the relationship among these phenomena.

Theoretical Background and Hypothesis Development

Entrepreneurship and economic growth

Entrepreneurship has been broadly studied by scholars and one of the main points of discussion about this field regards the relation between entrepreneurial activity and economic growth. This is due to the fact that economic development is a key issue in several scientific contexts, especially in policy making and economic research. Several authors in the last decades have debated about the impact of entrepreneurship on economic growth, both from a theoretical and empirical standpoint.

As far as the first one is concerned, since the publication of Schumpeter's study about entrepreneurship, entrepreneurs and their activities are believed to be relevant for economic development (Schumpeter, 1934). As a matter of fact, the author states that entrepreneurs are "agents of creative destruction". However, growth itself has been at the heart of a heated debate for a long period, after the publication of Schumpeter's study. The most acknowledged theories are the neo-classical growth theory and the endogenous growth theory. According to the first one, economic expansion is exclusively caused by labor, capital and some residual exogenous factors explained by technological changes (Solow, 1970). The second one deems that entrepreneurship can be treated like other factors such as capital investment, education, innovation and technology. These form a sequential-feedback process with economic growth (Baumol, 1993). However, entrepreneurship has begun to be incorporated in growth models only in the last decades. Entrepreneurship is recognized to boost growth in several ways: guaranteeing efficiency, accelerating structural change, favoring amplified innovation (Acs and Audretsch, 1988), enabling a greater variety of goods and services (Fritsch, 2008), increasing employment (Blanchflower, 2000; Parker, 2009), facilitating technology transfer and knowledge spill-overs from research to

industry (Acs et al., 2009; Grimaldi et al., 2011). The research project Global Entrepreneurship Monitor (GEM) points out that there are two categories of entrepreneurship. The first one is called opportunity entrepreneurship and it is typical of those entrepreneurs that that have discovered an opportunity and have the desire of exploit it. The second one is necessity entrepreneurship which is typical of those people that have no other options to make a living (Sautet, 2011). It can be noticed that a strong majority of the self-employed are not entrepreneurial in the Schumpeterian sense because they are not committed in bringing innovation to the market and because they do not have the inspiration of making their business bigger (Henrekson and Sanandaji, 2013). Analyzing more in depth the theoretical point of view, a large literature exists about the link among institutions, entrepreneurship and economic growth (North, 1990; Acemoglu and Johnson ,2005; Acemoglu and Robinson, 2012). Institutions advance the level of entrepreneurial activity and may also channel entrepreneurship in productive, rather than unproductive, directions. Furthermore, institutions could be related to economic growth through entrepreneurship (Urbano et al., 2018).

The second type of studies that faces this theme is characterized by an empirical approach in which the main challenge is finding a way to quantify the variables of the relation. If on one hand it is quite simple to measure economic growth, on the other, the same does not apply to entrepreneurship. Many scholars have tried to define a comprehensive way to measure this phenomenon, but the debate is anything but closed. One of the most influential methods to measure entrepreneurial activity is introduced by Acs et al. (2014) who highlight the urgency of this issue for policymakers. After analyzing the already existing methods - among which stand out the indicator by Global Entrepreneurship Monitor (GEM) (Reynolds et al., 2005), the Eurostat's Entrepreneurship Indicators Program (Lunati et al., 2010; OECD-Eurostat, 2007), the World Bank's Entrepreneurship Survey (World Bank, 2011), and the Flash Eurobarometer survey (Gallup, 2009) – they propose a new way to measure entrepreneurship.

The latter is named Global Entrepreneurship and Development Index (in brief, GEDI) and consists of a total of fifteen pillars which are designed to capture entrepreneurial attitudes, ability, and aspirations. This indicator is often exploited by other academics (Lafuente et al., 2016) in order to quantify the entrepreneurial phenomenon.

Other scholars, on the basis of their theoretical perspective, come up with other possible systems. The most used are self-employment (Bjørnskov and Foss, 2008; Dau and Cuervo-Cazurra, 2014; Gohmann, 2012; McMullen et al., 2008; Nystrom, 2008; Troilo, 2011) and the number of new firms (Audretsch and Fritsch, 1994). Some other measures are more connected to the concept of productive entrepreneurship (Stam, 2015). Examples concerning this statement are high-growth self-employment (Bowen and De Clercq, 2008) and the number of new startups (Audretsch and Acs, 1994; Ardagna and Lusardi, 2009). Other measures are the number of venture capital-backed firms or the VC investment as a share of GDP (Henrekson and Sanandaji, 2013). Henrekson and Sanandaji (2013) propose to use the number of billionaires as a share of GDP. Most studies are based on statistical methods encompassing cross-sectional data in different countries over a long time horizon (Wong et al., 2005; Valliere and Peterson, 2009; Bjørnskov and Foss, 2016; Aparicio et al., 2016; Acs et al., 2018; Bosma et al., 2018). Authors measure economic growth either through GDP per capita (Lafuente et al., 2016; Castaño-Martínez et al., 2015; Urbano and Aparicio, 2016) or GDP growth (Stam and van de Stel, 2011; Stam et al., 2011; Valliere and Peterson, 2009) or total factor productivity (Bjørnskov and Foss, 2013; Erken et al., 2016). Finally, Wong (2005) uses the ratio between GDP and the level of employment to obtain a similar measure to GDP per capita. Given the decision about the measures to adopt, the relation between entrepreneurship and economic growth is meticulously analyzed. Wong et al. (2005), exploiting an augmented Cobb–Douglas production function, say that among the four types of entrepreneurship - high growth potential entrepreneurship, necessity

entrepreneurship, opportunity entrepreneurship and overall entrepreneurship - only high growth potential entrepreneurship is found to have a significant impact on economic growth. Valliere and Peterson (2009), on the heels of the aforementioned study, affirm that in developed countries, a relevant part of economic growth rates is caused by high-expectation entrepreneurs exploiting national investments in knowledge creation and regulatory freedom. On the other side, in emerging countries this effect is absent. Braunerhjelm et al. (2010) claim, thanks to an extended Romer production function, GLS panel and OLS, that entrepreneurship is positive for growth and that entrepreneurs are the missing link in generating economically relevant knowledge. Stam et al. (2011) further investigate the relation and find that only growth-ambition entrepreneurship is positively associated to economic development. Hessels and Van Stel (2011), with a panel data estimation, suggest that entrepreneurship and export-driven entrepreneurship affect economic development. Stam and Van Stel (2011) argue that the presence of young and new businesses is positive for growth in high-income countries, but not in medium-income countries. This is tested using an OLS regression. Then, Bjørnskov and Foss (2013), through a panel data analysis, prove that strategic entrepreneurship is linked to economic growth. Castaño-Martínez et al. (2015), using a structural equation modeling, claim that political measures - such as research and development policies, education, elimination of administrative barriers and access to finance – promote the enhancement of an entrepreneurial culture which, in turn, contributes to economic performance. Audretsch and Desai (2015), focusing on cities with different market size find that entrepreneurship has a positive impact on growth. Urbano and Aparicio (2016), taking advantage of an augmented Cobb–Douglas production function and a panel data analysis, demonstrate that total entrepreneurial activity and opportunity activity have a positive effect on economic growth. Lafuente et al. (2016), through a data envelopment analysis, state that National system of entrepreneurship - defined as “the dynamic, institutionally embedded interaction

between entrepreneurial attitudes, ability, and aspirations, by individuals, which drives the allocation of resources through the creation and operation of new ventures" by Acs et al. (2014) - is linked to knowledge spillovers which are a fundamental element for a higher efficiency. The same result is obtained by Erken et al. (2016). Acs et al. (2017), exploiting National Entrepreneurial Ecosystem, introduce in the relation taken into consideration the concept of institutions. According to this study, entrepreneurship affects growth in combination with institutional factors, especially in the first phases of the development process. Accordingly, Bosma et al. (2018) confirm that productive entrepreneurship is a fundamental driver for economic development, and, in addition, they empirically underline the strong importance of institutions in this relation. Although there are different ways to measure the entrepreneurial phenomenon and economic growth and scholars use distinct statistical methodologies, the broad consensus is that entrepreneurship leads to economic growth. For these reasons, we propose:

H1: *The level of entrepreneurial activity is positively related to economic growth at country level*

Then, compared to the empirical studies previously analyzed, we propose to model entrepreneurial activity as the combination of three entrepreneurial dynamics (Cavallo et al., 2018) and not as the set of context factors at the basis of the entrepreneurial ecosystem. Each of these dynamics refer to a specific phase in a start-up lifecycle (Kazanjian, 1988) which are, in chronological order, the creation, the expansion and the stability. Hayward et al. (2006) state that every phase of the entrepreneurial process should be examined by scholars. Consequently, taking advantage of the novelty of this approach, hypothesis 1 can be subdivided into three sub-hypotheses, each of which is related to an exact entrepreneurial dynamic. The latter, in accordance to the reference literature, is supposed to affect economic growth.

The first phase regards the creation of new firms and it is named "entrepreneurial quantity". Referring to GEM, this phase comprehends both necessity and

opportunity entrepreneurship. Traditional measures of entrepreneurship in literature, such as self-employment and newborn companies, correspond to this description (Bjørnskov and Foss, 2008; Dau and Cuervo-Cazurra, 2014; Gohmann, 2012; McMullen et al., 2008; Nystrom, 2008; Troilo, 2011). Accordingly, the following sub-hypothesis is proposed:

H1a: *Entrepreneurial quantity positively affects economic growth at country level*

The second phase regards the expansion of the firm and it is named "entrepreneurial quality". This phase is mostly typical of those firms that are characterized by opportunity and productive entrepreneurship. Some scholars like Stam (2015) argue that only this kind of entrepreneurship leads to economic growth. Numerically, the measurement of this dynamic is similar to the one proposed by Henrekson and Sanandaji (2013) which is the number of venture capital-backed firms or the VC investment as a share of GDP. Moreover, in this way we capture also the contribution to entrepreneurial activity given by already existing firms in addition to the new firms'. Thus, the following sub-hypothesis is proposed:

H1b: *Entrepreneurial quality positively affects economic growth at country level*

The third phase refers to the stability achieved by the start-up - which can be an IPO or a write-off - and it is named "entrepreneurial outcome". This step is exclusively achieved by high-growth firms. Several scholars such as Bjornskov and Foss (2016) highlight the importance of the outcome of the entrepreneurial activity, even if this theme has never been completely debated in an empirical way. On the other side, it is clear that narrowing the ecosystem to these kind of start-ups risks to not capture the whole picture. Therefore, the following sub-hypothesis is proposed:

H1c: *Entrepreneurial outcome positively affects economic growth at country level*

Entrepreneurship and digitalization

Sussan and Acs (2017) deeply analyze the role of entrepreneurship in the digital age by integrating the concepts of entrepreneurial ecosystem and digital ecosystem. An intense entrepreneurial activity is supposed to favor the development of a strong digital infrastructure. The latter could be created from scratch or, alternatively, renewed from an already existing infrastructure. In addition, entrepreneurship has a fundamental role in facilitating the creation of new digital technologies and, equally importantly, of reducing the associated costs. This allows the actors of the ecosystem - which can be segmented in public administration, firms and citizens – to adopt this kind of technology in a broader way. Lower costs, in fact, guarantee a more extensive diffusion of the technologies. Thus, in doing so, the inevitable consequence is the increase of the level of digitalization within the ecosystem. For these reasons, we propose:

H2: *The level of entrepreneurial activity is positively related to the level of digitalization at country level*

Consistently with the first hypothesis and according to the conceptualization of entrepreneurship we propose, also this hypothesis can be split.

H2a: *Entrepreneurial quantity positively affects the level of digitalization at country level*

H2a: *Entrepreneurial quality positively affects the level of digitalization at country level*

H2a: *Entrepreneurial outcome positively affects the level of digitalization at country level*

Digitalization and economic growth

A very important stream of literature analyzes the impact of digitalization on economic growth. Digitalization refers to the impact of digital technologies at

macro-level (of an organization, or a country): it can be defined as "the sociotechnical process of applying digitizing techniques to broader social and institutional contexts that render digital technologies infrastructural" (Tilson et al., 2010). It is acknowledged that investment in Information and Communication Technologies and, in general, the exploitation of digital technologies in the service of business and society, favor economic expansion. (OECD, 2003; Yousefi, 2011; Evangelista et al., 2014; Ganju et al., 2015; Stanley et al., 2018). Therefore, digitalization can be compared to entrepreneurship and can assume a similar role in growth models. Thus, we propose:
H3: *The level of digitalization is positively related to economic growth at country level*

Mediating role of digitalization

Nowadays digital technologies are quickly changing the societal and business environments. Scholars refer to this phenomenon as digital transformation. Lately, both innovation and entrepreneurship have been changed by the advent of powerful digital technologies which can be classified in digital artifacts, digital platforms and digital infrastructures (Nambisan et al., 2019). Digital transformation affects, specifically, four main fields which are strategy, innovation, organization and society. IT strategy has to be considered a full-fledged driver of competitive advantage and not only a means through which improving efficiency and productivity (Bharadwaj et al., 2013). This typology of strategy has to be supported by several dynamic capabilities which are fundamental for companies to survive in such a rapidly changing context and to sustain their competitive advantage (Sambamurthy et al., 2003; Teece, 2007). Digital transformation requires new innovation culture and roles inside the companies such as the Chief Digital Officer (Colbert et al., 2016; Singh and Hess, 2017; Kane et al., 2017). In addition, it should be emphasized that this kind of

revolution has enormous social impacts that are reflected, in turn, in business, because companies are obviously composed by people, and due to the central importance of customers (Ganju et al. 2016). Nambisan et al. (2019) identify three important characteristics of digital transformation and its impact on innovation and entrepreneurship. These features are openness, affordances and generativity. As far as the first one is concerned, digital transformation has been changing the business scenario which, in practice, means that the combination of actors, processes and outcomes can be expanded by new internal and external contribution. Affordances, understood as new potentialities, can be enlarged and improved. Lastly, generativity is defined as the capacity of digital technologies to produce unprompted change by large, varied, unrelated, unaccredited and uncoordinated entities or actors. Thus, it is recognized that digital transformation reveals its effects in the entrepreneurial field. Therefore, the concept of digital entrepreneurship arises and gains relevance among scholars. The very first moment in which academics become aware of the beginning of the phenomenon dates back to the beginning of the '90s. As a matter of fact, Rosenbaum and Cronin (1993) highlight the increasing entrepreneurs' awareness about the great strategic and economic potential deriving from the growth of electronic networking. Before reaching a broad consensus on the exact phrase "digital entrepreneurship", the latter has been named with many terms. All of them can be treated as precursors of the new phenomenon. These new forms of entrepreneurship have begun to emerge due to the synergies between information and communication technology (ICT) and changing paradigms of economic transactions (Matlay and Westhead, 2005). The expressions used are internet entrepreneurship (McKelvey, 2001), tech-based entrepreneurship (Colombo and Delmastro, 2001), cyber entrepreneurship (Bouwman and Hulsink, 2002), e-entrepreneurship (Matlay, 2004), e-commerce entrepreneurship (Sebora et al., 2008) and online entrepreneurship (Dheeriya, 2009).

The phrase “digital entrepreneurship” has consolidated when many scholars have recognized the strong impact of digital technologies - such as mobile computing, cloud computing, social media, 3D printing and data analytics – on entrepreneurship (Nambisan, 2016; Zhao and Collier, 2016) and its related business opportunities such as new markets to be reached, reduced costs of international expansion, more scalable products and services (Davidson and Vaast, 2010; Dutot and Van Horne, 2015; Gustavsson and Ljungberg, 2018; Zaheer et al., 2019). Numerous definitions of digital entrepreneurship exist: the first one and one of the most reputable in the entrepreneurial field is given by Hull et al. (2007) who describe the phenomenon as “a subcategory of entrepreneurship in which some or all of what would be physical in a traditional organization has been digitized”. Outcomes and processes in digital entrepreneurship have become less bounded (Nambisan, 2016). Regarding the outcome, this explains why the structural boundaries of the product or service have changed in terms of features, scope and market reach.

Entrepreneurship and digital entrepreneurship have a common characteristic: both of them can occur through the formation of a new firm or the transformation of an already existing firm (Leong et al., 2016). It is also important to highlight that the level of digitalization in an entrepreneurial process can be more or less high. According to this degree, digital entrepreneurship can be mild, moderate or extreme (Hull et al., 2007). The differentiation goes from making use of digital assets to a business, which is completely conducted online and thereby defines the level to which those businesses operate in the digital world.

Among scholars, there is a strong debate about the environment where digital entrepreneurship develops. Entrepreneurial ecosystem can be defined as a: “set of interdependent actors and factors coordinated in such a way that they enable productive entrepreneurship within a particular territory” (Stam, 2015). Accordingly, digital entrepreneurship is based on the existence or development of a digital ecosystem. According to Li et al. a digital ecosystem is “a self-organizing,

scalable and sustainable system composed of heterogeneous digital entities and their interrelations focusing on interactions among entities to increase system utility, gain benefits, and promote information sharing, inner and inter cooperation and system innovation". Sussan and Acs (2017) link the concept of digital ecosystem to the concept of entrepreneurial ecosystem and thereby integrate agents and users into their concept of the digital entrepreneurial ecosystem.

A gap exists in literature about the combined effects of entrepreneurship and digitalization on economic growth. At this regard, it is interesting to understand how digitalization fits in the relationship between entrepreneurship and economic growth. Integrating H2 and H3, we propose that the level of digitalization mediates the relation between the level of entrepreneurial activity and economic growth, i.e., entrepreneurship enhances digitalization, which in turn influences economic growth. Therefore, the following hypothesis is proposed:

H4: *The level of digitalization mediates the relationship between entrepreneurship and economic growth at country level*

Consistently with the first hypothesis and according to the conceptualization of entrepreneurial activity we propose, also this hypothesis is sub-divided in three sub-hypotheses:

H4a: *The level of digitalization mediates the relationship between entrepreneurial quantity and economic growth at country level*

H4b: *The level of digitalization mediates the relationship between entrepreneurial quality and economic growth at country level*

H4c: *The level of digitalization mediates the relationship between entrepreneurial outcome and economic growth at country level*

Methodology

Sample and data collection

To test the hypotheses, we collected data from several sources. The final longitudinal dataset includes data which refer to the 28 countries belonging to European Union in 2019 and with a time horizon that goes from 2009 to 2017.

We constructed a statistical model to evaluate the mediating effect of digitalization in the relation between entrepreneurial activity and economic growth. This causal model is based on mediation effect (Baron and Kenny, 1986) and, more specifically, it is a multilevel mediation model because it is based on a clustered database (Krull and MacKinnon, 2001). The research model includes an independent variable, which is entrepreneurship, a mediator variable, which is digitalization, a dependent variable, which is economic growth, and a control variable which represents institutions or quality of governance.

The database is necessary to measure the four variables of the model: entrepreneurship, digitalization, economic growth and institutions. Entrepreneurial activity is measured through the Entrepreneurial Index which is the arithmetic average of three components. Each component refers to one of the three entrepreneurial dynamics we already analyzed: entrepreneurial quantity, entrepreneurial quality and entrepreneurial outcome. In order to measure these components, we used some quantifiable indicators, constructed with the available raw data. Entrepreneurial quantity is simply calculated with the number of newborn firms divided by GDP at country level. Entrepreneurial quality is the arithmetic average – after normalization – among three indicators which track high growth companies and their abilities of attracting capital and, most importantly, attracting it in large quantities in order to scale their business models. The first one is the ratio between the amount of investment in start-ups and GDP. The second one is the ratio between the amount of investment greater than 5 million USD and GDP. The third one is the ratio between the number of big deals and GDP. Entrepreneurial outcome has the task of detecting the ability of a country to bring start-ups with high potential to a significant "size", which is

manifested mainly through the achievement of an exit (Trade Sale or IPO) and/or particularly significant valorizations (greater than $ 1 billion - Unicorns). Specifically, two measures are used for this component. The first one is the ratio between the number of exits and GDP. The second one is the ratio between the number of the start-ups which become unicorns in a year and GDP. Entrepreneurial outcome, consequently, is the arithmetic average of these two indicators. Thus, entrepreneurship can be measured using the Entrepreneurial Index or, alternatively, one of its three components.[1]

Digitalization is measured through a comprehensive framework elaborated by the observatory "Agenda Digitale" of Politecnico di Milano. The final result is a weighted average of four components, that, similarly to the Entrepreneurial Index, compose this index. The four components of the Digital Maturity Index are Infrastructure, Public Administration, Citizens and Firms. The first one, which is Infrastructure, regards the diffusion and the utilization of the broadband and other key infrastructures like the cloud. The second one, Public Administration, concerns the diffusion and the utilization of e-Government services. The component about citizens evaluates the diffusion and usage of digital tools but also the digital competencies of the people. The last one is about the firms and it concerns the diffusion and the utilization of digital technologies in the production and sales processes of both products and services. Every component is a weighted average of many variables, gathered from different sources[2].

The dependent variable studied in the model measures economic growth. The variable chosen to evaluate the economic growth of a country is real GDP per capita[3]. It is calculated by dividing GDP by a country's population.

1 Data about entrepreneurship are gathered from: Eurostat, Crunchbase, International Monetary Fund, CB Insights

2 Data about digitalization are gathered from: DESI, DAS, OECD, Global Connectivity Index, Global Findex, Eurostat, Network Readiness Index, UNCTADSTAT, Euro Health Consumer Index, World Bank, World Economic Forum

3 Data about economic growth are gathered from: Eurostat

The last variable that has to be analyzed is the control variable. In this case an element to be used as control variable is the Quality of Governance which reflects the effectiveness of formal institutions within a country. The final indicator concerning the Quality of Governance is the arithmetic average of six components: Voice and Accountability, Political Stability and Absence of Violence, Government Effectiveness, Regulatory Quality, Rule of Law, Control of Corruption[4].

Analysis and results

To test the model, we used a statistical software package named Stata. After having standardized each variable we used an external Stata command to test mediation introduced in Krull and MacKinnon (2001), which is:
ml_mediation, dv (Dependent variable) mv (Mediator) iv (Independent variable) l2id (country) cv (Control variables)
This command refers to mediation analysis, introduced by Baron and Kenny (1986). The logical structure is schematized in the following figure. Path c is called the total effect, path c' is called the direct effect and paths a and b refer to the indirect effect.

[4] Data about quality of governance are gathered from: World Bank

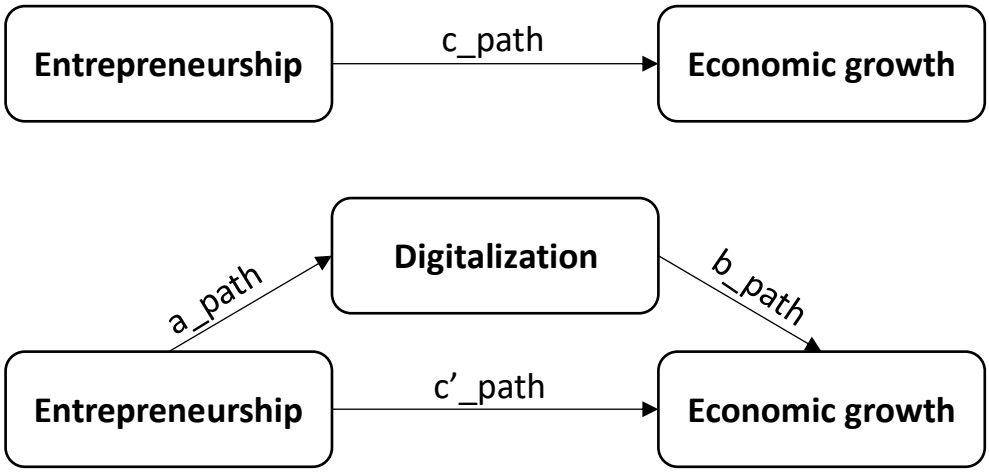

Figure B - Mediational Model

Then we evaluated the statistical significance of the effects through bootstrapping analysis. Given the fact that, according to literature, entrepreneurship and digitalization have an impact on economic growth only after 2/3 years (Carree and Thurik, 2010), a two-year time-lag has been considered. So, entrepreneurship and digitalization in year *n*, as well as the Quality of Governance, are supposed to affect economic growth in year *n+2*.

In the following table we can see an overview of the descriptive statistics of the variables composing the whole statistical model.

Variables	*Mean*	*S.D.*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
1) Entrepreneurial Index	0.1079	0.0896	1											
2) Entrepreneurial Quantity	0.2223	0.2161	0.75***	1										
3) Entrepreneurial Quality	0.0687	0.1199	0.56***	-0.06	1									
4) Entrepreneurial Outcome	0.0421	0.0811	0.47***	-0.09	0.49***	1								
5) DMI Achieved Results	0.2838	0.1364	0.21*	-0.26*	0.51***	0.48***	1							
6) DMI_Infrastructure	0.3086	0.1388	0.23*	-0.18	0.47***	0.42***	0.92***	1						
7) DMI_Firms	0.2928	0.1521	0.16	-0.23*	0.42***	0.40***	0.91***	0.78***	1					
8) DMI_Citizens	0.2831	0.1358	0.18	-0.31**	0.52***	0.50***	0.98***	0.89***	0.84***	1				
9) DMI_PAs	0.2323	0.1530	0.20*	-0.24*	0.50***	0.46***	0.96***	0.86***	0.87***	0.94***	1			
10) GDP per Capita	24,820	15,833	-0.40***	-0.71***	0.23*	0.13	0.43***	0.31**	0.39***	0.48***	0.38***	1		
11) GDP Growth	1.1853	3.8744	0.30**	0.08	0.29**	0.26*	0.43***	0.47***	0.42***	0.40***	0.35**	0.10	1	
12) Quality of Governance	1.0471	0.4443	-0.23*	-0.53***	0.23*	0.16	0.36**	0.23*	0.38***	0.38***	0.35**	0.56***	0.04	1

*Table A - Correlation Matrix; ***p < 0.001; **p < 0.01; *p < 0.05.*

	c_path				a_path				b_path and c’			
	Economic growth				Digitalization				Economic growth			
	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12
Control variable												
Quality of Governance	0.0474** (0.0146)	0.0633*** (0.0157)	0.0471** (0.0153)	0.0474** (0.0147)	0.2483** (0.0790)	0.1969** (0.0720)	0.1862** (0.0610)	0.1872** (0.0560)	0.0391** (0.0129)	0.0441** (0.0129)	0.0349** (0.0130)	0.0389** (0.0129)
Independent variables												
Entrepreneurial activity	0.0848*** (0.0175)				0.6181*** (0.0931)				0.0084 (0.0187)			
Entrepreneurial quantity		0.0323 (0.0283)				-0.1212 (0.0737)				0.0041 (0.0235)		
Entrepreneurial quality			0.0434** (0.0131)				0.4916*** (0.0752)				-0.0031 (0.0124)	
Entrepreneurial outcome				0.0831*** (0.0168)				0.8301*** (0.0984)				0.0165 (0.0173)
Mediator												
Digitalization									0.0797*** (0.0110)	0.0812*** (0.0090)	0.0837*** (0.0101)	0.0771*** (0.0106)

*Table B - Statistical Results; ***p < 0.001; **p < 0.01; *p < 0.05; standard errors in the parentheses*

	Effect	Observed Coef.	Bootstrap Std. Err.	z	P>|z|	Normal-based [95% Conf. Interval]	
Entrepreneurial activity	Indirect effect	0.0589	0.0212	2.78	0.006	0.0173	0.1005
	Direct effect	0.0093	0.0116	0.80	0.422	-0.0134	0.0321
	Total effect	0.0683	0.0175	3.89	0.000	0.0339	0.1026
Entrepreneurial quality	Indirect effect	0.0461	0.0111	4.15	0.000	0.0243	0.0679
	Direct effect	0.0000	0.0084	0.00	0.997	-0.0164	0.0165
	Total effect	0.0462	0.0134	3.45	0.001	0.0200	0.0724
Entrepreneurial outcome	Indirect effect	0.0701	0.0319	2.20	0.028	0.0075	0.1327
	Direct effect	0.0178	0.0116	1.54	0.123	-0.0048	0.0405
	Total effect	0.0879	0.0355	2.48	0.013	0.0183	0.1575

Table C - Bootstrapping Results; results are based on 5000 bootstrap samples

Looking at the results of the statistical analysis which are reported in the table above, we can evaluate the validity of the hypothesis of this research. For the sake of clearness, following the logical procedure, we can analyse them by focusing on the entrepreneurial activity and on its three phases. For hypothesis 1, which is concerned with the effect of entrepreneurship on economic growth, and its related sub-hypothesis, we have to evaluate c_path which refers to the total effects. This is statistically and positively significant, in terms of p-value and coefficients, for total entrepreneurial activity, entrepreneurial quality and entrepreneurial outcome. The same does not apply to entrepreneurial quantity. Bootstrapping analysis confirms this statement. Therefore, hypothesis 1, hypothesis 1b, hypothesis 1c are confirmed while hypothesis 1a is denied. For hypothesis 2, which is concerned with the effect of entrepreneurship on the level of digitalization at country level, and its related sub-hypothesis, we have to evaluate a_path which refers to a part of the indirect effects. This is statistically and positively significant, in terms of p-value and coefficients, for total entrepreneurial activity,

entrepreneurial quality and entrepreneurial outcome. The same does not apply to entrepreneurial quantity. Bootstrapping analysis confirms this statement. Therefore, hypothesis 2, hypothesis 2b, hypothesis 2c are confirmed while hypothesis 2a is denied. For hypothesis 3, which is concerned with the effect of digitalization on economic growth at country level, we have to evaluate b_path which refers to a part of the indirect effects. This is statistically and positively significant, in terms of p-value and coefficients. Bootstrapping analysis confirms this statement. Therefore, hypothesis 2 is confirmed. Regarding hypothesis 4, which is concerned with the mediating role of digitalization in the relation between entrepreneurship and economic growth, and its related sub-hypothesis, a_path, b_path and c'_path have to be evaluated since they refer to indirect and direct effects. Given that there is no total effect between entrepreneurial quantity and economic growth, there is not even mediation. On the contrary, with respect to total entrepreneurial activity, entrepreneurial quality and entrepreneurial outcome, the results indicate that digitalization plays a role of mediator in the link between entrepreneurship and economic growth. This is proven also by the bootstrapping analysis, which highlights that this is a full mediation. Therefore, hypothesis 4, hypothesis 4b and hypothesis 4c are confirmed while hypothesis 4a is denied.

The analysis is supported by the results of a sensitivity analysis composed of three robustness checks. In the first one, economic growth, namely the dependent variable, is measured through GDP growth. In the second one, digitalization, namely the mediator, is measured through a component of the Digital Maturity Index that is the one about the degree of digitalization achieved by firms. In the third one, a shorter lag-time is considered in the relation between entrepreneurship and economic growth. Given the statistical results, all three confirm the validity of the model.

Discussion

The first main hypothesis of this research, namely hypothesis 1, is the one regarding the level of total entrepreneurial activity measured by the Entrepreneurial Index. Entrepreneurship, in fact, is supposed to affect economic growth. According to the statistical results we obtained, entrepreneurial activity is positively related to economic growth. From a theoretical standpoint, as we have previously analyzed, entrepreneurship is acknowledged to have an impact on economic development. Thus, the results obtained seem to be consistent with the reference literature. This impact is mainly possible because of the ability of entrepreneurs of introducing innovations, creating change, favoring competition and enhancing rivalry. As far as the empirical standpoint is concerned, a strong debate about the method to measure this phenomenon is still ongoing. There is no unanimous agreement on how to quantify the entrepreneurial phenomenon and this inevitably leads to a divergence of opinions among scholars. Specifically, some studies claim that the whole entrepreneurial phenomenon affects growth (Bjornskov and Foss, 2013; Audretsch et al., 2015; Braunerhjelm et al., 2010), while other authors (Wong, 2005; Valliere and Peterson, 2009; Aparicio et al., 2016; Castaño-Martínez et al., 2015; Sanandaij, 2010) affirm that only a specific typology of entrepreneurship is responsible for economic development, meaning productive or high-growth entrepreneurship. It is important to remark that the Entrepreneurial Index we propose captures the whole entrepreneurial phenomenon as the sequence of three phases a start-up is subjected to. The focus is on the entrepreneurial dynamics rather than on the context factors. Therefore, you can understand the novelty of the approach compared to the other methods. The results obtained suggest that entrepreneurial activity as a whole affects economic growth. Anyway, the three sub-hypotheses provide further details to be explored. In fact, hypothesis 1a, which refers to the relation between the first phase of the process and growth, is not supported by the statistical analysis. We define entrepreneurial quantity as the number of newborn firms divided by GDP.

This derives from the popular quantity-based measures of entrepreneurship such as self-employment which is often used because of its simplicity. Some authors (Bjornskov and Foss, 2013; Doran et. al, 2016) state that entrepreneurship, measured in this way, positively influences growth. Others (Wong, 2005; Valliere and Peterson, 2009) empirically demonstrated the opposite. Our results indicate that the birth of more firms, which can enable both necessity and opportunity entrepreneurship, does not contribute to growth. New firms' creation as a stand-alone variable does not seem to be a comprehensive measure of entrepreneurship. Hypothesis 1b deals with the relation between entrepreneurial quality, which regards the phase of start-up's development, and economic growth. This hypothesis is confirmed by the statistical analysis. By measuring the investment in startups, we focus on high-growth companies because entrepreneurial quality is typical of those firms that are in a phase of scale-up. This measure includes also already existing firms unlike the quantity-based one. This kind of measurement can be associated to some methods used by other authors who come to the same conclusion (Urbano and Aparicio, 2016; Wong, 2005). This refers to the Schumpeterian vision of entrepreneurship which is also a key concept in Stam (2015). Our analysis confirms his thesis according to which the main cause of economic growth, among entrepreneurial phases, is productive entrepreneurship, intended as high-growth entrepreneurship. Hypothesis 1c, which is supported by the analysis, refers to the outcome of the entrepreneurial process in terms of creation of exits by start-ups and unicorns. Thus, it is focused on a small elite of high-growth firms, whose establishment should, according to the results, impacts growth. Acs et al. (2014) underline the necessity to study the outcome of the entrepreneurial process and our attempt tries to solve this gap. In fact, recently, a lot of attention has been paid about this topic to such an extent that the Kauffman Index itself has been changed to focus on this theme.

The confirmation of hypothesis 2 suggests that the level of entrepreneurial activity positively influences the level of digitalization at country level. Therefore,

entrepreneurship has a positive effect in enhancing the diffusion and the adoption of digital technologies among citizens, firms and public administration. Morover, it is confirmed that entrepreneurs have a key role in developing and digitizing the actual infrastructures. These concepts apply also to entrepreneurial quality and entrepreneurial outcome but not to entrepreneurial quantity, meaning that productive and high-growth entrepreneurship are the real facilitators of digitalization.

Hypothesis 3 is confirmed, and this indicates that the level of digitalization positively affects a country's economic growth. Specifically, considering the components of the Digital Maturity Index, a country which is committed to enhance the level of digitalization of its infrastructures, its citizens, its public administration, and its firms can achieve a higher level of economic growth. ICT infrastructure is a necessary condition for the impact of digitalization on economic development. Then, citizens, by using Internet for banking services, for buying and selling things and for booking travels and accommodation might increase competition, reduce costs and the time needed to purchasing products and services, and by these channels, also stimulate economic growth. Public administration and firms can exploit new communication opportunities and all the characteristics of digital technologies to become more competitive and thus to increase their productivity and growth. The increasing amount of information favors the conception of new business models and the collaboration among firms.

The last hypothesis of this research is the one regarding the mediating effect of digitalization in the relation between entrepreneurial activity and economic growth. The statistical results coming from the multilevel mediation analysis and bootstrapping suggest that the hypothesis 2 is confirmed and that the relation among these variables is a full mediation. This confirmation has some very important implications if we consider the current state of knowledge in the field of entrepreneurship. First of all, it empirically confirms that the trend of digital transformation has been influencing entrepreneurship for several years. This has

been possible thanks to the advent of powerful and pervasive digital technologies (Nambisan et al., 2019) which can manifest in the form of digital artifacts, platforms and infrastructure (Nambisan, 2016). Entrepreneurship, in fact, is becoming more and more digital, demonstrating that the phrase "digital entrepreneurship" has not to be considered as a novelty anymore. Suffice it to say that companies are trying to adapt to this revolution both from a strategic and an organizational point of view. At this regard, the phenomenon of digital entrepreneurship gains in importance and relevance because it is supposed to be a stronger enabler of economic growth compared to traditional entrepreneurship. Digitalization can be seen as the transmission mechanism from entrepreneurship to economic growth. In fact, entrepreneurship through the exploitation of digitalization can enhance its impact to economic growth considering the change in firms, public administration and infrastructure. The three peculiar elements of digital transformation, which are openness, affordances and generativity, allow digital entrepreneurship to have a more significant impact on growth. Therefore, the influence of entrepreneurship on economic growth is higher or lower depending on the level of digitalization of a country. This new phenomenon has specific characteristics, mainly enabled by digital technologies, that cause broad and strong improvements in the firm's productivity and efficiency, thanks also to the higher number of business opportunities that can be exploited in a more efficient and effective way. Then, digital entrepreneurship can boost economic growth through a stronger acceleration of companies' structural change which is a needed factor to face the current competitive environment. It is acknowledged that a lot of firms, especially the smallest ones, are struggling to keep up the pace of technology. Digital entrepreneurship, which can happen also in existing firms, is the means through which solve this issue. Linked to this point, there is the theme about innovation. Digital entrepreneurship is a facilitator of digital innovation which, in turn, leads to economic growth. Hypothesis 4a, given the fact that there is no total effect between entrepreneurial quantity and economic

growth is denied. It is obvious that we cannot talk about mediation of a third factor if there is no total effect between the independent and the dependent variable. On the contrary we found statistical evidence for hypothesis 4b which is concerned with entrepreneurial quality. This indicates that high-growth start-ups, which are able to achieve a scale-up phase, are the main enablers of an all-round process of digitalization. The latter involves both the business and the societal areas. The protagonists of this phase are, generally, start-ups which present a high or extreme form of digital entrepreneurship (Hull et al., 2007) in addition to a productive genre of entrepreneurship (Stam, 2015). These features allow this kind of firms to develop excellent dynamic capabilities and outstanding innovation capabilities. Finally, hypothesis 4c, which deals with the outcome of the entrepreneurial process, is found proved according to the results. This phase is reached only by a small group of firms belonging to the previous phase. Looking at the coefficients, the step of entrepreneurial outcome has a higher impact on digitalization than entrepreneurial quality. This means that the creation of start-ups capable of successfully achieving this stage (i.e. exit of unicorn) enhances to a greater extent a digital development of the ecosystem and consequently economic growth.

Conclusion

The aim of this dissertation was to assess the link between entrepreneurial activity and economic growth and to evaluate the role of digitalization in this relation. We have tested a multilevel mediational model applied to a longitudinal dataset whose data refer to 28 countries belonging to European Union in 2019 and to a time horizon which goes from 2009 to 2017. The statistical results indicate the existence of a positive relation between entrepreneurial activity and economic growth and, moreover, they suggest that digitalization assumes a mediating role in this relationship. Thus, entrepreneurship as a process, contributes to economic

growth and we can give a quantitative support to the almost completely established trend of digital entrepreneurship. Another contribution regards the new system developed to measure entrepreneurship. The latter has always been a critical issue in the empirical entrepreneurial studies. Several scholars have tried to provide a simplistic measure of the phenomenon, which despite being immediate and easy to elaborate, does not capture the whole picture. Given this criticality, we propose a new method to quantify entrepreneurship. This is performed through the Entrepreneurial Index which has the merit and the advantage of having a process view of the phenomenon. In fact, all the three steps of the entrepreneurial activity are encompassed in this index: entrepreneurial quantity, entrepreneurial quality and entrepreneurial outcome. Moreover, given its focus on digital and high growth start-ups, it responds to the need of having a measure that takes into account the digital transformation trend (Acs et al., 2014). GEDI, in fact, will be reviewed and changed to adapt to this revolution. Entrepreneurial quality and entrepreneurial outcome are statistically proven to be the only enablers of economic growth through the mediation of digitalization. This a very important finding because it suggests that the digital entrepreneurship affecting economic development is the one related to the Schumpeterian concept. Thus, only productive digital entrepreneurship, which is the one that has the merit to exploit high growth potential opportunities, is positively correlated with economic growth.

This study has two potential practical implication. First, policymakers can exploit this new approach to measure entrepreneurial activity, modifying it at their convenience if it is necessary. Second, policymakers and entrepreneurs should be aware that, in order to favor a process of economic development, attention should be focused on high-growth and digital start-ups, according to the results obtained. Clearly, this dissertation is not exempt for some limitations and some points which could be improved. These weaknesses can offer some ideas to practitioners to develop similar kinds of research and to continue in this direction. First of all,

the level of detail of the Entrepreneurial Index can be certainly improved, for example through the addition of other indicators at the lowest level. This observation is valid mainly for the last phase of entrepreneurship, intended as process, which is entrepreneurial outcome. In fact, we have seen that this component shows the highest number of outliers. A more meticulous analysis can be performed including more countries around the world and with a larger timeframe. Regarding the methodological approach, the statistical technique that has been adopted for this research has the disadvantage of dating back to almost twenty years ago. Moreover, the hypotheses are tested separately in the sense that entrepreneurial activity, entrepreneurial quantity, entrepreneurial quality and entrepreneurial outcome are not tested in the same regression model. This is due to the fact that quantity, quality and outcome are highly correlated concepts, and, given our small sample size, there is the risk of distorting the standard errors too much (high multicollinearity) if they are put altogether in the same model. For this reason, some more statistical techniques can be exploited in order to study this multilevel mediation, for example SEM modelling. Probably, the most significative weakness of this research is the treatment of institutions in the model. Institutional variable, computed as Quality of Governance, has a role of control variable. Given the theoretical importance of this theme and the on-going trend of including it in the empirical models, future research should have the objective of assigning to institutions a more central role in the model which comprehends entrepreneurship, digitalization and growth. This could be achieved through the creation of a new indicator that comprehends both an entrepreneurial and institutional perspective. Lastly, scholars can try to use other measures for digitalization rather than the Digital Maturity Index, like for example DESI, or, alternatively, a new measure can be created in order to focus on different macro-areas of digitalization.

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INTRODUCTION

Since the publication of "The theory of economic development: an inquiry into profits, capital, credit, interest, and the business cycle" by Schumpeter in 1934, entrepreneurship has always been considered a phenomenon which aims at challenging the status quo through the introduction of novelty in the economic realm. In recent years, the trend of digitalization has become more and more relevant both from a business and a societal point of view. At this regard, scholars have started a productive discussion and they have pointed out that this trend has resulted in the beginning of a process of digital transformation. The related changes are caused by a rapidly evolving context, continuously stimulated by innovation and digital technologies which are the fundamental underlying factors of this revolution. It is not difficult to think that also entrepreneurship has been going through this phase of evolution. Indeed, in the last period, several scholars and people close to this environment have been starting to analyze and discuss about digital entrepreneurship which can be defined, "as the pursuit of opportunities based on the use of digital media and other information and communication technologies" (Davidson and Vaast, 2010). Thus, ICT play a fundamental role in this context, which is confirmed by the strong investment that companies are making in this kind of technology. Moreover, it is comprehensively acknowledged that entrepreneurship leads to economic growth (Wong et al., 2005; Valliere and Peterson, 2009; Bjørnskov and Foss, 2008) in terms, for example, of GDP per capita, and the same applies to digitalization. Several papers and studies, in fact, demonstrate that strong investment in ICT contribute to the improvement of the welfare of a country. However, a gap exists in the current state of the research since the economic growth of a country has never been explained by its level of entrepreneurship, considering also its level of digitalization. So, the

aim of this research is to close this gap by providing some measuring systems of the above-mentioned phenomena at a country-level over several years and by studying the statistical relationship among them. In other words, we want to evaluate the effect of entrepreneurship on economic growth and the role of digitalization in this relationship. In order to conduct this assessment, we will use a quantitative approach. Through a software named Stata we will develop a multilevel mediation model which includes all the variables, among which there are entrepreneurship, digitalization and economic growth. We will construct a rigorous method to measure each single variable. Raw data are gathered from several sources and refer to a time horizon that goes from 2009 to 2017 and to the 28 countries belonging to European Union at the moment of data extraction (2019). The results of the analysis show that digitalization completely mediates the relationship between entrepreneurship and economic growth. Moreover, since we propose a process view of the entrepreneurial phenomenon made up of three phases, we state that only the last two phases have a positive impact on economic development. These refer to the phase of scale-up and stabilization of the firm. This research gives several contributions to the theory. First of all, the recent phenomenon of digital entrepreneurship is empirically proven. Then, a new and scrupulous way to measure the phenomenon of entrepreneurship is proposed. Scholars can exploit this research to take a cue to analyze more in depth the relationship among these phenomena.

This research is divided into the following main Chapters:

- Chapter 1 Literature Review: the first chapter aims at providing an overview of the current knowledge on the themes of digital transformation and digital entrepreneurship.
- Chapter 2 Hypothesis Development and Theoretical Background: in this chapter we analyze the impact of entrepreneurship and digitalization on

economic growth and their existing systems of measurement. Studying in detail the theoretical background about this topic, we can structure the hypotheses that drive this research.

- Chapter 3 Methodology: the third chapter carefully describes the methodological steps followed to draft this paper. Each variable of the model is deeply analyzed and explained. Then, the results of the statistical analysis are presented, together with some robustness checks.
- Chapter 4 Discussion: this chapter focuses into the meaning and importance of the results. It explains and evaluates the results, showing how they are related to the hypothesis formulated in Chapter 2.
- Chapter 5 Conclusion: finally, the limitations of this research are highlighted and some recommendations for future research are presented.

1. LITERATURE REVIEW

The aim of this Chapter is to provide an overview of the current knowledge on the themes of Digital Transformation and Digital Entrepreneurship. These topics are at the foundation of the whole research.

1.1 Digital Transformation

Nowadays digital technologies are quickly changing the societal and business environments. The caused phenomenon can be defined as digital transformation. In particular, here, we face this theme from a business point of view considering also the general opinion according to which the completion of digital transformation has to be achieved as quickly as possible. It is evident that, lately, both innovation and entrepreneurship have been changed by the advent of powerful digital technologies, digital platforms and digital infrastructure (Nambisan et al., 2019).

A fundamental characteristic of the digital transformation is its pervasiveness among different industries as for instance finance, automotive, retail, policy and energy. Most likely every sector in the future will join this list. Nambisan et al. (2019) highlight that the most recent forms of innovation and entrepreneurial initiatives are triggered by digital technologies. The relevant fact is that these initiatives cross the boundaries of traditional sectors, embrace new networks and communities, they take advantage of both digital and non-digital assets. This aspect witnesses that this phenomenon is relevant mainly from a practical point of view. In support of this, there are also some papers from the practitioners' world like for example the one by Andal-Ancion et al. (2003) in which the phrase digital transformation was used some years before its final consolidation. According to Nambisan et al. (2019) this term has come into very wide use only

more recently due to the necessity of companies to radically transform themselves to succeed in the digital world. However, companies, broadly speaking, are not in the right path to succeed in the management of this change (Fitzgerald et al., 2014). The reason of this difficulty relies on the fact that the major part of the companies does not have the necessary tools and competencies to face this transformation. The companies that tried to adapt to this new scenario are often the biggest ones as some studies confirm (Fitzgerald et al., 2014; Svahn et al., 2017).

Even if the importance of the impact of digital technologies on the business world is strongly acknowledged, the academic literature about the digital transformation is not as homogenous as it should be. This limitation is caused by the fact that this is a very recent topic and scholars have just started to study it. For this reason, at the moment, the major part of the academic papers is not based on other papers regarding digital transformation. Moreover, other elements that cause the inhomogeneity of the literature are the absence of a commonly accepted definition of the term digital transformation and the lack of quantitative reviews about the literature of digital transformation.

To better understand this phenomenon, it is possible to analyze its four relevant streams which can be identified as strategy, digital innovation, organization and society. They are fundamental in order to deeply understand the kind of transformation we are dealing with.

1.1.1 Strategy

The stream about strategy is the backbone of the digital transformation. The very first authors that understood the importance of strategy for digital transformation are Bharadwaj et al. (2013). Other authors, over the course of time, take a cue from this paper to analyze more deeply this topic. For this reason, this is the only stream which does not show the general characteristic according to which literature is not

so cohesive. As far as this particular topic is concerned, there is a good link among the papers published and authors take advantage of the work of other scholars. In other streams, instead, many authors try to improve their understanding with rarely interrelated points of view. The most important consideration that we can gather from these studies is that digital transformation is not something that happens autonomously, but it has to be driven directly from the top management of the company.

As it was already mentioned, the digital transformation was considered as a strategic topic since the publication of "Digital Business Strategy: Toward a Next Generation of Insights" by Bharadwaj et al. (2013). This paper, in fact, has inspired a new interest in the digital business strategy even if the phrase "Digital Transformation" is never used in the article. Until then, authors like Henderson and Venkatraman (1999) had set the so-called "alignment view" as the predominant line of thinking. This means that IT strategy was merely considered as a functional level strategy that had to follow the strict guidelines coming from the firm's business strategy even if its importance was strongly acknowledged. Bharadwaj et al. (2013) have the important merit of rethinking IT strategy as a "fusion between IT strategy and business strategy" called digital business strategy which allows "to create differential value" using digital resources. Consequently, it is easy to understand, that IT strategy has to be considered a full-fledged driver of competitive advantage and not only a means through which improving efficiency and productivity. Four attributes can be used to describe the digital business strategy: scope, scale, speed and sources of value creation and captures. As far as scope is concerned, digital business strategy can extend beyond the traditional boundaries, thanks to the development of digital platforms and new products or services. Then, new digital technologies and in particular cloud computing give the possibility to companies of rapidly scaling up or down their infrastructure. Moreover, thanks to digital technologies, data can be exploited in a more efficient way and this enables to increase the speed of product launches

and decision-making. Finally, information and interaction among different players in advanced network systems can bring more opportunities for value creation.

Matt et al. (2015) follow the path set out by Bharadwaj et al. (2013) and try to answer the question about the right collocation of digital transformation strategies compared to other business strategies. The authors are strongly aware of the necessity of obtaining a higher homogeneity among IT strategies, digital transformation strategies and all other functional strategies.

"While digital business strategies often describe desired future business opportunities and strategies for firms that are partly or fully based on digital technologies, they do typically not include transformational insights on how to reach these future states. In contrast, a digital transformation strategy is a blueprint that supports companies in governing the transformations that arise owing to the integration of digital technologies, as well as in their operations after a transformation" (Matt et al., 2015). Thus, digital business strategy and digital transformation strategy share the same cross-functional influence.

1.1.1.1 Dynamic Capabilities

Another relevant concept that arises from the analysis of the literature is the one concerning the dynamic capabilities framework. Dynamic capabilities are fundamental for companies to survive in such a rapidly changing context and to sustain their competitive advantage. In fact, according to Sambamurthy et al. (2003), the constant enhancement and redefinition of value creation is the secret for success in this particular marketplace. That is possible thanks to the innovation of products, services, channels and market segmentation. Also, Teece (2007) focuses on this important topic and he states that in fast-changing business environments, it is not sufficient for companies to own just difficult-to-replicate assets, but they also need to have difficult-to-replicate dynamic

capabilities. It is important to remark that traditional objectives like the pursuit of efficiency and operational optimization are still critical in this context, but they are not the only keys anymore. The framework about dynamic capabilities is in contrast with Porter's Five Forces model according to which, in order to formulate a good strategy, it is sufficient to choose an attractive market and positioning to be protected from competition. Consequently, the famous model by Porter is criticized for its static nature that cannot fit well to the new developing context. Dynamic capabilities model, instead, is concerned with the development of new technologies and business models and to shape competition in order to obtain and sustain competitive advantage. Dynamic capabilities framework can be compared also to the resource-based view: the difference is that, in the latter, resources and competencies are the ones related to the operational capabilities inside the company while in the other, capabilities are meant to be at a higher level. Teece (2007), specifically, considers three capabilities which are respectively sensing opportunities, seizing opportunities and the capacity to enhance, combine and reconfigure firm's tangible and intangible assets.

Dynamic capabilities framework allows to integrate the two topics about innovation and strategy as stated by Teece (2007). This line of thinking is confirmed if we consider the digital disruption theme. Dynamic capabilities are necessary to properly respond to potentially disruptive innovations in many aspects like, for example, the response to disruptive technological shifts and the integration of digital business transformation with the existing business operations (Karimi and Walter, 2015).

Sambamurthy et al. (2003) study the relation between dynamic capabilities, IT and digital economy. They affirm that information technology investment and capabilities have a strong impact on firm's performances. Moreover, they give another classification of dynamic capabilities which are agility, digital options and entrepreneurial alertness. Agility is the ability to find innovation opportunities and seize them. Digital options are a collection of IT-enabled capabilities in the

form of digitized firm's processes and knowledge systems. Entrepreneurial alertness measures the ability of a company to explore its marketplace in order to identify new business opportunities. To sum up, if companies want to compete in this digital environment, they have to develop each of the three capabilities.
Again, Adner and Helfat (2003) differentiate the organizational dynamic capabilities which have just been analyzed from the dynamic capabilities of managers. The latter are "the capabilities with which managers build, integrate and reconfigure organizational resources and competences". This theory is based on three elements which are managerial cognition, managerial social capital and managerial human capital (Helfat and Martin, 2015).

1.1.1.2 Digital Platforms

The other theme that affects the stream about strategy is the one related to multi-sided digital platforms which provide interfaces among two or more groups of actors who are part of different sides. Usually, there are a platform leader, players on different sides and complementary asset providers. A particular trait of these platforms is the generation of cross-side network effects, which can be both positive or negative, and consist in a phenomenon in which the higher the number and the quality of actors on one side, the better it is for the other sides. Positive network effects are not easy to achieve and only a good governance structure by the platform leader can allow to achieve this objective. About that, several strategic points have to be considered such as the definition of access rules and regulation about interactions between different sides of the platform. Teece (2018) claims that the initial design of the structure is not sufficient to guarantee the success of the platform, but a process of continuous innovation is necessary. Consequently, good network effects are only necessary to create interdependence between different groups of actors, but they are not the only element that can protect the platform from the competition. The latter can create platforms with a

better value proposition and disrupt the incumbents. Finally, Helfat and Raubitschek (2018) identify three dynamic capabilities that are critical for platforms leaders which are innovation capabilities, environmental scanning and sensing capabilities, and integrative capabilities for ecosystem orchestration. Thus, dynamic capabilities are useful also for the management of digital platforms.

1.1.2 Digital Innovation

According to Nambisan et al. (2017), digital innovation is "the creation of (and consequent change in) market offerings, business processes, or models that result from the use of digital technology". The same authors give also a definition of digital innovation management which is intended as the "practices, processes, and principles that underlie the effective orchestration of digital innovation". Some studies like the ones by Henfrisdsson et al. (2014) and Yoo et al. (2010) demonstrate that innovation is not a well-bounded phenomenon anymore. This change is caused by the digitization of the innovation itself. Moreover, innovation processes and outcomes can be seen as distinct phenomena. The last-cited articles can be considered as a progressive strategizing of innovation management. Yoo et al. (2010) focus view digital innovation as product innovation and, in addition, they analyze the concept of product architecture to include the new features of digital technology. The same applies to Henfridsson et al. (2014) who also extend the literature on technology and innovation management, taking advantage of the concept of modularity and examining the adoption of two architectural frames. The first one is called hierarchy of parts frame and explains that the decomposition of products into smaller parts is underlined, allowing to achieve design flexibility and production scalability. The authors, regarding the design flexibility, point out that it is limited to a specific time window because the design of a product has to be defined before the launch in production. Despite this, Porter

and Heppelmann (2014) state that products are composed by both physical and digital components. This particular aspect favors the reconfiguration also after the production (Yoo et al., 2010) and so the flexibility is granted all over the product life cycle at very low marginal costs. At this regard, Henfridsson et al. (2014) introduced a second frame which is called network-of-patterns in which patterns are general solutions to specific problems. It is important to understand that these two frameworks can be complementary in order to support innovation of digitized products: the first-mentioned framework helps to achieve scale economies for the physical components and the second one allows design flexibility and scalability to be achieved.

1.1.3 Organization

Organization is the third building block of the digital transformation. The first issue to appear regards the choice of the responsible of the digital transformation inside the company. Sing and Hess (2017) affirm that Chief Information Officers have been asked to change their role over time from a pure technological focalization to business strategy one. This goes hand in hand with the alignment of IT strategy with business strategy proposed by Bharadwaj et al. (2013). Digital transformation cannot be managed by the CEO alone because it is not a simple process to carry out. The shift ordered to the CIOs can lead to some critical points because the adoption of digital technologies requires completely new attitudes and skills which are not owned by CIOs (Singh and Hess, 2017). For this reason, some companies are establishing a new role at their top management level: digital transformation has to be managed by the chief digital officer. The CDO has no functional IT responsibility and has a broader corporate perspective than the CIO's and, moreover, has the duty to apply collaboration among the functional areas to digitally transform the whole company. For this purpose, a digital transformation strategy is required, coupled with a strong leadership which is, in

turn, necessary to spread the right culture in the company (Singh and Hess, 2017). Company's culture is meant as the whole of all those values at the basis of the organization. The job of the leaders should be to diffuse an innovation culture that favors a risk-taking behavior and experimentation (Dremel et al., 2017). According to Kane et al. (2016), in order to spread an appropriate culture, it is necessary to invest in the training of employees, to select leaders with excellent soft skills and to simplify company's structures.

Customers are becoming increasingly digitally connected, so IT's focus has to be shifted from the classical enterprise-centric ERP systems through IT deployment and organizational transformation (Gray et al., 2013). A new issue regards the alignment across all the channels used by the company. In particular, data coming from digital and physical sources have to be merged in a unique CRM system, adopting big data analytics. Other new criticalities are related to data access, data ownership and joint analytics which involve organizational transformations (new IT divisions, new digital innovation hubs). A data-driven culture is a strongly necessary characteristic that a company should have which can improve managers' knowledge and their capability to take thoughtful decisions (Dremel et al., 2017).

Digital transformation has also an impact on the way people work and leads to the creation of new roles like the previous-mentioned CDO and to the change of existing ones. In this respect, jobs and organizations may be redesigned in order to exploit new potentialities (Colbert et al., 2016). Two features are necessary in order to create a successful workplace in a digital era: employee connectedness and responsive leadership. Dery et al. (2017) define the first one as "the extent to which employees can engage with each other, stakeholders and customers, with information and knowledge, and with ideas" and the second one as "the extent to which management prioritizes the activities that focus on the development and continuous improvement of employee experience".

Some solutions like mobile e-mail, collaboration tools and video conferencing are the enablers of work virtualization (Westerman et al., 2011). To understand the importance of people and culture it is sufficient to look at the study of Kane et al. (2017) who named five elements to succeed in the digital age. Three out of five concern exactly people and culture. Also, automation changes the way of working and sometimes substitutes humans, allowing companies to allocate people to more strategic tasks (Westerman et al., 2011). However, extremizing the use of automation and data-driven management supplements could be counterproductive for companies (Westerman, 2016).

1.1.4 Sociology

The last stream of digital transformation is the one about sociology. Indeed, this phenomenon affects other aspects beyond business which are equally relevant for companies. The latter have to take into consideration that digital technologies affect people who are, in turn, the most important part of the company and the customers, too. Societal issues that are usually considered in the literature are gender inequalities, poverty, employment, health and many others.
Ganju et al. (2016) study the effects of ICT on the welfare of nations, on the social equality of their citizens, on the access to health-related information and services, on the education of less-favored communities and on the facilitation of commerce. Oreglia and Srinivasan (2016) analyze the potential empowerment of women in rural areas with hierarchical social structures, thanks to Information and Communication Technologies. McGrath (2016) addresses the issue of identity verification, which is something taken for granted in economically advanced countries, but not for the less developed ones. The introduction of digital technology is not sufficient to deal with the problem because the relationship between the citizen and the state has a strong importance, too.

Teece (2007) points out that the sociology foundations of the digital transformation do not regard only the impact of ICT on society. The author relies on social and behavioural sciences in order to disclose the necessary capabilities to sustain superior enterprise performance. Jarzabkowski et al. (2007) are on the same page since they prefer a micro-level analysis of people's contribution in the update of strategies rather than a macro-level focus of traditional strategy.
Finally, digital transformation affects also communication. Constant connectivity and globally wide instantaneous communication are the advantages brought by digital technologies but Colbert et al. (2016) assert that the empathy level of conversation is getting worse, along with the quality of the relationship.
Generally speaking, Nambisan et al. (2019) point out that digital transformation has also compelled government agencies and other public institutions to rethink the laws, regulations, and policies related to a wide range of issues including intellectual property rights, data privacy and security, consumer rights, worker skills and training, entrepreneurial financing and securities, incubator/accelerator programs, and regional/local economic development (e.g., Agrawal et al., 2014; Greenstein et al., 2013; Goldfarb et al., 2014; Goldfarb and Tucker, 2012; Martin, 2018; Sorenson et al., 2016; Varian, 2018; Zysman and Kenney, 2018).

1.1.5 Digital Technologies

A technological transformation like digital transformation must be based on technology. The first word of the phrase digital transformation is clearly typical of the concept of technology. On the other hand, as it was already analyzed, the technology itself does not explain the phenomenon as a whole but it can be considered as enabling factor. All the articles analyzed deal with digital technologies, at least as a relevant contextual element. Literature rarely focuses only on digital technologies because its fundamental importance is taken for

granted. On the contrary, it tries to analyze the effects of digital technologies on the four streams previously studied: strategy, organization, innovation and society. In addition, digital technologies are shaping the context we live in, to such an extent that this period is named the digital age. Digital technologies can be viewed as "combinations of information, computing, communication, and connectivity technologies" (Bharadwaj et al. 2013). Many authors refer to digital technologies as SMACIT (social, mobile, analytics, cloud and Internet of Things technologies), to highlight the most important ones.

1.1.6 Themes in the Digital Transformation of Innovation and Entrepreneurship

Analyzing in detail the phenomenon of digital transformation and in particular the impact it has on innovation and entrepreneurship, Nambisan et al. (2019) find three relevant themes that have to be examined in order to better understand the significance of digital transformation on entrepreneurship and innovation. These three themes are: openness, affordances and generativity.

As far as openness is concerned, several studies have demonstrated how a company can advance its innovation performance by listening to ideas from users and customers (Rothwell, 1972; Rothwell et al., 1974; Von Hippel, 1976; Prahalad and Ramaswamy, 2004). In a similar way, research on open innovation indicated that sharing and flow of knowledge and technological assets across organizational boundaries have the same effect (Chesbrough, 2003; Dahlander and Gann, 2010; West and Bogers, 2014). More broadly, digital transformation has transformed the nature and degree of openness in innovation and entrepreneurship in terms of who can participate (actors), what they contribute (processes) and to what ends (outcomes) (Nambisan et al., 2019).

Openness have implications at different levels. At the individual one several studies analyze individuals' motivations to embrace ideas in crowd-based innovation and entrepreneurship (Antons and Piller, 2015; Jeppesen and Frederiksen, 2006; Liang et al., 2018; Nambisan and Baron, 2010). At the organizational level, studies focus on firms' decisions on how open it wants its innovation or entrepreneurial initiatives to be and, finally, at the community and societal levels, studies concentrate on how openness favors social well-being (Gurin, 2014; Mergel, 2015) and on how it can provide access to different types of actors and resources needed to solve complex challenges.

Regarding affordances, they are defined as possibilities offered by an object in relation to a specific user or alternatively, according to Majchrzak and Markus (2013), as "what an individual or organization with a particular purpose can do with a technology". Affordance perspective can inform on issues and outcomes across multiple levels of analysis (Nambisan et al., 2019). The most important types of affordances are digital affordances, spatial affordances (Autio et al., 2018), institutional affordances and social affordances.

Generativity is the capacity of digital technologies to produce unprompted change by large, varied, unrelated, unaccredited and uncoordinated entities or actors (Nambisan et al., 2019). Zittrain (2006) considers the inherent generativity facilitated by the internet which is technology generativity defined as "the overall capacity to produce unprompted change driven by large, varied, and uncoordinated audiences". Some studies identify the attributes of digital technologies, artifacts and infrastructures in order to promote such generativity. (Bygstad, 2017; Kallinikos et al., 2013; Lyytinen et al., 2017; Tilson et al., 2010; Yoo et al., 2012). The extant set of studies on technology generativity focus on issues at two levels of analysis: at the technology level, by informing our understanding of how digital technologies (artifacts, platforms, infrastructures) facilitate or promote generativity, and at the firm/ecosystem level, by examining

how specific strategies, behaviors, and practices shape the nature and extent of technology generativity.

1.2 Digital Entrepreneurship

As already mentioned, entrepreneurship is strongly affected by digital transformation and for this reason the concept of digital entrepreneurship arises. In this section an analysis of the literature will be carried out in order to better understand this phenomenon. Digital entrepreneurship is a topic which, in the last years, has been increasingly studied and analyzed by scholars and academics. This is due to the fact that more and more people have understood the great potentialities behind digital technologies and their related business opportunities. The very first study concerning digital entrepreneurship dates back to 1993, year in which Rosenbaum and Cronin (1993) underline how many companies and entrepreneurs were starting to be aware about the great strategic and economic potential deriving from the growth of electronic networking. The latter, indeed, can provide information which are fundamental to compete with other organizations. Since it is the first publication regarding this topic, there is a strong uncertainty about the future of digital entrepreneurship. However, this study is important because it is the first which recognizes the ambitions of some new entrepreneurs in exploiting business opportunities enabled by the Internet.
After the publication of this article, there are no other specific studies concerning digital entrepreneurship before 2007, at the best of our knowledge. Despite this, it is interesting to note that before achieving a general agreement on the phrase "digital entrepreneurship" several scholars describe a new kind of entrepreneurship in different ways.

1.2.1 New Kinds of Entrepreneurship

McKelvey (2001) talks about internet entrepreneurship in order to explain the way in which modern entrepreneurs innovate. It is argued that internet entrepreneurship is a new means of innovating. Moreover, it has the merit to capture the potentially worldwide distributed nature of innovation processes. Internet entrepreneurship exists as a modern phenomenon both from the economic and social point of view.

At the end of 1990s high growth tech startups were playing a relevant role for the renewal of the economic system (Colombo and Delmastro, 2001). The technology revolution and its disruptive consequences were caused by the internet. Consequently, internet entrepreneurship or tech-based entrepreneurship, interchangeable concepts according to the authors, are the means through which exploiting the new opportunities. High tech startups are recognized to be a crucial part in the innovation process also by Bouwman and Hulsink (2002) who describe the associated entrepreneurial phenomenon as cyber entrepreneurship. Even if the name is different in respect to the other study, the meaning is very similar, and the actors involved in this phenomenon are defined also in this case as tech-based entrepreneurs.

The same phenomenon is also defined as e-entrepreneurship because of the relation with electronic business (e-business) (Matlay, 2004). E-entrepreneurship describes the establishment of new companies specifically in the net economy and thus e-entrepreneurship is understood as an entrepreneurial process used to create an e-business (Asghari and Gedeon, 2010). This new type of business is developing in a new type of environment, characterized by the advancement of the new economy and it is exploited by the internet entrepreneur who develops a business based on the internet connectivity model and strategically manages new business models and technologies (Millman et al., 2010). New economy is a concept that underlines the differences that were

emerging in respect to the so-called old economy and it is characterized by the fact that digital information is stored in computers and shared almost instantly through internal and/or external networks (Tapscott, 1996; Loasby, 2001). As a generic term, New Economy (often used interchangeably with 'Digital Economy', 'e-Economy', or 'Internet Economy) is broadly based on digital technologies and communication networks that provide a global platform (King et al., 2002). Thus, Internet is acknowledged to be fundamental and to have the potential to transform the competitive environment, to such an extent that it creates a new type of business (Brudlo, 2008). The "old" economy, on the other side, is characterized by physical information flows (Boddy et al., 2002; Corbett, 1992)

To sum up, these new forms of entrepreneurship have begun to emerge due to the synergies between information and communication technology and changing paradigms of economic transactions (Matlay and Westhead, 2005).

Sebora et al. (2008) use the term e-commerce entrepreneurship to focus on the development of e-commerce channel but the underlying concept is still the same. The last term used is online entrepreneurship (Dheeriya, 2009) intended as, indeed, any venture conducted exclusively on the internet. It comprehends activities of a regular entrepreneur, but the mode of operation is based on the potentialities of the new technology. Online entrepreneurship has distinct characteristics than typical entrepreneurship. These distinct characteristics themselves lead to different and complex problems faced by an online entrepreneur.

So far, all the papers analyzed recognize the technology as a transformative power and source of opportunities, but they do not link the specific characteristics of digitalization to entrepreneurship. Indeed, while discussing digital entrepreneurship, very little theorizing is spent on the nature of digitality itself (Gustavsson and Ljungberg, 2018).

1.2.2 The Introduction of the Term Digital Entrepreneurship

Since 2007 the phrase digital entrepreneurship has become widespread among the scholars in the field of entrepreneurship. This term has started to be used in order to precisely indicate the kind of entrepreneurship which comes from the broad diffusion of digital technologies such as mobile computing, cloud computing, social media, 3D printing and data analytics (Nambisan, 2016; Zhao and Collier, 2016). These technologies have the merit of creating opportunities for entrepreneurs to develop high-tech businesses (Davidson and Vaast, 2010). In fact, Internet, digital technologies, social media have created new ways for communication, new business models, and re-modelled entire industries (Dutot and Van Horne, 2015). Moreover, they allow to open up new markets as well as reduce the cost of international expansion (Gustavsson and Ljungberg, 2018). Digital technologies allow entrepreneurs to build scalable products and services which have the capacity to drive change and consequently growth. This is caused by generativity which enables digital technologies to facilitate unprompted actions by large audiences. Another advantage of digital technologies is the separation of content from the media which enables flexibility and thereby encourages rapidly experimentation and learning. Then, the fluid and dynamic processes enabled by digital technologies boost fast iterations in non-linear paths in the entrepreneurial process. And, digital technologies enable a distributed and diffused entrepreneurial agency, which favors disintermediation and results into an increased emphasis on the ecosystem (Zaheer et al., 2019). Digital technologies manifest themselves in the realm of entrepreneurship in the form of three distinct but related elements—digital artifacts, digital platforms, and digital infrastructure (Nambisan, 2016).

A digital artifact is defined as a digital component, application, or media content that is part of a new product (or service) and offers a specific functionality or value

to the end-user. Such digital artifacts or components are present not only on smartphones and other personal devices (e.g., apps that run on smart watch, fitness watch, etc.) but also as part of home appliances, toys, apparel, shoes, automobiles. The notion of generativity points to the fact that digital artifacts continue to evolve even after the commercial introduction (Nambisan, 2016). Digital artefacts are programmable as well as re-programmable (Yoo et al., 2010; Yoo et al., 2012; Kallinikos et al., 2013). This fact is fundamental for the emergence of the generative matrix, as software provides almost unlimited flexibility in information manipulation (Tilson et. al, 2010). The entrepreneur can, by employing programming skills, create or modify digital artefacts so that they appear in new, novel ways. Digital artefacts can be editable (Kallinikos et al., 2013). Editability is a built-in property which gives the entrepreneur the possibility to create and update content (blogs, vlogs). Digital artefacts are interactive (Kallinikos et al., 2013). Entrepreneurs can make use of digital artefacts by interacting with the functions and affordances they present. Digital artefacts can be combined, leading to combinatorial innovations (Yoo et al., 2010; Yoo et al., 2012). Entrepreneurs can create new products or services by combining software and data from multiple sources. Digital artefacts can be connected, and thereby become interoperable. An entrepreneur can discover an opportunity in connecting previous unconnected artefacts and by that allowing transparent movement of data (Marston et al., 2011).

A digital platform is defined as a shared, common set of services and architecture that serves to host complementary offerings, including digital artifacts. Apple's iOS platform and Google's Android platform enable apps to run on their respective smartphones. Digital platforms provide a wealth of opportunities for entrepreneurs—opportunities that involve developing complementary products and services (Zahra and Nambisan, 2011). Hsieh and Wu (2018) suggest a classification of platform strategies based on commercialization capabilities and tendency towards new product and/or service development. Accordingly,

platforms can be characterized within three types. First, there are innovation platforms, where entrepreneurs can develop complementary products and services within a digital ecosystem. Second, transaction platforms foster commercial activities, such as online retail or on-demand services. Third, integration platforms are a mixture of both transaction and innovation platforms. Within this form, entrepreneurs are given the possibility to innovate and create new technologies whereas consumers are able to make use of these technologies. Platforms provide a network for other actors and firms to co-exist and thrive and moreover they have become central to firm innovation in the digital context (Nzembayie et al., 2018).

In contrast to digital platforms, digital infrastructure is defined as digital technology tools and systems (e.g., cloud computing, data analytics, online communities, social media, 3D printing, digital makerspaces, etc.) that offer communication, collaboration, and/or computing capabilities to support innovation and entrepreneurship. Such digital infrastructures have led to the democratization of entrepreneurship (Aldrich, 2014), i.e., the engagement of a greater number and diverse set of people in all stages of the entrepreneurial process—from opportunity exploration to concept testing to venture funding and launch. For example, crowdsourcing and crowdfunding systems allow entrepreneurs to engage with potential customers and investors in acquiring varied resources (ideas, capital) on a global scale (Kim and Hann, 2013). They are the enablers of digital entrepreneurship (von Briel et al., 2017) and they are the cause of the distribution of control of innovation activities across multiple actors and organizations (von Hippel, 2005). Specifically, referring to Davidsson's (2015) entrepreneurial opportunity framework, digital artifacts and digital platforms serve as part of the new venture idea (outcome) while digital infrastructure serves as an external enabler (supporting the process).

The main difference between digital entrepreneurship and traditional entrepreneurship lies in the way each of them market but also in the product itself,

be it a good or a service and the workplace which becomes more and more virtual (Hull et al., 2007). Then, outcomes and processes in digital entrepreneurship have become less bounded (Nambisan, 2016). Regarding the outcome, this explains why the structural boundaries of the product or service have changed in terms of features, scope and market reach. The entrepreneurial process is described as the stages a founder of a startup has to take, from an initial idea to collecting the rewards from hard work. Regarding it, entrepreneurial activity is facilitated by the changes in the spatial and temporal boundaries. Indeed, digital entrepreneurial process is less predefined. Furthermore, digital entrepreneurship comprehends a broader set of actors. The process itself is also an aspect in which the two phenomena differ from each other. According to Yaghoubi et al. (2012) traditional entrepreneurship consists of five main phases: the first one is the (1) Recognizing and seizing opportunities, then (2) Transforming opportunities to marketable goods and services, (3) Adding value to goods and service through time and resources, (4) Assuming risk, and (5) Realizing reward. For digital entrepreneur there are stages of development of start-ups as outlined by, among others, Asghari and Gedeon (2010). These stages are pre-seed, seed, start-up and expansion/exit. The pre-seed stage involves ideation and forming the entrepreneurial team (Asghari and Gedeon, 2010). The "seed" stage of digital entrepreneurship involves the set-up of the new venture. It is at this stage that research, business plan development and legally forming the firm occurs. In the start-up phase the firm is established and the products and services built for customers (Asghari and Gedeon, 2010). The expansion phase occurs when new customers and markets are established. Although the authors do not include the discontinuation phase, this would need to be investigated in further studies.

To conclude, digital entrepreneurship is different from entrepreneurship based on 4 S Model: Scope, Speed, Scale, Sources.

On the other hand, entrepreneurship and digital entrepreneurship have a common characteristic: both of them can occur through the formation of a new

firm or the transformation of an already existing firm (Leong et al., 2016). However, despite the fact that digital entrepreneurship can occur through the formation of a new firm or the transformation of an existing firm (Shane and Venkataraman, 2000), studies have focused mainly on new firms, so far.

It is also important to highlight that the level of digitalization in an entrepreneurial process can be more or less high. According to this degree, digital entrepreneurship can be mild, moderate or extreme (Hull et al., 2007). The differentiation goes from making use of digital assets to a business, which is completely conducted online and thereby defines the level to which those businesses operate in the digital world. Whilst mild digital entrepreneurs focus on digital products, delivery or other major digital parts constituting the business, extreme digital entrepreneurs conduct their whole business model online. Actors belonging to this typology not only digitize the goods or services themselves, but also shift all business operations, such as production, advertising, distribution, transaction and customer relations into digitalization (Kraus et al., 2019).

The contexts in which these three categories differentiate are ease of entry, ease of manufacturing and storing, ease of distribution in the digital marketplace, digital workplace, digital goods, digital service, and digital commitment.

Digital entrepreneurship derives from the evolution of e-entrepreneurship in which the entrepreneurial process is itself transformed by the use of IT and takes place online (Asghari and Gedeon, 2010). Entrepreneurship in the digital economy encompasses three distinct, yet interrelated, forms of opportunity discovery and exploitation: business, knowledge, and institutional entrepreneurship (Davidson and Vaast, 2010).

As far as business entrepreneurship is concerned, new business-related, digital ventures aim at generating a financial profit and they are included in the competitive environment. However, economic opportunities are not the only ones that can be pursued in the new economy. Knowledge entrepreneurship aims at exploiting information-related opportunities in order to develop a strong

knowledge base. Consequently, the knowledge entrepreneur has very personal knowledge capital which is used to create value (Skrzeszewski, 2006).
Finally, institutional entrepreneurship refers to activities of actors who have an interest in particular institutional deals and who exploit resources to create new institutions (DiMaggio, 1988; Maguire et. al, 2004). The above-described kinds of entrepreneurship are not mutually exclusive but, on the contrary, can be combined together both sequentially or iteratively and a clear example of this is Google (Davidson and Vaast, 2010).

1.2.3 Opportunities of Digital Entrepreneurship

Digital technology seems to alter the behavior on how opportunities arise. The generative potential of digital technology acts as breeding ground for future innovation to happen (Gustavsson and Ljungberg, 2018). Generativity thus brings an additional dimension to the relationship between entrepreneur and opportunity. Not only can an opportunity be created or discovered (Alvarez and Barney 2007), but it can also be enabled. Several opportunities can emerge from the phenomenon of digital entrepreneurship.
Digital environments, where consumers and businesses interact with each other, provide companies with a considerable amount of information, which they can exploit for their own business purposes. The access of this huge amount of information gives entrepreneurs the possibility to exactly analyze what potential customers are looking for (Kraus et al., 2019).
Traditional entrepreneurs do not have the same possibility to access to information (Hair et al., 2012). Thanks to the exploitation of big data and algorithms, digital companies can even identify needs before (potential) customers are aware of it or manipulate consumer behavior by selective and customized advertising. For this reason, digital information and its management is not only the source of digital entrepreneurship but should also be its continuous

driver (Kraus et al., 2019). Furthermore, getting a high user base on a platform can also lead to the creation of tremendous network effects. This is where the digital ecosystem comes to play. Network effects, meaning support of users, participants adopting a provided technology, interactions and feedback from the digital society, present a huge potential to digital entrepreneurs. Success in launching phases can be highly dependent on the support generated by the digital society (Srinivasan and Venkatraman, 2018). Other opportunities are the ones related to the costs of client-facing as well as the operational costs which can decrease, for example advertising, communication and distribution costs (Fairlie, 2006; Hull et al., 2007; Hair et al., 2012; Nambisan, 2016). The relationship with the customer can be managed through social media (Fischer and Reuber, 2014; Hair et al., 2012; Nambisan, 2016). Furthermore, digital entrepreneurship facilitates the development of economies of scale (Giones and Brem, 2017; Nambisan, 2016; Reuber and Fischer, 2011; Sussan and Acs 2017) and the creation of completely new sales channels (Mahadevan, 2000) which can be used to increase profit.

1.2.4 Challenges of Digital Entrepreneurship

Even though there are excellent opportunities and the obvious challenge of being self-employed, digital entrepreneurs have to face specific obstacles.

The first challenge that has to be faced is the one regarding the lack of digital knowledge and capabilities which are crucial to run the business. Then, new business models are characterized by a very high level of uncertainty which is related to the advancement of digital technologies but also to the risk of facing legal or tax regulations once the field of business is established. New technologies might turn out as failures, whilst others go towards unpredictable directions (Brundin and Gustafsson, 2013). Therefore, continuous feedback from the market, rapid development of products, services, infrastructure and ways to deal

with high uncertainty are necessary (Ojala, 2016). Another problem, which derives from the high level of uncertainty, is the difficulty to find investors that provide the business with necessary financing. Srinivasan and Venkatraman (2018) suggest building up close relationships and getting support of high-status people in order to create validity for the business model. This might help to get investors providing the business with money, as many of them trust the voice of prominent people.

If digital entrepreneurs base their business on a platform, they make their business model be directly dependent to the technological status of the platform technology. Technological advancements of a platform need quick improvement of the business technology and vice versa. In fact, digital entrepreneurs in this case connect the outcomes of their activities directly to those of the platform. This can be a positive effect, though in negative surroundings this may create a considerable threat for the business model of a digital entrepreneur. Moreover, digital entrepreneurs need to innovate and differentiate continuously. Their possibility to differentiate is limited to the technological possibilities offered by the platform (Srinivasan and Venkatraman, 2018).

Another major challenge digital entrepreneurs have to face within the development of their business is the achievement of trust among market participants. Trust is an issue which is prevalent in offline businesses as well; nonetheless, the depersonalization of digital business is much more relevant in the field of non-face-to-face commerce. Nzembayie (2017) hypothesizes the missing of body language and “functional familiarity” poses as possible causes of misunderstandings. The trust of a potential customer is a necessary condition in order to do business with them. Feedback of customers, which is visible for all market participants, is one way to form a trustful relationship between potential customers and business partners. However, market participants must directly link the feedback to a certain customer and to the digital business in order to increase trust, what might be perceived as critical, again (Hair et al., 2012).

Dy et al. (2017) discovered that social hierarchies or rather social inequalities limit the possibility to become a digital entrepreneur. Obstacles to become an entrepreneur that exist offline regarding social structures are equally present in online activities towards becoming an entrepreneur.

1.2.5 Success Factors of Digital Entrepreneurship

The positioning of the platform where the digital business is built on is one of the factors contributing to the success of a business. Success does not exclusively depend on the business itself, but also on the architectural and technology decisions a platform company takes. If a platform is not characterized by a considerably high reputation and good positioning, the success of the respective business is limited, too (Srinivasan and Venkatraman, 2018).

In addition, relationship is vital for digital entrepreneurial success. Personal relationships and stable business networks as well as interactions with users on platforms are increasingly crucial for digital entrepreneurs to build legitimacy for their business and assemble resources necessary to conduct business activities (Srinivasan and Venkatraman, 2018). Hair et al. (2012) argue that market orientation (i.e. meeting customer demands with the business operations) is one of the most vital elements in digital business. Electronic communities offer good possibilities to understand peoples' demands and whether an entrepreneur's strategy is aligned to innovation activities and business development.

Besides technical developments, changing customer preferences, new forms of competition and markets as well as accompanying legal and tax regulations, it seems that the individual level of the entrepreneur has not been taken into account in digital entrepreneurship literature appropriately.

According to Zaheer et al. (2019), who interviewed founders of 12 digital start-ups, the entrepreneur's experience and education as well as vision, purpose, values, timing and focus are directly linked to entrepreneurial success. Family

background, personal commitment, motivation and knowledge as well as personal skills related to the industry and industrial sector are important factors contributing to entrepreneurial success. Obviously, the level of flexibility and adaptability of the founder and/or CEO directly contributes to a digital business' success. Participative structures enable innovative environments and give the opportunity to directly response to market forces. If success gets measured in terms of internationalization speed, then international experience of the entrepreneur also plays a critical role for success. Entrepreneurs who spent time abroad tend to exploit international possibilities much faster than others (Ziyae et al., 2014).

1.2.6 Where does Digital Entrepreneurship happen?

To understand the environment where digital entrepreneurship develops, it is necessary to analyze first the traditional entrepreneurship. Research entrepreneurship has shown that environmental factors, such as cultural factors-social, legal, political and technological positive or negative impact on the development of entrepreneurs (Deakins and Freel, 2003). The ecosystem consists of a set of actors linked together in a specific location, including universities, research institutions and formal networks, governments, investors, professional service providers (Ghanemzadeh, 2012). Entrepreneurial ecosystem can be defined as a: "set of interdependent actors and factors coordinated in such a way that they enable productive entrepreneurship within a particular territory" (Stam, 2015). This definition is acknowledged for its comprehensive nature because it embodies all the relevant elements of the entrepreneurial ecosystem which are: the interaction between actors and components as its dimension of dynamic complexity; the creation of new ventures is the end aim of the entrepreneurial ecosystem; the focus on productive entrepreneurship (innovative and growth-oriented) since it is considered mostly responsible for increasing innovation level

and economic growth by leading political institutions; the focus on territory-specific dimension, despite digital technologies. Entrepreneurship ecosystem is made up of three key factors: there is a set of entrepreneurs, companies, and institutions in a specific location; established and dense network of relationships between the actors; a culture where all the IT brings together elements. The entrepreneurship ecosystem consists of hundreds of specific elements that, for convenience, we group into six general domains: a conducive culture, enabling policies and leadership, availability of appropriate finance, qualitative human capital, venture-friendly markets for products, and a range of institutional and infrastructural supports. Although any entrepreneurship ecosystem can be described using the same six domains, each ecosystem is the result of the hundreds of elements interacting in highly complex and idiosyncratic ways. Equivalently, digital entrepreneurship is based on the existence or development of a digital ecosystem. According to Li et al. (as cited in Sussan and Acs, 2017), a digital ecosystem is "a self-organizing, scalable and sustainable system composed of heterogeneous digital entities and their interrelations focusing on interactions among entities to increase system utility, gain benefits, and promote information sharing, inner and inter cooperation and system innovation". Users and participant of a digital ecosystem is everybody who has the opportunity to access connected devices, e.g. computers, mobiles, tablets. The World Wide Web created an open space to provide and access information, knowledge, data and even free labor. Digital ecosystems therefore have a kind of self-generative nature working on a service-oriented logic where users can act as providers at the same time. Thus, digital ecosystems offer great opportunities for entrepreneurs (Sussan and Acs, 2017). Digital ecosystem can also be defined as the ICT enabling infrastructure that supports the cooperation, the knowledge sharing and the building of a business ecosystem (Corallo et al., 2007).

A digital entrepreneurship ecosystem is an ecosystem where digital entrepreneurship emerges and develops. Because an ecosystem can facilitate the

integration of resources and supportive elements beyond the firm-level, a digital entrepreneurship ecosystem is important for the success of digital entrepreneurship (Spigel, 2017). A digital entrepreneurship ecosystem is based on digital entrepreneurship, while a digital business ecosystem is based on digital business (Li et al., 2017). Sussan and Acs (2017) identify the ability to connect customers of different groups with each other at vastly decreasing transaction costs as the core competence of recent successful ventures. They introduce us to a new framework for digital entrepreneurial ecosystems, which conceptualizes digital infrastructure governance, digital user citizenship, digital entrepreneurship and digital marketplace. Here, Sussan and Acs (2017) link the digital ecosystem with the entrepreneurial ecosystem and thereby integrate agents and users into their concept of the digital entrepreneurial ecosystem. The four quadrants of the digital entrepreneurial ecosystem should help users as well as agents to match on multisided digital platforms whereby they use the innovative digital ecosystem governance and business ecosystem management while reducing transaction costs (Sussan and Acs, 2017).

Autio et al. (2017) underline that the rapid evolution of digital technologies and infrastructures is giving rise to new affordances that impact the entrepreneurial ecosystem. An affordance can be defined as a potentiality of the new technology that needs to be discovered and articulated. Digitalization, in entrepreneurship, supports three key affordances: decoupling between form and function which means that the importance of asset specificity in regulating dependency relationship within traditional value chains is reduced; disintermediation which means that the power of middlemen in value chains is reduced. Products and service provider are freer to configure their delivery activities; generativity which enables the coordination of geographically dispersed actors and creates new ways to build and exploit platform momentum. These affordances allow new ventures to reinvent how they create, deliver and capture value and finally to disrupt incumbents with completely new business models. Given the importance of

digitalization, it is important to highlight the differences between this concept and the one related to digitization. Digitalization refers to the impact of digital technologies at the macro-level (of an organization, or a country): it can be defined as "the sociotechnical process of applying digitizing techniques to broader social and institutional contexts that render digital technologies infrastructural" (Tilson et al., 2010). Digitization, instead, refers to the technical conversion of analogue information into digital form, thus, stands more at micro-level (with reference on a single task or process).

1.2.7 Digital Entrepreneur

Digital technologies affect individual entrepreneurs by reshaping their mentality (Di Domenico et al., 2014). According to Hair et al. (2012) a digital entrepreneur is therefore an individual who creates and delivers key business activities and functions, such as production, marketing, distribution and stakeholder management, using information and communication technologies (ICTs). Digital entrepreneurs rely upon the characteristics of digital media and IT to pursue opportunities. In doing so, they exacerbate changes in the competitive landscape, as they attempt to seize the opportunities and thereby potentially further the creative destruction process of the digital economy (Davidson and Vaast, 2010).
Hafezieh et al. (2011), based on the work of Carrier et al. (2004) also proposed a typology of the characteristics of digital entrepreneurs. Their typology advances six main characteristics. The first is the age and experience of the entrepreneur (as pointed earlier by Blais and Toulouse, 1992 or Kisfalvi, 2002). The second and third are the personal characteristics of the entrepreneur (such as enthusiasm), the previous experiences, and most importantly, previous experiences in digital. As fourth, authors suggest education (Colombo and Delmastro, 2001). And finally, the last two criteria that had to be considered are the motivation (Colombo and Delmastro, 2001) and the perception of the market needs (Carrier et al.,

2004). In addition, the motivation of the digital entrepreneur has been investigated by Taleghani et al. (2013), who looked at the personality characteristics of Iranian Internet entrepreneurs. They contest that there are eight characteristics common amongst the studied entrepreneurs: external control, intending to risk, need to succeed and improve, pragmatic, tolerant, intellectual health, having dreams, and seeking challenges.

Personality of entrepreneurs was first investigated in the 1960s with Collins and Moore (1964). According to Serarols-Tarrés et al. (2006) there are thirteen traits that are important for a successful digital entrepreneur: leadership capacity; ability to delegate and form a good team; ability to work in team (networking); ability to assume risks and take decisions; ambition of economic and professional independence; be confident about the business; be the right age (not too young) and have entrepreneurial parents; have right creative and marketing skills; ability to select right colleagues (team of entrepreneurs is better than one); be highly tolerant of ambiguity and persistent; be dynamic and enthusiastic; have experience and knowledge about the industry, products and market; be trained in starting up firms. Digital entrepreneurship seems to associate characteristics of traditional entrepreneurship with specificities of the digital sphere, with a better sensibility to risk, creativity or agility. According to Hull et al. (2007), digital entrepreneurs face a lot of differences compared to traditional entrepreneurs. Products, marketing activities and workplace are major differentiation criteria between digital and non-digital entrepreneurs. Taken together, today's digital entrepreneurs, in comparison to traditional entrepreneurs, do not follow a predefined blueprint or highly defined business plan. Rather, the behavior and decisions of a digital entrepreneur get shaped throughout the whole entrepreneurial process (Kraus et al., 2018). Continuing evolution of technology and on-going interactions with the digital economy initiate, create and change the digital entrepreneurial process many times. Thus, the digital entrepreneur faces

increasingly dynamic paths, determined by diverse activities with uncertain time frames (Nambisan, 2017)

Finally, as pointed out by Giones and Brem (2017) digital entrepreneurs often do not really care about the specific technology behind their business idea, they simply focus on the service that is based on it. Hence, technology here is an input factor only. At this point, the authors make a distinction among digital entrepreneurship. Technology entrepreneurship and digital technology entrepreneurship.

1.2.8 Defining Digital Entrepreneurship

In the following table there are the definitions of digital entrepreneurship that have been provided, so far. The first column indicates the authors of the article and the year of publication. In the second and in the third columns there are the title of the article and the source, respectively. Finally, in the last column there is the definition of digital entrepreneurship.

An analysis of these definitions is carried out downstream of the table.

Authors (year)	Title of the article	Source	Definition of Digital Entrepreneurship
Clyde Eiríkur Hull, Yu-Ting Caisy Hung, Neil Hair, Victor Perotti and Richard DeMartino (2007)	Taking Advantage of Digital Opportunities: A Typology of Digital Entrepreneurship	International Journal of Networking and Virtual Organisations	*Digital entrepreneurship* is a subcategory of entrepreneurship in which some or all of what would be physical in a traditional organization has been digitized.
Elizabeth Davidson and Emmanuelle Vaast (2010)	Digital Entrepreneurship and its Sociomaterial Enactment	2010 43rd Hawaii International Conference on System Sciences	We refer to digital entrepreneurship as the pursuit of opportunities based on the use of digital

			media and other information and communication technologies.
Fang Zhao and Alan Collier (2016)	Digital Entrepreneurship: Research and Practice	9th Annual Conference of the EuroMed Academy of Business	Digital entrepreneurship is broadly defined as creating new ventures and transforming existing businesses by developing novel digital technologies and/or novel usage of such technologies
Marc Bogdanowicz (2015)	Digital Entrepreneurship Barriers and Drivers	Joint research centre technical reports.	Digital entrepreneurship is the phenomenon associated with digital entrepreneurial activity. Digital entrepreneurial activity is the enterprising human action in pursuit of the generation of value, through the creation or expansion of economic activity, by identifying and exploiting new ICT or ICT-enabled products, processes and corresponding markets.
Angela Martinez Dy, Lee Martin and Susan Marlow (2018)	Emancipation Through Digital Entrepreneurship? A Critical Realist Analysis	Organization	Digital entrepreneurship, in contrast, is an emergent phenomenon in which new digital artefacts, platforms and infrastructure are being used to pursue innovative and entrepreneurial opportunities, to the extent that the

			relevance and applicability of traditional understandings of entrepreneurship are called into question
Kisito Futonge Nzembayie, Anthony Paul Buckley and Thomas Cooney (2018)	Researching Pure Digital Entrepreneurship – A Multimethod Insider Action Research approach	Journal of Business Venturing Insights	we define PDE as entrepreneurship in which digital artifacts, digital platforms or both, are the new venture ideas and market offers; while digital infrastructures, other platforms and related technologies are immediate external enablers of new venture emergence
Abraham K. Song (2019)	The Digital Entrepreneurial Ecosystem—A Critique and Reconfiguration	Small Business Economics	Entrepreneurial opportunities based on the Internet and the cloud and using big data and artificial intelligence.
Cesar Bandera; Miriam Helmy and Rola Shehata (2016)	Orthogonal Dimensions in Digital Entrepreneurship	7th Annual George Washington University (GWU)-International Council for Small Business (ICSB) Global Entrepreneurship Research and Policy Conference	We thus propose defining digital entrepreneurship in a three-dimensional feature space with physical vs. virtual offering being one dimension, service/product being the second, and custom vs. mass-produced being the third.
Thang Le Dinh, Manh Chien Vu, Ayi Ayayi (2018)	Towards a Living Lab for Promoting the Digital Entrepreneurship Process	International Journal of Entrepreneurship	Digital entrepreneurship is defined as the reconciliation of traditional entrepreneurship with the new way of creating and doing

			business in the digital era.
Fiona Sussan and Zoltan J. Acs (2017)	The Digital Entrepreneurial Ecosystem	Small Business Economics	Entrepreneurial activities that optimize the utilization and reconfiguration of digital infrastructure in the form of new systems, new platforms, and new networks. Digital entrepreneurship [...] includes any agent that is engaged in any sort of venture be it commercial, social, government, or corporate that uses digital technologies. [...] In other words, they are performing activities that need digital engagement but may not in themselves be digital, for example, an Uber taxi driver
Chris Richter, Sascha Kraus, Alexander Brem, Susanne Durst and Clemens Giselbrecht (2017)	Digital Entrepreneurship: Innovative Business Models for The Sharing Economy	Strategic entrepreneurship Journal	Entrepreneurship [...] is [...] defined as occupying niches, monetizing business opportunities, as well as being innovative, radical and risk-taking
Neil Hair; Lyle R. Wetsch; Clyde Eiríkur Hull; Victor Perotti; Yu-Ting Caisy Hung (2012)	Market Orientation in Digital Entrepreneurship: Advantages and Challenges in A Web 2.0 Networked World	International Journal of Innovation and Technology Management	Digital entrepreneurship may be defined as entrepreneurship in which some or all of the entrepreneurial venture takes place digitally instead of more traditional formats

Guthrie, C. (2014)	The Digital Factory: A Hands-On Learning Project-Digital Entrepreneurship	Journal of Entrepreneurship Education	[Digital entrepreneurship is] the creation of a venture to produce and generate revenue from digital goods across electronic networks
Hasnain Zaheer, Yvonne Breyer, John Dumay (2019)	Digital Entrepreneurship: An Interdisciplinary Structured Literature Review and Research Agenda	Technological Forecasting and Social Change	Finally, digital entrepreneurship is the process of creating a digital startup as a new business or within an established firm
Rahim Rashidi, Saeid Yousefpour Yalda sani and Shadi Rezaei (2013)	Presenting a Butterfly Ecosystem for Digital Entrepreneurship Development in Knowledge Age	International Conference on Application of Information and Communication Technologies	Digital entrepreneurship is a field of entrepreneurship in which the new technological instruments such as internet and ICT have been utilized for business.
Bozhena Kelestyn and Ola Henfridsson (2014)	Everyday Digital Entrepreneurship: The Inception, Shifts, and Scaling of Future Shaping Practices	Thirty Fifth International Conference on Information Systems	Everyday digital entrepreneurship refers to users' practice of seizing digitally enabled innovation opportunities discovered in their everyday life to build new business ventures.
Stephen Fox and Brent Stucker (2009)	Digiproneurship	VTT Technical Research Centre of Finland	Digiproneurship is digitally driven entrepreneurship that establishes/expands profitable enterprises undertaking ideation, creation, and/or propagation of physical products

European Commission (2015)	European Commission (EC), Digital Transformation of European Industry and Enterprises; A report of the Strategic Policy Forum on Digital Entrepreneurship	Website	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 characterized by a high intensity of utilization 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.

Table 1- Definitions of digital entrepreneurship

The first recognized definition of digital entrepreneurship is the one of Hull et al. (2007) in which it is considered as a "subcategory of entrepreneurship". Entrepreneurship, in the broadest sense of the word, is defined by Stevenson (1993, 1985, 1980) as "pursuit of opportunities beyond resources you currently controlled". Every term in this definition has a fundamental relevance: pursuit corresponds to a sense of urgency and focus; opportunity implies a completely new type of offering and finally this definition through the part "beyond resources controlled" implies resources constraints.

Hull et al. (2007) add to the definition of digital entrepreneurship that "some or all of what would be physical in a traditional organization has been digitized". This is the part of the definition which refers to the term "digital". Thus, digital entrepreneurship can be considered as a distinct phenomenon from traditional entrepreneurship because, in recent years, digital technologies have pervasively affected entrepreneurship. Hair et al. (2012) slightly revise the first definition given by Hull et al. but the concept is basically the same. The authors, in fact, point out that digital entrepreneurship differs from traditional entrepreneurship because at least some of entrepreneurial ventures take place in a digital realm. The last source which defines digital entrepreneurship as a subcategory or, equivalently, as a field of entrepreneurship is the article by Rashidi et al. (2013). However, in this case, the authors do not refer to the modification of the traditional organization to a more digital one. The fundamental concept of this definition is the strong importance given to the new technological instruments. In particular, the most relevant tools, at this regard, are internet and information and communication technologies which are exploited since the very beginning of the entrepreneurial activity and, more importantly, during all the development of the business at hand. If we take into consideration again the definition given by Stevenson in which traditional entrepreneurship is considered as a "pursuit of opportunities", it is easy to link its thinking to the one of Davidsson and Vaast (2010) who also describe digital entrepreneurship as a pursuit of opportunities. The element of originality is that the opportunities are related exclusively to the pervasive use of digital media and other information technologies. Therefore, the new digital technologies, as in the case of Rashidi et al. (2013), play a fundamental role in the launching and development of the entrepreneurial activity. The definitions by Hull et al. (2007) and Davidsson and Vaast (2010) are the most cited by the other authors in the articles concerning the topic about digital entrepreneurship. This is due to their simplicity which is intertwined with a high efficacy in explaining the concept. For this reason, Rashidi decided to take the

fundamental traits of the two definitions and put them together. However, the other two remained the most famous and acknowledged also after the publication of Rashidi's article. Despite this, several authors tried to give their own interpretation of the definition of digital entrepreneurship. Each of them focuses his attention on more specific characteristics of this phenomenon. One of these is the creative nature of digital entrepreneurship. According to Guthrie (2014) thanks to this particular type of entrepreneurship new ventures are created and value can be generated exploiting electronics networks. At this regard, Zhao and Collier (2016) are on the same page because their definition is based on the importance of the verb "creating" which again refers to new ventures. The element of novelty, compared to Guthrie (2014), is that digital entrepreneurship does not stop here but it can also transform existing business. These activities are possible because of the presence of digital technologies which are usually completely new, but a similar effect can be caused also by the new way of usage of an already existing technology. This is a very important point because we can understand that a person can become a digital entrepreneur even without inventing a new digital technology: it is sufficient to re-think the way in which the technology is used. Thus, digital entrepreneurship deals with new ventures and with the transformation of existing business (European commission 2015) which are, also according to these scholars, enabled by new digital technologies (social, bid data, mobile and cloud solutions). These kinds of technology are fundamental for the exploitation of new entrepreneurial opportunities (Song 2019).

Other authors who marked the importance of the process of creation are Le Dinh et al. (2018). In this case digital entrepreneurship is seen as a natural consequence and evolution of traditional entrepreneurship. In fact, according to the authors, the entrepreneurial activity, like a living being has to adapt to the context in which it lives and in this specific situation there is a completely new way of creating business caused by the coming of the digital era. The last academic paper which directly links digital entrepreneurship to a process of creation is the one by Zaheer

et al. (2019). It seems to be less precise and more superficial compared to the other definitions because it refers specifically to the establishment of a digital startup. However, it is better referring to new ventures as in the other cases because the term digital startup places some limits to the concept of digital entrepreneurship. Despite this, also Zaheer et al. (2019) underline the fact that the process of creation comprehends not only new business but also current and already active ventures.

This set of four definitions presents a more dynamic trait in respect to the first ones but a bit of efficacy to explain the phenomenon is lost. Who addresses the issue of explaining what digital entrepreneurship is using the exact term "phenomenon" is Martinez Dy et al. (2018) which moreover highlight its emergent nature. According to the author, new digital artefact, platforms and infrastructure are adopted in order to exploit every entrepreneurial opportunity. A more schematic and pragmatic interpretation of digital entrepreneurship is provided by Bogdanowicz (2015). It is simply "the phenomenon associated with digital entrepreneurial activity". Thus, it is relevant to analyze what the author means with digital entrepreneurial activity. This is seen a necessary action in order to generate value which, in turn, can be achieved by exploiting new information and communication technologies. From this last point, it is clear that this definition includes some aspects which are similar to the ones given by Rashidi et al. (2013) and Davidson and Vaast (2010) in which the active role of ICT is crucial for the creation of digital entrepreneurship. These definitions which are based on the concept of phenomenon are probably too much generic and this is caused right by the term chosen. Also, Nzembayie (2018), in addition to Martinez Dy et al. (2018), makes use of digital artefact, platforms and infrastructure to describe digital entrepreneurship. However, his attempt turns out to be more precise because these three elements are not at the same level. In fact, artifacts and platforms are the new ideas that constitute the offer for the customer and the infrastructure is the technology that facilitates the development of the new business.

New platforms and digital infrastructure are present also in the definition of Sussan and Acs (2017) who refer to digital entrepreneurship as a set of entrepreneurial activities. These last allow the implementation of digital infrastructure. Moreover, any venture of any kind, which exploits digital technologies in order to perform its own activity, has to be considered a part of the new world of digital entrepreneurship.

2. THEORETICAL BACKGROUND AND HYPOTHESES DEVELOPMENT

The recent growing importance of the effects of entrepreneurship and digitalization on economic growth lays the foundations for the formulation of the hypotheses of this research and they will be described in this chapter. First, the current knowledge about the relationship between entrepreneurship and growth and digitalization and growth will be tackled. At the same moment, also the different ways to measure these two phenomena will be analyzed. The analysis of the studies published so far, regarding this topic, will lead to the formulation of the hypothesis.

2.1 Entrepreneurship and Economic Growth

Economic growth is a key issue in different fields and in particular in policy making and economic research. Several authors have discussed about the impact of entrepreneurship on economic growth, both from a theoretical and empirical perspective.

2.1.1 Theoretical Point of View

Initially, the studies have been conducted from a pure theoretical point of view. Since the publication of Schumpeter's study about entrepreneurship (Schumpeter, 1934), entrepreneurs are believed to be relevant for economic development. Schumpeter states that entrepreneurs are "agents of creative destruction", who change the economic environment by constantly undermining and challenging established industry incumbents. Wennekers and Thurik (1999)

affirm that, at the moment in which they were conducting their study, entrepreneurship was starting to get renewed attention in the study of economic development. For this reason, they study this relationship, taking advantage of different literature strands: historical views, endogenous growth theory, economic history, management literature, industrial economics and evolutionary economics. In particular, looking at the first field, that is historical views, they mention two very important theories about growth. The first one is the neo-classical theory which explains economic growth by accumulation of production factors and by exogenous technological change. For a long period, this theory concentrated exclusively on the contribution of labor and capital to the process of economic expansion (Solow, 1970). On the other side, some authors like Baumol (1993), realized that entrepreneurship does not fit the neo-classical model. Thus, the basic idea of his new theory is to endogenize the role of entrepreneurship for economic growth. Entrepreneurship is considered as a serious generator of job creation and economic growth. Moreover, small firms are acknowledged to play an important role in the economy because they serve as agents of change through their intrinsic entrepreneurial activity leading to the creation of new job opportunities (Friar and Meyer, 2003).

From a theoretical perspective, Fritsch (2008) lists different possible ways through which new firm formation, which is considered entrepreneurship, can boost growth: guaranteeing efficiency thanks to stable market positions as new entrants force efficiency upon existing businesses; accelerating structural change linked to Schumpeter's (1934) concept of creative destruction where industrial change occurs when new firms substitute for older firms; amplified innovation; greater variety of goods and services as the products offered by new entrants may differ from those of older firms. Researchers, in fact, have discussed about these economic benefits generated by entrepreneurs, ranging from innovation (Acs and Audretsch, 1988) to job creation (Blanchflower, 2000; Parker, 2009) to productivity (van Praag and Versloot, 2007) to, e.g., facilitation of technology

transfer and knowledge spill-overs from research to industry (Acs et al., 2009; Grimaldi et al., 2011; Plummer and Acs, 2012; Terjesen and Wang, 2013). Whatever the specific contribution, the broad consensus is that entrepreneurship leads to economic growth. In fact, competitiveness, patents, innovation alone cannot generate growth and prosperity automatically (Acs et al., 2009; Acs and Sanders, 2013). They are necessary but not sufficient. Entrepreneurs must take advantage of the new knowledge and bring the innovations into the marketplace. Knowledge is a key driver for a society to increase its wealth and welfare over time (Economidou et al., 2019).

The research project Global Entrepreneurship Monitor (GEM) points out that there are two categories of entrepreneurship. The first one is called opportunity entrepreneurship and it is typical of those entrepreneurs that that have discovered an opportunity and have the desire of exploit it. The second one is necessity entrepreneurship which is typical of those people that have no other options to make a living (Sautet, 2011). This is a strong categorization that will be useful for this research. In fact, it can be noticed that a strong majority of the self-employed are not entrepreneurial in the Schumpeterian sense because they are not committed in bringing innovation to the market and they do not have the inspiration of making their business bigger (Henrekson and Sanandaji, 2013). More precisely, the layers of differentiation between these two kinds of entrepreneurship are three (Smith and Chimucheka, 2014). The first one, as already mentioned, deals with innovation. Small business, compared to high-growth ventures, are specialized in delivering an established product and service. The second layer regards the potential of growth, which is very high, for definition, in one case and zero in the other. Finally, these two forms of entrepreneurship have different strategic objectives. The major part of small business does not care about this aspect. It is clear that both types of business are important for a well-functioning economy, but their outputs are entirely different. Stam (2015) refers to opportunity entrepreneurship when he talks about productive

entrepreneurship. According to the author, this is the kind of entrepreneurship that contributes to economic growth.

Analyzing more in depth the theoretical point of view, a large literature exists about the link among institutions, entrepreneurship and economic growth (North, 1990; Acemoglu and Johnson ,2005; Acemoglu and Robinson ,2012). A study about this topic is the one by Urbano et al. (2018) in which the authors analyze the process through which institutional factors shape entrepreneurial activity and its consequent impact on economic growth. According to Bradley and Klein (2016), Bruton et al. (2010), and Thornton et al. (2011), among others, institutions have proven to be especially helpful in understanding how entrepreneurial activity is shaped and how entrepreneurs make decisions in order to improve the economy. Although Audretsch et al. (2008) state that entrepreneurship has a positive impact on growth, they suggest not only new research in this line but also improving the measurement of the entrepreneurship variable as will be later discussed, also considering the differences that emerge from the study of these effects across countries. North (1990, 2005) hypothesizes that both formal and informal institutions contribute to economic growth and other authors, deepening this theme, suggest that this relationship can be indirect rather than direct (Acemoglu et al., 2014). Examples of formal institutions are the procedures and costs to create a business and the support mechanisms for new firm creation, while informal factors are considered to be the entrepreneurial culture, attitudes towards entrepreneurship. Among these, informal institutions have a higher and more positive effect than formal institutions. The final conclusion of this broad study is that institutions affect economic growth through endogenous factors such as entrepreneurship and industrial development. However, most of the literature has focused on either entrepreneurship (e.g. Koellinger and Thurik, 2012) or institutions (e.g. Fatas and Mihov, 2013), with less emphasis on the joint effects of entrepreneurship and institutions on economic growth. Entrepreneurship and institutions, in combination as an

ecosystem, might represent the missing link in explaining cross-country differences in economic growth (Braunerhjelm et al., 2010; Acs et al., 2017; Sussan and Acs ,2017). The idea is that the stronger the entrepreneurial ecosystem, the more productive will be the technology, and hence the stronger the impact of technology on economic growth. Finally, the relationships among institutions, entrepreneurship, and aggregate outcomes are, as a logical matter, multilevel (Shepherd, 2011). It is proved that entrepreneurial activity has positive long-run economic consequences in terms of wealth, productivity, and growth. Institutions advance the level of entrepreneurial activity and may also channel entrepreneurship in productive, rather than unproductive, directions.

2.1.2 Empirical Point of View

The second type of study that focuses attention on the link between entrepreneurship and economic growth is the empirical one in which the most important challenge is to find a way to measure the variables that have to be analyzed in the statistical model. Of course, economic growth is easier than entrepreneurship to be quantified. Before discussing the most important studies elaborated so far, it is important to analyze the scientific paper by Acs et al. (2014). According to these authors, measuring entrepreneurship is not an easy task and this kind of challenge becomes even more complex when dealing with entrepreneurship at country-level because it has never received an adequate treatment. However, it is important to provide policymakers with means of facilitating the economic contributions of entrepreneurship and with up-to-date measures of the phenomenon. At the country level, entrepreneurship should be treated as a systemic phenomenon because, not only it provides a more realistic representation of the phenomenon, but also, it helps to take a broad perspective when considering both individual and country-level indicators of entrepreneurial action (Acs et al., 2014). At this regard, the authors review the concept of National

System of Entrepreneurship which is “the dynamic, institutionally embedded interaction between entrepreneurial attitudes, ability, and aspirations, by individuals, which drives the allocation of resources through the creation and operation of new ventures”. The existing ways to measure entrepreneurship in countries can be broadly divided into three categories: output, attitude, and framework indicators. The different approaches imply different conceptions of country-level entrepreneurship (Acs et al., 2014).

Regarding output measures, the indicators belonging to this category record the emergence of new self-employment or new firms within a given population. They are aggregated at the national level, normalized by population size and consequently density measures. The most widely referred output indicator is the Global Entrepreneurship Monitor GEM, which records the self-employment rates annually (Reynolds et al., 2005). Other output measures include OECD-Eurostat’s Entrepreneurship Indicators Program (Lunati et al., 2010; OECD-Eurostat, 2007), World Bank’s Entrepreneurship Survey (World Bank, 2011), and the Flash Eurobarometer survey (Gallup, 2009). Whereas the GEM index is based on random sampling of the adult population, the OECD and World Bank indices draw on data from national registries. The reliance on public registries means that the data is not strictly comparable across countries due to differences in registration practices. This approach also does not distinguish between de novo entries and, for example, reorganizations of existing businesses. Further, this approach does not consider new firms that do not register for any reason. However, this approach tracks formal and more consequential new entries. On the other side, survey data tracks genuinely entrepreneurial entries and it standardizes the data across countries.

Regarding attitude measures, several opinions and value surveys exist, and some of these comprehend opinions, values, and attitudes that are significant for entrepreneurship. The most famous of these is the Euro-barometer survey, which has been conducted since 2000 (Gallup, 2009). Other sources of entrepreneurial

attitudes include the GEM survey (which also tracks attitudes) and the International Social Survey (ISSP, 1997). Of these, the Eurobarometer survey is clearly the most extensive, and it has been extended in recent years also to cover entrepreneurial activity. The attitudes analyzed by this kind of surveys range from preference and reasons for self-employment to self-efficacy perceptions. Opinion surveys give us a rough pointer into the potential for self- employment activity that prevails in a given country (Blanchflower et al., 2001). However, attitude surveys tell us little about how opinions and attitudes translate into action within a given context (McMullen and Shepherd, 2006).

Finally, three types of framework measures exist. One surveys national experts with through questionnaire to construct multi-item scales that reflect entrepreneurial framework conditions. An example of these is the Global Entrepreneurship Monitor's National Expert Survey (Reynolds et al., 2005). Another approach compares the national regulatory framework for new business entry (Djankov et al., 2002). This effort has produced the widely used World Bank 'Ease of Doing Business' index. Partly building on this effort, OECD Entrepreneurship Indicators Program has developed a more comprehensive framework measure that distinguishes between framework conditions, entrepreneurship performance, and economic impact (Ahmad and Hoffmann, 2008). Framework indicators provide useful benchmarks of the institutional and regulatory conditions that prevail in the economy. However, they lack connectivity with actual activity. A further limitation of the regulations-focused framework indices is that they can only target registered activity, and the 'standardized' approach overlooks up to the majority of self-employment attempts and new firm formations, depending on country.

These approaches have been developed for different reasons and each of them have their own pros and cons, as highlighted.

At this point the authors propose a way to measure entrepreneurship. The Global Entrepreneurship and Development Index (in brief, GEDI) consists of a total of

fifteen components, called pillars. These are designed to capture entrepreneurial attitudes, ability, and aspirations. This index responds to the needs of comprising a broad range of components. The novelty of the approach by Acs et al. (2014) is the use of institutional variables as interaction components and not as stand-alone variables. Moreover, they think that an entrepreneurship index should incorporate individual level as well as contextual variables. Finally, they try to emphasize the role of the quality and outcome of the entrepreneurial action. However, as admitted by the authors themselves, this indicator examines mostly traditional startups and it does not capture the effect of the digital revolution on entrepreneurship.

Most of the literature in economics and sociology takes entrepreneurship to be exclusively about start-ups and/or self-employment (Foss & Klein, 2012; Foss & Lyngsie, 2012; Parker, 2005, 2011). However, management research points to entrepreneurship by established firms as a very real element of substantive importance. This is due to the fact that entrepreneurship can happen both in a completely new firm but also in an already existing one. Empirical studies suffer from a data availability issue and to conduct this kind of analysis the quality of data is fundamental.

Bjørnskov and Foss (2016) reiterate the fact that very few studies have focused attention on the outcome of the entrepreneurial activity, and they analyze all the ways in which entrepreneurship and economic growth have been measured. The open issues about this topic are conceptual, theoretical, methodological and empirical. In particular, the authors state that entrepreneurship can be measured in a lot of different ways, depending on the theoretical perspective. While labor economists may prefer measuring potentially productive entrepreneurship in terms of self-employment, other economists may prefer to measure it as start-up activity. Management scholars inspired by Kirzner (1973) tend to highlight the discovery of opportunities, while others inspired by another approach (Foss & Klein, 2012) may prefer to measure it in terms of the actual investments dedicated

to the pursuit of imagined opportunities. Obviously, measures will differ widely based on these different conceptualizations. The correct measurement is usually a compromise between the theoretical perspective and available measures. In literature, authors have used a lot of different ways to measure this phenomenon. The most used is the self-employment (Bjørnskov and Foss, 2008; Dau and Cuervo-Cazurra, 2014; Gohmann, 2012; McMullen et al., 2008; Nystrom, 2008; Troilo, 2011). This is a pure quantity-based measure which has the advantage of being simple to calculate but the disadvantage to not be able to capture the whole phenomenon. In fact, in this way the measurement cannot refer exclusively to innovative and growing firms, namely the ones related to Schumpeterian entrepreneurship. Thus, it is clear that there is no distinction between opportunity, or productive entrepreneurship, and necessity entrepreneurship. There are other similar alternatives to measure entrepreneurship. For example, it can be measured quantifying the birth of new firms (Audretsch and Fritsch, 1994), calculating the ratio between self-employment and total employment, or through the small business entrepreneurship rate (Henrekson and Sanandaji, 2013). The most famous quantity-based measure is the Kauffman Index which tracks when and how many people first started working for themselves, becoming entrepreneurs (Dove, 2015). However, in the last period the the Kauffman Index has changed its structure focusing more on the output of the entrepreneurial activity, given its increasing relevance. Some other measures are more connected to the concept of productive entrepreneurship. Examples concerning this statement are: high-growth self-employment (Bowen and De Clercq, 2008) and the number of new startups (Audretsch and Acs, 1994; Ardagna and Lusardi, 2009). A very similar measure is the number of venture capital-backed firms or the VC investment as a share of GDP (Henrekson and Sanandaji, 2013). Henrekson and Sanandaji (2013) propose to use the number of billionaires over the GDP to measure the level of entrepreneurship in a certain country.

Focusing more in detail on the most important empirical studies about this topic, the first scientific paper is the one by Wong et al. (2005). The authors, taking advantage of a cross-sectional data on the 37 countries participating in GEM 2002, use an augmented Cobb–Douglas production to explore firm formation and technological innovation as separate determinants of growth. Furthermore, they underline the importance of GEM data to improve the possibilities of measuring entrepreneurship and they are one of the first authors that clearly state that the Schumpeterian theory had never been empirically demonstrated. The output of the GEM project is the comparable measures of entrepreneurship, namely the Total Entrepreneurship Activity (TEA). The TEA rate measures the proportion of working-age adults in the population who are either involved in the process of starting-up a business or are active as owner-managers of enterprises less than 42 months old. In addition, three sub-types of TEA rates are used to evaluate the influence of different types of entrepreneurial business creation activities on economic growth. Opportunity and Necessity TEA rates differentiate between entrepreneurs that are motivated to pursue perceived business opportunities and those that are driven to become entrepreneurs as a last resort, when other options for economic activity are absent or unsatisfactory. Then, High-Growth TEA rate identifies the sub-set of entrepreneurs that are involved in businesses that have "high growth potential". GEM defines high-expectation entrepreneurship as all start-ups and newly formed businesses (less than 42 months-old) which expect to employ at least 20 employees in 5 years. The main finding of this study is that only High-Growth TEA has a significative impact on economic growth. The paper by Valliere and Peterson (2009) is an extension of the above-mentioned study in which data from 44 countries for the years 2004 and 2005, collected by Global Entrepreneurship Monitor (GEM) research and Global Competitiveness Report (GCR) research, are used to identify predictors of economic growth for emerging and developed nations. Also here, the distinction between opportunity and necessity entrepreneurship is fundamental. Bjørnskov and Foss (2016) argue that

the main effect from entrepreneurship to economic growth is moderated by institutions. Consequently, it is one of the first cases that quantitatively considers the contribution of institutions. Institutions are important because they reduce uncertainty by establishing a stable structure to human interaction and they stimulate, through the offer of incentives for productive behavior, individuals to start activities for the private and social return. Finally, they are able to control the consequences of economic undertakings in a more efficient way. Doran et al. (2016) statistically demonstrate that entrepreneurship, simply measured as new firm formation, impact on economic growth in European regions. The main limit is once again the simplistic kind of system to measure the entrepreneurial activity, as highlighted by the authors themselves, who suggest taking advantage of the GEM. According to Aparicio et al. (2016), opportunity entrepreneurship, measured through TEA, is identified as one such mechanism that impacts on economic growth. Using a three-stage least-square method through unbalanced panel data with 43 countries (2004–2012), they find that informal institutions have a higher impact on opportunity entrepreneurship than formal institutions. Acs et al. (2018) analyze conceptually and in an empirical counterpart the relationship between economic growth, factor inputs, institutions, and entrepreneurship. They affirm that countries with weak institutions do not incentivize productive entrepreneurship but rather either unproductive or, worst-case scenario, destructive entrepreneurship. They use a panel fix effects model to test the hypothesis that a National System of Entrepreneurship as measured by the GEI is positively associated with economic growth. Among the findings there is the conviction that entrepreneurship is the transmission mechanism from innovation to economic growth. Another study which emphasizes the importance of the institutions in the relationship between entrepreneurship and economic growth is the one by Bosma et al. (2018) who remember that the three ways through which entrepreneurship leads to economic growth are innovation creation, innovation diffusion, and competition (Wennekers and Thurik 1999).

Furthermore, they prove that productive entrepreneurship contributes to economic growth. This is demonstrated through a classical growth regression for a sample of 25 European countries in the period 2003-2014. The last empirical study that is analyzed in this section is the one by Stam and van de Ven (2019) and it is relevant for the way through which the authors build a measurement of the entrepreneurial ecosystem elements. Productive entrepreneurship is the output of this entrepreneurial ecosystem. The entrepreneurial ecosystem index has the goal to capture all the ten key elements of an entrepreneurial ecosystem developed by Stam (2015). It is easy to understand that this is not a measure of the level of entrepreneurial activity that, in this case, is the output of the system. Hence, productive entrepreneurship is approximated by the prevalence of high-growth firms, but the authors take also in consideration the possibility of measuring the entrepreneurial activity with the numbers of unicorns. Finally, a key concept of the relation between entrepreneurship and economic growth, namely the lag effect, has to be remarked. Carree and Thurik (2008) examine the lag structure of the impact of the level of entrepreneurial activity some measures of economic performance: their results confirm earlier evidence of three stages in the impact of entry on economic performance using country-level data: the initial direct positive effect, followed by a negative effect due to exiting capacities and, finally, a stage of positive supply-side effects. It can be assumed that the final positive effect has a time-lag of about two or three years.

On the other side, there are different alternatives also to measure economic growth of a specific country. The most used involve Gross Domestic Product (GDP). GDP, indeed, is one of the most widely used measures of an economy's output or production. It is defined as the total value of goods and services produced within a country's borders in a specific time period — monthly, quarterly or annually. GDP gives an overall picture of the state of the economy and enables policymakers to evaluate whether the economy is contracting or expanding. To capture economic growth, both GDP growth and GDP per capita

can be used. GDP per capita is used as a measure of economic growth because it is proven that has a high correlation with GDP growth in living standards over time. It is adopted as a dependent variable by Lafuente et al. (2016), Castaño-Martínez et al. (2015) and Urbano and Aparicio (2016). In particular, Audretsch et al. (2015) argue that, although some scholars use population change, employment growth or income growth (Fritsch and Mueller 2004, 2008; Mueller et al. 2008; Glaeser et al. 2010) as a measure of economic development, GDP per capita in PPP is a better measurement. In fact, given a high job market mobility in Europe (Stam 2014) the measurement of economic development by a number of full-time job placements is not appropriate. Job unit is not equal to income and productivity growth. Moreover, it does not capture heterogeneity of a labor force and its results. On the contrary, GDP does capture labor efficiency challenged by technology, inter-regional and inter-national knowledge flow, outsourcing. Although it does not differentiate between resource-based and knowledge-intense businesses, it measures how much value was added in a city by employees. GDP growth instead is used by Stam and van de Stel (2011), by Stam et al. (2011) and by Valliere and Peterson (2009). In addition, also GDP per capita growth is a good measure and it is used by several authors like Braunerhjelm et al. (2010), Hessels and Van Stel (2011) and by Prieger et al. (2016). Economic growth can also be expressed by Total Factor Productivity (Bjørnskov and Foss, 2013; Erken et al., 2016). TFP is considered by the authors as the variable that accounts for those changes in total output that are not caused by changes in 'traditional' inputs, namely labor and capital. Wong (2005) uses the ratio between GDP and the level of employment to obtain a measure similar to GDP per capita.

2.2 Digitalization and Economic Growth

As already mentioned, over the last period, the important role of Information and Communication Technologies has been acknowledged and a considerable part of the literature about this topic has tried to assess the economic impact of ICT, in particular on key performance variables such as output and productivity growth. One of the first recognitions of the impact of ICT on GDP growth is the one by OECD (2003) in a study that analyses the investments in Information and Communication Technologies. According to Evangelista et al. (2014) there are several transmission mechanisms between digitalization and major macro-economic variables and namely growth in per capita GDP, labor productivity and employment in the sense that digitalization can drive the listed factors. This conclusion is derived from the study of a set of composite ICT indicators. The considerable impact of ICT on economic growth is confirmed by other studies (Yousefi, 2011; Stanley et al., 2018). The first one states that digitalization plays a fundamental role in the growth of high and middle classes but not of low ones. In the same way, those firms that take advantage of ICT become more efficient and competitive. Yousefi (2011) points out that the impact of digitalization on economic growth is statistically significant in developed economies. However, for developing countries the results are mixed in terms of significance. Finally, about the impact of digitalization, it has to be remarked the fact that ICT has a broader social impact on society that goes beyond productivity measures, namely on aspects like improvements in social capital, health, education, employment and commerce (Ganju et al., 2015).

Also the level of digitalization in a specific country is not easy to be measured. Regarding this issue, the most important index is DESI. The Digital Economy and Society Index (DESI) is a composite index, elaborated by the European Commission, that summarizes relevant indicators on Europe's digital performance and tracks the evolution of EU member states in digital competitiveness. The components of this index are connectivity, human capital, use of internet services, integration of digital technology and digital public service.

The main drawback of this index is the fact that has available data only after 2013. To overcome this problem, the Observatory Agenda Digitale of Politecnico di Milano has created a new index called Digital Maturity Index that is based on more than 100 parameters. Compared to DESI, it is better in considering some specific aspects like the infrastructure, the presence of open government mechanisms, the economic impact of research and development activities and the innovation of processes in the companies.

2.3 Hypotheses Formulation

Given this theoretical background, it is possible to formulate the hypothesis that will drive this research. We have seen that both entrepreneurship and digitalization are recognized to have an impact on economic growth of a country. Thus, the first hypothesis regards the relationship between entrepreneurial activity and economic growth.

H1: *The level of entrepreneurial activity is positively related to economic growth at country level*

Since we propose a new method to measure entrepreneurship, other three sub-hypotheses can be defined. In fact, if we look at the whole entrepreneurial process, there are three phases: new venture creation, new venture growth and new venture stability (Kazanjian, 1988). It is interesting to evaluate how each of these entrepreneurial phases influences economic growth.

The first one refers to the concept of quantity-based measures that were previously analyzed, such as self-employment and number of new firms. At this regard there are opposing opinions as we have seen. We hypothesize that the higher number of new ventures a country can boast, the higher growth it can achieve.

H1a: *Entrepreneurial quantity positively affects economic growth at country level*

The second phase regards the expansion of the firm and it is named "entrepreneurial quality". This phase is mostly typical of those firms that are characterized by opportunity and productive entrepreneurship. Several scholars like Stam (2015) argue that only this kind of entrepreneurship leads to economic growth. Moreover, in this way we consider also the contribution by already existing firms in addition to new firms'. Thus, we hypothesize:

H1b: *Entrepreneurial quality positively affects its economic growth at country level*

The third phase refers to the stability achieved by the start-up - which can be an IPO or a write-off – and it is named "entrepreneurial outcome". This step is exclusively achieved by high-growth firms. Several scholars such as Bjornskov and Foss (2016) highlight the importance of the outcome of the entrepreneurial activity, even if this theme has never been completely debated. On the other side, it is clear that narrowing the ecosystem to these kind of start-ups risks to not capture the whole picture. We hypothesize:

H1c: *Entrepreneurial outcome positively affects its economic growth at country level*

Sussan and Acs (2017) deeply analyze the role of entrepreneurship in the digital age by integrating the concepts of entrepreneurial ecosystem and digital ecosystem. An intense entrepreneurial activity is supposed to favor the development of a strong digital infrastructure. The latter could be created from scratch or, alternatively, renewed from an already existing infrastructure. In addition, entrepreneurship has a fundamental role in facilitating the creation of new digital technologies and, equally importantly, of reducing the associated costs. This allows the actors of the ecosystem - which can be segmented in public administration, firms and citizens – to adopt this kind of technology in a broader way. Lower costs, in fact, guarantee a more extensive diffusion of the technologies.

Thus, in doing so, the inevitable consequence is the increase of the level of digitalization within the ecosystem. Thus, we propose:

H2: *The level of entrepreneurial activity is positively related to the level of digitalization at country level*

Consistently with the first hypothesis and according to the conceptualization of entrepreneurial activity we propose, also this hypothesis is sub-divided in three sub-hypotheses.

H2a: *Entrepreneurial quantity positively affects the level of digitalization at country level*

H2a: *Entrepreneurial quality positively affects the level of digitalization at country level*

H2a: *Entrepreneurial outcome positively affects the level of digitalization at country level*

Then, we have seen how digitalization is acknowledged to lead to economic development. Thus, we propose:

H3: *The level of digitalization is positively related to economic growth at country level*

Furthermore, there is a significative gap in literature about the combined effects of entrepreneurship and digitalization on economic growth. At this regard, it is interesting to understand how digitalization fits in the relationship between entrepreneurship and economic growth. Digital entrepreneurship, as we have seen, is a relevant trend in the last years. Digitalization is supposed to be a mediator because it should better explain the link between entrepreneurship and economic growth. Thus, we argue that:

H4: *The level of digitalization mediates the relationship between entrepreneurship and economic growth at country level*

Consistently with the first hypothesis and for the same reasons, also this can be divided in three sub-hypotheses.

H4a: *The level of digitalization mediates the relationship between entrepreneurial quantity and economic growth at country level*

H4b: *The level of digitalization mediates the relationship between entrepreneurial quality and economic growth at country level*

H4c: *The level of digitalization mediates the relationship between entrepreneurial outcome and economic growth at country level*

Therefore, these hypotheses and the related sub-hypotheses will be the driving force of the whole research.

3. METHODOLOGY

In order to test the hypotheses described in the previous chapter, a statistical model has been developed, consistently with the available data and the intentions of this research. This chapter shows the methodology applied in performing the research and the related results. Starting from an analysis of how the data was collected, the sources used and the formation of the starting database, we obtain the basis for outlining the key variables to be included in the model. Then, an analysis of the main variables used is carried out, defining their construction and their relationship with the hypotheses developed. Later, the multilevel mediation statistical model used in this research is defined, together with some theoretical explanations of the underlying elements. Finally, the results coming from a statistical analysis software will be presented and some robustness tests will also be performed, aiming at supporting the validity of the applied method.

3.1 Data Sources and Database Formation

The data obtained to form the statistical base of this research was obtained from different sources and then intersected in a single database. This section explains how the data collection was carried out and how data was aggregated in the final database. The final dataset encompasses data related to several years and different countries. In particular, the time horizon of this study goes from 2009 to 2017 and the geographical area analyzed includes the 28 nations belonging to the 28 European Union at the moment of gathering data. 2018 and 2019 are not considered in this research due to a lack of several data for the concerned years.
For the sake of clarity, the section, like the final database, is divided in four section on the basis of the proposed model and every component will have a specific paragraph.

The final database is the combination of the four datasets explained in the following pages.

3.1.1 Entrepreneurship

The first building block of the model regards entrepreneurship. In order to measure entrepreneurship at country-level some specific data is needed. Every piece of data refers to a specific year and to a specific country.
The very first statistics regards the births of enterprises in a year and the source is Eurostat which is an important statistical institution. Its main role is to process and publish comparable statistical information at European level. Then, some data about the investment in high growth companies are needed. For this purpose, a peculiar database was used: Crunchbase. This is a platform for the research of commercial information about private and public companies. It is an online directory that collect data about investments in startups and exit operations. It works mainly with a crowdsourcing logic and it is supervised by an internal team. Crunchbase was created in 2007 by Michael Arrington and since 2015, it has been an independent company, where AOL / Verizon has held a stake in it together with other investors (such as Emergence Capital). It covers the operations of both formal (venture capital funds) and informal investors (business angels). Moreover, it is recognized and used in several scientific journals (e.g. Block and Sandner, 2009, Cavallo et al., 2018; Bertoni and Tykvová, 2015). Thanks to the filters of the database a lot of specific data can be obtained. To be more precise, information coming from Crunchbase is the one concerning the amount of capital invested, the amount of capital greater than 5 million USD and the number of great deals, that is the ones which refer to amounts greater than 5 million USD. All these statistics are related to high-growth companies of the analyzed country. This approach, based only on investments in startups, allows to focus on high potential entrepreneurship (Stam, 2015) and to reduce the typical problems of

more traditional measures which consider only the quantity-aspect of entrepreneurship, e.g. self-employment. In particular, with these approaches (Ahmad and Hoffmann, 2008; Reynolds, et al.,2005), the risk is to present a photograph which does not capture completely the reality because it focus only on a part of the phenomenon.

The last information that comes from this database and that is needed for this research regards the number of exits which is the sum of the number of trade sales and the number of IPOs. Then, the number of unicorns, which are defined as private startups that are worth one billion USD, is gathered from an online database named CB Insights. This is a company dealing with the development of technological solution for the enterprises. In the last years it has developed a very unique database which includes the name of the unicorn, its valuation, the date in which the company has become unicorn and the headquarter country. Lastly, data about GDP for every country is obtained from the online website of the International Monetary Fund, an international organization headquartered in Washington, D.C., which aims at fostering global cooperation.

The following table summarizes all the data above-mentioned related to entrepreneurship.

Data	**Source**
Number of born enterprises in a year	Eurostat
Amount of investment in high growth companies	Crunchbase
Amount of investment greater than 5 million $ in high growth companies	Crunchbase
Number of big deals (which amount is greater than 5 million $)	Crunchbase
Number of exit (trade sales + IPOs)	Crunchbase
Number of new Unicorns	CB Insights

GDP	IMF

Table 2- Data about entrepreneurship gathered from 2009 to 2017 for EU28.

3.1.2 Digitalization

The second component of the model is concerned with the level of digitalization within a certain country. The main source of this typology of data is the Observatory Agenda Digitale of Politecnico di Milano. The dataset contains a lot of information from different sources, for different years and for different countries. The main sources used are BCG, a management consulting firm, DESI which is The Digital Economy and Society Index, a composite index that summarizes relevant indicators on Europe's digital performance and tracks the evolution of EU member states in digital competitiveness. Then, there is DAS which is, the Digital Agenda Scoreboard which measures the performance of Europe and the Member States in a wide range of areas, from connectivity and digital skills to the digitization of businesses and public services.

Another source for this comprehensive dataset is the OECD, which is the Organization for Economic Co-operation and Development, an intergovernmental economic organization with 36 member countries, founded in 1961 to stimulate economic progress and world trade. The Global Findex, which is used for other data, is one of the world's most comprehensive dataset on how adults save, borrow, make payments, and manage risk. Launched with funding from the Bill & Melinda Gates Foundation, the database has been published every three years since 2011. The data are collected in partnership with Gallup, Inc., through nationally representative surveys of more than 150,000 adults in over 140 economies.

Also, as far as digitalization is concerned, Eurostat Database has been used. Network Readiness Index is used for very specific data. It measures the propensity for countries to exploit the opportunities offered by information and communications technology (ICT). It is published in collaboration with INSEAD, as part of their annual Global Information Technology Report (GITR). The report is regarded as the most authoritative and comprehensive assessment of how ICT impacts the competitiveness and well-being of nations. For other specific data, the Observatory Agenda Digitale has taken advantage of the United Nation Conference on Trade and Development which is the part of the United Nations Secretariat dealing with trade, investment, and development issues. For data about public administration the Euro Health Consumer Index is used. This is a is a comparison of European health care systems based on waiting times, results, and generosity. Finally, the last sources are the World Bank and the World Economic Forum. The former, broadly acknowledged, is one of the world's largest sources of funding and knowledge for developing countries. The latter is the International Organization for Public-Private Cooperation. The Forum engages the foremost political, business, cultural and other leaders of society to shape global, regional and industry agendas. It was established in 1971 as a not-for-profit foundation and is headquartered in Geneva, Switzerland.

Given that, compared to the entrepreneurship sector, there is a lot of data, only a recap table will be provided in which the indicator and its source are shown.

Data	**Source**
Fixed broadband take-up (subscriptions/100 people)	DESI
DSL subscriptions share in fixed broadband	DAS
Households having a broadband connection	DAS
Households with fixed broadband connection	DAS
Households that have no access to Internet at home, because the costs are too high	DAS
Enterprises having a fixed broadband connection	DAS

Take-up of mobile - active SIM cards for voice or data	DAS
Take-up of mobile broadband (subscriptions/100 people)	DESI
Individuals accessing the Internet through a mobile phone via UMTS (3G)	DAS
Average Revenue per User (ARPU) in the Retail Mobile Market	DAS
Telecommunication revenues as a percentage of GDP	OECD
Fast Broadband take-up	DESI
Ultrafast Broadband Take-up	DESI
Enterprises having a fast-fixed broadband connection	DAS
Cloud Experience	Global Connectivity Index
Big Data Experience	Global Connectivity Index
Individuals who have used internet in the last 12 months	DAS
Individuals who are regular internet users (at least once a week)	DESI
Individuals who are frequent internet users (every day or almost every day)	DAS
Individuals who have never used the internet	DAS
Individuals using a laptop/tablet to access the internet, away from home or work	DAS
Diversification index for the activities realised online by internet users	DAS
Reading / downloading online newspapers / news magazines	DESI
Playing or downloading games, images, films or music	DESI
Households subscribed to Video on Demand	DESI
Individuals watching video on demand from commercial services	DAS
looking online for a job or sending a job application	DAS
looking online for information about education, training or course offers	DAS
looking for information about goods and services online	DAS
Individuals ordering goods or services online	DESI

Individuals ordering goods or services online, from sellers from other EU countries	DAS
Individuals ordering physical goods online	DAS
Individuals ordering services online	DAS
Individuals ordering content or software that were delivered or upgraded online	DAS
Individuals ordering content or software delivered online or offline	DAS
Using online banking	DESI
Made digital payments in the past year	Global Findex
Paid utility bills: using an account	Global Findex
Financial activities over the internet	Eurostat database
telephoning or video calls (via webcam) over the internet	DESI
uploading self-created content to be shared	DAS
participating in social networks, over the internet, last 3 months	DESI
doing an online course (in any subject)	DAS
Used internet storage space to save documents, pictures, music, video or other files	DAS
Individuals who have written a computer program using a specialised programming language	DAS
Individuals experienced financial loss	DAS
Individuals experienced abuse of personal information and/or other privacy violations	DAS
Individuals caught a virus or other computer infection resulting in loss of information or time	DAS
Individuals who know that cookies can be used to trace movements of people on the internet	DAS
Individuals using anti-tracking software	DAS
Individuals not allowing use of personal information for advertising	DAS
Enterprises reporting hard-to-fill vacancies for jobs requiring ICT specialist skills	DAS
Selling online	DESI

Software piracy rate, % software installed	Network Readiness Index
Total electronic sales by enterprises, as a % of their total turnover	DESI
Enterprises having done electronic sales to other EU countries in the last calender year	DESI
Enterprises exploiting the "Businees to Consumers" opportunities of web sales	DAS
Enterprises purchasing online	Eurostat database
Proportion of businesses receiving orders over the Internet	UNCTADSTAT
ICT use for business-to-business transactions	Network Readiness Index
Shares of ICT goods in total merchandise exports	UNCTADSTAT
Enterprises using Customer Relationship Management (CRM) software	DAS
Enterprises that share internally electronic information with an ERP	DESI
Enterprises sharing electronic information on the supply chain	DAS
Enterprises sending e-invoices (derived indicator)	DESI
Security concerns kept individual from ordering or buying online	DAS
Impact of ICTs on new organizational models	Network Readiness Index
Individuals interacting online with public authorities, last 12 months	DAS
Individuals submitting completed forms to public authorities, over the internet, last 12 months	DESI
E Participation Index	UN
Received government payments: into an account	Global Findex
Taking part in on-line consultations or voting to define civic or political issues	DAS
eHealth	DESI
Seeking online information about health	DAS
Making an appointment with a practitioner via a website	DAS

ePrescriptions	Euro Health Consumer Index
Medical data exchange	DESI
Government effectiveness	World Bank
ICT use and government efficiency	World Economic Forum
Impact of ICTs on access to basic services	World Economic Forum
Government Online Service Index	World Economic Forum
Patient records e-accessible	Euro Health Consumer Index
Government success in ICT promotion	World Economic Forum
Importance of ICTs to government vision of the future	World Economic Forum
No. procedures to enforce a contract	Network Readiness Index
No. days to enforce a contract	Network Readiness Index

Table 3- Data about digitalization gathered from 2009 to 2017 for EU28

3.1.3 Economic Growth

In order to measure economic growth data about real GDP per capita and real GDP growth are necessary. The Gross Domestic Product (GDP) of an economy is a measure of total production. More precisely, it is the monetary value of all goods and services produced within a country or region in a specific time period. While the definition of GDP is straightforward, accurately measuring it is a surprisingly difficult undertaking. The source used for these data is, once again, Eurostat.

3.1.4 Quality of Governance

Lastly, data about the quality of governance is gathered from the World Bank, an institution which has already been described. Governance consists of the traditions and institutions by which authority in a country is exercised. This includes the process by which governments are selected, monitored and replaced; the capacity of the government to effectively formulate and implement sound policies; and the respect of citizens and the state for the institutions that govern economic and social interactions among them. In particular, in this case, The Worldwide Governance Indicators is exploited. It is a project that reports aggregate and individual governance indicators for over 200 countries and territories over the period 1996–2018, for six dimensions of governance: Voice and Accountability, Political Stability and Absence of Violence, Government Effectiveness, Regulatory Quality, Rule of Law, Control of Corruption. These data are gathered from a number of survey institutes, think tanks, non-governmental organizations, international organizations, and private sector firms (Kaufmann and Kraay, 1999).

Data	**Source**
Voice and Accountability	World Bank
Political Stability and Absence of Violence	World Bank
Government Effectiveness	World Bank
Regulatory Quality	World Bank
Rule of Law	World Bank
Control of Corruption	World Bank

Table 4- Data about quality of governance gathered from 2009 to 2017 for EU28

3.2 Variables Definition

Once gathered the specific data, the process of variables definition can be carried out. In fact, the standalone data cannot provide us with a measure of the specific phenomenon and for this reason, data pre-processing is necessary. The variables used in the model are explained in this section. In order to better identify them, the variables have been divided, like in the previous paragraph, into four categories: independent variable, mediation variable, dependent variables and control variable.

3.2.1 Independent Variable - Entrepreneurship

The independent variable of the model is represented by the level of entrepreneurship at country-level. The data here are processed in order to obtain a comprehensive and synthetic indicator which is defined as Entrepreneurial Index. This measures the effectiveness of the entrepreneurial ecosystems of general firms and also start-ups financed with venture capital, in every country of the European Union. The Entrepreneurial Index, in fact, mostly focuses on the entrepreneurial dynamics of those companies which - due to their characteristics of innovation and growth potential - require specific risk capital, managed both by institutional investors (venture capitalists) and by "informal" investors (business angel, family office, etc.). Despite this, also the whole entrepreneurial activity-opportunity and necessity entrepreneurship- is taken into consideration. Furthermore, the Entrepreneurial Index is based, from a methodological point of view, on a conceptual framework that looks at entrepreneurship through a "process" perspective, measuring the effectiveness of the three key phases of an entrepreneurial development process: the creation of the firm, its growth and maturation. The Index, in fact, summarizes three key measures, which refer to three phases of the entrepreneurial process.

The choice to focus mainly on innovative high potential start-ups is consistent with the reference scientific literature (for example, Stam, 2015). Furthermore, it is important to underline that the Entrepreneurial Index, unlike other studies and indices on entrepreneurship (for example, Autio et al., 2018), does not focus on contextual factors that can facilitate entrepreneurial activity, but focuses on what the ecosystem is producing in terms of quantity, quality and outcome. The Entrepreneurial Index, in fact, is calculated as the arithmetic average of the three dimensions (i) Entrepreneurial Quantity, (ii) Entrepreneurial Quality and (iii) Entrepreneurial Outcome. Each dimension is detected on the basis of specific indicators. It is important to explain the mathematical process through which the component is calculated. Every component encompasses different measures which are, in turn, the ratio between specific data in the database explained in the previous section. Before averaging the different measures, these have to be normalized in order to make them comparable. The normalization method used to carry out this process is the given by the application of the following formula: $\frac{X-min}{\max-min}$. X is the value of the original ratio; max is the maximum value assumed by the measure among the whole-time horizon and among the 28 countries under consideration. In the same way, min in the minimum value assumed by the concerned measure. The result is that each measure is normalized, and it assumes values from 0 to 1. Only in this moment an arithmetic average makes sense. Below, for each dimension, we illustrate the measured phenomenon, the definition and the indicators used for its calculation.

According to the hypothesis to be tested the independent variable can be represented by either the Entrepreneurial Index, either its three components.

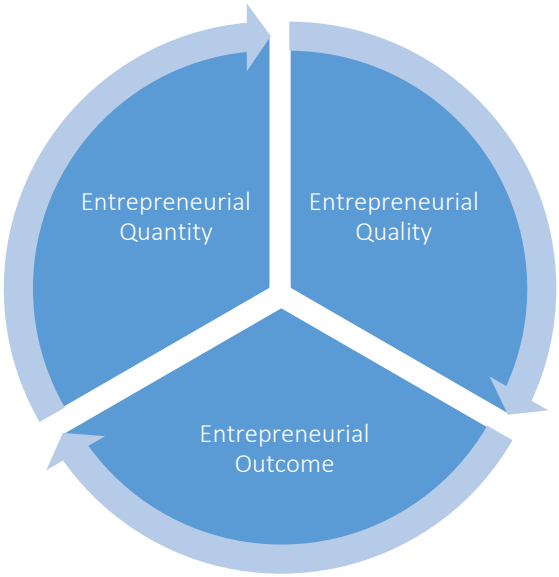

Figure 1- The virtuous cycle of entrepreneurship

3.2.1.1 Entrepreneurial Quantity

As far as Entrepreneurial Quantity is concerned, only one indicator has been chosen to represent this component of the Entrepreneurial Index. That is the ratio between the number of new enterprises and GDP. This is a very traditional way of measuring entrepreneurial quantity and, for this reason, it is characterized by some drawbacks. The main one regards the difficulty in capturing the primacy of some geographical areas with excellent performances (Fazio et al., 2016).

In this way the indicator captures all the possible typologies of entrepreneurship that are opportunity entrepreneurship, necessity entrepreneurship and high growth entrepreneurship. This is due to the fact that the other components, namely, Entrepreneurial Quality and Outcome seek to focus on productive entrepreneurship. For this reason and to better capture the whole entrepreneurial phenomenon this measure was chosen.

3.2.1.2 Entrepreneurial Quality

Entrepreneurial Quality is the component of the Index in charge of measuring the development of the high-growth companies. The assumption in this case is that the fastest growing start-ups are capable not only of attracting capital, but also of attracting it in large quantities in order to scale their business model. Specifically, three measures are used to build this component. The first one is the ratio between the amount of investment in start-ups and GDP. The second one is the ratio between the amount of investment greater than 5 million USD and GDP. The third one is the ratio between the number of big deals and GDP. In this way, especially with the last two indicators, we capture investments greater than 5 million USD in high potential start-ups and the number of rounds with investments of at least 5 million USD. The first one is considered in order to not excessively penalize some smaller countries. Entrepreneurial Quality, consequently, is the arithmetic average of these three indicators.

3.2.1.3 Entrepreneurial Outcome

Entrepreneurial Outcome has the task of detecting the ability of a country to bring start-ups with high potential to a significant "size", which is manifested mainly through the achievement of an exit (Trade Sale or IPO) and/or particularly significant valorizations (greater than $ 1 billion - Unicorns). Specifically, two measures are used for this component. The first one is the ratio between the number of exits and GDP. The second one is the ratio between the number of the start-ups which become unicorns in a year and GDP. Entrepreneurial Outcome, consequently, is the arithmetic average of these two indicators.

The final structure of the Entrepreneurial Index is the following:

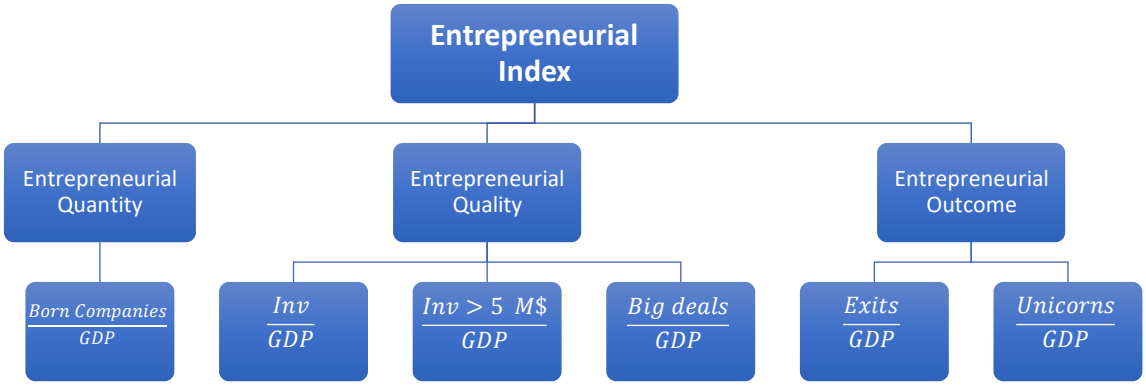

Figure 2-Structure of the Entrepreneurial Index

The Entrepreneurial Index is the arithmetic average of its three components: Entrepreneurial Quantity, Entrepreneurial Quality and Entrepreneurial Outcome. Furthermore, its peculiar structure is good not only from a theoretical point of view, highlighting the virtuous cycle but it is also consistence. This is demonstrated by the exploratory factor analysis carried out on these measures using Stata which is a statistical software created in 1985 by StataCorp. The result of this precise analysis shows that the Cronbach's alpha of the factor, in this case the Entrepreneurial Index, is 0.7795 which is greater than the acceptable threshold which is, for this kind of test, 0.7 (Cronbach, 1951). The factor is composed by the six items at the basis of the Entrepreneurial Index.

3.2.2 Mediator Variable – Digitalization

The mediator variable of the model concerns the level of digitalization at a country-level. The data here are processed in order to obtain a comprehensive and synthetic indicator which is defined as Digital Maturity Index. The Digital Maturity Index is a framework elaborated by the Observatory Agenda Digitale of Politecnico di Milano, that sums up several indicators on performances about the digitalization and measures the digital transformation of each country. The

progression of digital competitiveness among the EU member states is evaluated through the years. In this research the time horizon goes from 2009 to 2017. Then, the Digital Maturity Index considers two main components: enabling factors and achieved results. For this research only one component is considered and used for the analysis, that is the component regarding the achieved results. This choice is given by the fact that this category better captures the current level of digitalization within a specific country. The other one, instead, deals with the measurement of the investments to make the area more digitalized.

The structure of this index is very similar to the Entrepreneurial Index, but it has more measures at the lowest level. The four components of the Digital Maturity Index are Infrastructure, Public Administration, Citizens and Firms. The first one, which is Infrastructure, regards the diffusion and the utilization of the broadband and other key infrastructures like the cloud. The second one, Public Administration, concerns the diffusion and the utilization of e-Government services. The component about citizens evaluates the diffusion and usage of digital tools but also the digital competencies of the people. The last one is about the firms and it concerns the diffusion and the utilization of digital technologies in the production and sales processes of both products and services. Every component is a weighted average of the measures provided in figure 3.

To sum up and have a better idea, you can see the final structure of the Digital Maturity Index in the following figure.

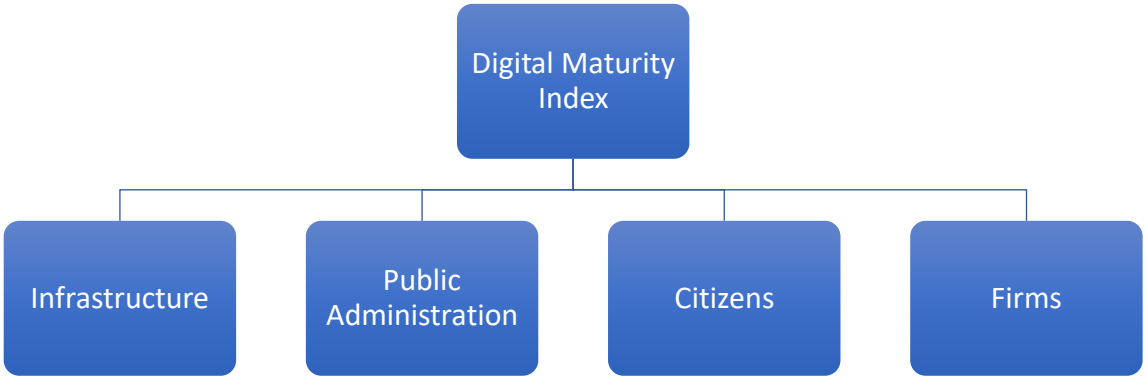

Figure 3-Structure of Digital Maturity Index

3.2.3 Dependent Variable – Economic Growth

The dependent variable studied in the model measures the economic growth. The variable chosen to evaluate the economic growth of a country is real GDP per capita. It is calculated by dividing GDP over a country's population. GDP per capita is a universal measure globally for gauging the prosperity of nations. Worldwide it is used by economists alongside GDP to analyze the prosperity of a country and its economic growth. Small, rich countries and more developed industrial countries tend to have the highest per capita GDP. Among the ways to analyze a country's wealth and prosperity, GDP per capita is the most universal because its components are regularly tracked on a global scale, providing for ease of calculation and usage. GDP per capita shows how much economic production value can be attributed to each individual citizen. Alternatively, this translates to a measure of national wealth since GDP market value per person also readily serves as a prosperity measure. Through the research economic, in particular in the sensitivity analysis, economic growth will be measured also through GDP growth. GDP growth rate measures how fast the economy is growing. It does this

by comparing one period of the country's gross domestic product to the previous period.

3.2.4 Control Variable – Quality of Governance

The last variable that has to be explained is the control variable. In this case a good element to be used as control variable is the Quality of Governance which reflects the effectiveness of the formal institutions within a country. Formal institutions display the rules of the game in society (North 1990). For entrepreneurship, the quality and efficiency of formal institutions matter: the level of perceived corruption and the general regulatory framework within countries. So, to measure this phenomenon, we use data coming from World Bank explained in the previous section.

The final indicator concerning the Quality of Governance is the arithmetic average of six components: Voice and Accountability, Political Stability and Absence of Violence, Government Effectiveness, Regulatory Quality, Rule of Law, Control of Corruption. Let's focus on each of them to better understand the nature of this indicator.

Voice and Accountability captures perceptions of the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media. Political Stability and Absence of Violence/Terrorism measures perceptions of the likelihood of political instability and/or politically motivated violence, including terrorism. Government effectiveness captures perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies. Regulatory quality captures perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector

development. Rule of law captures perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence. Control of corruption captures perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests.

3.3 Statistical Analysis

In this section the statistical model used to test the initial hypothesis is presented. Also, some theoretical considerations are discussed to better understand the process through which the model is built.

3.3.1 Longitudinal Dataset

One of the peculiar characteristics of this model is the fact that it is based on a longitudinal dataset. In fact, it encompasses several variables that measure entrepreneurship, digitalization and economic growth. Moreover, these data refer to different years (from 2009 to 2017) and to several countries (28 countries belonging to the European Union). Longitudinal data, sometimes called panel data, is a collection of repeated observations of the same subjects, taken from a larger population, over some time – and is useful for measuring change. Longitudinal data differs from cross-sectional data because it follows the same subjects over some time, while cross-sectional data samples different subjects at each point in time. Thus, it has several advantages over repeated cross-sectional data.

3.3.2 Mediation

Mediation is a particular kind of regression analysis which can be represented in the following scheme.

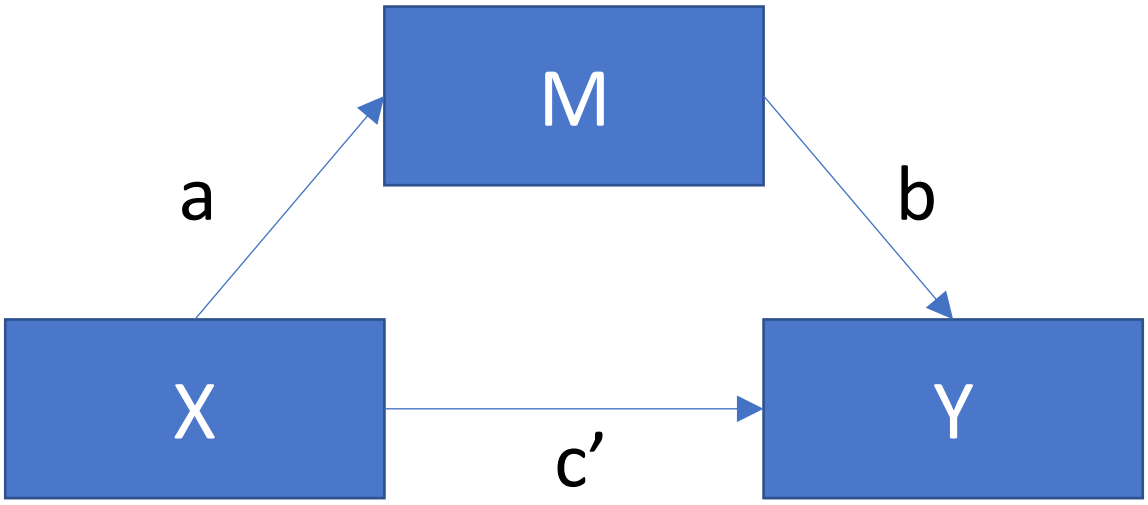

Figure 4-Mediation model

In order to explain to explain this model the first consideration that has to be made regards the relationship between the variables X and Y. The fundamental assumption is that variable X causes variable Y. Therefore, variable X is called the causal variable and variable Y is called the outcome. Considering these two variables alone as an unmediated model, the c-path that links them is called total effect. However, the effect of X on Y could be mediated by a mediating variable M and the variable X may still affect Y. The figure above represents this relationship. In this case path c’ is called the direct effect and the mediator is considered as a process variable. Theoretically, there could be two types of mediation: complete mediation is the case in which variable X no longer affects Y after M has been controlled, making path c' zero. Partial mediation is the case in which the path from X to Y is reduced in absolute size but is still different from zero when the

mediator is introduced. A mediational model is a causal model. In fact, the mediator is presumed to cause the outcome and not vice versa. If the presumed causal model is not correct, the results from the mediational analysis are likely of little value. There is a long history in the study of mediation (Hyman, 1955; MacCorquodale & Meehl, 1948; Wright, 1934).

There are some reasons for the great interest in this topic: one reason for testing mediation is trying to understand the mechanism through which the causal variable affects the outcome. Mediation and moderation analyses are a key part of what has been called process analysis, but mediation analyses tend to be more powerful than moderation analyses. Moreover, when most causal or structural models are examined, the mediational part of the model is often the most interesting part of that model.

If the mediational model is correctly specified, the paths of c, a, b, and c' can be assessed using a multiple regression. Sometimes, other ways of estimation (e.g., logistic regression, multilevel modeling, and structural equal modeling) have to be exploited. Regardless of which method is used, the four steps necessary for testing mediation are the same (Baron and Kenny, 1986).

- Step 1: demonstrate the causal relationship between the independent variable and the outcome. Use Y as the criterion variable in a regression equation and X as a predictor (estimate and test path c in the above figure). This step establishes that an effect that may be mediated exists.
- Step 2: demonstrate the causal relationship between the independent variable and the mediator. Use M as the criterion variable in the regression equation and X as a predictor (estimate and test path a). This step considers the mediator as an outcome variable.
- Step 3: demonstrate that the mediator influences the outcome variable. Use Y as the criterion variable in a regression equation and X and M as predictors (estimate and test path b). It is not sufficient just to correlate

the mediator with the outcome because the mediator and the outcome may be correlated because they are both caused by the causal variable X. Thus, the causal variable must be controlled in establishing the effect of the mediator on the outcome.

- Step 4: prove that M completely mediates the X-Y relationship, the effect of X on Y controlling for M (path c') has to be zero. The effects in both Steps 3 and 4 are considered in the same equation.

The data are consistent with the hypothesis that variable M completely mediates the X-Y relationship if all four of these steps are proven right, and if the first three steps are met but the Step 4 is not, we have a case of partial mediation. The amount of mediation is called the indirect effect. Note that the total effect = direct effect + indirect effect or using symbols c = c' + ab. A method to test the indirect effect is bootstrapping (Bollen and Stine, 1990; Shrout and Bolger, 2002). Bootstrapping is a non-parametric method based on resampling with replacement which is done many times, e.g., 5000 times. From each of these samples the indirect effect is calculated, and a sampling distribution can be analytically created. With the distribution, a confidence interval, a p-value, or a standard error can be determined.

3.3.3 Multilevel Mediation Model

Multilevel modelling was developed in response to the challenge of appropriately analyzing clustered data. This technique preserves the original data structure. Because of the complex structure of the model and the nature of the error terms, multilevel models are estimated using iterative Empirical Bayes/ maximum likelihood (EB/ML) techniques, rather than the OLS methods typically employed to estimate the parameters of single-level models. In addition to the correction of standard error estimates and the more appropriate significance tests that result,

multilevel models also provide other advantages over traditional analytic techniques. Prominent among these is the ability to simultaneously examine the effects of variables at both individual and group levels, as well as possible cross-level interaction effects. The basic prerequisites for the appropriate application of multilevel mediational analysis include (a) clustered data with positive ICC, and (b) a proposed three-variable mediational model in which the outcome variable is measured at the lowest level of the data. Multilevel mediational modelling is a flexible technique which allows researchers to appropriately test mediated effects in clustered datasets (Krull and MacKinnon, 2001).

This kind of model is the one applied in this research. Since we have longitudinal data, multilevel mediation analysis is required in order to perform the analysis (each country has several observations over the years, so the observations are clustered by countries). OLS regression is not applicable in this case. The independent variable is represented by entrepreneurship, the dependent variable by economic growth and the mediator is the level of digitalization. Moreover, there is a control variable which is the quality of the governance previously explained. The following figure better explains the research model. Every variable assumes different values on the basis of year i and country j.

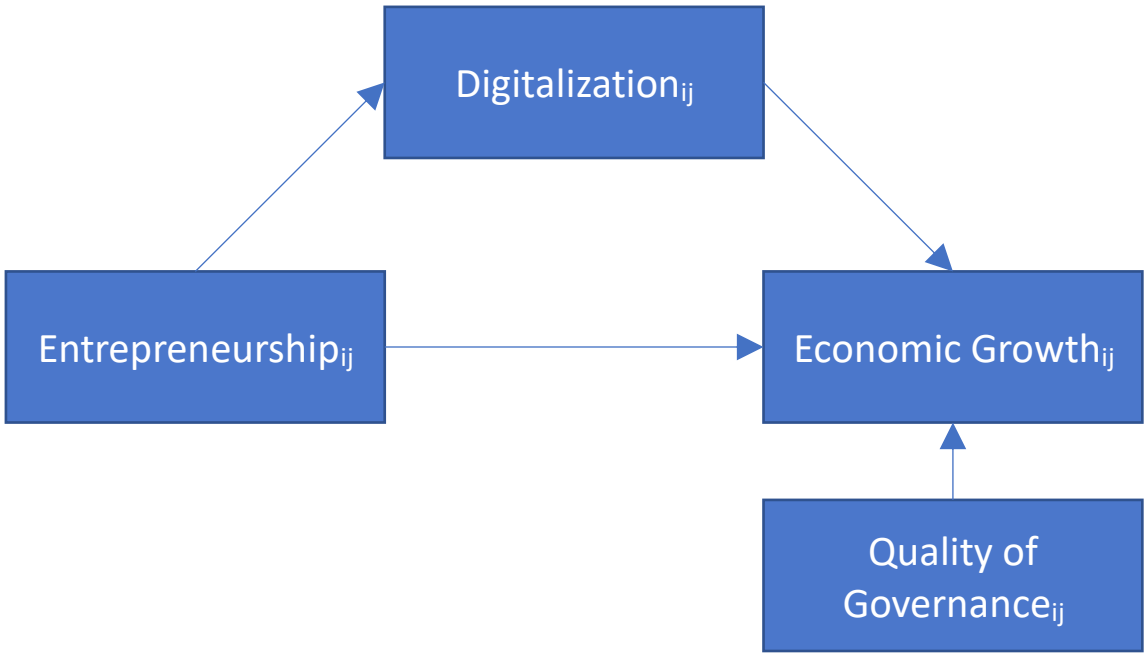

Figure 5-Multilevel mediation model

This statistical model is tested using the software Stata. First of all, data have to be standardized in order to make the results comparable among them. The command used to execute this process is the following:

foreach x of varlist Var1 Var2 Var3 {egen `x'_Z=std(`x')}

Given the longitudinal dataset, a specific command is used to analyze the data which is:

ml_mediation, dv (Dependent variable) mv (Mediator) iv (Independent variable) l2id (country) cv (Control variables)

This is a user written Stata command and adopts the approach introduced in Krull and MacKinnon (2001). This command allows to evaluate the statistical significance of the three relationships. The first one is the one corresponding to

equation 1 and it evaluates the significance of c_path, namely the relationship without the mediator. The second one assesses a_path and the third one evaluates the combination of b_path and c'_path.
The output of the command is the level of significance between each variable which can be measured through the respective p-value. Furthermore, this kind of analysis measures also the coefficients of the equations tested.
Another important output of this model is the proportion of total effect mediated which is, mathematically speaking, the following ratio: $\frac{a*b}{c+a*b}$. Therefore, it measures the weight of the mediation effect out of the total effect.
The statistical significance of the mediation effect can be assessed using the Bootstrapping and its related command which is:

bootstrap indeff=r(ind_eff) direff=r(dir_eff) toteff=r(tot_eff), reps(5000) seed(512) cluster(country) idcluster(NEW_country): ml_mediation, dv(gdpprocapita) iv(desi) mv(Med) l2id(NEW_country).

Through this command the statistical significance of the effects can be evaluated. In particular, we obtain the significance levels, measured through the p-values, of the indirect effect, the direct effect and the total effect, together with their coefficients.
According to the hypothesis that has to be tested, different variables can be used to test the model. Specifically, entrepreneurship can be represented by the Entrepreneurial Index or one of its three components while digitalization can be expressed by the Digital Maturity Index or one of its four components.

3.4 Results

In this section the results obtained from the analysis of the multilevel mediation model previously defined are presented. The objective of these analyses is to evaluate and measure the existence of an indirect effect of digitalization in the relationship between entrepreneurship and economic growth. Specifically, the intention is to verify the hypotheses presented in chapter 2.

3.4.1 Descriptive Statistics

Before presenting the final results of the statistical model together with some robustness checks, it is important to look and study the descriptive statistics of the model in order to summarize the dataset. Regarding, digitalization and entrepreneurship, the breakdown is done only at the first level, because the presentation of all the data would require too much space.

The following table shows the main parameters of the variables at the most aggregated level. In particular, you can see the mean, the standard deviation, the median, Skewness and Kurtosis and finally the number of observations.

Variables (number of observations: 252)	*Mean*	*Standard deviation*	*Median*	*Skewness*	*Kurtosis*
Entrepreneurial Index	0.1079	0.0896	0.0911	1.5824	4.0302
Entrepreneurial Quantity	0.2223	0.2161	0.1287	0.9716	0.1409
Entrepreneurial Quality	0.0687	0.1199	0.0164	2.5666	6.9490
Entrepreneurial Outcome	0.0421	0.0811	0.0201	7.3196	78.2918
DMI Achieved Results	0.2838	0.1364	0.2602	0.5403	-0.4779
DMI_Infrastructure	0.3086	0.1388	0.2840	0.4319	-0.5441

DMI_Firms	0.2928	0.1521	0.2605	0.3452	-0.9539
DMI_Citizens	0.2831	0.1358	0.2591	0.7708	0.0988
DMI_PAs	0.2323	0.1530	0.2200	0.5208	-0.5448
GDP per Capita	24,820	15,833	20,670	1.4340	2.8501
GDP Growth	1.1853	3.8744	1.8000	-0.1565	7.9294
Quality of Governance	1.0471	0.4443	1.0013	-0.1480	-0.8986

Table 5-Overall descriptive statistics

The main insights about this table are the following. The number of observations is given by the product of the number of years taken in consideration (9) and the number of countries (28).

First of all, a comparison between the Entrepreneurial Index and the Digital Maturity Index can be made, since they have a very similar structure and they are both measured with a from zero to one scale. The latter has an average value greater than the former. This is caused by the fact that the Entrepreneurial Index, for the first years of the time horizon analyzed, presents lower values than the last period. This means that entrepreneurial activity has strongly increased in the last years. Another cause of this difference relies on the way through which the two measures are composed. Regarding entrepreneurship you can see that the three components have quite different means. Specifically, entrepreneurial quality and entrepreneurial outcome have low values. This is due to the nature of the measures because the underlying indicators can be equal or near to zero very often, for example taking in consideration the number of unicorns or the investments greater than 5 million USD. On the other side, digitalization components are very homogenous. This is caused by the fact that it is composed by a lot of indicators which have more distributed values. Both Entrepreneurial

Index and Digital Maturity Index have a similar mean and median. However, you can see that both of them have a slightly greater mean than the median, meaning that more than the half of the countries over the years have lower values for these two indexes. Entrepreneurial Index has a lower standard deviation which means that within entrepreneurship there is less variability. The values tend to be closer to the mean in respect to digitalization which has its values spread over a wider range. Then, skewness and kurtosis can be evaluated. In probability theory and statistics, skewness is a measure of the asymmetry of the probability distribution of a real-valued random variable about its mean while kurtosis is a measure of the "tailedness". The Entrepreneurial Index has a greater value of Skewness. This means that Digital Maturity Index has a more symmetric data distribution. Given that they both have a positive skewness, they both are skewed right. In particular entrepreneurial data are highly skewed because skewness is greater than 1. Comparing the kurtosis, we can understand that the Entrepreneurial Index tends to have more outliers than Digital Maturity Index.

Looking at the components of the Entrepreneurial Index, we can see that Entrepreneurial Quantity has a greater average than the other two components. In addition, all of them have a high standard deviation, in particular Entrepreneurial Quality and Entrepreneurial Outcome. All of them have a mean higher than the median, as confirmed by the positive value of skewness. Entrepreneurial outcome is highly skewed and most importantly has a very high kurtosis. This corresponds to greater extremity of deviations which is the main limit of this measure. In fact, it should be underlined how this index, as it is built, can favor small ecosystems, characterized by low investments but which have managed (sometimes even exceptionally or luckily) to obtain success cases in terms of Exit or Unicorns. Therefore, it can be an extremely hysterical indicator a good probability to have some outliers.

The components of the Digital Maturity Index, as already mentioned, are more homogenous, also considering skewness and kurtosis.

GDP per capita is not measured in a scale from 0 to 1 as the other indicators. Skewness is positively high, meaning that the distribution is highly skewed right.
GDP growth is measured in percentage and, since it can have negative values (mainly during the first years of the time horizon caused by the financial crisis of 2008).
Quality of governance is measured on a scale that goes from -2.5 to 2.5 which is set by the authors of this particular measure.
Now we can better analyze the dataset by looking at the situation in each of the 28 countries taken into account.

Variables (number of observations:9)	*Mean*	*Standard deviation*	*Median*	*Skewness*	*Kurtosis*
Entrepreneurial Index AT	0.0216	0.0112	0.0180	1.8892	5.5756
Entrepreneurial Index BE	0.0330	0.0155	0.0269	0.4372	-1.5503
Entrepreneurial Index BG	0.2442	0.0406	0.2366	0.9187	1.4084
Entrepreneurial Index CY	0.0968	0.0605	0.0837	0.5014	0.3261
Entrepreneurial Index CZ	0.1358	0.0131	0.1401	-0.7894	0.0059
Entrepreneurial Index DE	0.0333	0.0177	0.0253	0.5558	-0.9288
Entrepreneurial Index DK	0.0426	0.0280	0.0264	0.5364	-1.2497
Entrepreneurial Index EE	0.1843	0.0744	0.1898	0.3046	-1.6160
Entrepreneurial Index EL	0.0212	0.0224	0.0071	0.6189	-1.6328
Entrepreneurial Index ES	0.0649	0.0227	0.0548	0.6441	-0.6924
Entrepreneurial Index FI	0.0791	0.0438	0.0686	0.8749	-0.2898
Entrepreneurial Index FR	0.0558	0.0239	0.0426	0.7218	-1.2266
Entrepreneurial Index HR	0.0477	0.0339	0.0588	-0.3200	-1.3988
Entrepreneurial Index HU	0.1221	0.0179	0.1122	0.6889	-0.8381
Entrepreneurial Index IE	0.1011	0.0549	0.1079	-0.1427	-1.5514
Entrepreneurial Index IT	0.0331	0.0078	0.0306	0.6683	-0.0644

Entrepreneurial Index LT	0.2825	0.0808	0.2794	-0.2501	-0.2904
Entrepreneurial Index LU	0.0628	0.0688	0.0235	0.8563	-0.4705
Entrepreneurial Index LV	0.2496	0.1023	0.1709	0.3584	-2.0434
Entrepreneurial Index MT	0.1512	0.1797	0.0676	1.6420	4.0963
Entrepreneurial Index NL	0.0682	0.0296	0.0635	0.4685	-1.5052
Entrepreneurial Index PL	0.1517	0.0125	0.1566	-0.2277	-1.9095
Entrepreneurial Index PT	0.1579	0.0315	0.1482	0.5365	-1.6206
Entrepreneurial Index RO	0.1169	0.0302	0.1272	-0.4230	-0.1945
Entrepreneurial Index SE	0.0872	0.0574	0.0524	0.8518	-0.6466
Entrepreneurial Index SI	0.0854	0.0171	0.0851	0.4016	-0.7369
Entrepreneurial Index SK	0.1772	0.0421	0.1787	0.5984	1.3130
Entrepreneurial Index UK	0.1136	0.0724	0.0857	0.9392	0.7807
DMI Achieved Results AT	0.3078	0.1104	0.3161	-0.1152	-1.6884
DMI Achieved Results BE	0.3149	0.1507	0.3235	-0.1380	-1.3162
DMI Achieved Results BG	0.1856	0.0674	0.1981	-0.6611	-0.3099
DMI Achieved Results CY	0.2185	0.0873	0.2262	-0.0028	-1.5653
DMI Achieved Results CZ	0.2349	0.1057	0.2461	-0.0351	-1.7993
DMI Achieved Results DE	0.3339	0.1288	0.3335	0.0381	-1.6565
DMI Achieved Results DK	0.4004	0.1593	0.4088	0.0028	-1.6407
DMI Achieved Results EE	0.3126	0.1471	0.3047	0.0946	-1.7802
DMI Achieved Results EL	0.1982	0.0784	0.2063	0.0162	-1.3636
DMI Achieved Results ES	0.2960	0.1251	0.3021	-0.0199	-1.7787
DMI Achieved Results FI	0.3949	0.1471	0.4202	-0.1193	-1.7078
DMI Achieved Results FR	0.2946	0.1079	0.3171	-0.1395	-1.6656
DMI Achieved Results HR	0.2494	0.0975	0.2708	-0.1256	-1.6198
DMI Achieved Results HU	0.2265	0.0930	0.2327	-0.0036	-1.6246
DMI Achieved Results IE	0.3080	0.1254	0.3150	-0.0468	-1.7763

DMI Achieved Results IT	0.2112	0.0715	0.2259	0.0719	-1.3457
DMI Achieved Results LT	0.2684	0.1168	0.2929	-0.0313	-1.5256
DMI Achieved Results LU	0.3816	0.1457	0.3776	0.1863	-1.6072
DMI Achieved Results LV	0.2357	0.0815	0.2602	-0.2897	-1.3446
DMI Achieved Results MT	0.3097	0.1250	0.3239	0.0008	-1.7066
DMI Achieved Results NL	0.3805	0.1707	0.3623	0.2545	-1.5378
DMI Achieved Results PL	0.1986	0.0778	0.2121	0.0257	-1.3217
DMI Achieved Results PT	0.2760	0.1179	0.2919	0.0287	-1.6248
DMI Achieved Results RO	0.1579	0.0768	0.1741	-0.1082	-1.7000
DMI Achieved Results SE	0.3977	0.1470	0.4230	-0.0602	-1.5794
DMI Achieved Results SI	0.2523	0.0973	0.2733	-0.0838	-1.5999
DMI Achieved Results SK	0.2417	0.0806	0.2658	-0.0903	-1.4802
DMI Achieved Results UK	0.3585	0.1545	0.3878	-0.0888	-1.6296
GDP per Capita AT	36,098	609	36,180	-0.6612	1.3097
GDP per Capita BE	33,850	741	33,490	0.4571	-0.1516
GDP per Capita BG	5,530	418	5,400	0.5250	-0.4706
GDP per Capita CY	22,088	1,207	22,360	-0.3319	-1.5715
GDP per Capita CZ	15,556	821	15,200	0.8190	-0.1467
GDP per Capita DE	33,400	1,369	33,330	-0.6240	0.7205
GDP per Capita DK	44,942	1,293	44,410	0.6521	-0.3752
GDP per Capita EE	12,616	1,098	12,640	-0.1207	-0.5718
GDP per Capita EL	18,114	1,595	17,240	1.2040	0.8902
GDP per Capita ES	22,921	774	23,040	0.4022	-0.1368
GDP per Capita FI	35,028	655	35,080	0.4966	-0.3850
GDP per Capita FR	31,276	571	31,210	0.1001	0.8388
GDP per Capita HR	10,646	402	10,500	1.2432	1.8394
GDP per Capita HU	10,580	711	10,230	0.6483	-0.7431

GDP per Capita IE	41,984	6,881	37,010	0.7426	-1.2264
GDP per Capita IT	26,187	571	26,090	0.0671	-1.5674
GDP per Capita LT	10,690	1,279	10,780	-0.0741	-1.0317
GDP per Capita LU	79,651	2,053	79,310	0.2984	-1.1803
GDP per Capita LV	9,976	988	10,030	-0.0107	-1.1082
GDP per Capita MT	17,710	1,925	16,910	0.4692	-1.4265
GDP per Capita NL	38,924	810	38,580	1.1274	1.3482
GDP per Capita PL	10,336	835	10,170	0.2384	-0.6016
GDP per Capita PT	16,680	477	16,710	0.4792	0.3252
GDP per Capita RO	6,956	672	6,760	0.7696	0.0152
GDP per Capita SE	41,003	1,595	40,820	-0.2402	0.0372
GDP per Capita SI	17,921	650	17,750	1.2045	2.2853
GDP per Capita SK	13,477	931	13,270	0.0138	-0.6552
GDP per Capita UK	30,824	1,022	30,660	0.2131	-1.4695
GDP Growth AT	0.8778	1.8796	1.0000	-1.4707	4.0089
GDP Growth BE	1.2111	1.3186	1.6000	-1.3378	3.5239
GDP Growth BG	1.5000	2.2106	1.9000	-0.8728	1.3171
GDP Growth CY	0.3333	3.9679	0.4000	-0.0896	-0.6677
GDP Growth CZ	1.4333	2.8860	2.3000	-0.7983	1.0848
GDP Growth DE	1.3111	2.7691	2.2000	-1.5780	4.5558
GDP Growth DK	0.9444	2.2167	1.6000	-1.8740	5.9353
GDP Growth EE	1.4667	5.8958	2.7000	-2.0052	6.8063
GDP Growth EL	-3.0889	3.5300	-3.2000	-0.2857	-1.2628
GDP Growth ES	0.2556	2.5669	0.2000	-0.1428	-1.3698
GDP Growth FI	0.1333	3.3599	0.6000	-1.4051	3.4603
GDP Growth FR	0.8444	1.4758	1.1000	-1.5862	4.6098
GDP Growth HR	-0.3333	3.1415	-0.3000	-0.8736	1.7704

GDP Growth HU	1.2000	3.2884	2.0000	-1.3647	2.9741
GDP Growth IE	4.9111	8.1824	1.8000	1.4508	3.9730
GDP Growth IT	-0.4333	2.2910	0.7000	-0.9857	0.5162
GDP Growth LT	1.3778	5.8524	3.5000	-2.2594	7.8947
GDP Growth LU	2.3667	2.8760	3.7000	-1.3404	2.3966
GDP Growth LV	0.5333	5.9001	2.3000	-1.6351	4.0243
GDP Growth MT	4.6778	3.7847	4.8000	-0.1967	0.1785
GDP Growth NL	0.7333	1.9241	1.4000	-1.1922	2.0050
GDP Growth PL	3.2778	1.1821	3.3000	-0.1282	-0.6454
GDP Growth PT	0.0000	2.4299	0.8000	-0.3270	-1.1156
GDP Growth RO	1.9333	3.8398	3.4000	-0.8500	0.3124
GDP Growth SE	1.9444	2.8167	2.4000	-0.7708	1.5964
GDP Growth SI	0.4444	3.4970	1.3000	-1.0706	1.8310
GDP Growth SK	2.0444	3.0170	2.8000	-1.4571	4.3201
GDP Growth UK	1.2889	1.9706	1.9000	-2.3306	8.2430
Quality of Governance AT	1.4969	0.0444	1.5228	-0.3454	-1.7075
Quality of Governance BE	1.3057	0.0598	1.3158	-0.6803	0.7264
Quality of Governance BG	0.1895	0.0415	0.1955	-0.0424	-1.6363
Quality of Governance CY	1.0029	0.0840	1.0178	-0.5306	-0.9970
Quality of Governance CZ	0.9269	0.0296	0.9267	0.2701	-0.1671
Quality of Governance DE	1.4889	0.0443	1.4825	0.8260	0.4636
Quality of Governance DK	1.7530	0.0659	1.7717	-0.3099	-1.2429
Quality of Governance EE	1.0935	0.0965	1.0323	0.1859	-2.3956
Quality of Governance EL	0.5791	0.3403	0.8509	-0.2294	-2.5237
Quality of Governance ES	1.2057	0.3579	1.4950	-0.2226	-2.5432
Quality of Governance FI	1.5722	0.1836	1.4393	0.2542	-2.3866
Quality of Governance FR	1.2610	0.1476	1.3704	-0.2420	-2.3470

Quality of Governance HR	0.4492	0.0443	0.4443	0.5171	2.1820
Quality of Governance HU	0.4924	0.0289	0.4939	-0.4968	-0.8014
Quality of Governance IE	1.1072	0.3030	0.8998	0.2605	-2.2839
Quality of Governance IT	0.9436	0.4029	1.2905	-0.2253	-2.5594
Quality of Governance LT	0.7351	0.1795	0.5996	0.2478	-2.3807
Quality of Governance LU	1.3009	0.3540	1.0365	0.2059	-2.5117
Quality of Governance LV	1.1489	0.3173	1.3990	-0.2185	-2.5619
Quality of Governance MT	0.9427	0.1093	0.8710	0.2709	-2.1800
Quality of Governance NL	1.4287	0.2238	1.2766	0.1919	-2.5018
Quality of Governance PL	1.2303	0.4010	1.5592	-0.2864	-2.3329
Quality of Governance PT	0.8994	0.1285	0.8336	0.3140	-1.8715
Quality of Governance RO	0.5198	0.2722	0.7127	-0.1760	-2.3923
Quality of Governance SE	1.0409	0.6181	0.5437	0.2192	-2.5618
Quality of Governance SI	0.8223	0.0813	0.7910	0.0139	-1.3953
Quality of Governance SK	0.8429	0.1165	0.9088	-0.1311	-2.2257
Quality of Governance UK	1.5396	0.0900	1.5567	-0.3409	-1.2832

Table 6-Descriptive statistic across countries

A lot of considerations can be done looking at this table. For the sake of simplicity, we can analyze the Italian situation. Italy has lower values than the European average, both in entrepreneurship and digitalization. This does not apply to the GDP per capita. However, it is one of the few countries that has a negative average for GDP growth, meaning that the economic growth during this period has not been good.

The following graph shows the mean value of the Entrepreneurial Index for every country belonging to the European Union in the period that goes from 2009 to 2017. Italy has been one of the worst entrepreneurial ecosystems in this period. In

fact, it 25th out of 28 countries. In the first positions there are some small countries that have been able to implement good strategies from the political point of view.

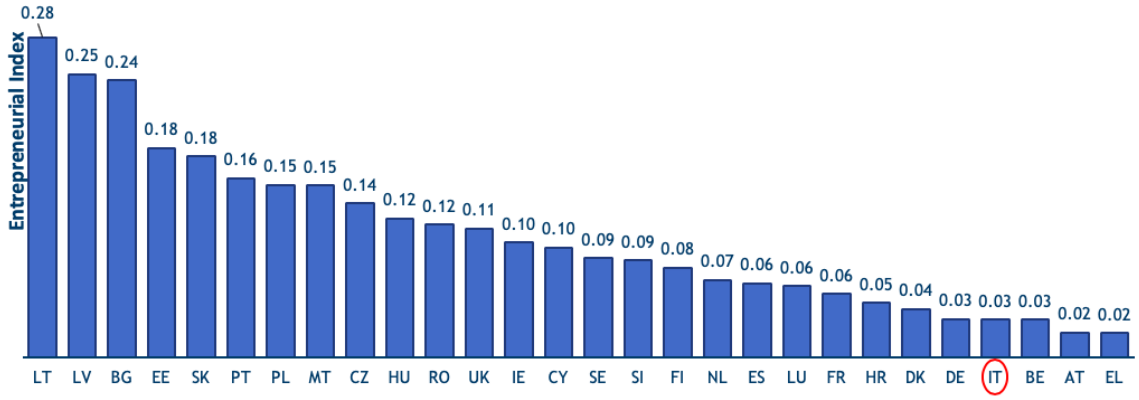

Figure 6-Entrepreneurial Index in EU

The same analysis can be done also for the Digital Maturity Index. In this case the performances of the European countries are more homogenous among each other, if compared to the Entrepreneurial Index. Scandinavian countries are the best thanks to their strong commitment and to the proactive culture. Italy, again, is in the last positions demonstrating a bad level of digitalization in comparison to the other countries.

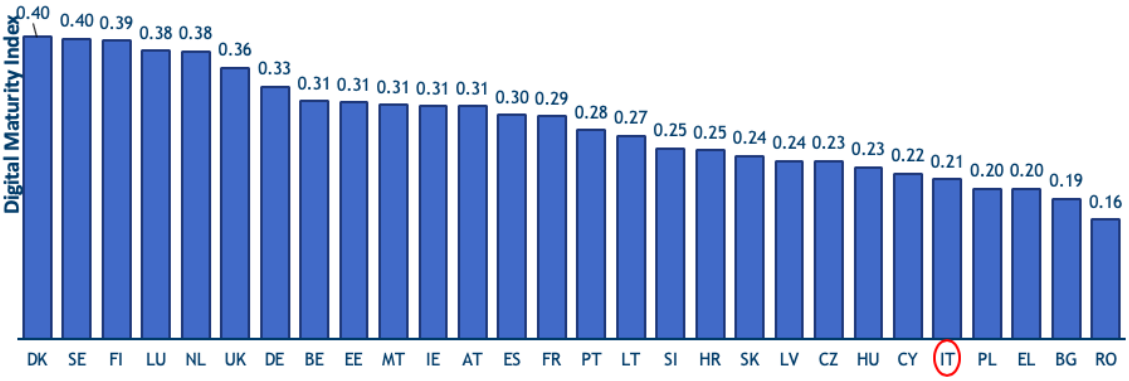

Figure 7- Digital Maturity Index in EU

Then we can analyze the dataset through a yearly logic. The following table shows this.

Variables (number of observations: 28)	*Mean*	*Standard deviation*	*Median*	*Skewness*	*Kurtosis*
Entrepreneurial Index 2009	0.0682	0.0759	0.0360	1.6552	3.7947
DMI Achieved Results 2009	0.1219	0.0355	0.1204	0.0683	-0.3565
GDP per Capita 2009	23,735	15,177	22,315	1.4007	3.7476
GDP Growth 2009	-5.4071	3.7437	-4.6000	-1.0635	2.1950
Quality of Governance 2009	1.0589	0.3973	1.0013	-0.1068	-0.7779
Entrepreneurial Index 2010	0.0800	0.0630	0.0611	0.6470	-0.8876
DMI Achieved Results 2010	0.1528	0.0449	0.1462	0.0947	-0.2672
GDP per Capita 2010	24,138	15,623	21,680	1.4347	3.8752
GDP Growth 2010	1.5750	2.6802	1.8500	-0.9790	1.4878
Quality of Governance 2010	1.0640	0.4037	1.0078	-0.1291	-0.9057
Entrepreneurial Index 2011	0.0744	0.0623	0.0490	0.8372	-0.3131
DMI Achieved Results 2011	0.1721	0.0426	0.1649	0.0710	-0.5144
GDP per Capita 2011	24,396	15,675	20,635	1.4286	3.7350
GDP Growth 2011	1.8036	2.9195	1.8000	-1.4167	6.2245
Quality of Governance 2011	1.0546	0.4132	0.9834	-0.1278	-0.7858
Entrepreneurial Index 2012	0.0825	0.0661	0.0568	1.2750	1.7815
DMI Achieved Results 2012	0.2289	0.0533	0.2260	0.1884	-0.5089
GDP per Capita 2012	24,153	15,346	19,570	1.3884	3.4328
GDP Growth 2012	-0.2679	2.5257	0.2000	-0.5393	0.7049
Quality of Governance 2012	1.0538	0.4205	1.0167	-0.1675	-0.9515
Entrepreneurial Index 2013	0.0910	0.0667	0.0699	1.0842	0.8823
DMI Achieved Results 2013	0.2962	0.0674	0.2975	0.2153	-0.6606
GDP per Capita 2013	24,166	15,408	18,780	1.4470	3.6762

GDP Growth 2013	0.4893	2.2364	0.5500	-0.7972	2.5131
Quality of Governance 2013	1.0588	0.4155	0.9992	-0.1566	-0.8051
Entrepreneurial Index 2014	0.1141	0.0906	0.0927	1.1324	1.0958
DMI Achieved Results 2014	0.3415	0.0840	0.3437	0.1248	-0.9884
GDP per Capita 2014	24,616	15,641	19,135	1.4690	3.7672
GDP Growth 2014	2.3393	2.2562	2.0500	1.2182	2.9114
Quality of Governance 2014	1.0485	0.4964	0.9751	-0.1339	-0.9639
Entrepreneurial Index 2015	0.1334	0.0811	0.1130	1.0332	0.6237
DMI Achieved Results 2015	0.3735	0.0932	0.3741	0.0662	-1.2403
GDP per Capita 2015	25,474	16,246	20,280	1.4360	3.3687
GDP Growth 2015	3.7357	4.6115	2.4000	3.6587	17.1417
Quality of Governance 2015	1.0428	0.4896	1.0119	-0.1625	-0.9827
Entrepreneurial Index 2016	0.1574	0.0902	0.1523	0.7692	0.4509
DMI Achieved Results 2016	0.4196	0.1066	0.4231	0.1801	-1.0321
GDP per Capita 2016	26,009	16,489	21,270	1.4568	3.4655
GDP Growth 2016	2.7929	1.3995	2.5500	0.8124	1.6017
Quality of Governance 2016	1.0234	0.4762	0.9905	-0.1164	-0.9448
Entrepreneurial Index 2017	0.1699	0.1247	0.1385	1.7989	4.1532
DMI Achieved Results 2017	0.4476	0.1105	0.4474	0.1733	-1.0684
GDP per Capita 2017	26,692	16,572	22,030	1.3949	3.0440
GDP Growth 2017	3.6071	1.6744	3.1000	1.0202	0.7255
Quality of Governance 2017	1.0192	0.4700	1.0389	-0.1106	-0.9483

Table 7-Descriptive statistics over time horizon

Looking at this table, we can evaluate the trend over the years for the most important variables. In particular, Entrepreneurial Index has been increasing since 2009, as you can better understand from the following graph. This is the

proof that the entrepreneurial activity has been getting more and more attention by a lot of new entrepreneurs.

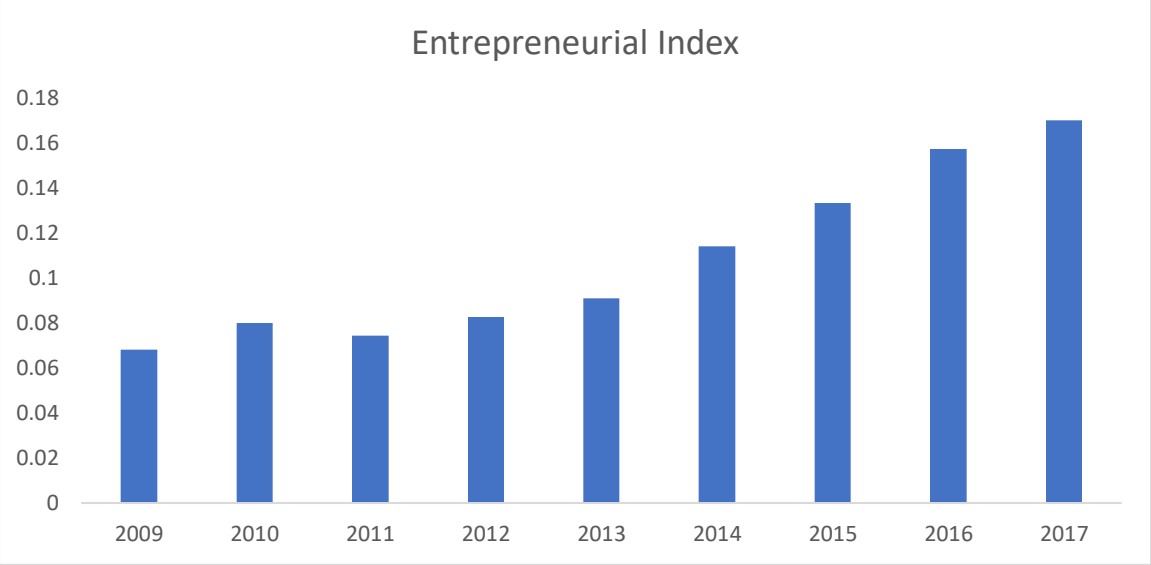

Figure 8- Entrepreneurial Index trend

Also, the level of digitalization has increased in the last years. In this case, the increase is even stronger. In fact, the European average has more than tripled its value from 2009 to 2017.

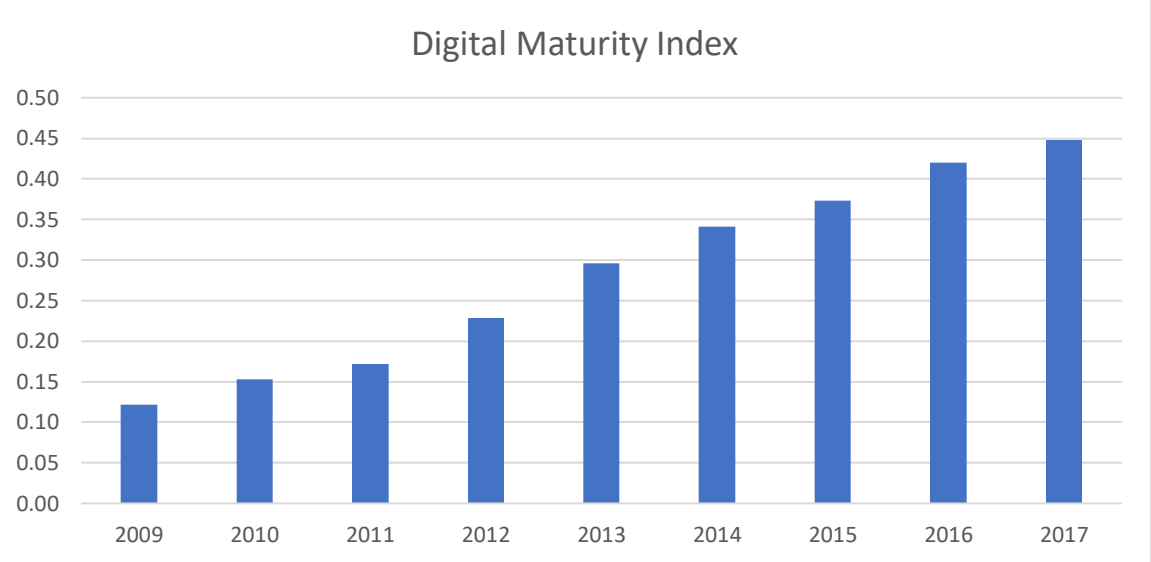

Figure 9- Digital Maturity Index trend

Finally, the correlation matrix can be used to evaluate the correlation among the most relevant variables of the model. The result is presented below:

Variables	1	2	3	4	5	6	7	8	9	10	11	12
1) Entrepreneurial Index	1											
2) Entrepreneurial Quantity	0.75***	1										
3) Entrepreneurial Quality	0.56***	-0.06	1									
4) Entrepreneurial Outcome	0.47***	-0.09	0.49***	1								
5) DMI Achieved Results	0.21*	-0.26*	0.51***	0.48***	1							
6) DMI_Infrastructure	0.23*	-0.18	0.47***	0.42***	0.92***	1						
7) DMI_Firms	0.16	-0.23*	0.42***	0.40***	0.91***	0.78***	1					
8) DMI_Citizens	0.18	-0.31**	0.52***	0.50***	0.98***	0.89***	0.84***	1				
9) DMI_PAs	0.20*	-0.24*	0.50***	0.46***	0.96***	0.86***	0.87***	0.94***	1			
10) GDP per Capita	-0.40***	-0.71***	0.23*	0.13	0.43***	0.31**	0.39***	0.48***	0.38***	1		
11) GDP Growth	0.30**	0.08	0.29**	0.26*	0.43***	0.47***	0.42***	0.40***	0.35**	0.10	1	
12) Quality of Governance	-0.23*	-0.53***	0.23*	0.16	0.36**	0.23*	0.38***	0.38***	0.35**	0.56***	0.04	1

*Structural estimates: *p<0.05; **p<0.01; ***p<0.001*

Table 8- Correlation matrix

The correlation matrix shows that the components of the Entrepreneurial Index are well positively correlated with the overall index. This bond is even stronger if we look at the Digital Maturity Index. In this case the correlation coefficients are almost 1, that is the perfect correlation. Entrepreneurial Quantity is not correlated at all with the other two components of the Entrepreneurial Index. This means that they capture different aspects of the entrepreneurial activity.

3.4.2 Multilevel Mediation Model

In this section the results obtained through the use of the statistical software Stata will be presented. The objective is to quantitatively and statistically demonstrate the hypothesis, taking advantage of the longitudinal dataset. Variables used for the model vary on the basis of the hypothesis that has to be tested. The models present the same dependent variable, which is GDP per capita, the same mediator variable, which is Digital Maturity Index and the same control variables, Quality of Governance. What changes is the independent variable which can be, in order, Entrepreneurial Index or its components, namely Entrepreneurial Quantity, Entrepreneurial Quality and Entrepreneurial Outcome. Thus, every hypothesis introduced in chapter 2 has its own set of results. Given the fact that, according to literature, entrepreneurship and digitalization have an impact on economic growth only after 2/3 years (Carree and Thurik, 2010), a two-year time-lag has been considered. So, entrepreneurship and digitalization in year *n*, as well as the Quality of Governance, are supposed to affect economic growth in year *n+2*.
Moreover, some robustness checks will be performed to corroborate the thesis of this research. In one case GDP per capita, the dependent variable, will be substituted with GDP growth. In another case the level of digitalization will be measured through a component of the Digital Maturity Index. In the last case the time-lag among the variable will be changed. Following the steps of the methodology previously presented, the first statistical result to be analyzed is the one that comes from the statistical analysis of the paths of the multilevel mediation model.
The letter "Z" next to the names of the variables means that they have been standardized. The "L2" or "L1" refers to the time lag and it means that the variables are referred to two years or one year before the normal variables. In the case of the model to be tested, entrepreneurship, digitalization and the control

variable are marked by L2, meaning that they refer to two years before the dependent variable.
The results of this function can be divided in three equations, each of them related to a specific path. The number of observations is 196 given by the product of 28 countries and 7 years. Two years are not considered due to the time-lag.

Entrepreneurial Activity

The first result regards the relationship among the level of entrepreneurial activity, the level of digitalization and economic growth.
The following function has been used in Stata.

ml_mediation, dv (gdppercapita_Z) mv (dmi_achieved_results_Z_L2) iv (entrepreneurship_Z_L2) l2id (country) cv (qog_Z_L2)

The following table shows the output related to each equation.

gdppercapita_Z (c_path)	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
entrepreneurship_Z_L2	0.0848	0.0175	4.85	0.000	0.0505	0.1190
qog_Z_L2	0.0474	0.0146	3.24	0.001	0.0188	0.0760
_cons	0.0302	0.1956	0.15	0.877	-0.3532	0.4135
dmi_achieved_results_Z_L2 (a_path)	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
entrepreneurship_Z_L2	0.6181	0.0931	6.64	0.000	0.4356	0.0801
qog_Z_L2	0.2483	0.0790	3.14	0.002	0.0935	0.4031
_cons	-0.2076	0.1241	-1.67	0.094	-0.4509	0.0357
gdppercapita_Z (b_path & c')	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
dmi_achieved_results_Z_L2	0.0797	0.0110	7.27	0.000	0.0582	0.1012
entrepreneurship_Z_L2	0.0084	0.0187	0.45	0.654	-0.0282	0.0450
qog_Z_L2	0.0391	0.0129	3.03	0.002	0.0138	0.0644
_cons	0.0417	0.1849	0.23	0.821	-0.3207	0.4041

Table 9-Results about entrepreneurial activity

The main highlights offered by this chart are concerned with the values of the coefficients and the levels of p-value.

The first path, which is the one evaluating c_path, refers to the total effect. In this case the level of entrepreneurial activity, measured through the Entrepreneurial Index, has a positive and significant effect on economic growth, measured by GDP per capita, because the coefficient is greater than zero, even if it is not high in absolute value. Moreover, the p-value is 0.000, which is lower than 0.05, threshold chosen to accept or refuse the hypothesis. Also, regarding the control variable, Quality of Governance has a positive and significant impact on economic growth because the p-value is 0.001.

The second path, which is the one evaluating a_path, refers to one element of the indirect effect. In this case the level of entrepreneurial activity, measured through Entrepreneurial Index, has a positive and significant impact on the level of digitalization, measured through Digital Maturity Index, because the coefficient is greater than zero. Moreover, the p-value is 0.000, which is lower than 0.05. Also, regarding the control variable, Quality of Governance has a positive and significant impact on the level of digitalization because the p-value is 0.002.

The third equation, which evaluates b_path and c', refers to both indirect and direct effect. In this case the level of digitalization, measured through Digital Maturity Index, has a positive and significant impact on economic growth, measured by GDP per capita, because the coefficient is greater than zero. Moreover, the p-value is 0.000, which is lower than 0.05. Then, the level of entrepreneurial activity has not a significant impact on economic growth if we consider only the direct effect because the p-value is 0.654, much greater than 0.05. Also, regarding the control variable, Quality of Governance has a positive and significant impact on economic growth because the p-value is 0.002.

Furthermore, the proportion of total effect mediated, which is the ratio between the indirect effect (ab) and the total effect (c) is equal to 85.47%.

The second step of the statistical analysis consists in performing the bootstrapping, which is defined, in this case, by the following formula:

bootstrap indeff=r (ind_eff) direff=r (dir_eff) toteff=r (tot_eff),reps (5000) seed (512) cluster (country) idcluster (NEW_Country) ml_mediation, dv (gdppercapita_Z) iv (entrepreneurship_Z_L2) mv (dmi_achieved_results_Z_L2) l2id (NEW_country)
(running ml_mediation on estimation sample)

The following table shows the output related to this function.

	Observed Coef.	Bootstrap Std. Err.	z	P>|z|	Normal-based [95% Conf. Interval]	
indeff	0.0589	0.0212	2.78	0.006	0.0173	0.1005
direff	0.0093	0.0116	0.80	0.422	-0.0134	0.0321
toteff	0.0683	0.0175	3.89	0.000	0.0339	0.1026

Table 10-Bootstrapping results for entrepreneurial activity

From this table it can be deduced that, in the relationship among the level of entrepreneurship, the level of digitalization and economic growth, the indirect effect is significant, given that the p-value is equal to 0.006. The same applies to the total effect because the p-value is 0.000. On the contrary, the direct effect is not significant.

Entrepreneurial Quantity

The second result regards the relationship among the level of entrepreneurial activity, the level of digitalization and economic growth.
The following function has been used in Stata.

ml_mediation, dv (gdppercapita_Z) mv (dmi_achieved_results_Z_L2) iv (entrquantity_Z_L2) l2id (country) cv (qog_Z_L2)

The following table shows the output related to each equation.

gdppercapita_Z (c_path)	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
entrquantity_Z_L2	0.0323	0.0283	1.14	0.255	-0.0233	0.0878
qog_Z_L2	0.0633	0.0157	4.05	0.000	0.0327	0.0940
_cons	0.0182	0.1903	0.10	0.924	-0.3548	0.3912
dmi_achieved_results_Z_L2 (a_path)	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
entrquantity_Z_L2	-0.1212	0.0737	-1.64	0.100	-0.2656	0.0234
qog_Z_L2	0.1969	0.0720	2.74	0.006	0.0558	0.3380
_cons	-0.2913	0.0644	-4.52	0.000	-0.4176	-0.1651
gdppercapita_Z (b_path & c')	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
dmi_achieved_results_Z_L2	0.0812	0.0090	8.99	0.000	0.0635	0.0989
entrquantity_Z_L2	0.0041	0.0235	0.18	0.861	-0.0419	0.0501
qog_Z_L2	0.0441	0.0129	3.41	0.001	0.0187	0.0695
_cons	0.0385	0.1838	0.21	0.834	-0.3218	0.3988

Table 11-Results about entrepreneurial quantity

The main highlights offered by this chart are concerned with the values of the coefficients and the levels of p-value.

The first path, which is the one evaluating c_path, refers to the total effect. In this case the level of entrepreneurial quantity, measured through the first component of the Entrepreneurial Index, has a not significant effect on economic growth, measured by GDP per capita, because the p-value is 0.255, which is higher than 0.05, threshold chosen to accept or refuse the hypothesis. Also, regarding the control variable, Quality of Governance has a positive and significant impact on economic growth because the p-value is 0.000.

The second path, which is the one evaluating a_path, refers to one element of the indirect effect. In this case the level of entrepreneurial quantity, measured through the first component of the Entrepreneurial Index, has a not significant impact on the level of digitalization, measured through Digital Maturity Index,

because the p-value is 0.100, higher than 0.05. Also, regarding the control variable, Quality of Governance has a positive and significant impact on the level of digitalization because the p-value is 0.006.
The third equation, which evaluates b_path and c', refers to both indirect and direct effect. In this case the level of digitalization, measured through Digital Maturity Index, has a positive and significant impact on economic growth, measured by GDP per capita, because the coefficient is greater than zero. Moreover, the p-value is 0.000, which is lower than 0.05. Then, the level of entrepreneurial quantity has not a significant impact on economic growth if we consider only the direct effect because the p-value is is 0.861, much greater than 0.05. Also, regarding the control variable, Quality of Governance has a positive and significant impact on economic growth because the p-value is 0.001.

Given the non-significance of a_path and c_path, there is no need to run the bootstrapping analysis.

Entrepreneurial Quality

The third result regards the relationship among the level of entrepreneurial activity, the level of digitalization and economic growth.
The following function has been used in Stata.

ml_mediation, dv (gdppercapita_Z) mv (dmi_achieved_results_Z_L2) iv (entrquality_Z_L2) l2id (country) cv (qog_Z_L2)

The following table shows the output related to each equation.

gdppercapita_Z (c_path)	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
entrquality_Z_L2	0.0434	0.0131	3.31	0.001	0.0177	0.0691

qog_Z_L2	0.0471	0.0153	3.08	0.002	0.0171	0.0770
_cons	0.0238	0.1872	0.13	0.899	-0.3431	0.3908
dmi_achieved_results_Z_L2 (a_path)	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
entrquality_Z_L2	0.4916	0.0752	6.54	0.000	0.3441	0.6390
qog_Z_L2	0.1862	0.0610	3.05	0.002	0.0667	0.3058
_cons	-0.2177	0.0662	-3.29	0.001	-0.3475	-0.0879
gdppercapita_Z (b_path & c')	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
dmi_achieved_results_Z_L2	0.0837	0.0101	8.25	0.000	0.0638	0.1035
entrquality_Z_L2	-0.0031	0.0124	-0.25	0.802	-0.0275	0.0212
qog_Z_L2	0.0349	0.0130	3.05	0.002	0.0141	0.0649
_cons	0.04083	0.1840	0.22	0.824	-0.3198	0.4014

Table 12-Results about entrepreneurial quality

The main highlights offered by this chart are concerned with the values of the coefficients and the levels of p-value.

The first path, which is the one evaluating c_path, refers to the total effect. In this case the level of entrepreneurial quality, measured through the second component of the Entrepreneurial Index, has a positive and significant effect on economic growth, measured by GDP per capita, because the coefficient is greater than zero, even if it is not high in absolute value. Moreover, the p-value is 0.001, which is lower than 0.05, threshold chosen to accept or refuse the hypothesis. Also, regarding the control variable, Quality of Governance has a positive and significant impact on economic growth because the p-value is 0.002.

The second path, which is the one evaluating a_path, refers to one element of the indirect effect. In this case the level of entrepreneurial quality, measured through the second component of the Entrepreneurial Index, has a positive and significant impact on the level of digitalization, measured through Digital Maturity Index, because the coefficient is greater than zero. Moreover, the p-value is 0.000, which is lower than 0.05. Also, regarding the control variable, Quality of Governance has a positive and significant impact on the level of digitalization because the p-value is 0.002.

The third equation, which evaluates b_path and c', refers to both indirect and direct effect. In this case the level of digitalization, measured through Digital Maturity Index, has a positive and significant impact on economic growth, measured by GDP per capita, because the coefficient is greater than zero. Moreover, the p-value is 0.000, which is lower than 0.05. Then, the level of entrepreneurial quality has not a significant impact on economic growth if we consider only the direct effect because the p-value is 0.802, much greater than 0.05. Also, regarding the control variable, Quality of Governance has a positive and significant impact on economic growth because the p-value is 0.002.

The second step of the statistical analysis consists in performing the bootstrapping, which is defined, in this case, by the following formula:

bootstrap indeff=r (ind_eff) direff=r (dir_eff) toteff=r (tot_eff),reps (5000) seed (512) cluster (country) idcluster (NEW_Country) ml_mediation, dv (gdppercapita_Z) iv (entrquality_Z_L2) mv (dmi_achieved_results_Z_L2) l2id (NEW_country)
(running ml_mediation on estimation sample)

The following table shows the output related to this function.

	Observed Coef.	Bootstrap Std. Err.	z	P>|z|	Normal-based [95% Conf. Interval]	
indeff	0.0461	0.0111	4.15	0.000	0.0243	0.0679
direff	0.0000	0.0084	0.00	0.997	-0.0164	0.0165
toteff	0.0462	0.0134	3.45	0.001	0.0200	0.0724

Table 13- Bootstrapping results for entrepreneurial quality

From this table it can be deduced that, in the relationship among the level of entrepreneurial quality, the level of digitalization and economic growth, the

indirect effect is significant, given that the p-value is equal to 0.000. The same applies to the total effect because the p-value is 0.001. On the contrary, the direct effect is not significant.

Entrepreneurial Outcome

The first result regards the relationship among the level of entrepreneurial activity, the level of digitalization and economic growth.
The following function has been used in Stata.

ml_mediation, dv (gdppercapita_Z) mv (dmi_achieved_results_Z_L2) iv (entroutcome_Z_L2) l2id (country) cv (qog_Z_L2)

The following table shows the output related to each equation.

gdppercapita_Z (c_path)	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
entroutcome_Z_L2	0.0831	0.0168	4.95	0.000	0.0502	0.1160
qog_Z_L2	0.0474	0.0147	3.22	0.001	0.0185	0.0760
_cons	0.0312	0.1868	0.17	0.867	-0.3350	0.3974
dmi_achieved_results_Z_L2 (a_path)	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
entroutcome_Z_L2	0.8301	0.0984	8.44	0.000	0.6373	1.0230
qog_Z_L2	0.1872	0.0560	3.34	0.001	0.0773	0.2970
_cons	-0.1556	0.0615	-2.53	0.011	-0.2763	-0.0350
gdppercapita_Z (b_path & c')	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
dmi_achieved_results_Z_L2	0.0771	0.0106	7.25	0.000	0.0563	0.0980
entroutcome_Z_L2	0.0165	0.0173	0.95	0.342	-0.0175	0.0504
qog_Z_L2	0.0389	0.0129	3.02	0.003	0.0136	0.0641
_cons	0.0426	0.1840	0.23	0.817	-0.3181	0.4033

Table 14-Results about entrepreneurial outcome

The main highlights offered by this chart are concerned with the values of the coefficients and the levels of p-value.

The first path, which is the one evaluating c_path, refers to the total effect. In this case the level of entrepreneurial outcome, measured through the third component of the Entrepreneurial Index, has a positive and significant effect on economic growth, measured by GDP per capita, because the coefficient is greater than zero, even if it is not high in absolute value. Moreover, the p-value is 0.000, which is lower than 0.05, threshold chosen to accept or refuse the hypothesis. Also, regarding the control variable, Quality of Governance has a positive and significant impact on economic growth because the p-value is 0.001.

The second path, which is the one evaluating a_path, refers to one element of the indirect effect. In this case the level of entrepreneurial outcome, measured through the third component of the Entrepreneurial Index, has a positive and significant impact on the level of digitalization, measured through Digital Maturity Index, because the coefficient is greater than zero. Moreover, the p-value is 0.001, which is lower than 0.05. Also, regarding the control variable, Quality of Governance has a positive and significant impact on the level of digitalization because the p-value is 0.001.

The third equation, which evaluates b_path and c', refers to both indirect and direct effect. In this case the level of digitalization, measured through Digital Maturity Index, has a positive and significant impact on economic growth, measured by GDP per capita, because the coefficient is greater than zero. Moreover, the p-value is 0.000, which is lower than 0.05. Then, the level of entrepreneurial outcome has not a significant impact on economic growth if we consider only the direct effect because the p-value is 0.342, much greater than 0.05. Also, regarding the control variable, Quality of Governance has a positive and significant impact on economic growth because the p-value is 0.003.

Furthermore, the proportion of total effect mediated, which is the ratio between the indirect effect (ab) and the total effect (c) is equal to 79.55%.

The second step of the statistical analysis consists in performing the bootstrapping, which is defined, in this case, by the following formula:

bootstrap indeff=r (ind_eff) direff=r (dir_eff) toteff=r (tot_eff),reps (5000) seed (512) cluster (country) idcluster (NEW_Country) ml_mediation, dv (gdppercapita_Z) iv (entroutcome_Z_L2) mv (dmi_achieved_results_Z_L2) l2id (NEW_country)
(running ml_mediation on estimation sample)

The following table shows the output related to this function.

	Observed Coef.	Bootstrap Std. Err.	z	P>|z|	Normal-based [95% Conf. Interval]	
indeff	0.0701	0.0319	2.20	0.028	0.0075	0.1327
direff	0.0178	0.0116	1.54	0.123	-0.0048	0.0405
toteff	0.0879	0.0355	2.48	0.013	0.0183	0.1575

Table 15-Bootstrapping results for entrepreneurial outcome

From this table it can be deduced that, in the relationship among the level of entrepreneurship, the level of digitalization and economic growth, the indirect effect is significant, given that the p-value is equal to 0.028. The same applies to the total effect because the p-value is 0.013. On the contrary, the direct effect is not significant.

3.4.3 Sensitivity Analysis

In this last section dedicated to the results of the research, a sensitivity analysis aims at testing the robustness of the model in order to understand what happens to the outputs of the model. For this reason, different variables and different time lags in respect to the main model will be used. In particular, three new cases will

be analyzed. The first one consists in substituting GDP per capita as a measure of economic growth with GDP growth. The second one comprehends a component of the Digital Maturity Index in order to measure the level of digitalization, rather than the Digital Maturity index itself. Finally, it is also interesting to evaluate the case in which the model presents a different time-lag among the variables.

Robustness Check 1

The first robustness check consists in measuring economic growth with another very used method, that is GDP growth. The latter is often exploited in literature as we have already analyzed, and it can be considered an even stronger measure of economic growth.

To test this specific check the following function has been used in Stata.

ml_mediation, dv (gdpgrowth_Z) mv (dmi_achieved_results_Z_L2) iv (entrepreneurship_Z_L2) l2id (country) cv (qog_Z_L2)

The following table shows the output related to each equation.

gdpgrowth_Z (c_path)	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
entrepreneurship_Z_L2	0.1993	0.0839	2.37	0.018	0.0348	0.3638
qog_Z_L2	-0.0581	0.0719	-0.81	0.419	-0.1990	0.0828
_cons	0.2646	0.0853	3.10	0.002	0.0975	0.4317
dmi_achieved_results_Z_L2 (a_path)	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
entrepreneurship_Z_L2	0.6181	0.0931	6.64	0.000	0.4356	0.8007
qog_Z_L2	0.2483	0.0790	3.14	0.002	0.0935	0.4031
_cons	-0.2076	0.1241	-1.67	0.094	-0.4509	0.0357
gdpgrowth_Z (b_path & c')	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
dmi_achieved_results_Z_L2	0.3745	0.0677	5.55	0.000	0.2422	0.5069
entrepreneurship_Z_L2	0.0182	0.0878	0.21	0.836	-0.1538	0.1902
qog_Z_L2	-0.1824	0.0726	-2.51	0.012	-0.3246	-0.0401
_cons	0.3518	0.0910	3.86	0.000	0.1734	0.5302

Table 16- Results about robustness check 1

The main highlights offered by this chart are concerned with the values of the coefficients and the levels of p-value.

The first path, which is the one evaluating c_path, refers to the total effect. In this case the level of entrepreneurial quality, measured through the Entrepreneurial Index, has a positive and significant effect on economic growth, measured by GDP growth, because the coefficient is greater than zero. Moreover, the p-value is 0.018, which is lower than 0.05, threshold chosen to accept or refuse the hypothesis. Regarding the control variable, however, Quality of Governance has a not significant impact on economic growth because the p-value is 0.419.

Compared to the main model, the coefficient of the impact of the level of entrepreneurial activity on economic growth is higher and the control variable is not significant anymore.

The second path, which is the one evaluating a_path, refers to one element of the indirect effect. In this case the level of entrepreneurial quality, measured through the Entrepreneurial Index, has a positive and significant impact on the level of digitalization, measured through Digital Maturity Index, because the coefficient is greater than zero. Moreover, the p-value is 0.000, which is lower than 0.05. Also, regarding the control variable, Quality of Governance has a positive and significant impact on the level of digitalization because the p-value is 0.002.

In this case there are not any substantial differences with the main model.

The third equation, which evaluates b_path and c', refers to both indirect and direct effect. In this case the level of digitalization, measured through Digital Maturity Index, has a positive and significant impact on economic growth, measured by GDP growth, because the coefficient is greater than zero. Moreover, the p-value is 0.000, which is lower than 0.05. Then, the level of entrepreneurial activity has not a significant impact on economic growth if we consider only the direct effect because the p-value is 0.836, much greater than 0.05. Also, regarding the control variable, Quality of Governance has a positive and significant impact on economic growth because the p-value is 0.012.

Also in this case there are not any substantial differences with the main model. Furthermore, the proportion of total effect mediated, which is the ratio between the indirect effect (ab) and the total effect (c) is equal to 92.71%, higher than the base case.

The second step of the statistical analysis consists in performing the bootstrapping, which is defined, in this case, by the following formula:

bootstrap indeff=r (ind_eff) direff=r (dir_eff) toteff=r (tot_eff),reps (5000) seed (512) cluster (country) idcluster (NEW_Country) ml_mediation, dv (gdpgrowth_Z) iv (entrepreneurship_Z_L2) mv (dmi_achieved_results_Z_L2) l2id (NEW_country)
(running ml_mediation on estimation sample)

The following table shows the output related to this function.

	Observed Coef.	Bootstrap Std. Err.	z	P>|z|	Normal-based [95% Conf. Interval]	
indeff	0.2307	0.0825	2.80	0.005	0.0690	0.3923
direff	0.0860	0.0876	0.98	0.327	-0.0858	0.2578
toteff	0.3166	0.1088	2.91	0.004	0.1033	0.5300

Table 17- Bootstrapping results for robustness check 1

From this table it can be deduced that, in the relationship among the level of entrepreneurship, the level of digitalization and economic growth, the indirect effect is significant, given that the p-value is equal to 0.005. The same applies to the total effect because the p-value is 0.004. On the contrary, the direct effect is not significant. Therefore, the results are in perfect accord with the ones of the main model.

Robustness Check 2

The second robustness check consists in measuring the level of digitalization with a component of the Digital Maturity Index. The item that best fits in this case is the one about the degree of digitalization achieved by the firms in the European countries.
To test this specific check the following function has been used in Stata.

ml_mediation, dv (gdppercapita_Z) mv (firms_Z_L2) iv (entrepreneurship_Z_L2) l2id (country) cv (qog_Z_L2)

The following table shows the output related to each equation.

gdppercapita_Z (c_path)	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
entrepreneurship_Z_L2	0.0848	0.0175	4.85	0.000	0.0505	0.1190
qog_Z_L2	0.0474	0.0146	3.24	0.001	0.0188	0.0760
_cons	0.0302	0.1956	0.15	0.877	-0.3532	0.4135
firms_Z_L2 (a_path)	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
entrepreneurship_Z_L2	0.4922	0.0970	5.08	0.000	0.3021	0.6823
qog_Z_L2	0.3070	0.0824	3.73	0.000	0.1455	0.4685
_cons	-0.1681	0.1221	-1.38	0.169	-0.4075	0.0713
gdppercapita_Z (b_path & c')	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
firms_Z_L2	0.0730	0.0101	7.20	0.000	0.0531	0.0929
entrepreneurship_Z_L2	0.0267	0.0174	1.53	0.125	-0.0074	0.0608
qog_Z_L2	0.0330	0.0130	2.54	0.011	0.0075	0.0585
_cons	0.0384	0.1875	0.20	0.838	-0.3292	0.4059

Table 18- Results about robustness check 2

The main highlights offered by this chart are concerned with the values of the coefficients and the levels of p-value.
The first path, which is the one evaluating c_path, refers to the total effect. In this case the level of entrepreneurial activity, measured through the Entrepreneurial Index, has a positive and significant effect on economic growth, measured by GDP

per capita, because the coefficient is greater than zero. Moreover, the p-value is 0.000, which is lower than 0.05, threshold chosen to accept or refuse the hypothesis. Regarding the control variable, however, Quality of Governance has a positive and significant impact on economic growth because the p-value is 0.001. Compared to the main model, there are not any substantial differences.

The second path, which is the one evaluating a_path, refers to one element of the indirect effect. In this case the level of entrepreneurial activity, measured through the Entrepreneurial Index, has a positive and significant impact on the level of digitalization, measured through the degree of digitalization of the firms, because the coefficient is greater than zero. Moreover, the p-value is 0.000, which is lower than 0.05. Also, regarding the control variable, Quality of Governance has a positive and significant impact on the level of digitalization because the p-value is 0.000.

In this case there are not any substantial differences with the main model.

The third equation, which evaluates b_path and c', refers to both indirect and direct effect. In this case the level of digitalization, measured the degree of digitalization of the firms, has a positive and significant impact on economic growth, measured by GDP per capita, because the coefficient is greater than zero. Moreover, the p-value is 0.000, which is lower than 0.05. Then, the level of entrepreneurial activity has not a significant impact 0n economic growth if we consider only the direct effect because the p-value is 0.125, greater than 0.05. Also, regarding the control variable, Quality of Governance has a positive and significant impact on economic growth because the p-value is 0.011.

Also in this case there are not any substantial differences with the main model.

Furthermore, the proportion of total effect mediated, which is the ratio between the indirect effect (ab) and the total effect (c) is equal to 57.39%, lower than the base case.

The second step of the statistical analysis consists in performing the bootstrapping, which is defined, in this case, by the following formula:

bootstrap indeff=r (ind_eff) direff=r (dir_eff) toteff=r (tot_eff),reps (1000) seed (512) cluster (country) idcluster (NEW_Country) ml_mediation, dv (gdppercapita_Z) iv (entrepreneurship_Z_L2) mv (firms_Z_L2) l2id (NEW_country)
(running ml_mediation on estimation sample)

The following table shows the output related to this function.

	Observed Coef.	Bootstrap Std. Err.	z	P>|z|	Normal-based [95% Conf. Interval]	
indeff	0.0419	0.0215	1.95	0.052	-0.0003	0.0840
direff	0.0267	0.0152	1.76	0.079	-0.0030	0.0564
toteff	0.0686	0.016	4.30	0.000	0.0373	0.0998

Table 19- Bootstrapping results for robustness check 2

From this table it can be deduced that, in the relationship among the level of entrepreneurship, the level of digitalization and economic growth, the indirect effect can be considered significant, given that the p-value is equal to 0.052. However, it is relevant to remark that the level of significance is borderline and consequently it is not so strong as in the base case.
The same applies to the total effect because the p-value is 0.000. On the contrary, the direct effect is not significant. Therefore, the results are quite in accord with the ones of the main model.

Robustness Check 3

The third robustness check consists in changing the time lag among the variables. The new temporal combination consists in measuring the entrepreneurial activity,

through the Entrepreneurial Index, and the Quality of Governance in a given year n and the other variables (Digital Maturity Index and GDP per capita) in the following year n+1.
To test this specific check the following function has been used in Stata.

ml_mediation, dv (gdppercapita_Z) mv (dmi_achieved_results_Z) iv (entrepreneurship_Z_L1) l2id (country) cv (qog_Z_L1)

The following table shows the output related to each equation.

gdppercapita_Z (c_path)	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
entrepreneurship_Z_L1	0.0928	0.0125	7.42	0.000	0.0683	0.1174
qog_Z_L1	0.0497	0.0119	4.17	0.000	0.0263	0.0731
_cons	0.0162	0.1949	0.08	0.934	-0.3659	0.3982
dmi_achieved_results_Z (a_path)	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
entrepreneurship_Z_L1	0.8296	0.0840	9.87	0.000	0.6648	0.9943
qog_Z_L1	0.1806	0.0793	2.28	0.023	0.0251	0.3360
_cons	0.2183	0.1680	1.30	0.194	-0.1109	0.5475
gdppercapita_Z (b_path & c')	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
dmi_achieved_results_Z	0.0465	0.0095	4.90	0.000	0.0279	0.0651
entrepreneurship_Z_L1	0.0461	0.0153	3.02	0.003	0.0162	0.0760
qog_Z_L1	0.0470	0.0113	4.15	0.000	0.0248	0.0693
_cons	0.0053	0.1877	0.03	0.978	-0.3626	0.3732

Table 20- Results about robustness check 3

The main highlights offered by this chart are concerned with the values of the coefficients and the levels of p-value.
The first path, which is the one evaluating c_path, refers to the total effect. In this case the level of entrepreneurial activity, measured through the Entrepreneurial Index, has a positive and significant effect on economic growth, measured by GDP per capita, because the coefficient is greater than zero. Moreover, the p-value is 0.000, which is lower than 0.05, threshold chosen to accept or refuse the hypothesis. Regarding the control variable, however, Quality of Governance has a positive and significant impact on economic growth because the p-value is 0.000.

Compared to the main model, there are not any substantial differences.
The second path, which is the one evaluating a_path, refers to one element of the indirect effect. In this case the level of entrepreneurial activity, measured through the Entrepreneurial Index, has a positive and significant impact on the level of digitalization, measured through the Digital Maturity Index of the following year, because the coefficient is greater than zero. Moreover, the p-value is 0.000, which is lower than 0.05. Also, regarding the control variable, Quality of Governance has a positive and significant impact on the level of digitalization because the p-value is 0.023.
In this case there are not any substantial differences with the main model.
The third equation, which evaluates b_path and c', refers to both indirect and direct effect. In this case the level of digitalization, measured through the Digital Maturity Index, has a positive and significant impact on economic growth, measured by GDP per capita, because the coefficient is greater than zero. Moreover, the p-value is 0.000, which is lower than 0.05. Then, the level of entrepreneurial activity has also a significant impact on economic growth if we consider only the direct effect because the p-value is 0.003, lower than 0.05. Also, regarding the control variable, Quality of Governance has a positive and significant impact on economic growth because the p-value is 0.000.
In this case there are is a difference with the main model if we look at the impact of entrepreneurship on economic growth.
Furthermore, the proportion of total effect mediated, which is the ratio between the indirect effect (ab) and the total effect (c) is equal to 45.58%, lower than the base case.

The second step of the statistical analysis consists in performing the bootstrapping, which is defined, in this case, by the following formula:

bootstrap indeff=r (ind_eff) direff=r (dir_eff) toteff=r (tot_eff),reps (5000) seed (512) cluster (country) idcluster (NEW_Country) ml_mediation, dv (gdppercapita_Z) iv (entrepreneurship_Z_L1) mv (dmi_achieved_results_Z) l2id (NEW_country)
(running ml_mediation on estimation sample)

The following table shows the output related to this function.

	Observed Coef.	Bootstrap Std. Err.	z	P>|z|	Normal-based [95% Conf. Interval]	
indeff	0.0422	0.0215	3.36	0.001	0.0176	0.0668
direff	0.0489	0.0149	3.28	0.001	0.0197	0.0781
toteff	0.0911	0.0229	3.99	0.000	0.0463	0.1360

Table 21-Boostrapping results about robustness check 3

From this table it can be deduced that, in the relationship among the level of entrepreneurship, the level of digitalization and economic growth with a different time lag, the indirect effect is significant, given that the p-value is equal to 0.001. The same applies to the total effect because the p-value is 0.000. Differently from the case base, the direct effect is also strongly significant, given that the p-value is equal to 0.001.

4. DISCUSSION

The results shown in the previous chapter in relation to the assumptions made in this dissertation are now discussed in this section. In particular, it will be discussed how the entrepreneurial activity, measured through the Entrepreneurial Index and its components, affects economic growth and the mediating role assumed by digitalization.

4.1 H1: Entrepreneurial Activity and Economic Growth – Confirmed

The first main hypothesis of this research is the one regarding the level of total entrepreneurial activity measured by the Entrepreneurial Index and economic growth. Entrepreneurship, in fact, is supposed to affect economic growth. In order to confirm or deny this hypothesis we have to look at the results of the multilevel mediation analysis and at the four steps established by Baron and Kenny (1986) and accurately described in Chapter 3.

Given the statistical results and in particular the ones concerning the coefficients and the p-values, the level of entrepreneurial activity is positively related to economic growth. This can be understood looking at the significance of c_path, which indicates the total effect, and at the results of bootstrapping analysis which confirm the statistical significance of total effect.

The confirmation of this hypothesis is consistent with the reference theory. Thus, entrepreneurial activity, measured as a sequence of three different phases referring to the lifecycle of the startup, positively affects economic growth. From a theoretical standpoint, as we have previously analyzed, entrepreneurship is acknowledged to have an impact on economic development. Thus, the results

obtained seem to be consistent with the reference literature. This impact is mainly possible because of the ability of entrepreneurs of introducing innovations, creating change, favoring competition and enhancing rivalry. As far as the empirical standpoint is concerned, a strong debate about the method to measure this phenomenon is still ongoing. There is no unanimous agreement on how to quantify the entrepreneurial phenomenon and this inevitably leads to a divergence of opinion among scholars. Specifically, some studies claim that the whole entrepreneurial phenomenon affects growth (Bjornskov and Foss, 2013; Audretsch et al., 2015; Braunerhjelm et al., 2010), while other authors (Wong, 2005; Valliere and Peterson, 2009; Aparicio et al., 2016; Castaño-Martínez et al., 2015; Sanandaij, 2010) affirm that only a specific typology of entrepreneurship is responsible for economic development, meaning productive or high-growth entrepreneurship. It is important to remark that the Entrepreneurial Index we propose captures the whole entrepreneurial phenomenon as the sequence of three phases a start-up is subjected to. The focus is on the entrepreneurial dynamics rather than on the context factors. Therefore, you can understand the novelty of the approach compared to the other methods. The results obtained suggest that entrepreneurial activity as a whole affects economic growth.

4.1.1 H1a: Entrepreneurial Quantity and Economic Growth – Denied

The first main hypothesis of this research is the one regarding the level of total entrepreneurial activity measured by the Entrepreneurial Index. Entrepreneurship, in fact, is supposed to affect economic growth. In order to confirm or deny this hypothesis we have to look at the results of the multilevel mediation analysis and at the four steps established by Baron and Kenny (1986) and accurately described in Chapter 3.

Given the statistical results and in particular the ones concerning the coefficients and the p-values, entrepreneurial quantity is not related to economic growth. This can be understood looking at the significance of c_path, which indicates the total effect. We defined entrepreneurial quantity as the number of newborn firms divided by GDP. This derives from the popular quantity-based measures of entrepreneurship such as self-employment which is often because of its simplicity. Some authors (Bjornskov and Foss, 2013; Doran et. al, 2016) state that entrepreneurship, measured in this way, positively influences growth. Others (Wong, 2005; Valliere and Peterson, 2009) empirically demonstrated the opposite. Our results indicate that the birth of more firms, which can enable both necessity and opportunity entrepreneurship, does not contribute to growth. New firms' creation as a stand-alone variable does not seem to be a good measure of entrepreneurship.

4.1.2 H1b: Entrepreneurial Quality and Economic Growth – Confirmed

The first main hypothesis of this research is the one regarding the level of total entrepreneurial activity measured by the Entrepreneurial Index. Entrepreneurship, in fact, is supposed to affect economic growth. In order to confirm or deny this hypothesis we have to look at the results of the multilevel mediation analysis and at the four steps established by Baron and Kenny (1986) and accurately described in Chapter 3.

Given the statistical results and in particular the ones concerning the coefficients and the p-values, entrepreneurial quality is positively correlated with the economic growth. This can be understood looking at the significance of c_path, which indicates the total effect, and at the results of bootstrapping analysis.

This a significant result because it confirms and improves several findings of other studies in which it is declared that only opportunity entrepreneurship has a

positive impact on economic growth. This is the Schumpeterian vision of entrepreneurship which is also a key concept in Stam (2015). This author, indeed, strongly states that the cause of economic growth is productive entrepreneurship intended as high-growth entrepreneurship. This kind of measure has also the merit to consider already existing firms in the realm of entrepreneurship.

4.1.3 H1c: Entrepreneurial Outcome and Economic Growth – Confirmed

The first main hypothesis of this research is the one regarding the level of total entrepreneurial activity measured by the Entrepreneurial Index. Entrepreneurship, in fact, is supposed to affect economic growth. In order to confirm or deny this hypothesis we have to look at the results of the multilevel mediation analysis and at the four steps established by Baron and Kenny (1986) and accurately described in Chapter 3.

Given the statistical results and in particular the ones concerning the coefficients and the p-values, entrepreneurial outcome is positively correlated with the economic growth. This can be understood looking at the significance of c_path, which indicates the total effect, and at the results of bootstrapping analysis. Hypothesis 1c, which is supported by the analysis refers to the outcome of the entrepreneurial process in terms of creation of exit by the startup and of unicorns. Thus, it is focused on a small elite of high-growth firms, whose establishment is supposed to impact growth. Acs et al. (2014) underline the necessity to study the outcome of the entrepreneurial process and this attempt tries to solve this gap. In fact, recently, a lot of attention has been paid about this topic to such an extent that the Kauffman Index has been changed to focus on this theme.

4.2 H2: Entrepreneurial Activity and Digitalization – Confirmed

The second hypothesis of this research is the one regarding the level of total entrepreneurial activity measured by the Entrepreneurial Index and the level of digitalization measured by the Digital Maturity Index. In order to confirm or deny this hypothesis we have to look at the results of the multilevel mediation analysis and at the four steps established by Baron and Kenny (1986) and accurately described in Chapter 3.

Given the statistical results and in particular the ones concerning the coefficients and the p-values, the level of entrepreneurial activity is positively related to economic growth. This can be understood looking at the significance of a_path. The confirmation of hypothesis 2 suggests that the level of entrepreneurial activity positively influences the level of digitalization at country level. Therefore, entrepreneurship has a positive effect in enhancing the diffusion and the adoption of digital technologies among citizens, firms and public administration. Morover, it is confirmed the fact that entrepreneurs have a key role in developing and digitizing the actual infrastructures. These concepts apply also to entrepreneurial quality and entrepreneurial outcome but not to entrepreneurial quantity, meaning that productive and high-growth entrepreneurship are the real facilitators of digitalization.

4.3 H3: Digitalization and Economic Growth – Confirmed

The third hypothesis of this research is the one regarding the level of digitalization measured by the Entrepreneurial Index and economic growth. In order to confirm or deny this hypothesis we have to look at the results of the multilevel mediation

analysis and at the four steps established by Baron and Kenny (1986) and accurately described in Chapter 3.

Given the statistical results and in particular the ones concerning the coefficients and the p-values, the level of digitalization is positively related to economic growth. This can be understood looking at the significance of b_path. Hypothesis 3 is confirmed, and this indicates that the level of digitalization positively affects a country's economic growth. Specifically, considering the components of the Digital Maturity Index, a country which is committed to enhance the level of digitalization of its infrastructures, its citizens, its public administration, and its firms can achieve a higher level of economic growth. ICT infrastructure is a necessary condition for the impact of digitalization on economic development. Then, citizens, by using Internet for banking services, for buying and selling things and for booking travels and accommodation might increase competition, reduce costs and the time needed to purchasing products and services, and by these channels, also stimulate economic growth. Public administration and firms can exploit new communication opportunities and all the characteristics of digital technologies to become more competitive and thus to increase their productivity and growth. The increasing amount of information favors the conception of new business models and the collaboration among firms.

4.4 H4: Entrepreneurship, Digitalization and Economic Growth – Confirmed

The last main hypothesis of this research is the one regarding the mediating effect of digitalization in the relation between entrepreneurial activity and economic growth. In order to confirm or deny this hypothesis we have to look at the results of the multilevel mediation analysis and at the four steps established by Baron and Kenny (1986) and accurately described in Chapter 3.

Given the statistical results and in particular the ones concerning the coefficients and the p-values, the level of entrepreneurial activity is positively correlated with the economic growth. Then, the level of entrepreneurial activity is correlated with the level of digitalization and according to the statistical evidence, the latter affects, in turn, economic growth. Lastly, c'_path is not significant and so, the effect of the entrepreneurial activity on economic growth controlling for the level of digitalization is zero. All these considerations lead to the conclusion that the level of digitalization completely mediates the relationship between the level of entrepreneurship and economic growth. This statement is confirmed by the fact that the amount of mediation, measured through the proportion of total effect mediated, is 85.47%. A rule of thumb to claim a full mediation says that this figure should be greater than 80% (Baron and Kenny, 1986).

The statistical test of the various types of effects, performed through bootstrapping, highlights that in the relationship analyzed there is an indirect effect and a total effect. At the same time, however, there is no direct effect. This is the last and strong proof that the relationship under consideration is a full mediation. In practical terms this predicts that the effect of entrepreneurship on economic growth is significant only if the mediator is absent. When the mediator is present and taken into consideration, this direct effect becomes insignificant. In other words, digitalization completely mediates the relationship between entrepreneurship and economic growth. Thus, when you take it into account, it has a fundamental role in this relationship. Consequently, hypothesis 2 is proven right. This confirmation has some very important implications if we consider the current state of knowledge in the field of entrepreneurship.

First of all, it empirically confirms that the trend of digital transformation has been influencing entrepreneurship for several years. This has been possible thanks to the advent of powerful and pervasive digital technologies (Nambisan et al., 2019) which can manifest in the form of digital artifacts, platforms and infrastructure (Nambisan, 2016). Entrepreneurship, in fact, is becoming more

and more digital, demonstrating that the phrase “digital entrepreneurship” has not to be considered as a novelty anymore. Suffice it to say that firms are trying to adapt to this revolution both from a strategic and an organizational point of view. At this regard, the phenomenon of digital entrepreneurship gains in importance and relevance because it is supposed to be a stronger enabler of economic growth compared to traditional entrepreneurship. Digitalization can be seen as the transmission mechanism from entrepreneurship to economic growth. In fact, entrepreneurship through the exploitation of digitalization can enhance its impact to economic growth considering the change in firms, public administration and infrastructure. The three peculiar elements of digital transformation, which are openness, affordances and generativity, allow digital entrepreneurship to have a more significant impact on growth. This new phenomenon has specific characteristics, mainly enabled by digital technologies, that cause broad and strong improvements in the firm’s productivity and efficiency, thanks also to the fact that more business opportunities can be exploited in a more efficient and effective way. Then, digital entrepreneurship can boost economic growth through a stronger acceleration of companies’ structural change which is a needed factor to face the current competitive environment. It is acknowledged that a lot of firms, especially the smallest ones, are struggling to keep up the pace of the technology. Digital entrepreneurship, which can happen also in existing firms, is the means through which solve this issue. Linked to this point, there is the theme about the innovation. Digital entrepreneurship is a facilitator of digital innovation which, in turn, leads to economic growth. Furthermore, the results of the statistical analysis empirically confirm the relevance of the concept of digital entrepreneurship ecosystem and its elements (Sussan and Acs, 2017). It is proven that it is an environment in which digital entrepreneurship can emerge and develop and consequently it is the enabler at the basis of economic growth.

4.4.1 H4a: Entrepreneurial Quantity, Digitalization and Economic Growth – Denied

The first sub-hypothesis of this research is the one regarding the mediating effect of digitalization in the relation between entrepreneurial quantity and economic growth. In order to confirm or deny this hypothesis we have to look at the results of the multilevel mediation analysis and at the four steps established by Baron and Kenny (1986) and accurately described in Chapter 3. Given the statistical results and in particular the ones concerning the coefficients and the p-values, the level of entrepreneurial quantity is not correlated with the economic growth, as we have already analyzed. Then, the level of entrepreneurial quantity is not related to the level of digitalization. These two considerations are sufficient to claim that there is not any significant direct effect of entrepreneurial quantity on economic growth. In the same way, there is not any indirect effect and consequently no mediation at all. Therefore, hypothesis 4a has to be denied.

4.4.2 H4b: Entrepreneurial Quality, Digitalization and Economic Growth – Confirmed

The second sub-hypothesis of this research is the one regarding the mediating effect of digitalization in the relation between entrepreneurial quality and economic growth. In order to confirm or deny this hypothesis we have to look at the results of the multilevel mediation analysis and at the four steps established by Baron and Kenny (1986) and accurately described in Chapter 3.
Given the statistical results and in particular the ones concerning the coefficients and the p-values, the level of entrepreneurial quality is positively correlated with the economic growth. Then, the level of entrepreneurial quality is correlated with the level of digitalization and according to the statistical evidence, the latter

affects, in turn, economic growth. Lastly, c'_path is not significant and so, the effect of the entrepreneurial quality on economic growth controlling for the level of digitalization is zero. All these considerations lead to the conclusion that the level of digitalization completely mediates the relationship between the level of entrepreneurial quality and economic growth. The statistical test of the various types of effects, performed through bootstrapping, highlights that in the relationship analyzed there is an indirect effect and a total effect. At the same time, however, there is no direct effect. This is the last and strong proof that the relationship under consideration is a full mediation. In practical terms this predicts that the effect of entrepreneurial quality on economic growth is significant only if the mediator is absent. When the mediator is present and taken into consideration, this direct effect becomes insignificant. In other words, digitalization completely mediates the relationship between entrepreneurial quality and economic growth. Thus, when you take it into account, it has a fundamental role in this relationship. Consequently, hypothesis 2b is proven right. This indicates that high-growth start-ups, which are able to achieve a scale-up phase, are the real enablers of an all-round process of digitalization. The latter involves both the business and the societal areas. The protagonists of this phase are, generally, start-ups which present a high or extreme form of digital entrepreneurship (Hull et al., 2007) in addition to a productive genre of entrepreneurship (Stam, 2015). These features allow this kind of firms to develop excellent dynamic capabilities and outstanding innovation capabilities.

4.4.3 H4c: Entrepreneurial Outcome, Digitalization and Economic Growth – Confirmed

The third sub-hypothesis of this research is the one regarding the mediating effect of digitalization in the relation between entrepreneurial quality and economic growth. In order to confirm or deny this hypothesis we have to look at the results

of the multilevel mediation analysis and at the four steps established by Baron and Kenny (1986) and accurately described in Chapter 3.

Given the statistical results and in particular the ones concerning the coefficients and the p-values, the level of entrepreneurial outcome is positively correlated with the economic growth. Then, the level of entrepreneurial outcome is correlated with the level of digitalization and according to the statistical evidence, the latter affects, in turn, economic growth. Lastly, c'_path is not significant and so, the effect of the entrepreneurial outcome on economic growth controlling for the level of digitalization is zero. All these considerations lead to the conclusion that the level of digitalization completely mediates the relationship between the level of entrepreneurial outcome and economic growth. The statistical test of the various types of effects, performed through bootstrapping, highlights that in the relationship analyzed there is an indirect effect and a total effect. At the same time, however, there is no direct effect. This is the last and strong proof that the relationship under consideration is a full mediation. In practical terms this predicts that the effect of entrepreneurial outcome on economic growth is significant only if the mediator is absent. When the mediator is present and taken into consideration, this direct effect becomes insignificant. In other words, digitalization completely mediates the relationship between entrepreneurial outcome and economic growth. Thus, when you take it into account, it has a fundamental role in this relationship. Consequently, hypothesis 2c is confirmed. This phase is reached only by a small group of firms belonging to the previous phase. Looking at the coefficients, the step of entrepreneurial outcome has a higher impact on digitalization than entrepreneurial quality. This means that the creation of start-ups capable of achieving this stage in a successful way (i.e. exit of unicorn) enhances to a greater extent a digital development of the ecosystem and consequently economic growth.

4.5 Sensitivity Analysis

Some considerations have to be made also about sensitivity performed after the main statistical analysis whose results have been previously discussed and analyzed. The first robustness check is the one in which the dependent variable of the model, that is economic growth, is measured through GDP growth and not through GDP per capita. The usual statistical considerations lead to the conclusion that the level of digitalization completely mediates the relationship between the level of entrepreneurial activity and economic growth also in this case. The statistical test of the various types of effects, performed through bootstrapping, highlights that in the relationship analyzed there is an indirect effect and a total effect. At the same time, however, there is no direct effect. In other words, digitalization completely mediates the relationship between entrepreneurial outcome and economic growth, measured as GDP growth. Consequently, it is easy to understand that the whole model demonstrates its robustness also in the case in which economic growth is measured through GDP growth which is the other broadly used variable to measure this particular phenomenon. Furthermore, considering the coefficients of the regression equation and comparing them with hypothesis 1, entrepreneurship, in this case, is set to have even a higher impact on economic growth through digitalization.

The second robustness check is the one in which the mediator is measured through one component of the Digital Maturity Index, in particular the one about the degree of digitalization achieved by the firms. The statistical result confirms the validity of the model also in this case. However, a slight difference in the result of the bootstrapping analysis has to be highlighted. The statistical significance of the indirect effect is weaker and at the limit of acceptance. This means that considering the overall level of digitalization of a country or of an ecosystem is a better measure to be the mediator of the relationship between entrepreneurship and economic growth. Digitalizing the firms is not completely sufficient but

attention should be put also in the other areas considered by the Digital Maturity Index which are public administration, citizens and infrastructure.

Finally, the third robustness check considers a different time lag of only one year between the variables, if compared to the main model. The statistical result in this case is slightly different because, although the mediation is confirmed, some considerations are not valid anymore. Specifically, c'_path, given these variables, becomes statistically significant. The mediation is not a full mediation like the previous cases, but it is a partial mediation. This is confirmed also by the bootstrapping analysis which highlights the statistical significance of the direct effect in addition to direct and total effect. This peculiar result suggests that if we consider digitalization as a mediator and therefore the established phenomenon of digital entrepreneurship the relationship between entrepreneurship and economic growth can undergo changes. The positive effects of digital entrepreneurship on economic growth seem to necessitate less time than traditional entrepreneurship. In fact, they can be seen after one year as the robustness check witnesses. On the other side, we have seen that traditional entrepreneurship requires at least two/three years to show its effects on economic growth.

5. CONCLUSION

In this section the conclusions of this research will be presented. Specifically, we will evaluate the contribution to the theory and the limitations together with some implications for practice and recommendations for future research. The aim of this research was to assess the role of digitalization in the relationship between entrepreneurship and economic growth. We have used multilevel mediation analysis which is suited for a longitudinal and clustered dataset. Through this technique, performed through a statistical package named Stata, we have empirically demonstrated that digitalization plays a role of mediator in the above-mentioned relationship. In particular, this is a case of complete mediation. Given this statistical evidence, we are able to state that the recent trend of digitalization in the entrepreneurial field is confirmed and we can prove the importance of the so-called digital entrepreneurship which has a significant impact on economic growth. Another contribution regards the new system developed to measure entrepreneurship. The latter has always been a critical issue in the empirical entrepreneurial studies. Several scholars have tried to provide a simplistic measure of the phenomenon, which despite being immediate and easy to elaborate, does not capture the whole picture. Given this criticality, we tried to establish a new method to quantify entrepreneurship. This is done through the Entrepreneurial Index which has the merit and the advantage of having a process view. In fact, all the three steps of the entrepreneurial activity are encompassed in this index: entrepreneurial quantity, entrepreneurial quality and entrepreneurial outcome. Entrepreneurial quantity can be compared to the major part of the measures introduced in the literature so far. In addition, there are the other two measures that are focused on the so-defined productive entrepreneurship (Stam, 2015) and to the high-growth entrepreneurship. In this way another limit of the previous measures can be overcome. These ones are criticized to focus only on

new firms and to not sufficiently care about the existing firms. Since digital entrepreneurship can happen also in existing firms this is a good strength of this indicator. Entrepreneurial quality and entrepreneurial outcome are statistically proven to be the real enablers of economic growth through the mediation of digitalization. This a very important finding because digital entrepreneurship affecting economic development is the one related to the Schumpeterian concept. Thus, only productive digital entrepreneurship, which is the one that has the merit to exploit high growth potential opportunities, is positively correlated with economic growth. Through a more detailed analysis, we have obtained an initial clue according to which digital entrepreneurship could show its effects in less time than traditional entrepreneurship. Finally, it is important that all the actors belonging to the digital entrepreneurial ecosystem are subject to a process of digitalization in order to have a more effective impact on growth.

This study has two potential practical implication. First, policymakers can exploit this new approach to measure entrepreneurial activity, modifying it at their convenience if it is necessary. Second, policymakers and entrepreneurs should be aware that, in order to favor a process of economic development, attention should be focused on high-growth and digital start-ups, according to the results obtained.

Clearly, this dissertation is not exempt for some limitations and some points which could be improved. These weaknesses can offer some ideas to practitioners to develop similar kinds of research. First of all, the level of detail of the Entrepreneurial Index can be certainly improved, for example through the addition of other indicators at the lowest level. This observation is valid mainly for the last phase of entrepreneurship, intended as process, which is entrepreneurial outcome. In fact, we have seen that this component shows the highest number of outliers. Practitioners can also exploit comprehensive and already existing measures like GEDI to evaluate the goodness of the model. The dataset includes exclusively those countries that belong to European Union. A more meticulous analysis can be performed including more countries around the

world and with a larger timeframe. Regarding the methodological approach, the statistical technique that has been adopted for this research has the disadvantage of dating back to almost twenty years ago. Moreover, the hypotheses are tested separately in the sense that entrepreneurial activity, entrepreneurial quantity, entrepreneurial quality and entrepreneurial outcome are not tested in the same regression model. This is due to the fact that quantity, quality and outcome are highly correlated concepts, and, given our small sample size, there is the risk of distorting the standard errors too much (high multicollinearity) if they are put altogether in the same model. For this reason, some more statistical tests can be exploited in order to study this multilevel mediation, for example SEM modelling. The objective would that of obtaining more precise and more accurate results. Then, several sources have been used to obtain the data for this analysis and Crunchbase seems to be the weakest among these, since it is based on a crowdsourcing logic. Different and more prestigious databases could be adopted to evaluate the robustness of the results and related possible changes. Probably, the most significative weakness of this research is the treatment of institutions in the model. Institutional variable, computed as Quality of Governance, has a role of control variable. Given the theoretical importance of this theme future research should have the objective of assign to institutions a more central role in the model which comprehends entrepreneurship, digitalization and growth. Another clue for future research could be related to the different time-lag between digital entrepreneurship and growth compared to traditional entrepreneurship. Lastly, scholars can try to use other measures for digitalization rather than the Digital Maturity Index, like, for example, DESI.

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