



Understanding the Impact of Intangible Capital on Entrepreneurship at the Regional Level

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Abstract

This paper uses new data for the Spanish case on investment in intangible assets broken down by regions and by type of assets to calibrate the importance of intangible capital for entrepreneurship as a main concern but also to understand which region-specific factors drive entrepreneurship. These new data allow to fill a gap in the literature and contribute to the field of technological entrepreneurial intent by linking entrepreneurship to digitalization and intangible assets of the economy. To this end, the paper presents an index obtained by Principal Component Analysis to measure the regional endowment of intangible capital and analyzes whether the determinants of regional entrepreneurship are driven differently in large and small firms. Using different econometric approaches, the paper finds that for small firms, entrepreneurship is directly related to a prosperity-pull context and the expectation of economic gain. For large firms, the rate of entrepreneurship is also explained by the resources available to firms, such as endowment of intangible capital, stage of technological development, and human capital, as well as the demographic composition of each region.

Keywords Intangible capital · Entrepreneurship · Regional environment · Competitiveness

JEL Classification R11 · M13 · E22

Introduction

Entrepreneurship has gained considerable importance for economies in recent years, especially at the regional level providing higher levels of employment, wealth, and prosperity (Feki & Mnif, 2016; Covi, 2016; Audretsch et al., 2018, 2019; Fritsch & Wyrwich, 2019; Neumann, 2021; Sternberg, 2022). Despite these positive benefits, the underlying mechanisms to promote innovative entrepreneurship and implement

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effective business policy instruments are still not well understood (Audretsch et al., 2022). Hence, given the importance of entrepreneurship as a factor of regional growth, it is interesting and relevant to provide empirical evidence of the factors and determinants that promote entrepreneurship, and this paper attempts to delve into this question.

Focusing on this issue, there seems to be a general agreement that a regional ecosystem conducive to entrepreneurship development, new ventures or start-ups feeds on human capital, access to R&D and technology (Lane et al., 2017) and opportunities created by the market (Cabrer & Paz, 2018). In addition, macroeconomic conditions such as the employment situation in the region or economic growth can influence the context in which entrepreneurs identify opportunities and decide whether to start their own business (Rusu & Roman, 2017). That is, there is consensus that spatial factors and regional characteristics can influence the creation of new businesses (Fischer et al., 2022). However, the present analysis goes further grounded on the fact that in recent years, the most advanced regions have shifted away from being based on physical capital towards being based on intangible capital (Niebel et al., 2017; Zambon et al., 2020; Corrado et al., 2021a, b). This shift from a broadly manufacturing economy to a knowledge economy has entailed significant changes in regions and, consequently, recent literature reveals that digitalization and intangible assets promote entrepreneurial activities and vibrant ecosystems (Von Briel et al., 2018; Kuester et al., 2018; Kraus et al., 2019; Belitski et al., 2021) and develop new ventures' activities that are not dependent on a single firm but rest on the entire entrepreneurial ecosystem (Lado et al., 2017; Zahra et al., 2023). As such, the endowment of intangible capital becomes a competitive advantage, developing distinctive innovative capabilities and encouraging entrepreneurship (Crupi et al., 2020; Hormiga et al., 2011). That is, the ongoing digital and intellectual transformation and the deep and accelerating transformation of processes, activities, and competences open entrepreneurial opportunities (Corvello et al., 2021; Kraus et al., 2019; Nambisan et al., 2019). More precisely, intangible assets, such as the use of digital methods, brands, intellectual property rights, management reputation, employee "know-how," partnerships with customers, suppliers, and partners, all represent a source of growth and become an essential tool in designing companies' business models and enabling their success (McGrattan, 2020; Piekkola, 2020; Roth, 2020). Due to their growing relevance, intangible capital becomes an important factor to add to the list of variables that favor an entrepreneurial ecosystem, but the difficulty in measuring intangible assets has often meant that they are excluded from numerous economic contexts. However, the Ivie-Cotec Foundation has recently provided a new database that offers information on investment in intangible capital for the Spanish regions broken down by components including not only R&D but also software, copyrights, brands, firm-specific human capital, and organizational change. For this reason, this paper focus on the Spanish regions. These new data allow us to fill a gap in the literature and contribute to the nascent field of technological entrepreneurial intent by linking entrepreneurship to digitalization and intangible assets of the economy.

Having solved this problem thanks to a new database on investment in intangible assets, the purpose of this paper is to study the determinants of entrepreneurship,

focusing on the impact that specific regional factors can have on entrepreneurial activity, particularly analyzing weather regions with higher endowments of intangible capital also have higher rates of entrepreneurship. Hence, this paper answers the main research question of whether intangible assets play a significant role in explaining or determining the entrepreneurship rate at regional level. In addition, the study disentangles the determinants of the regional rate of entrepreneurship in large and small firms, shedding light on the design of entrepreneurship policies and promotion of business activity.

The paper makes several relevant contributions. First, this study fills a gap in the lack of quantitative studies related to the contribution of intangible capital on entrepreneurship (Crupi et al., 2020). Second, the paper uses new data and provides regional empirical evidence of the contribution that intangible assets make to entrepreneurship by considering not only intangible assets that, to date, National Accounts classify as investment, but also other assets that are currently considered intermediate consumption. As far as we know, this paper is the first to provide empirical evidence on a regional level, since it is the only study with a database on intangible assets available at that level of disaggregation at the time it was written. Therefore, it can also be highlighted as a significant contribution and added value to this work. And finally, the study distinguishes between the factors that affect the regional rate of entrepreneurship in large and small firms. Using different econometric approaches, the results show that the rate of small firm entrepreneurship (self-employment start-ups) of the regions is directly related to a prosperity-pull context and the expectation of economic gain. In contrast, the rate of large firm entrepreneurship of the regions is also explained by the resources available to them, such as the intangible capital, technological resources, and human capital, as well as the demographic structure of the population in each region. The results confirm the importance of including the intangible assets as a determinant of entrepreneurship as they are closely related to the regional rate of entrepreneurship among large firms.

The paper is structured as follows: Section “[Determinants of Entrepreneurship: Literature Review and Hypotheses](#)” presents the literature review and hypotheses. Section “[Methodology](#)” introduces the methodology while Section “[Data](#)” describes the data and defines the variables. The results and discussion are presented in Section “[Results and Discussion](#)”. Finally, Section “[Conclusions](#)” concludes.

Determinants of Entrepreneurship: Literature Review and Hypotheses

Theory and Literature Review

Innovation policies have been very important for the regions. On the one hand, they have contributed to changing economic activity by boosting long-term productivity and welfare. On the other hand, innovation policies have reduced disparities between regions. Those that have low innovation indicators show that they are inefficient in solving problems and meeting needs (Malcolm et al., 2021). Therefore, regions should increasingly focus their efforts on the promotion of innovation and

knowledge. In the same way, regions looking for sources of growth should pay more attention to the full range of intangible assets to successfully create the conditions for a long-term economic development in support of less favored regions (Gumbau & Maudos, 2022). Intangible assets are an important source of value and competitive advantage; hence, an inadequate intensity of the effort in promoting digitalization and intangible assets widens the gap between regions.

In the last years, the intangible assets have acquired more economic and strategic value becoming the real engine of the modern economy (Adarov & Stehrer, 2019; OECD, 2021). This is true for highly capitalized companies as well as for startups that own few tangible assets and base their entire ability to generate value on intangible assets. This fact is recently reflected in the academic literature where we can find several studies emphasizing the influence of intangible capital on entrepreneurship. For instance, Bisbe and Malagueño (2015) and Teece (2018) find that entrepreneurial orientation and company success are highly dependent on the intangible assets that are owned and controlled. Mata et al. (2021) state that to survive in this global world, firms cannot rely solely on the physical assets they have, but intangible and intellectual capital must be considered vital. And Santoro et al. (2020) find that nowadays, intangible capital is strategic and more critical than tangible capital in the first period of life of a business.

Another group of studies has paid attention to the link between entrepreneurship and the different sources of intangible assets on which firms rely. For Trimi and Berbegal (2012) intangible assets—like the firm's human capital acquired through workplace employee training, or efforts to enhance organizational structure—improve business models, that in turn, help new entrepreneurs to make more informed decisions contributing to the firm's chance of success. Likewise, Chesbrough (2007, 2010) points that intangible assets such as innovation and creativity are crucial to carry out new projects and set up new companies but also highlights the importance of analyzing the market, acquiring intellectual property, cooperating with the environment, and adopting safety and quality standards. In turn, Kraus et al. (2019) affirm that new ventures are grounded on talent, good ideas, and a knowledge-based economy. That is, entrepreneurs will be more likely to encourage proactive behavior, look for new opportunities, and create new business as their ability to use knowledge or intangible capital grows (Heavey & Simsek, 2013; Garcia-Sanchez et al., 2018) because intellectual and technological skills allow potential entrepreneurs to innovate and respond to existing opportunities in dynamic and turbulent environments and encourage better exploitation of existing resources and opportunities, thus driving entrepreneurial activities (Martín-Rojas et al., 2011; Pérez-López & Alegre, 2012). In addition, Alvarez and Barney (2020) hold that not only innovation is at the basis of entrepreneurial process and link the exploitation of opportunities with the strategic management. Therefore, investments in intangible capital also can be seen as an entrepreneurial strategy which allow entrepreneurs to create value inventing new goods and services (R&D) or commercializing them (advertising) (Belitski et al., 2021).

Recently, literature added that digitalization is one of the intangible assets related to entrepreneurship (Nambisan, 2017; Fossen & Sorgner, 2021; Jafari-Sadeghi, 2021). Digital technologies and virtualization offer new opportunities to entrepreneurs thanks to the reduction of sunk costs and barriers to entry; they transform the nature of the

uncertainty inherent in the entrepreneurial process and its outcomes and how these uncertainties are handled; they reduce the costs of doing business, ease the problems related to the establishment of start-ups, and extend markets because much of the time-consuming and labor-intensive administrative work involved, including access to market and relationship with consumers, is handled by the Internet. As a result of the reduced risk, greater ease and flexibility, new ideas, and business projects for start-ups are offered, and more people are engaging in entrepreneurial activities. In addition, educational support for entrepreneurship is being facilitated by information and communication technologies (ICT) which are allowing students to develop their creativity, critical thinking, and other soft-skills required for entrepreneurship (Alvarez-Sousa, 2019). At the same time, the widespread use of digital technologies changes customer behavior by creating new needs that, in turn, require new firms and a new type of entrepreneur (Aslesen et al., 2019; Porter & Heppelmann, 2017). Also, Kraus et al. (2018) and Kraus et al. (2021) reveal that technological developments jointly with advances in infrastructure create various opportunities for entrepreneurs and start-ups searching for new markets or new business models that change the consumer behavior. In the same vein, Steininger (2019) and Sahut et al. (2021) highlight that information and communication technologies play different roles in digital entrepreneurial operations: making the operations of start-ups easier, enabling new digital business models, acting as mediators for new ventures' operations, or just being the outcome of entrepreneurial operations. That is, thanks to digital technologies, the potential of collaboration and collective intelligence is being used to design and implement more robust and sustainable entrepreneurial initiatives (Elia et al., 2020). Digital technologies are playing a transformational role in the world economy by changing the entrepreneurship process and are providing new opportunities for entrepreneurs to set up businesses and sell their products and services worldwide (Youssef et al., 2021).

Literature has also revealed that entrepreneurial activities are inseparable from their regional environments; the influence of spatial characteristics and regional-specific factors affects new firm formation and must be considered as determinants of entrepreneurship and used as variables of control. Authors focus especially on whether entrepreneurship is affected by prosperity or recession (Wang, 2006) or shows how progressive factors (e.g., profit expectations) and regressive factors (e.g., low wages, fear of unemployment) can influence the rate of new start-ups (Santarelli & Vivarelli, 2007). However, based on empirical research, other conditions are necessary for entrepreneurial activity such as the existence of opportunities together with individuals able to seize them (Stam, 2008), the existence of certain characteristics of entrepreneurs, such as education or income as well as characteristics of the localities and regions where they carry out their activities such as size, population density, firm density, and whether the locality is urban or rural (Backman & Karlsson, 2013). Also, other studies (Albulescu & Tamasila, 2014; and Sayed & Slimane, 2014) indicate that the most important factors affecting the entrepreneurial activity are the following: the level of economic development, population growth, employment, the level of education in the region, and technological development. That is, individuals base their decision to work for others or to start their own venture on the existence of opportunities that are marked by the economic or environmental conditions, the resources, personal characteristics available to them (Thai & Turkina, 2014), human capital, and institutions

(Arin et al., 2015). Cala et al. (2015) added macroeconomic stability, public policies, and knowledge as important determinants of entrepreneurship in developed countries, but also industrial structure, income, and financing. According to Garcia-Sanchez et al. (2018), Urbano et al. (2019), and Martínez-Fierro et al. (2020), the environment also plays an important role in influencing the process of initiating any entrepreneurial activity, since the environment includes macroeconomic and structural factors that affect entrepreneurs' activity.

To control for the aforementioned spatial factors, Verheul et al. (2002), Grilo and Thurik (2004, 2008), Thai and Turkina (2014), Barreneche (2014), Cala et al. (2015), Van der Zwan et al. (2016), Dvouletý (2017), and Jabeur et al. (2022) have proposed and developed the Eclectic Theory, confirming that the determinants of entrepreneurship can be united in a conceptual framework that links the demand side or product market perspective with the supply side or labor market perspective. The demand side represents the opportunities of entrepreneurship and is determined by a combination of factors including economic development, technological development, and industry structure. On the supply side, population characteristics (human capital), demographic composition, and labor market structure (unemployment rate and wages) determine the availability of resources and abilities. Using this framework constructed by the Eclectic Theory regarding the determinants of entrepreneurship, this paper addresses the question of how a region's intangible capital determines its regional entrepreneurial capacity while controlling for the influence of regional environmental factors on new business formation.

Formulation of Hypothesis

Based on the existing scholarly literature, this section derives the hypotheses to be tested in the empirical analysis. The first hypothesis is directly related to the main research question of whether intangibles assets are also an important explanatory variable or determinant of the entrepreneurship rate at regional level. The following hypotheses are related to the demand and supply sides of the determinants of entrepreneurship as classified by the Eclectic Theory. These hypotheses are formulated as follows:

Intangible Assets

According to the reviewed literature, the constitution of a new venture is a complex process where intangible assets have become the basis for achieving sustainable competitive advantage. They have transformed the economy and created a new ecosystem that can provide opportunities for entrepreneurs. Consequently, the first hypothesis this paper proposes to test is:

H1: Regions with a greater endowment of intangible assets are positively related to higher rates of entrepreneurship.

Economic Development (Growth)

The level of development is usually measured by gross value-added growth and can be either positively or negatively related to new firm formation. The idea is that regions with a higher level of development and growth have a higher market potential and, consequently, a positive relationship (Audretsch, 2007; García-Posada & Mora-Sanguinetti, 2015; Guerrero et al., 2021). Conversely, the idea that a higher average income implies higher labor costs for the entrepreneur, as well as higher opportunity costs of self-employment, suggests a negative relationship (Ashcroft et al., 1991; Love, 1996). That is, with lower growth, an effective way to overcome the lack of employment opportunities and even stave off poverty is to start a business (Amorós & Bosma, 2014). In this context, the following hypothesis is suggested:

H2: There is a significative connection between economic growth and entrepreneurship.

Technological Development

Entrepreneurship can be fostered by current technological development in a region since new technologies and knowledge result in business opportunities, and entrepreneurs exploit these opportunities by turning the new knowledge into innovative products and economic growth (Acs et al., 2013; Block et al., 2017; Kraus et al., 2021; Neumann, 2021; Anokhin & Wincent, 2012). More precisely, Van Stel et al. (2019) point out the positive relationship between R&D expenditures and the individual level of entrepreneurial performance, while Guerrero et al. (2021) highlight the importance of diffusion of innovation in the entrepreneurship process and legitimize incubators and accelerators. Also in this vein, Audrestsch (2017), Urbano et al. (2019), Tartari and Stern (2021), and Aparicio et al. (2016, 2021) affirm that a firm's entry is closely related to proximity to research institutions and support services in a region that may not simply increase the quantity of entrepreneurs but also their average quality (Bosma et al., 2018). Consequently, the third hypothesis is:

H3: Entrepreneurship is positively associated with technological development.

Industry Structure: (Diversification)

Glaeser and Gottlieb (2009) and Obschonka et al. (2015) argue that, together with human capital, industrial structure is a key factor affecting innovation and entrepreneurship because industrial diversity increases the flow of ideas between different industries, thereby facilitating the creation of new companies. Also, Stuetzer et al. (2016) and Fritsch and Wyrwich (2019) rely on regional differences in specialized industries and diversification to explain historical entrepreneurship. That is, because industries often rely on different knowledge stocks, if a region has a mix of

industries, there can be greater potential for knowledge spillovers, recombination, and emergence of new market opportunities than in regions with a single-industry agglomeration. The fourth hypothesis to test is the following:

H4: Entrepreneurship is positively associated with industry diversification.

Structure of the Population

The literature highlights the impact of population density and the population's age structure on new firm formation. On the one hand, knowledge spillovers tend to be greater in regions with a higher population and industrial density, where the competitive advantage of urban areas can be exploited (Audretsch & Keilbach, 2007; Audretsch & Lehmann, 2005; Tavassoli et al., 2021). Particularly, metropolitan and urban areas accommodate agglomeration effects that should be a fertile ground for start-ups (Brixy & Grotz, 2007; Bashir & Gebremedhin, 2011; Baptista & Preto, 2011; Audrestch et al., 2019; Neumann, 2021). Cities characterized by a high level of knowledge and cultural diversity may form an ideal ecosystem to explore and commercialize entrepreneurial ideas because they provide more opportunities for personal, social, and professional interactions (Audretsch et al., 2021; Van der Zwan et al., 2013). Over time, these contacts can help build mutual trust among partners, leading to lower interaction costs, knowledge transfer, and cooperation. Local networks may provide information and advice that reduce the costs of starting up a new firm, as well as helping to find the necessary financial resources. On the other hand, the age structure of the population affects entrepreneurship and, according to Reynolds (1997), Parker (2004), and the Global Entrepreneurship Monitor (GEM, 2019), the 25 to 44-year-old cohort generates a positive impact in particular because of agglomeration effects such as knowledge spillovers, input sharing, or labor market pooling. This is because people below the age of 25 are unlikely to have the skills gained through work experience and the financial resources for entrepreneurship, while those older than 44 tend to avoid significant occupational changes (Davidsson & Honig, 2003; Guerrero et al., 2021; Obschonka et al., 2015). In this context, the fifth hypothesis to test is:

H5: Entrepreneurship is positively related to the demographic structure of the population.

Unemployment Rate

Previously identified regional factors also include unemployment as a determinant of entrepreneurship at regional level, but this relationship can be recession-push or prosperity-pull. If the recession-push hypothesis is correct, there will be a positive correlation between the number of new firms established and the unemployment rate. If the prosperity-pull hypothesis is correct (the higher the economic growth rate or the lower the unemployment), more new firms will be established in a region (Wang, 2006). That is, the link between the unemployment rate and new firm formation can be positive or negative (Bosma &

Schutjens, 2011; Vidal-Suñé & Lopez-Panisello, 2013; Sayed & Slimane, 2014; Arin et al., 2015; Obschonka et al., 2015; García-Posada & Mora-Sanguinetti, 2015). These contradictory results in the analysis of the relationship between unemployment and new firm formation are supported by different arguments. On the one hand, unemployment may be negatively related to new firm formation if the unemployed do not perceive opportunities due to lack of experience and funds with which to become entrepreneurs (Baptista et al., 2006). In consequence, good opportunities are better perceived by people in employment who may be “pulled” into self-employment. High unemployment in a region may also suggest reduced aggregated income and may limit new business-creation activities (Brixy & Grotz, 2007). That is, higher unemployment reduces the demand for goods and services and, in turn, reduces business opportunities and deters entry (Rusu & Roman, 2017). On the other hand, higher unemployment and job insecurity reduce the chances of finding a salaried job, which incentivizes self-employment. This argument considers entrepreneurship as an escape from unemployment playing a particularly significant role during economic crises for some regions (Santarelli & Vivarelli, 2007; Vivarelli, 2013). For Rusu and Roman (2017), unemployment may be positively related to a new firm formation if the opportunity costs to start a firm are low, and the unemployed are pushed into self-employment due to a lack of other opportunities, that is, a “refugee” or “necessity” effect. In the same vein, Fritsch et al. (2015) and Dvouletý (2018) obtain a non-linear influence of unemployment. Their findings indicate that when unemployment rises, some individuals go into entrepreneurship/self-employment out of necessity, but if there is a recession or economic crisis with a substantial increase in unemployment, then it negatively affects entrepreneurs and self-employed. Therefore, the next hypothesis is:

H6: There is a significative connection between unemployment and entrepreneurship.

Wages

Starting a new business is, therefore, a personal choice if the perceived profits from starting and owning a new firm exceed the wage alternative (Evans & Jovanovic, 1989; Evans & Leighton, 1990). According to Backman and Karlsson (2013), entrepreneurs will decide to start a new business if this is the best of all available alternatives in terms of expected financial outcome. For Manso (2016) and Babina (2020), when wages fall, the value of working in paid employment is lower, which makes self-employment attractive to individuals. In this context, the next hypothesis to be tested is:

H7: Entrepreneurship is negatively associated with wages.

Human Capital

Human capital is identified as an influential factor in the formation of new companies because it refers to people's abilities and skills, problem solving and management ability, and is a combination of factors such as educational background, experience, knowledge, and competences (Brüne & Lutz, 2020; Canavati et al., 2021; Krieger et al., 2021). At any given moment in a region, only a certain number of people are

endowed with the right entrepreneurial human capital to discover specific technologies and markets, detect valuable business opportunities, and deal with the implicit uncertainty of business events. Education reflects abilities, and individuals' entrepreneurial human capital will depend on their general and specific education and training (Backman & Karlsson, 2013; Obschonka et al., 2015). Also, Arin et al. (2015) affirm that human capital allows individuals to seize profit opportunities and generate changes in the markets. Human capital determines not only the quantity but the quality of these changes, and Jimenez et al. (2015) point to tertiary education as the driver of formal entrepreneurship because of graduates' higher self-confidence, lower perceived risk, and enhanced skills. In recent times in particular, the role of higher education has transformed attitudes towards entrepreneurship in the university community. Universities have integrated resources and capabilities to configure a favorable environment to commercialize their research outcomes via patents, licenses, and spin-offs (Guerrero & Urbano, 2019; Hannibal et al., 2016; Wright et al., 2017). As a result, the academic entrepreneurship phenomenon has grown considerably during the past decade. In addition, human capital via training entrepreneurship programs provides favorable conditions for new re-entries into entrepreneurship (Guerrero & Peña-Legazkue, 2019; Guerrero & Espinosa-Benavides, 2021). Hence, the final hypothesis to test is:

H8: There is a positive interaction between human capital and entrepreneurship.

Methodology

The extensive evidence reviewed on the determinants of entrepreneurship shows the importance of the supply and demand factors. However, intangible assets have changed the economy, and regions with the greatest endowments of intangible capital have a new way of capturing additional ideas that can lead to greater entrepreneurial spirit. That is, intangible capital becomes an important factor to add to the list of variables that favor an entrepreneurial ecosystem. To test this hypothesis, the paper adopts the widely accepted definition of intangible capital provided by Corrado et al. (2005, 2009) and Mas and Quesada (2019): (a) computerized information: software and databases; (b) innovative property including R&D, entertainment, artistic and literary originals; mineral exploration; design and new products/systems; and (c) investment in economic competences including advertising, market research and branding, firm-specific resources such as employer-provided training or investment in organizational structure (purchased organizational capital and own account). In this context, the Eclectic Theory provides the basis from which to develop an extended model to include intangible assets as depicted in Fig. 1.

To verify the predefined hypothesis, an econometric approach is used. The regression analysis starts from the following equation, which is based on the theoretical background, the existing empirical studies in the field, and the available data:

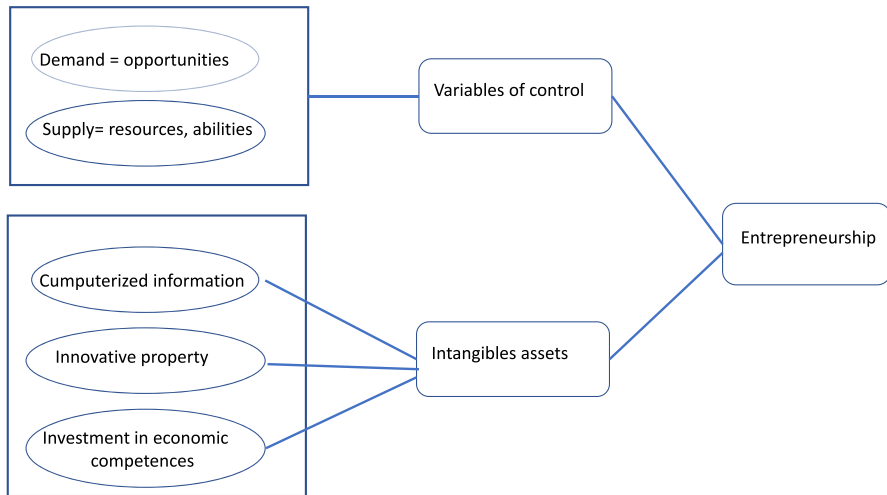


Fig. 1 Framework of determinants of entrepreneurship

$$E_{it} = \alpha_{it} + \beta_1 \cdot S1_{it} + \beta_2 \cdot S2_{it} + \beta_3 \cdot S3_{it} + \dots + \beta_n \cdot Sn_{it} + \lambda \cdot I_{it} + \mu_{it} \quad (1)$$

where E is the entrepreneurship rate measured by the percentage of new companies over the total population, S is the set of regional variables mentioned above (*Growth*, *Population* 25–44, *Unemployment*, *Education*, *Wages*, *Technological development*, *Diversification*) that represent the opportunity, skills, and resources of the Spanish regions, I represent the regional endowment of intangible capital (*Intangibles*), and μ is a random disturbance term. This approach is an extension of that chosen by Audretsch and Keilbach (2004), Williams et al. (2017), and Lee and Rodriguez-Pose (2020).

Two econometric approaches are used to estimate the model. First, we reproduce the fixed effects panel data which captures the possible unobservable characteristics of each region that are constant over time. Despite its advantages, this technique also has the drawback that it cannot adequately solve problems of endogeneity. For this reason, to increase the robustness of the results, as in Audretsch and Keilbach (2004), Aparicio et al. (2016), and Bosma et al. (2018), the paper estimates a simultaneous three-stage least squares (3SLS) panel data, often used in econometrics when equations contain endogenous variables among the explanatory variables and is interpreted as an estimator of instrumental variables. It is asymptotically more efficient as it considers the correlation between the errors of each of the simultaneous equations of interest as well as excluding possible biases due to heteroskedasticity problems (Aparicio et al., 2016). In this paper, it is estimated to avoid endogeneity problems between entrepreneurship and *Growth* due to reverse causality. That is, the start-up activity might depend on the regional growth dynamic, but regional growth might be more pronounced in regions where a larger proportion of start-ups are located. To this end, a second equation is introduced:

$$G_i = f(G_{t-1}, G_{t-2}, E) \quad (2)$$

which explains *Growth* (G) in region i as a function of the region's past dynamics and the entrepreneurship level.

Data

The link between entrepreneurship and intangible assets, controlling for the regional environment and the regional macroeconomic situation, is analyzed on a sample of 17 regions in Spain for the period 2001–2016. The reason is that Spain is the first EU member state to have disaggregated data on intangible assets at a regional level. The variables and statistical sources used are the following:

- *Entrepreneurship* is defined by the number of new firms in the respective region relative to its population, representing the propensity to start new businesses in each region. The information of new company registrations by regions has been requested to the National Statistics Institute (INE) which provides the regionalized data of new start-ups disaggregated by company size. Thus, two different entrepreneurship variables are considered: *Small firm entrepreneurship* (self-employment, fewer than six employees) and *Large firm entrepreneurship* (more than six employees).
- *Growth*: economic Development is proxied by the rate of growth of gross value added of each region obtained from the Regional Accounts of Spain released by the National Statistics Institute.
- *Diversification*: regional productive diversification is measured as the proportion represented by employment in region i in sector j, compared to the proportion of sector j. That is, the Herfindhal index = $\sum (E_{ij}/E_j)^2$ where E is employment. The higher the index, the less diversified is the productive structure of the region, so the expected sign of this variable on the entrepreneurship rate is negative (Regional Accounts of Spain released by the National Statistics Institute).
- *Unemployment*: percentage of total workforce who are unemployed (Economically Active Population Survey released by the National Statistics Institute).
- *Wages*: employee remuneration obtained, as above from the Regional Accounts of Spain released by the National Statistics Institute.
- *Population 25–44*: to measure the demographic structure of each region, this study uses the percentage of the population aged between 25 and 44 years as a proxy for the workforce most likely to start a business. Figures were provided by the National Statistics Institute.
- *Technological Development Stage* is proxied by propensity to patent, that is, the number of patents per inhabitant, which reflects the state of technology or inventive activity of a region's population. The information on patents comes from the Spanish Patent and Trademark Office at the Industrial Property Register (*Registro de la Propiedad Industrial, Oficina Española de Patentes and Marcas*). Patents are understood to reflect a region's innovative output, and analysis of patents provides information about the available technological capabilities in the regions.

- *Education*: the accumulation of education and skills at regional level is measured as the percentage of people of working age who have completed higher education (university degree or bachelor's degree or certificate of higher education). These data are obtained from estimates by the Instituto Valenciano de Investigaciones Economicas (Ivie) and subsequent updates with data from the Economically Active Population Survey provided by the National Statistics Institute.
- *Intangibles*: an index of the regional investment capacity in intangibles will be constructed from the Ivie-Cotec Foundation database. This database contains two sets of highly valuable information: first, it provides data on investments in intangible assets that are included in the GDP (they are considered in the National Accounts and are therefore regarded as value added). These assets are as follows: (1) software and data base; (2) R&D; and (3) entertainment, artistic and literary originals, and mineral explorations. Second, it provides data on other intangible assets that are not considered as investments in the National Accounts, but as intermediate consumption goods or services, namely investments in the following: (1) design; (2) advertising; (3) market research; (4) workplace training; and (5) organizational capital (own or purchased). In fact, until recently, economists had excluded this last group of intangible assets from the National Accounts. This exclusion means that the investment in the economy is underestimated and highlights the need to correct the measurements.

Therefore, the index of intangibles to be built not only includes intangible assets included in the GDP but other intangible assets that are not.¹ Before constructing this index, Table 1 provides detailed information on intangibles by asset type, both the national average and for each region. In the case of Spain as a whole, the asset with the largest share of total investment is software, 18.4% of the total, which is very similar to investment in R&D (18.2%). The third largest share of intangible asset investment is spending to improve organizational structure (15.3%), followed closely by investment in design (14.4%) and advertising (14.8%). Investment in employee training is slightly lower (11.8%), while spending on intellectual property (3.7%) and market research (3.5%) has much lower shares. By regions, the greatest difference in investment share is in R&D, with a difference of almost 18 percentage points between the region with the highest investment (the Basque Country) and the lowest (the Balearic Islands).

As in Barreneche (2014) and Audretsch et al. (2021), these data are not used in the regression model in their raw state. Thus, principal component analysis is performed to create the index of the regional investment capacity in intangibles, presented in Table 2, using the intellectual and intangible assets in which the regions invest. The main components are expressed as a linear combination of the original variables. Therefore, the index avoids problems of correlation by respecting the

¹ The analysis estimating the regions' investments in intangible assets that do not form part of the GDP—that is, those not included in the National Accounts—can be found in Mas and Quesada (2019); Spain is the first member state of the European Union for which this information is available at the regional level.

Table 1 Regional differences in the composition of investments in intangible capital. Average 2001–2016

	Software and database	R&D	Entertainment, artistic and literary originals + mineral explorations	Total IA-GDP	Design	Advertising	Market research	Vocational training	Organizational capital	Total IA-no GDP
Spain	18.60%	18.40%	3.70%	40.60%	14.40%	14.50%	3.40%	11.80%	15.30%	59.40%
Andalusia	18.50%	17.60%	3.70%	39.80%	14.90%	14.30%	3.50%	13.60%	13.80%	60.20%
Aragon	20.30%	17.20%	4.20%	41.70%	13.60%	14.40%	2.90%	13.10%	14.40%	58.30%
Asturias	17.20%	14.00%	2.90%	34.10%	19.80%	13.30%	4.00%	14.00%	14.80%	65.90%
Balearic Islands	29.00%	7.60%	7.30%	44.00%	10.40%	9.20%	2.40%	17.00%	17.00%	56.00%
Canaries	21.30%	11.20%	3.90%	36.40%	16.30%	13.10%	3.60%	14.60%	15.90%	63.60%
Cantabria	16.80%	14.50%	2.70%	34.10%	18.60%	15.20%	3.70%	13.30%	15.20%	65.90%
Castille Leon	20.90%	18.60%	4.50%	43.90%	13.10%	14.50%	2.70%	13.70%	12.00%	56.10%
Castille-La Mancha	22.80%	13.60%	4.20%	40.60%	13.20%	13.40%	2.90%	16.60%	13.30%	59.40%
Catalonia	17.60%	21.40%	3.60%	18.60%	13.30%	15.20%	3.00%	11.30%	14.60%	57.40%
Valencian Com	17.10%	17.20%	3.30%	18.60%	12.60%	17.60%	4.20%	12.50%	15.40%	62.40%
Extremadura	25.00%	14.40%	4.50%	18.60%	11.20%	11.00%	2.80%	16.70%	14.40%	56.10%
Galicia	20.60%	16.80%	3.60%	18.60%	15.20%	14.70%	3.10%	13.50%	12.50%	59.00%
Madrid	18.40%	18.20%	3.40%	18.60%	15.50%	14.10%	3.60%	8.90%	18.00%	60.00%
Murcia	16.90%	13.60%	3.90%	18.60%	13.10%	20.80%	4.00%	12.20%	15.50%	65.60%
Navarra	16.30%	24.10%	3.70%	18.60%	15.10%	14.40%	2.80%	10.90%	12.80%	56.00%
Basque Country	15.30%	25.50%	3.00%	18.60%	15.70%	10.60%	3.20%	12.30%	14.40%	56.20%
La Rioja	23.20%	14.50%	9.10%	18.60%	10.80%	11.70%	2.20%	12.90%	15.50%	53.20%

Source: Cotec Foundation and Ivie

Table 2 Principal component analysis: intangible capital

Component	Eigenvalue	Difference	Proportion	Cumulative			
Comp1	8.703	8.5131	0.967	0.967			
Comp2	0.1899	0.1493	0.0211	0.9881			
Comp3	0.0406	0.0152	0.0045	0.9926			
Comp4	0.2538	0.0063	0.0028	0.9954			
Comp5	0.1910	0.0083	0.0021	0.9976			
Comp6	0.0108	0.0027	0.0012	0.9988			
Comp7	0.0081	0.005	0.0090	0.9937			
Comp8	0.0031	0.0031	0.003	1.0000			
Comp9	0.0000		0.0000	1.0000			
	PC1	PC2	PC3	PC4	PC5	PC6	PC7
Software/databases	0.3289	0.5201	0.023	0.0437	-0.3112	0.6776	-0.2093
R&D	0.3354	-0.1824	0.2347	-0.5855	0.3195	-0.0479	-0.3340
Artistic/literary	0.326	0.5719	0.3715	0.3298	0.3294	-0.4499	0.0945
Design	0.3341	-0.2736	-0.2775	0.3414	0.574	0.273	-0.3113
Advertising	0.3371	-0.0273	-0.1398	-0.0950	-0.5039	-0.4508	-0.5204
Market research	0.3354	-0.1672	-0.4864	0.3682	-0.1650	-0.1890	0.1811
Firm training	0.3341	0.2327	-0.4530	-0.5258	0.1273	-0.0193	0.5081
Org. Cap. Purchased	0.3344	-0.3251	0.3593	0.0667	-0.1813	0.1055	0.2975
Org. Cap. Own	0.3344	-0.3251	0.3593	0.0667	-0.1813	0.1055	0.2975

independence between the explanatory variables. That is, in applying the principal component method, the researchers reduce the dimension of the number of original variables considered in the analysis and deal with the problem of multicollinearity among the initial variables. The table shows that the first component accounts for 96% of the total variance while the following component explains 2% of the total variance. Thus, most of the variance is contained in the first principal component. The intangibles index obtained by principal component analysis is used in the next section to test H1 with econometric techniques.

Results and Discussion

Results

This section presents the empirical contribution of the determinants of entrepreneurship, focusing on the relationship between the endowment of intangible assets and start-ups. The hypothesis is tested empirically on a sample of 17 Spanish regions for the period 2001–2016. Table 3 reproduces the fixed effects (FE) panel data model, and Table 4 displays the results of the simultaneous three-stage least squares (3SLS) panel data setting. The results of auxiliary 3SLS regressions are presented in Table 4. This estimation is included to correct for endogeneity and shows the reverse causality between growth and entrepreneurship. The comparison of the two

Table 3 Impact of intangible capital on entrepreneurship. Fixed effect panel data estimation

	Small firms	Large firms
Growth	0.5136 (1.62)	2.7235 (4.88)***
Population 25–44	−0.3260 (−1.21)	0.3264 (1.87)**
Unemployment	−0.0919 (−1.99)***	−0.1695 (−5.64)***
Education	0.3144 (1.29)	0.4570 (2.88)***
Wages	−0.3615 (−2.03)***	−0.7508 (−6.50)***
Technological development	0.0002 (0.70)	0.0005 (2.47)***
Diversification	−1.3627 (−1.37)	−2.8454 (−4.41)***
Intangibles	0.3510 (0.50)	0.1106 (2.43)***
Constant	4.8067 (1.17)	0.7551 (0.28)
R^2	0.699	0.750
No. of observations	272	272

Figures in parentheses are *t*-values

***significant at 1%, **significant at 5%, *significant at 10%

tables reveals minor differences between the two econometric models, thus reinforcing the robustness of the results obtained. That is, most of the coefficients of the explanatory variables in the 3SLS regressions of Table 4 provide comparable signs and significances to the results of the standard FE regressions presented in Table 3. However, both tables include regressions for small (or self-employment) and large firms, and significant differences are appreciated between these two rates of regional entrepreneurship.

Both tables show that for the regional rate of entrepreneurship of small firms (or self-employment), the only statistically significant variables are *Unemployment* and *Wages*, which negatively affect entrepreneurship. For the regional rate of entrepreneurship of larger firms, most of the variables are statistically significant at 1%, and the most outstanding result is that intangible assets are significant and have the expected positive sign. They positively impact entrepreneurship together with *Education*, *Technological development*, and *Growth*. The high statistical significance of this variable *Intangibles* shows the importance of introducing this type of assets endowed by a region into the theoretical explanation of the determinants of entrepreneurship, as in this paper. Therefore, studies that ignore its importance may suffer from omitted variable bias. These results give strong support to the model and are empirically consistent with all the hypotheses

Table 4 Impact of intangible capital on entrepreneurship. Simultaneous equation estimation

	Small firms	Large firms
Growth	−0.2504 (−0.11)	0.6754 (4.04)***
Population 25–44	0.2129 (1.24)	0.5330 (3.05)***
Unemployment	−0.242 (−4.91)***	−0.2456 (−2.33)***
Education	0.3231 (1.39)	0.1534 (2.40)***
Wages	−0.250 (−2.16)***	−0.5644 (−3.26)***
Technological development	0.0006 (0.92)	0.0010 (4.19)***
Diversification	−1.144 (−4.33)***	−1.6130 (−6.19)***
Intangibles	0.0050 (0.25)	0.2314 (2.15)***
Constant	−2.6484 (−2.60)	−1.9262 (−5.04)
R^2	0.326	0.396
No. of observations	238	238
Growth _{t-1}	0.7558 (11.57)	0.4930 (6.71)
Growth _{t-2}	−0.5972 (−5.62)	−0.5481 (−5.77)
Entrepreneurship	(0.118) (1.45)	0.0330 (5.96)
Constant	0.0824 (2.03)	0.2968 (6.47)
R^2	0.399	0.515
No. of observations	238	238

Dependent variable Eq. 1: entrepreneurship; dependent variable Eq. 2: growth. Figures in parentheses are *t*-values

***significant at 1%, **significant at 5%, *significant at 10%

regarding large firm's entrepreneurship. Consequently, the main hypothesis of the paper is confirmed, which indicates that regions with the greatest endowments of intangible capital have a new way of capturing additional ideas that can lead to a greater entrepreneurial spirit. In addition, the rate of entrepreneurship of large firms is explained by the specific regional environmental characteristics. However, the findings partially support the proposed hypotheses in the case of small start-ups. More precisely, because there is a significant connection between unemployment and entrepreneurship, as well as with entrepreneurship and wages, the results are empirically consistent with hypotheses H6 and H7.

Discussion of the Results

Because regional entrepreneurship of both large and small firms is negatively influenced by *Unemployment* and *Wages*, the results support that the higher the economic perspective and the lower the unemployment, the more start-ups will be established. In other words, entrepreneurs need a prosperity-pull or favorable context in which to enact and exploit opportunities, as well as a healthy financing channel that, in turn, is highly sensitive to macroeconomic conditions. The expected sign is obtained, confirming the results of other studies on the Spanish economy such as García-Posada and Mora-Sanguinetti (2015). In addition, wages have a negative effect on entrepreneurship, which shows that the higher the wages, the lower the entrepreneurship. This finding suggests that the fundamental motivation for entrepreneurs is the expectation of economic gain. If a worker has job opportunities that would pay a similar wage, there is a penalty for entrepreneurship and self-employment. The results obtained for the Spanish regions coincide with the findings of Backman and Karlsson (2013), Manso (2016), and Babina (2020), who claim that entrepreneurs will decide to start a new business if this is the best alternative available in terms of expected profit.

The results also show other differences between the regional rate of entrepreneurship of large and small firms. Unlike small firms, large companies are generated in regions with greater human capital endowments measured by *Education* and an advanced stage of *Technological development*. That is, the use of knowledge and technology represent a notable advantage, so regions with greater endowments achieve a sustainable competitive superiority that encourages people to engage in more ambitious entrepreneurial activities. In other words, because more aspiring and scalable projects are needed to create larger companies, entrepreneurs must have access to greater human capital capacities and be in a more innovative and favorable environment for new ideas to emerge. This result is widely supported in the literature (for instance, Brüne & Lutz, 2020; Canavati et al., 2021; Krieger et al., 2021), although previous studies do not usually distinguish between firms of different size. Likewise, large firm entrepreneurship is positively affected by the level of development in the region, measured by the gross value-added growth rate, which confirms that large companies are fostered by higher market potential. It must be considered that setting up a larger company (which needs a greater investment) requires a minimum market growth, while to create small companies, market growth is not so important, since they are often created to provide self-employment (Audretsch, 2007; García-Posada & Mora-Sanguinetti, 2015; Guerrero et al., 2021). The weight of the 25–44 years old cohort in the total population also has a positive and significant effect in the case of the larger firms. On the one hand, it corroborates the need for a critical mass of individuals in this age group; by which time young people have gained skills and work experience, more people are willing to make a significant occupational change by starting their own business, and they have access to more and better financial resources (Guerrero et al., 2021; Obschonka et al., 2015), and on the

other hand, it confirms that better conditions for transmission of spillovers, personal contacts, and social and professional interactions fostered by denser regions are significant to explain entrepreneurship rates of large firms (Brixy & Grotz, 2007; Bashir & Gebremedhin, 2011; Baptista & Preto, 2011; Audrestch et al., 2019; Neumann, 2021). The results also show that *Diversification* negatively affects large firm entrepreneurship. As expected, the more diversified a region's production (lower value of the Herfindahl index), the higher the rate of entrepreneurship (Fritsch & Wyrwich, 2019; Stuetzer et al., 2016). Consequently, those regions that are specialized in certain sectors of the economy are less likely to have new ventures. Therefore, from the point of view of economic policy, encouraging productive diversification is a way to promote entrepreneurship. This effect is also statistically significant for small companies, although only in the 3SLS.

Finally, the most outstanding result of the analysis is that endowment of intangible capital only has a positive and significant effect in the case of large firm entrepreneurship. These resources improve competitiveness, foster innovation, renew the core business logic of new firms, help to enact, and exploit opportunities, increase the capacity for customer relationship and problem solving, and are a competitive advantage for regions that have a larger volume of this capital. The reason why these resources are relevant in the case of large companies and not small ones may be that to create a company of a certain size, it is important to develop a larger business project in which intangible capital is most relevant; digitalization, promotion, or internationalization are necessary for the survival of the largest companies, and require considerable investment in R&D, design, market studies, advertising, etc. In contrast, when starting a small company (often self-employment), these variables are much less relevant. This finding also shows that there is a threshold below which companies are highly unlikely to efficiently leverage the intangible capital available in their region. For this reason, given the importance of intangible capital, concerted efforts must be made to increase the firms' size.

As proposed in our theoretical model, the results show the importance of intangible capital as one of the main economic resources with intrinsic capacity to promote entrepreneurship in the regions, particularly in larger companies. Therefore, promoting entrepreneurship not only calls for more science and technology but also a greater volume of intangible assets and improvements in business processes and organizational models based on knowledge. For this reason, the main social agents must understand that intangible capital is one of the cornerstones of entrepreneurship; it is therefore essential for entrepreneurs not only to possess knowledge but also to learn to direct and manage intellectual and intangible assets efficiently. Firm's success may largely depend on the intangible assets it owns and controls. That is, firms intangible endowments foster their ability to rapidly access new knowledge and integrate it into their current processes, help to adopt new organizational mechanisms, strengthen their capacity to identify, and assimilate new external knowledge or market opportunities, or to convert knowledge acquired from outside into action within the organization.

Conclusions

Main Contributions

This study assesses the determinants that encourage entrepreneurship in regions emphasizing the importance of intangible capital. The study is framed in the Eclectic Theory, which analyzes the influence of spatial factors and regional characteristics on the formation of new businesses and identifies a set of factors—including economic opportunities, resources, and abilities—that have an impact on entrepreneurship. However, the main research question raised in this paper is whether regions with higher endowments of intangible assets are those that have higher rates of entrepreneurship. To this end, an index has been created by Principal Component Analysis to measure the regional endowment of intangible capital. The analysis focuses on the case of the Spanish regions since information on intangible assets disaggregated by assets and regions is available for Spain. In addition, this study disentangles the determinants of the regional rate of entrepreneurship in large and small firms, shedding light on the design of entrepreneurship policies and promotion of business activity. Thus, the paper makes several contributions that fill important gaps in the literature: (1) thanks to the use of new data, it calibrates the importance of intangible assets for entrepreneurship providing evidence for the Spanish case in particular; (2) it contributes to the Eclectic Theory of entrepreneurship by identifying regional-specific factors driving entrepreneurship; and (3) it also shows the differences on the determinants of the regional rate of entrepreneurship for large and small firms.

Summary of Results and Implications

The results show that the regional rate of small firm entrepreneurship (self-employment start-ups) is directly related to a prosperity-pull context; that is, potential entrepreneurs need a favorable situation in the labor market to undertake their new activity and, therefore, do not perceive business opportunities in a high unemployment context in a region; this negative context may suggest reduced aggregated income and demand and may limit business-creation. Furthermore, the primary motivation for entrepreneurs is the expectation of economic gain suggesting that there is a cost to entrepreneurship and self-employment if a worker has access to employment opportunities that offer a similar income. On the other side, for large firms, a positive macroeconomic context is also necessary (probably because a greater investment must be made profitable), but also the available abilities and resources are strongly related to entrepreneurship: the stage of technical development of the regions, the availability of human capital resources, and a critical mass of people at an age when they are likely to start a venture are all significant factors. Additionally, the results clearly allow to conclude that, after controlling for regional characteristics, intangible capital endowments have a significant positive effect on the creation of large firms (although not on small ones), showing that there is a threshold below which entrepreneurs will be less likely to have the capacity to leverage the intangible capital available in the region. The results obtained give strong support

for the model and are empirically consistent with all the hypotheses in the case of large firm's entrepreneurship. Consequently, entrepreneurship is conditioned by regional specific-factors and particularly, regions with the greatest endowments of intangible capital have a new way of capturing additional ideas that can lead to greater entrepreneurial spirit or can improve the performance of established companies. However, the findings only partially support the proposed hypotheses in the case of the small start-ups.

Given the importance of intangible capital and the use of resources such as human capital in the world's most developed countries and regions, economic policymakers in the Spanish regions must implement measures that encourage investment in intangibles, including training in companies, creating a business-friendly environment, and removing barriers to the creation of companies (bureaucratic, legal, regulatory, etc.). Society could also benefit from regional industrial policies that promote digitalization and the creation of clusters to attract new knowledge-intensive companies as well as policies that favor spillovers and connections between economic agents. The commitment to the ecosystem should not be limited to favoring the creation of startups, but also to assist their founders in expanding the company with the aim of achieving an optimal size. It is important to insist on the need for an adequate firm size (scale-up) and, as a result, on the need for growth-oriented entrepreneurship policies, in order for entrepreneurs to obtain the financing they require to invest in R&D, access foreign markets, operate in the global market where size increases the possibilities of access, improve management and organizational quality, or be able to attract sufficiently qualified personnel for managerial and decision-making roles. In contrast, the lack of size implies that entrepreneurs will be much less likely to have R&D, market research or appropriate training for employees, and managers, among other factors.

Study Limitations and Future Lines of Investigation

The first of these limitations concerns the lack of data from other regions that would allow us to broaden the scope of the analysis or make comparisons between countries to better understand the impact of intangible assets as they are defined in this paper. The second limitation is that when explaining the differences in the rate of entrepreneurship between regions and the importance of intangibles, we cannot control for the effect of firm characteristics, such as their degree of internationalization (orientation to the national or international market), capital structure (sources of financing), corporate governance, and the educational level of the entrepreneur. These are variables that can affect the propensity to start new ventures, but whose effect can only be analyzed with databases at the company level. This limitation therefore opens a line for future research on the determinants of business creation. Further research is also needed to explore the determinants of self-employment and look for policies that will increase this type of entrepreneurship. This research could embrace a more extensive set of personality factors as well as the human capital profiles of the two groups of entrepreneurs to further insight into the differences between the two groups of entrepreneurs. It could also be relevant to study the implications of such personality differences, for example, for subsequent venture performance and survival for opportunity and necessity entrepreneurs. **Funding** Open Access funding provided thanks to the CRUE-CSIC agreement with Springer Nature.

Declarations

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