

Senior and technology entrepreneurship: An analysis for OECD countries

Sara Fernández-López¹ | David Rodeiro-Pazos¹ |
Guillermo Andrés Zapata-Huamani¹ | María Jesús Rodríguez-Gulías²

¹Universidade de Santiago de Compostela, Galicia, Spain

²Universidade da Coruña, Galicia, Spain

Correspondence

David Rodeiro-Pazos, Department of Finance and Accounting, Universidade de Santiago de Compostela, Avda. do Burgo, s/n., 15782 Santiago de Compostela, Galicia, Spain.
Email: david.rodeiro@usc.es

Abstract

Aging of the population has created a direct effect on economies and tension on social security systems. Policymakers have been senior entrepreneurship as an option to reduce unemployment and delay the age of retirement. The positive effects, of creating a firm increase when is operating in technology-based sectors. This paper explores the technological and senior entrepreneurship relations, analyzing if age influences technological entrepreneurship and if determining factors for senior and non-senior groups are different. By using a sample of 8637 entrepreneurs in 22 OECD countries based on *Global Entrepreneurial Monitor* 2018 data, the results firstly show a negative effect of being a senior entrepreneur, understood as an entrepreneur aged 50+ years, on technological entrepreneurship. Secondly, it has been detected that in some way senior entrepreneurship follows a different pattern of the probability of entrepreneurship in technology sectors than the sample of the non-senior entrepreneurs.

KEYWORDS

global entrepreneurship monitor, new technology-based firms, OECD, senior entrepreneurship, technology entrepreneurship

JEL CLASSIFICATION

L26, E24, J14

1 | INTRODUCTION

The aging of the population has become a major concern for politicians and societies in western countries as an increase in the number of elderly persons has a major impact on society as a whole and, in particular, on public pension systems. Negative implications of the aging of the population are an older workforce and an increased retirement age (Pilková et al., 2016). Furthermore, people take out mortgages later in life and low basic pensions create financial pressure on elderly people (Weber & Schaper, 2004). These factors have increased the proportion of pensioners who live in poverty in many

European countries (Doward, 2019; Walmsley & Nabi, 2020) and create a higher demand for employment as well as increased pressure on social security systems (Pilková et al., 2016).

In the field of entrepreneurship, population aging also involves negative consequences. Schøtt et al. (2017) showed that the ratio of business creation falls when individuals reach the age of 50 years. Similarly, Sternberg (2019) indicated that the level of senior entrepreneurship is lower than expected based on this population's share in society.¹ In other words, although the potential segment for senior entrepreneurs is rapidly increasing because of the aging of the population, the entrepreneurial intention and

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activity of this age cohort are lower than that of other age groups (Cossette et al., 2010).

On the other hand, senior entrepreneurship has positive economic and social consequences that have been pointed out by numerous authors. Senior entrepreneurship implies unemployment reduction (Kautonen et al., 2015; Maritz, 2015) in a segment of the population that faces difficulty in being active in the labour market. In addition, senior entrepreneurship could imply a delay in the age of retirement (Kautonen et al., 2017; Zhang, 2008). Both effects reduce the actual tension in social security systems, thereby facilitating governments to better address population aging. These benefits can be increased if governments implement policies to promote and improve senior entrepreneurship just as they do with young people (Figueiredo & Paiva, 2018). Entrepreneurship in older adults has recently become a social and public policy aimed at fostering the development of new economic income when pensions are limited and there are few opportunities to participate in the labour market (Kautonen, 2012).

Whether motivated by the positive and/or negative consequences, the entrepreneurial activity of seniors is of increasing interest. In today's knowledge-driven economy, entrepreneurship per se and senior entrepreneurship is of greater importance (Byun et al., 2017), and technology entrepreneurship (TE) is considered an effective mechanism to create and develop economies (Bertoni et al., 2011). Following Kantis et al. (2002), TE transforms innovative ideas into economic opportunities, improves competitiveness, increases productivity, and creates jobs.

In a recent study, Garza Puentes and El Hag (2020) stated that the combination of innovation and entrepreneurial processes is essential for the development of mature economies in which senior entrepreneurship has an important role.

To sum up, in recent decades, senior entrepreneurship has become a relevant issue for policymakers as an alternative way to solve individual and societal economic problems in an aging society (Jang & Ha, 2018). Consequently, a strand of entrepreneurship literature has begun to devote attention to senior entrepreneurship. Likewise, TE and the factors that influence its creation have increasingly attracted the attention of academia and policymakers (Colombo & Grilli, 2010) who see it as a tool for boosting economic growth in modern economies. However, no study addresses both questions at the same time. As far as we know, this is the first study which addresses the issue of TE and senior entrepreneurship.

By adopting an individual level of study, this paper aims to fill this gap in the literature. Using a sample of 8637 entrepreneurs in 22 OECD countries and applying logit models, we explore the role of age and, in particular, of senior entrepreneurship, in the creation of new technology-based firms (NTBFs). As a second objective, we analyze whether individual drivers for being a technology entrepreneur differ between senior and non-senior entrepreneurs. In doing so, this paper contributes to a better understanding of the best conditions for enhancing seniors' entrepreneurial initiatives given that empirical research on this issue is still scarce (Villegas Mateos & Amorós, 2020). At a policy level, NTBF creation has often been supported by public

policies at a country level. Knowing how age might influence NTBF creation and which factors are more relevant for senior entrepreneurs could help policymakers design supportive policies.

This work is structured as follows. After this introduction, Section 2 presents the literature review for our theoretical framework and the hypotheses. In Section 3, the research methodology is presented, and then, in Section 4, we provide the results of the descriptive and econometric analyses. Finally, Section 5 concludes with the findings, policies, and limitations of this study.

2 | LITERATURE REVIEW

Research in the field of senior entrepreneurship has drawn academic and political interest in the last decade, and a significant strand in the literature revolves around barriers and drivers (motivations) of entrepreneurial behavior in this age cohort (Rehák et al., 2017). Based on a literature review, we first discuss if age affects TE, and second, the variables which influence TE in senior and non-senior entrepreneurs to understand whether the determinants of TE differ between these two groups.

2.1 | Effect of age on technology entrepreneurship

In the literature, age seems to be a relevant variable in explaining entrepreneurship. Oelckers (2015) pointed out that senior entrepreneurs have specific difficulties which produce a negative correlation between entrepreneurial intention and age (Duhamel et al., 2016). The flexibility and commitment of the elderly to entrepreneurship is generally thought to be lower than that of other groups (Kautonen, 2012), which makes seniors believe that there are obstacles for them to become an entrepreneur (Kibler et al., 2012). Furthermore, the energy of adults decreases with age while their health problems increase (Weber & Schaper, 2004), so they are more willing to spend time on leisure activities (Singh & DeNoble, 2003). Halabisky (2012) found that older people are less interested in entrepreneurial activities that require long periods of consolidation. For these reasons, older people are less disposed to engage in entrepreneurial activities (Curran & Blackburn, 2001; Levesque & Minniti, 2006; Singh & DeNoble, 2003), and the percentage of older people who start new businesses is about half that of young people (Hart et al., 2004; Kautonen, 2008). In this sense, Kibler et al. (2012) pointed out that age is an obstacle to entrepreneurship, and entrepreneurial intention is negatively correlated with age.

Another group of authors have shown that the effect of age depends on the type of entrepreneurship and/or that it does not follow a linear behavior (Tervo, 2014). For example, Kautonen et al. (2014) suggested that for those individuals with the preference to run their own business, the effect of age on entrepreneurial propensity is described by an inverse U-shape. Tervo and Haapanen (2010) determined that for men in Finland, age had a nonlinear effect on the probability of being self-employed. A study by

Costa Joana et al. (2020) found a positive relationship between age and entrepreneurship up to a certain level. Finally, some authors have pointed out that as people get older, their willingness to take more risks, especially financial, increases as they no longer have financially dependent children (Kilber et al., 2011).

Based on the literature review, our first hypothesis is:

Hypothesis 1. Being a senior (50 years and over) has a negative effect on technological entrepreneurship.

2.2 | Determining factors on technological entrepreneurship

Some studies have analyzed if age influences entrepreneurship, while other authors have focused on the differences between the factors that affect senior entrepreneurs and other groups. Our second hypothesis is in line with the second strand of the literature, and like the first hypothesis, is focussed on TE. To test whether the determinants of TE differ between seniors and non-seniors (Hypothesis 2), we first explain the main factors other than age that are cited in the literature, and which affect the probability of being an entrepreneur.

2.2.1 | Gender

Most of the studies on senior entrepreneurship have shown that entrepreneurs are predominantly male (Martin & Omrani, 2019). While family obligations may have an impact on female entrepreneurship, this mainly affects younger women due to the effect of parenting and family obligations (McKay, 2001). Therefore, senior entrepreneurship will be less affected by the entrepreneurship gender gap to the extent that childcare obligations and other family burdens may have disappeared due to the stage of the life cycle in which women find themselves. In line with these arguments, Rehák et al. (2017) found that the highest negative impact of being a female on the probability of entrepreneurial activity occurs in the youth cohort. The traditional barriers to women's entrepreneurship are intensified further when the firm has a technological component; therefore, in the case of TE, the presence of women will be even lower (Rodríguez-Gulías et al., 2013).

2.2.2 | Education

One of the most recursive topics in the literature on individuals' entrepreneurial intentions is the role of education. But when we focus on senior entrepreneurship, some authors consider education an unimportant variable because the most valuable skills required by entrepreneurship may be learned by doing rather than acquired at school (Martin & Omrani, 2019). The experiences accumulated over time may provide senior entrepreneurs with such skills. Pilková et al. (2014) found that the knowledge acquired through the formal

education system has less value for senior entrepreneurs than the work experience accumulated during their life. Weber and Schaper (2004) pointed out that the level of education of senior entrepreneurs is often lower than that of other groups (Kautonen, 2008; Parker, 2004). Many senior entrepreneurs state that they have the skills and knowledge needed to start a business, but they lack experienced mentors (Kautonen, 2012).

2.2.3 | Work experience

Accumulated human capital has been consistently associated with the propensity for entrepreneurial behavior. Past work experience acquired over an extended period is perceived as higher accumulated human capital by seniors compared with other age cohorts (Tervo, 2014), thereby favoring seniors' entrepreneurial initiative. However, human capital can also depreciate with age (Rincón Díaz et al., 2020). Past entrepreneurial experience provides senior entrepreneurs with a cumulative body of knowledge, skills, and attitudes acquired during their working lives (Kautonen et al., 2010; Martin & Omrani, 2019) that favors senior entrepreneurship. In the case of TE, a study by Zapata Huamaní et al. (2017) found that being actively employed has a positive and highly significant influence on the probability of setting up a technology-based business.

2.2.4 | Financial capital

Whether financial capital matters in entrepreneurial intention has been a subject of contention. From an entrepreneurship policy approach, the need for a stream of income to support the person's lifestyle could be the main motivation to start a business (Martin & Omrani, 2019; Singh & DeNoble, 2003). This motivation becomes especially relevant for senior entrepreneurs because of the absence of paid/well-paid employment opportunities, the low level of worker satisfaction with wages and other labour conditions or deficient retirement funds in pensions (Martin & Omrani, 2019). In contrast, using the resource-based view, financial capital accumulated during working life could favor senior entrepreneurship. In this respect, Rehák et al. (2017) found that the positive impact of income on the propensity of entrepreneurial behavior is higher in a group of seniors compared with other age cohorts (youth and young adults). It is noteworthy that in the case of TE, the requirements of initial financial resources are high, invalidating the arguments that positively relate the financial resources accumulated over time and senior entrepreneurship.

2.2.5 | Social networks

Social capital and social networks can be considered a major element for the development of entrepreneurial initiatives (Pilková et al., 2014). Senior entrepreneurs may possess superior networks established over

an extended period (Martin & Omrani, 2019) that can provide them with better access to advice and potential partners (Rehák et al., 2017). However, older entrepreneurs may experience more difficulty in creating new networks and may suffer higher network obsolescence, especially if they have been unemployed or retired for a long time (Kibler et al., 2012), which would prevent them from leveraging social capital. Particularly, knowing other entrepreneurs has a positive effect on setting up a NTBF (Venkataraman, 2004; Zapata Huamani et al., 2017).

2.2.6 | Managerial skills

The technical and managerial skills accumulated in the past should be an advantage for seniors compared with other age cohorts (Tervo, 2014), and if we add previous experiences in business start-ups, senior entrepreneurs will have a higher level of skills (Kautonen et al., 2010; Martin & Omrani, 2019). The entrepreneur's previous experience is critical to acquiring the required skills and knowledge (Kibler et al., 2012), but sometimes the lack of adequate skills (Kautonen, 2012) or skills that are not updated (Kadefors, 2011) makes it difficult to create a firm. Álvarez and Urbano (2011) found that entrepreneurs' skills affected the creation of firms in countries with high incomes. Álvarez and Barney (2002), Shane and Venkataraman (2000) and Zapata Huamani et al. (2017) confirmed that in the field of technology entrepreneurship, the beliefs of entrepreneurs in their skills were a significant variable for the number of businesses created.

2.2.7 | Fear of failure

Fear of failure is considered a barrier that would prevent the start-up of a new business, and a percentage of people who see entrepreneurship as a good career option still lack the confidence to succeed because of this fear. Al-Jubari and Mosbah (2021) stated that fear of failure is one of the challenges for senior entrepreneurs. Rehák et al. (2017) found that the fear of failure of senior entrepreneurs had a higher effect on opportunity-based entrepreneurs. Fear of failure is related to leadership and has implications concerning innovativeness in business (Bogahalande et al., 2019), a crucial factor for TE. Recent uncertainties like economic recession, financial crisis and the current COVID-19 pandemic hinder people from engaging in entrepreneurial activity. For instance, a study by Al-Jubari and Mosbah (2021) based on the Global Entrepreneurship Monitor's (GEM) reports pointed out that the fear of failure among Malaysians is increasing every year.

Therefore, we establish a second hypothesis to find out whether the previous factors found in the literature differently affect the probability of entrepreneurship in technology sectors for both seniors and non-seniors.

Hypothesis 2. The determining factors for technological entrepreneurship by senior (50 years and over) and non-senior groups are different.

To test this second hypothesis, the sample was divided into seniors and non-seniors.

3 | RESEARCH METHODOLOGY

In this section, we will describe the database, the sample and the variables used in our analyses.

The database belongs to the international entrepreneurship observatory GEM, a project that annually measures the entrepreneurial intentionality and activity of countries worldwide. Our sample corresponds to the 2018 edition (the latest available at the time of the study) for 22 OECD countries.² A total of 95,343 people were interviewed, of which 8637 were entrepreneurs (9.06%), that is, people who were involved in starting up a business between 3 and 42 months (i.e., 3.5 years) according to the GEM definition.

The dependent variable for the empirical analysis is the technological entrepreneur. This variable is defined by the differentiation of entrepreneurs into two groups, those who start a business in medium- or high-technology sectors (1) and those who do so in no- or low-technology sectors (0) according to the OECD (2001) classifications. OECD classifications identify high- and medium-technology sectors as those in which research and development (R&D) investments are made above or equal to the average (measured as industry R&D expenditures divided by industry sales).

Definitions of senior entrepreneurs are not consistent in the literature (Biron & St-Jean, 2019), but most of the authors have defined this concept based on people's age. As the literature differs on the age with which to start for senior entrepreneurs, our research considers senior entrepreneurs to be those over 50 years old who decide to start a new business. This definition is consistent with the GEM data and previous studies, such as Cervený et al. (2016), Karoly and Zissimopoulos (2004), Maâlaoui et al. (2012), Maritz and Eager (2017), Kenny and Rossiter (2018), Van Solinge (2014) and Saiz-Álvarez and Coduras-Martínez (2020).

Therefore, the main independent variable is the senior variable which is coded as (1) for persons 50 years of age and older and (0) for persons younger than 50 years of age. Likewise, the analysis includes other independent variables that measure socioeconomic characteristics, such as gender, employment situation, and annual family income, as well as senior attitudes and perceptions toward entrepreneurship, such as knowing entrepreneurs, entrepreneurial skills, and fear of failure. The definitions of these variables can be found in Table 1.

For the empirical analysis and due to the dichotomous qualitative nature of the dependent variable (technological entrepreneur), we applied non-linear regression models, particularly logit models and proposed the following relation:

$$\text{Prob}(Y_i = 1) = \phi(\beta_0 + \beta_1 \text{Senior}_i + \beta_i X_i)$$

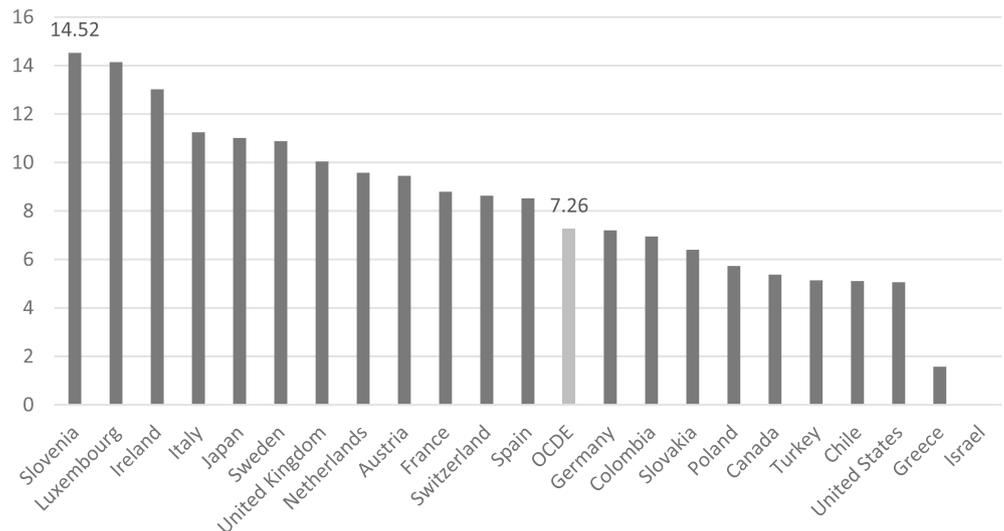
The dependent variable (Y_i) quantifies the individual's probability of being a 'technology entrepreneur', i is the index of individuals, and

TABLE 1 Definition of variables

Factor	Variable	Description	Categories
	Technological entrepreneur	Entrepreneur in medium- or high-technology sector	No (0) Yes (1)
Age	Senior	Older than or equal to 50 years of age	No (0) Yes (1)
Gender	Gender	What is your gender?	Male (0) Female (1)
Education	Studies completed	Studies currently completed	No studies (0) Primary studies (1) Secondary studies (2) Higher studies (3) Postgraduate studies (4)
Work experience	Employment situation	Which of the following describes your current job status?	Unemployed (0) Employed (1)
Financial capital	Annual family income	Annual rent of your household including yours and other potential family members	Inferior third level (1) Middle third level (2) Superior third level (3)
Social networks	Knowing entrepreneurs	Do you personally know someone who has started a new business in the last 2 years?	No (0) Yes (1)
Managerial skills	Entrepreneurial skills	Do you have the knowledge, skills and experience required to start up a new business?	No (0) Yes (1)
Fear of failure	Fear of failure	Would fear of failure prevent you from starting a business?	No (0) Yes (1)

Source: Own elaboration based on GEM 2018 data.

FIGURE 1 Technological entrepreneurship in OECD countries (% of total entrepreneurship). Source: own elaboration based on GEM 2018 data.



ϕ denotes the logistic distribution function. Senior variable has been previously defined, and X_i refers to the remaining variables included in Table 1.

The logit models were estimated by using the logit estimator of Stata. Additionally, marginal effects were calculated by applying the Stata *margeff* command (Bartus, 2005).

4 | RESULTS

4.1 | Descriptive analysis

Of the total of 8637 entrepreneurs in the sample, 627 had started a business in medium- or high-technology sectors, which represents

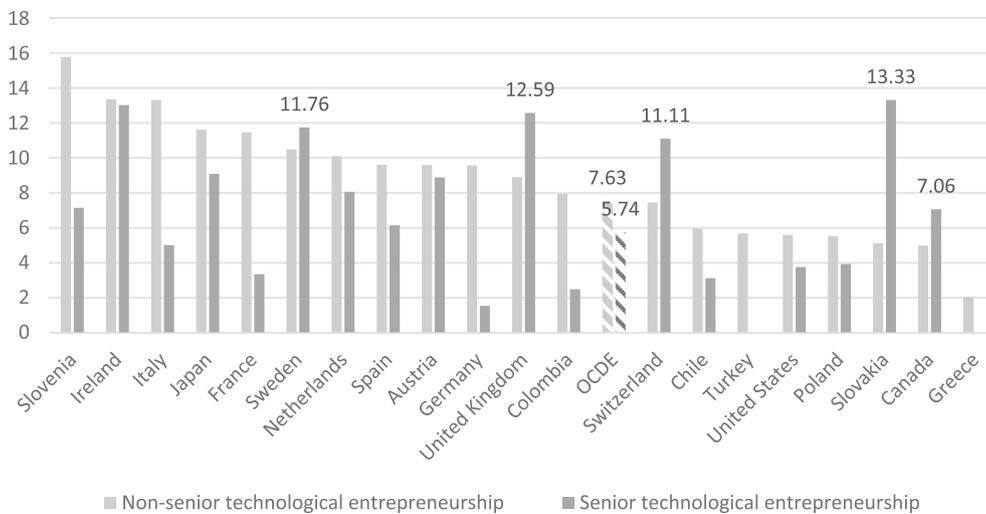


FIGURE 2 Non-senior technological entrepreneurship vs. senior technological entrepreneurship (%), 2018). Note: Israel is not considered in the analysis because it does not register entrepreneurship in medium- and high-technology sectors. Source: own elaboration based on GEM 2018 data.

TABLE 2 Technological entrepreneur versus non-technological entrepreneur (%), 2018)

	Non-technological entrepreneur	Technological entrepreneur	Significance		
			χ^2 -test	F-test	t-test
Senior	(n = 7727)	(n = 589)	0.006***		
No (<50 years old)	74.50	79.63		0.012**	0.003***
Yes (50+ years old)	25.50	20.37		0.012**	0.003***

Notes: χ^2 -test is the test of independence or association of variables; F-test is the test of equality of variances and t-test is the test of independence of means. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

7.26% of the total number of entrepreneurs in the OECD for 2018 (Figure 1). Slovenia registered the most technological entrepreneurs (14.52%) in contrast to Israel, which does not register entrepreneurs in this sector. On average, these values are higher than those recorded in comparative studies of TE for groups of lower-income countries (Zapata Huamani et al., 2018).

When we divide the sample between senior and non-senior entrepreneurs, Figure 2 shows that for the OECD, the percentage of senior entrepreneurs in technology sectors (5.74%) is lower than that of non-senior entrepreneurs (7.53%). However, this difference is extreme compared with Turkey and Greece where there were no senior entrepreneurs registered in technology sectors. On the other hand, Sweden, the United Kingdom, Switzerland, Slovakia, and Canada were the only countries in which the percentage of technology entrepreneurs was higher in the senior population.

Using the t-test of independence of means, we evaluated whether there were significant differences in the variables used in our study for the senior and non-senior technology entrepreneur groups. We first checked the homogeneity of variances through the F-test; given that the analysis was cross-sectional and the variables were qualitative (categorical), we also checked the association between the variables contrasted by the means of the chi-squared test.

In Table 2, the association between the variables of technological entrepreneur and senior status are shown. The chi-squared test (χ^2 -test) indicated that there is an association between these

variables ($p < 0.006$). Furthermore, the t-test confirmed these differences ($p < 0.003$) under the assumption of unequal variances ($p < 0.012$). Thus, 25.5% of the non-technological entrepreneurs are senior versus 20.4% of the technological entrepreneurs.

Once the association was detected, we evaluated whether the differences between senior and non-senior technological entrepreneurs for all of the variables included in the study were significant (Table 3).

Of the 627 entrepreneurs in medium- or high-technology sectors, 589 is the valid number of adults age (18 years and older) that allows us to classify the sample by the senior variable. According to the chi-squared test, the variables of studies completed and knowing entrepreneurs were associated with senior and non-senior technological entrepreneurs. Concerning the completed studies, the t-test showed significant differences in the categories of primary studies ($p < 0.010$) and higher studies ($p < 0.093$). Thus, 11.67% of the senior technological entrepreneurs completed primary studies versus 3.67% of the non-senior; and 54.43% of the non-senior technological entrepreneurs completed higher studies versus 45.83% of the senior. Likewise, significant differences ($p < 0.000$) were found using the t-test in the category of knowing entrepreneurs, with 71.61% of the non-senior technological entrepreneurs versus 50% of the seniors. No significant differences were found for the other variables at the descriptive analysis level.

To give robustness to these results, we replicated the analysis for the same variables under the assumption of defining the senior

TABLE 3 Technological entrepreneur: Senior versus non-senior

	Non-senior subsample (<50 years old)	Senior subsample (50+ years old)	Significance		
			χ^2 -test	F-test	t-test
Gender	(n = 469)	(n = 120)			
Male	76.76	80.83			
Female	23.24	19.17			
Studies completed	(n = 463)	(n = 120)	0.010**		
No studies	1.30	0.83		0.005**	
Primary studies	3.67	11.67		0.000***	0.010**
Secondary studies	22.89	25.00			
Higher studies	54.43	45.83			0.093*
Postgraduate studies	17.71	16.67			
Employment situation	(n = 463)	(n = 119)			
Unemployed	6.05	5.04			
Employed	93.95	94.96			
Annual family income	(n = 393)	(n = 96)			
Inferior third level	18.07	21.88			
Middle third level	30.03	30.21			
Superior third level	51.91	47.92			
Knowing entrepreneurs	(n = 465)	(n = 120)	0.000***		
No	28.39	50.00			0.000***
Yes	71.61	50.00			0.000***
Entrepreneurial skills	(n = 458)	(n = 116)			
No	12.23	12.07			
Yes	87.77	87.93			
Fear of failure	(n = 453)	(n = 118)			
No	73.51	77.97			
Yes	26.49	22.03			

Notes: χ^2 -test is the test of independence or association of variables; F-test is the test of equality of variances and t-test is the test of independence of means. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

variable as 45 years of age and older. In general, we obtained similar results, except for the employment situation variable for which the t-test detected significant differences ($p < 0.076$). On the other hand, the higher studies variable lost significance in its differences (Appendix A: Table A.1).

4.2 | Empirical analysis

Table 4 shows the estimated models of the logit regressions (marginal effects). In the first column, the entire sample of entrepreneurs is used to mainly identify the effect of belonging to the senior group on the probability of entrepreneurship in medium- or high-technology sectors. The next two columns show estimated models for two subsamples which were obtained by dividing the sample between seniors and non-seniors to find differences and similarities between the two groups concerning the effects of the other individual variables on the probability of entrepreneurship in technology sectors.

For the model which included the complete sample, the senior target variable had a negative and significant effect ($p < 0.1$) on TE; that is, the status of the senior entrepreneur, understood as an entrepreneur aged 50+ years, had a negative effect on the probability of entrepreneurship in medium- or high-technology sectors. Therefore, Hypothesis 1 is confirmed; being a senior has a negative effect on the probability of entrepreneurship in medium- and high-technology sectors. These results are in line with those studies that have pointed out the difficulties senior entrepreneurs face in creating companies (Kautonen, 2012; Kibler et al., 2012; Oelckers, 2015) and that has also found a negative correlation between entrepreneurial intention and age (Curran & Blackburn, 2001; Duhamel et al., 2016; Kibler et al., 2012; Levesque & Minniti, 2006; Singh & DeNoble, 2003). In addition, Halabisky (2012) stated that firms that require longer periods for consolidation, such as TE firms, are less attractive to senior entrepreneurs.

For the other variables, significant effects were found for gender, studies completed and entrepreneurial skills. Concerning gender,

TABLE 4 Logit regressions (marginal effects) of the probability of being a technology entrepreneur (senior = 50+ years of age)

	All sample	Senior subsample (50+ years old)	Non-senior subsample (<50 years old)
Senior (50+ years old) (ref.: No)			
Yes	-0.012* (0.007)		
Gender (ref.: Male)			
Female	-0.050*** (0.006)	-0.058*** (0.011)	-0.047*** (0.007)
Studies completed (ref.: Secondary studies)			
No studies	-0.036** (0.014)	-0.053*** (0.011)	-0.015 (0.026)
Primary studies	-0.021* (0.012)	0.009 (0.023)	-0.037*** (0.012)
Higher studies	0.027*** (0.008)	0.004 (0.015)	0.033*** (0.009)
Postgraduate studies	0.057*** (0.016)	0.046 (0.029)	0.061*** (0.019)
Employment situation (ref.: Unemployed)			
Employed	0.004 (0.014)	-0.013 (0.028)	0.009 (0.017)
Annual family income (ref.: Middle third level)			
Inferior third level	0.003 (0.009)	0.002 (0.017)	0.004 (0.011)
Superior third level	0.010 (0.007)	0.009 (0.014)	0.011 (0.009)
Knowing entrepreneurs (ref.: No)			
Yes	-0.007 (0.007)	-0.026** (0.013)	0.000 (0.008)
Entrepreneurial skills (ref.: No)			
Yes	0.022*** (0.008)	0.012 (0.016)	0.025*** (0.009)
Fear of failure (ref.: No)			
Yes	-0.002 (0.007)	0.001 (0.014)	-0.003 (0.008)
Constant	-2.937*** (0.300)	-2.298*** (0.609)	-3.189*** (0.347)
Observations	6524	1581	4943
-2LL	-1577.818	-327.336	-1241.496
Verosimilitude test chi-squared	134.77	47.17	101.34
Degrees of freedom	12	11	11
p-value	0.000	0.000	0.000
Pseudo-R ²	0.041	0.067	0.039

Notes: Standard errors in parenthesis. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

being female had a negative and highly significant effect on the probability of being a technological entrepreneur. For studies completed, a negative relation was found between no studies/primary studies and

a positive relation was found for higher studies/postgraduate studies with the probability of being an entrepreneur in technological sectors with high significance in all categories. Finally, the perception of

TABLE 5 Summary of results for Hypothesis 2 and determinant factors on total entrepreneurship

	Senior subsample (50+ years old)	Non-senior subsample (<50 years old)	Differences
Female	(-) ^{***}	(-) ^{***}	No
Studies completed (ref.: Secondary studies)			
No studies	(-) ^{***}	0	Yes
Primary studies	0	(-) ^{***}	Yes
Higher studies	0	(+) ^{***}	Yes
Postgraduate studies	0	(+) ^{***}	Yes
Employed (ref.: Unemployed)	0	0	No
Annual family income (ref.: Middle third level)			
Inferior third level	0	0	No
Superior third level	0	0	No
Knowing entrepreneurs (ref.: No)	(-) ^{**}	0	Yes
Entrepreneurial skills (ref.: No)	0	(+) ^{***}	Yes
Fear of failure (ref.: No)	0	0	No

Notes: ^{***} $p < 0.01$, ^{**} $p < 0.05$, ^{*} $p < 0.1$.

possessing entrepreneurial skills positively and significantly influenced the probability of entrepreneurship in the technology sectors.

For the senior subsample model, which measures the probability of entrepreneurship in medium- or high-technology sectors for the senior group, results showed that about three of the seven groups of variables differed from the non-senior subsample, following a different pattern of the probability of entrepreneurship. This confirms Hypothesis 2: the determining factors for TE for senior and non-senior groups are different (Table 4).

Thus, significance is lost in the entrepreneurial skills variable and gained in the knowing entrepreneurs variable. These differences can be observed when contrasted with the probabilities of the model for the non-senior subsample. The knowing entrepreneur's variable negatively and significantly affects the probability of entrepreneurship in technology sectors in the senior group, which is particularly relevant because its effect is exclusive to this group. This result is contrary to what was expected, as authors like Pilková et al. (2014) considered social networks to be a major element in the development of entrepreneurial initiatives. However, the results are consistent with the difficulties older entrepreneurs have in creating new networks (Kibler et al., 2012). Regarding the entrepreneurial skills variable, it has a significant effect only for the non-senior subsample.

For the studies that have already been completed, we can only confirm that not having an education negatively and significantly affects the probability of being a senior technology entrepreneur. This is consistent with previous studies that have pointed out that the level of education of senior entrepreneurs is often lower than that of other groups (Weber & Schaper, 2004) and that education is an unimportant variable (Martin & Omrani, 2019; Pilková et al., 2014).

In the case of gender, the sign and significance remain the same for the three samples. Being female reduces the probability of being a senior technology entrepreneur, and the same is true for non-senior and all entrepreneurs. These results are consistent with the studies

which show that senior entrepreneurs are mainly male (Martin & Omrani, 2019).

Finally, results show that fear of failure, work experience and financial capital are not significant in any of the three samples. Table 5 summarizes the results regarding Hypothesis 2 and the determinant factors for TE.

It should be mentioned that all these results are robust to the extent that the meaning and significance of the relationships of the dependent and independent variables were also confirmed when the senior population was defined as from 45 years of age and older, except for the variable of knowing entrepreneurs, for which no significant effects were found (Appendix A: Table A.2).

5 | DISCUSSION OF THE RESULTS

Related to our first hypothesis, our results show that being a senior entrepreneur negatively affects the probability of entrepreneurship in medium- or high-technology sectors. As was pointed out in the introduction, senior entrepreneurship has positive effects at micro and macro levels. Therefore, to take advantage of this type of entrepreneurship for individuals and economies, politicians and public administrations must develop policies to solve the negative effect of age on the creation of companies. This challenge can be addressed through mentoring and training programmes. Training is essential for entrepreneurship. If we want a project to be successful, we must have a broad knowledge of the sector we want to enter. This condition is equally important at any age, but for senior entrepreneurs, it implies an extra effort as it may be some time since they last renewed their knowledge. They must continually recycle themselves and keep up to date with the latest trends and techniques so that they will be able to adapt their businesses to current times and make them viable. As stressed by Walmsley and Nabi (2020), monitoring can be of great value to senior

entrepreneurs. Another line of action is to incorporate senior entrepreneurs in those areas in which technology is vital for the creation of firms; for example, they could participate in an academic environment where research and technological developments lead to the creation of university spinoffs in which they can participate.

Regarding our second hypothesis, we analyzed if the individual drivers for becoming a technology entrepreneur differed in some ways between senior and non-senior entrepreneurs. Our results show a different pattern in the two subsamples. For the senior subsample, the probability of entrepreneurship in medium- or high-technology sectors is affected by the variables of studies completed (no studies category) and entrepreneurial skills. In contrast, for the non-senior subsample, the variables of studies completed (primary, secondary and postgraduate studies categories) and entrepreneurial skills are significant. For both subsamples, gender has a significant effect on TE.

A recurring belief among people over 50 is that they are too old to further their education or that they do not have the time. With today's online courses and specific programmes for entrepreneurship in universities and schools, it is easier to combine training with other personal and professional activities. Entrepreneurship courses are an option for seniors to analyze case studies and meet entrepreneurs.

6 | CONCLUSION

Senior entrepreneurship has become a relevant issue, mainly because of the aging of the population and the effects of seniors on societies and economies. At the same time, TE is desired and promoted in modern economies. This paper used a sample of 8637 entrepreneurs in 22 OECD countries and applied logit models to explore relations between being a senior entrepreneur and the creation of NTBFs, as well as the determinants of TE for senior and non-senior subsamples. Our results show that being a senior entrepreneur negatively affects the probability of entrepreneurship in medium- or high-technology sectors and that individual drivers to become a technology entrepreneur are different for senior and non-senior technology entrepreneurs.

Exploration of the effect of age in becoming a technology entrepreneur and individual drivers for senior and non-senior entrepreneurs will contribute from both a theoretical and practical point of view. At a theoretical level, no study to our knowledge has addressed this issue, even though TE and senior entrepreneurship have been broadly analyzed. Therefore, a consideration of both questions opens a new strand of literature. From a practical point of view, a senior entrepreneurship and TE will become a recurrent alternative in our increasingly older and technological societies. Our results can help policymakers to take decisions. Since the status of a senior entrepreneur has a negative effect on TE policies, technology-based firms should be developed to increase the participation of seniors. In this sense, we contribute some policies and recommendations that can increase the promotion and adoption of digital technologies among the elderly population. Information and communication technologies have synergies with knowledge management that might help senior entrepreneurs to achieve their goals and bring their enterprises into

the digital transformation (Olalla-Caballero, 2020). Taking action that addresses TE by senior entrepreneurs is a way to encourage the development of technologies, which face societal challenges and to look for solutions to problems and challenges for the elderly, which have come to be called Aging Products and Services (Gutierrez Martin, 2020).

Some of the limitations of this paper open the way for further research. First, the database and information used were determined by the content of the GEM reports. We used information for 22 OECD countries, but it would be interesting to create different groups of countries that are more homogeneous to compare the effects of age. For example, countries could be analyzed according to their degree of economic development or environment. Approaches other than the logit models we applied could also be used, such as multilevel techniques, which would account for the unobserved heterogeneity across groups of countries. In addition, a consideration of other characteristics of the entrepreneurs not included in this study would give a better picture of senior entrepreneurship across the countries. For example, personal characteristics, such as motivation, persistence, commitment to work and self-confidence, are variables that play a critical role in the intention to create a company. Finally, this study focused on entrepreneurs who had started a business in medium- or high-technology sectors, but an analysis of the performance of these firms would contribute to the literature as the continuous growth and success of a business in a competitive enterprise environment is the key to the creation and promotion of wealth in our society.

ENDNOTES

- ¹ In European Union countries, the proportion of the population over 55 years old in 1990 was 25% and in 2010 was 30%. It is estimated to reach 37% by 2030 (Eurostat, 2012).
- ² Austria, Canada, Chile, Colombia, France, Germany, Greece, Ireland, Israel, Italy, Japan, Luxembourg, Netherlands, Poland, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom and United States.

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AUTHOR BIOGRAPHIES

Sara Fernández-López joined the Universidade de Santiago de Compostela (Galicia/Spain) as associate professor in 2006, after 11 years of working as a lecturer and researcher. She is the Secretary of the Committee of Ph.D. program in Economics and Business since 2013. Her research interests are in two main areas: household finance and academic entrepreneurship. She has around 40 internationally refereed papers. Recently, she has published in journals included in *Journal Citation Reports* (JCR).

David Rodeiro-Pazos joined Universidade de Santiago de Compostela (Galicia/Spain) as associate professor in 2009, after 7 years of working as a lecturer and researcher. His research interests are academic entrepreneurship, university spin-offs, technology transfer and venture capital. He is the author and co-author of several books on entrepreneurship. He has published in journals included in JCR. Recently, he participated in European projects “Citizenergy” and “LACES” and is currently involved in “FAN-BEST.”

Guillermo Andrés Zapata-Huamaní is a researcher at the Universidade de Santiago de Compostela. His research has been published in scientific journals, book chapters, and reports, as well as presented in national and international congresses.

María Jesús Rodríguez-Gulías joined the Universidade da Coruña (Galicia/Spain) as lecturer in 2015. Previously, she combined her work as a technician in the Technology Transfer Office of Universidade de Santiago de Compostela (Spain), and worked for Universidade de Vigo. Her research interests are in the two main areas of intellectual property valuation and academic entrepreneurship. Recently, she has published in journals included in JCR.

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APPENDIX A

TABLE A.1 Technological entrepreneur: Senior (45 years old and over) versus non-senior (% , 2018)

	Non-senior subsample (<45 years old)	Senior subsample (45+ years old)	Significance		
			χ^2 -test	F-test	t-test
Gender	(n = 416)	(n = 173)			
Male	76.92	79.19			
Female	23.08	20.81			
Studies completed	(n = 411)	(n = 172)			
No studies	0.97	1.74		0.000***	
Primary studies	3.89	8.72		0.000***	0.042**
Secondary studies	23.84	22.09			
Higher studies	53.04	51.74			
Postgraduate studies	18.25	15.7			
Employment situation	(n = 410)	(n = 172)			
Unemployed	6.83	3.49		0.000***	0.076*
Employed	93.17	96.51		0.000***	0.076*
Annual family income	(n = 349)	(n = 140)			
Inferior third level	18.62	19.29			
Middle third level	31.52	26.43			
Superior third level	49.86	54.29			
Knowing entrepreneurs	(n = 412)	(n = 173)	0.000***		
No	27.67	45.09		0.085*	0.000***
Yes	72.33	54.91		0.085*	0.000***
Entrepreneurial skills	(n = 406)	(n = 168)			
No	12.81	10.71			
Yes	87.19	89.29			
Fear of failure	(n = 402)	(n = 169)			
No	73.88	75.74			
Yes	26.12	24.26			

Note: χ^2 -test is the test of independence or association of variables; F-test is the test of equality of variances and t-test is the test of independence of means. * $p < 0.1$. ** $p < 0.05$. *** $p < 0.01$.

TABLE A.2 Logit regressions (marginal effects) of the probability of being a technology entrepreneur. (senior = 45+ years old)

	All sample	Senior subsample (45+ years old)	Non-senior subsample (<45 years old)
Senior (45+ years old) (ref.: No)			
Yes	-0.013** (0.006)		
Gender (ref.: Male)			
Female	-0.049*** (0.006)	-0.053*** (0.009)	-0.049*** (0.008)
Studies completed (ref.: Secondary studies)			
No studies	-0.036** (0.014)	-0.046*** (0.013)	-0.015 (0.029)
Primary studies	-0.021* (0.012)	0.004 (0.021)	-0.038*** (0.013)
Higher studies	0.027*** (0.008)	0.019 (0.013)	0.030*** (0.010)
Postgraduate studies	0.058*** (0.016)	0.037 (0.024)	0.068*** (0.020)
Employment situation (ref.: Unemployed)			
Employed	0.004 (0.014)	0.005 (0.022)	0.003 (0.018)
Annual family income (ref.: Middle third level)			
Inferior third level	0.003 (0.009)	0.008 (0.016)	0.000 (0.012)
Superior third level	0.010 (0.007)	0.018 (0.012)	0.007 (0.009)
Knowing entrepreneurs (ref.: No)			
Yes	-0.007 (0.007)	-0.018 (0.011)	-0.001 (0.009)
Entrepreneurial skills (ref.: No)			
Yes	0.022*** (0.008)	0.013 (0.014)	0.026*** (0.010)
Fear of failure (ref.: No)			
Yes	-0.002 (0.007)	0.006 (0.012)	-0.006 (0.009)
Constant	-2.925*** (0.300)	-2.960*** (0.562)	-3.005*** (0.354)
Observations	6524	2240	4284
-2LL	-1577.306	-480.461	-1091.549
Verosimilitude test chi-squared	135.80	53.69	87.71
Degrees of freedom	12	11	11
p-value	0.000	0.000	0.000
Pseudo-R2	0.041	0.053	0.039

Note: Standard errors in parenthesis. * $p < 0.1$. ** $p < 0.05$. *** $p < 0.01$.