

Technology Adoption and Product Innovation by Third-Age Entrepreneurs: Evidence from GEM Data



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Abstract While innovation remains a focus of policymakers, very little is known about how older entrepreneurs adopt new technology or introduce new products. Similarly, demographic studies of entrepreneurship are mostly interested in non-age-related demographic influences on entrepreneurial behavior. In this study we examine how age influences the choice of innovative entrepreneurship by considering both technology adoption and product innovation by those who enter entrepreneurship late in their career (over 50 years old). Our results suggest that as in other spheres of life, third-age entrepreneurs tend to lag behind their younger counterparts in technology adoption and innovation. This is extremely significant as, due to the aging population in many countries, it could have serious consequences for the overall development and growth of high impact entrepreneurship. We suggest some measures to address this issue.

1 Introduction

In recent years, researchers have become increasingly interested in older entrepreneurs (Clegg and Fifer 2014; Halvorsen and Morrow-Howell 2016; Schøtt et al. 2017). With aging populations, policymakers in many western economies are increasingly trying to encourage entrepreneurship among their older populations (Wainwright and Kibler 2014; Schøtt et al. 2017). Data collected from large-scale

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surveys also point toward increasing entrepreneurship by older people. Kelley et al. (2013) found that although in absolute terms entrepreneurship among older people is lower than in younger age groups, if we consider the labor force participation rate,¹ the entrepreneurial activity of older entrepreneurs is much greater. According to the Kauffman index of entrepreneurial activity, while in 1996 14.3% of the 55–64 age group were new entrepreneurs, this figure increased to 23.4% in 2012 (Fairlie 2013). Using data from 35 European countries, Kautonen (2013) found that although the entrepreneurial potential² of older people is lower than in other age groups, it is by no means marginal. A significant number of older people are intending to start a business, involved in early-stage entrepreneurial activity, or considering entrepreneurship as a late-career alternative (Kautonen 2013). Similar evidence from the GEM survey across 70 countries suggests that older-age entrepreneurship is no longer an oxymoron (Wainwright et al. 2011; Hudson and Goodwin 2014; Schøtt et al. 2017). Some authors even consider it the new dawn or the new normal (Isele and Rogoff 2014) noting that “fifty is the new thirty” (Kautonen and Minniti 2014).

Also known as third-age entrepreneurship,³ entrepreneurship by older people has emerged as a promising field of study within entrepreneurship. Studies show that both pull and push factors encourage third-age entrepreneurs (Gimmon et al. 2016; Stirzaker and Galloway 2017). On one hand, young retirees are increasingly attracted toward entrepreneurship to maintain their lifestyle and flexibility (Colovic and Lamotte 2012; Lamotte and Colovic 2013). On the other hand, an increasing number of older people are forced to start their own business as a source of income because they are excluded from the labor market (Kautonen et al. 2011; Stirzaker and Galloway 2017). Recently, Kautonen et al. (2017) identified several research gaps in the study of third-age entrepreneurship. For instance, what type of entrepreneurship do third-age people prefer? In this regard, the study by Bonte et al. (2009) shows that older people are less likely to pursue opportunities in the high-tech sector. While limited in their coverage, these findings raise concerns about the effect of demographic aging on a society’s capacity to produce high impact entrepreneurship, especially involving innovation (Frosch 2011; Lamotte and Colovic 2013). Moreover, as entrepreneurship is the vehicle through which knowledge that leads to innovation is introduced into the economy, it is necessary to understand the propensity to innovate among new entrepreneurs (Acs et al. 2009). As the article by Bonte et al. (2009) mainly focuses on high-tech and a single country, the main objective of our study is to compare the type of entrepreneurship preferred by third-age people and those in other age groups across countries.

¹Older people are more likely to be retired and hence less likely to be actively looking for work. Hence, their labor force participation rate will be low.

²Entrepreneurial potential is defined as the number of people thinking about starting a business or in early-stage entrepreneurship (Kautonen 2013).

³Other terms associated with older-age entrepreneurship are gray entrepreneurship, senior entrepreneurship, or late-career entrepreneurship.

To that aim, we have reviewed the literature in different disciplines and conducted an empirical study on a large data sample. Our research contributes to knowledge on third-age entrepreneurship in two ways. First, we highlight a phenomenon that has rarely been studied. For instance, while innovation remains a focus of policymakers, very little is known about how older entrepreneurs adopt new technology or introduce new products (Schneider and Veugelers 2010; Czarnitzki and Delanote 2012; Maula et al. 2007). Similarly, demographic studies of entrepreneurship mostly investigate non-age-related factors (Low and MacMillan 1988; Arenius and Minniti 2005). To our knowledge, except for Colovic and Lamotte (2012), on which this chapter builds, no other research has specifically investigated this issue, although, due to demographic change in Western societies, the elderly increasingly attract the attention of researchers. Second, our empirical study is based on a large database, thus improving the generalizability of the results.

The rest of this chapter is structured as follows. Sections 2 and 3 review the literature on the influence of age on entrepreneurship and innovation. Section 4 describes the database and the methodology we used. Section 5 tests our hypotheses. Section 6 discusses the main findings, highlights the limitations of the research and future research directions, and offers recommendations for supporting of third-age entrepreneurs.

2 Age and Entrepreneurship

The individual level factors that influence entrepreneurial behavior can be categorized as psychological, motivational, cognitive, and demographic. These factors influence entrepreneurship directly, either individually or in combination. However, unlike psychological, motivational, and cognitive factors, which can be context dependent (Welter 2011; Zahra et al. 2014), demographic factors such as gender and age are “inherent factors” of entrepreneurship (Parker 2004). Demographic studies of entrepreneurship mainly focus on gender. Interestingly, age seems to be present in most studies but mainly as a control factor rather than a substantive variable. In other words, although the effect of age is taken into account, it is simply explained away while other factors dominate explanations of entrepreneurial behavior. However, since age affects several of these individual level factors, it becomes an important factor in the decision to become an entrepreneur (Parker 2004; Lévesque and Minniti 2006; Minola et al. 2014). Indeed, recent studies show that age distribution is a key factor in determining the rate of entrepreneurship in a region (Bonte et al. 2009; Lamotte and Colovic 2013). In this regard, previous studies linking age and entrepreneurship suggest an inverted U relationship between age and the decision to start a business (Bonte et al. 2009), with the proportion of people trying to start a business being highest in the 25- to 35-year age group (Lévesque and Minniti 2006; Reynolds 2007). Mueller (2006) finds a positive, curvilinear relationship between age and the desire to start a business, peaking at the age of 41. Most empirical analysis that considers age as a control variable suggests that the probability of creating ones’ own business is highest among the relatively young (Blanchflower 2004; Lévesque and Minniti 2006).

The issue of the influence of age on entrepreneurial behavior can be examined from an employment choice perspective. As an employment choice decision, a long tradition of research highlights the significance of risk attitude in the choice of entrepreneurship over salaried employment. However, most studies do not consider the interplay between risk and age in influencing employment choices over people's entire life. However, it is generally known that risk aptitude decreases as people grow older (Josef et al. 2016). If the same applies to employment choice, it can be surmised that as individuals grow older, they are less likely to choose entrepreneurship over salaried employment. Lévesque and Minniti (2006) proposed that the dynamic interplay between age, risk, and employment choice can be explained if "time" is taken into account. Based on Becker's time allocation model, the authors propose that as time is an important and finite resource, people prefer an income-producing activity that produces the highest expected utility within a given time span, in this case the person's life span (Lévesque and Minniti 2006). Moreover, as entrepreneurship does not produce an instant (or riskless) return, the older the person, the less time they have to enjoy the future returns from business activity. This reduces the attractiveness of entrepreneurship over salaried employment, as people grow older. By incorporating time, Lévesque and Minniti's (2006) theoretical model suggests that in addition to attitude toward risk, activities that involve a "time commitment component" before producing an income, such as a new business, are less attractive than activities with immediate payoffs such as salaried employment.

However, it should also be noted that entrepreneurial ability is likely to increase with age, as people develop or acquire human, social, and financial capital over time (Curran and Blackburn 2001; Fairlie and Krashinsky 2012). The optimal time to be an entrepreneur should therefore be when one has developed sufficient human, social, and financial capital, but risk aversion and the emphasis on time are not yet too important. Hence, the preference of younger people for entrepreneurship. Although older people are more likely to be able to create a business than their younger peers, they are less likely to be willing to do so (Curran and Blackburn 2001).

However, the above explanation does not indicate the relationship between age and innovative entrepreneurship. When choosing innovative entrepreneurship, people face not only the risk arising from the employment choice decision but also that arising from the nature of innovation (Koellinger 2008; Dencker and Gruber 2015; Bayon et al. 2016). Moreover, the choice of innovative entrepreneurship requires both the ability and the desire to develop and implement innovative ideas, a propensity that might differ across different age groups.

3 Age and Innovation

Innovation propensity is essential for innovative entrepreneurs. Lumpkin and Dess (1996) define the propensity to innovate as a tendency to initiate and support new ideas, novelty, experimentation, and creative processes that may result in the

creation of new products, new services, or new processes technology. Such a propensity may be affected by the biological process of aging (Meyer 2011; Rietzschel et al. 2016). Studies on the evolution of cognitive abilities during a lifetime, of which Desjardins and Warnke (2012) provide a comprehensive review, are particularly interesting. They show that cognitive decline can start as early as the age of 20 and that it accelerates from the age of 50 (Hertzog et al. 2008). However, to understand the effect of cognition on the creative process, it is necessary to consider two types of intelligence that undergo cognitive changes: fluid intelligence and crystallized intelligence. While the former refers to the ability to reason logically and solve problems, the latter is the ability to use skills, knowledge, and experience (Cattell 1971). Fluid intelligence is genetically and biologically determined and tends to decline from adulthood. However, crystallized intelligence, which is socially and culturally determined, tends to increase until the age of 55, stabilizes up to the age of 75, and then declines (Baltes 1993; Desjardins and Warnke 2012). Baltes (1993) has suggested that the decline of fluid intelligence is offset by increased crystallized intelligence at least until the age of 75. In addition, studies have shown that creative ability decreases with age (Ruth and Birren 1985) because people are over influenced by their experience, which reduces their creative abilities. Thus, some abilities increase with age while others decline. In addition, physical and cognitive abilities depend not only on biological but also on behavioral, environmental, and social factors (Desjardins and Warnke 2012).

While changes in cognitive makeup may explain why older people may be less innovative, there are significant differences in the way younger and older people adopt new technology. For instance, the emerging literature on technology adoption by older people suggests that seniors are slower than other categories of workers to adopt innovative tools such as information and communication technology (Friedberg 2003; Weinberg 2004; Koning and Gelderblom 2006; Borghans and ter Weel 2002; Bertschek and Meyer 2008). Behaghel and Greenan (2010) provide one explanation for this phenomenon. Based on data from French firms, they suggest that workers over 50 are more reluctant to adopt technology because they receive less training during the implementation of technical changes. In the field of marketing too, several studies have shown that attitudes toward technology adoption vary with age. For instance, older people are often among the last to adopt innovative products, services, or ideas (Lunsford and Burnett 1992). Older consumers also seem to have a more negative attitude toward technology and use fewer new technologies (Gilly and Zeithmal 1985). This leads us to hypothesize:

H1: Third-age entrepreneurs are less likely to adopt innovative technology than those in other age groups.

While research findings generally conclude that older people are less likely to favor technology adoption, one of the very few studies that has looked at individual level factors influencing the choice of innovative entrepreneurship, by Koellinger (2008), suggests that age has no influence. However, the study by Bonte et al. (2009) on the innovation propensity of different age groups suggests the opposite. Based on regional data about German startups, the authors found a significant U-shaped

relationship, between age and innovative entrepreneurship. Age groups 20–29 and 40–49 are the most active in terms of innovative entrepreneurship, while age group 30–39 is less active. This is an interesting result, because it suggests that innovative entrepreneurs are concentrated in specific age groups. The authors suggest several explanations for this. Accumulated experience and knowledge that help create an innovative enterprise increase with age. However, the mindset and routines that become established over time leave less room for the recognition of entrepreneurial opportunities or creativity, and this inhibits the decision to create an innovative company (Bonte et al. 2009). Moreover, attitudes toward risk could influence the choice of innovative entrepreneurship, especially that related to new product introduction, since older people are themselves reluctant to use innovative products. This leads us to suggest that third-age entrepreneurs are less likely to pursue product/service innovation than other age groups.

H2: Third-age entrepreneurs are less likely to pursue product/service innovation than those in other age groups.

4 Empirical Analysis

The objective of this chapter is to determine whether third-age people, defined as those 50 years old and above, choose innovative entrepreneurship more or less than other age groups (Curran and Blackburn 2001; Kautonen et al. 2011; Maâlaoui et al. 2013). We used the Global Entrepreneurship Monitor (GEM) database. GEM is an annual assessment of entrepreneurial activity. The data come from surveys of a random sample of the adult population (APS) conducted between 2003 and 2013 on at least 2000 people per country. The database covers 100 developed and developing countries. From the main sample, we use the subsample of early-stage entrepreneurs (TEA) defined as those who have been engaged in an entrepreneurial activity for between 3 and 42 months at the time of the survey. The respondents are aged between 15 and 97. The full sample comprises 154,502 observations. We present the variables used in this study and data sources in Table 1.

The explained variables are binary variables *Product innovation* and *Technology adoption*. *Product innovation*, denoted by 1, is indicated when the product or service offered to the customers is considered new by all or some customers. Otherwise, it takes the value of 0. *Technology adoption* takes the value 1 when the technology or procedure required for production has been available for less than a year, 0 otherwise. In this sense, our definition of technology innovation is a broad one and includes procedures involved in the production/manufacture of the product or service. In other words, our explained variables take account of both product and process innovation. We consider the result of innovation rather than the intention to innovate, i.e., those in our sample are (or are not) in the actual process of introducing innovations. Our explanatory variable, *third-age entrepreneur* is binary. It takes the value 1 when the entrepreneur is 50 years old or more and 0 otherwise. We also include a set of control variables. Empirical studies have indeed highlighted the role of other personal characteristics of the entrepreneur, such as gender (Minniti and

Table 1 Description of variables and sources (Author's own table)

Dependent variables	
<i>New product (product innovation)</i>	= 1 if the product is new to all or some clients, 0 otherwise. Source: Global Entrepreneurship Monitor (GEM)
<i>New technology (technology adoption)</i>	= 1 if the technology or the procedure required for the production has been available for less than 1 year, 0 otherwise. Source: GEM
Independent variable	
<i>Third age</i>	= 1 if the entrepreneur is 50 years old or older, 0 otherwise. Source: GEM
Control variables	
<i>Gender</i>	= 1 if the entrepreneur is a male, 0 if the entrepreneur is a female. Source: GEM
<i>Higher education</i>	= 1 if the entrepreneur has a higher education degree, 0 otherwise. Source: GEM
<i>Opportunity</i>	= 1 if the entrepreneur stated that he/she created the enterprise because there was an opportunity, 0 if this happened because of economic necessity. Source: GEM
<i>Technology sector</i>	= 1 if the entrepreneurial activity takes place in the medium or high technology sector, 0 otherwise. Source: GEM

Table 2 Characteristics of the sample (Author's own table)

Age	New product		New technology		Total
	Yes	No	Yes	No	
<50	56,896	70,108	16,325	110,679	127,004
	44.8%	55.2%	12.9%	87.1%	100%
>50	11,897	15,601	2,940	24,558	27,498
	43.3%	56.7%	10.7%	89.3%	100%
Total	68,793	85,709	19,265	135,237	154,502
	44.5%	55.5%	12.5%	87.5%	100%

Nardone 2007) or education level (Davidsson and Honig 2003; Bayon et al. 2016), motivations (McMullen et al. 2008), and sector of activity (Thornhill 2006) in influencing innovative entrepreneurship. We also include country and year dummies in all regressions to control for country-level differences in terms of economic development and institutions over time.

Table 2 presents the characteristics of the sample related to explanatory variables and age groups. It shows, for each age group, the distribution of entrepreneurs according to innovative products and technologies. For example, of 27,498 third-age entrepreneurs, 11,897, that is, 43.3%, offer an innovative product. In comparison, 44.8% of entrepreneurs who are less than 50 years old offer an innovative product. There is also a difference with respect to the use of new technologies. 12.9% of younger entrepreneurs rely on technology that has been available for less than a year, as against 10.7% for their older peers.

Table 3 presents the main descriptive statistics of the variables and a correlation matrix. The variance inflation factors (VIF) in all regression models are between 1.06 and 2.88, which confirm the absence of colinearity between the explanatory and control variables.

Table 3 Descriptive statistics and correlation matrix (Author's own table)

Variables	Mean (S.d.)	1	2	3	4	5	6	7
1. New product (product innovation)	0.445 (0.497)	1.000						
2. New technology (Technology adoption)	0.125 (0.330)	0.091*	1.000					
3. Third age	0.178 (0.382)	-0.011*	-0.025*	1.000				
4. Gender	0.588 (0.492)	0.012*	-0.005*	0.013*	1.000			
5. Higher education	0.386 (0.487)	0.088*	-0.006*	0.004*	0.037*	1.000		
6. Opportunity	0.707 (0.455)	0.076*	0.000	-0.042*	0.063*	0.143*	1.000	
7. Technological sector	0.045 (0.207)	0.051*	0.011*	-0.008*	0.079*	0.099*	0.041*	1.000

Note: * $p < 0.1$

5 Results

Table 4 presents four models of probit regressions. In Models 1 and 2, the explained variable is *Product innovation*, while in Models 3 and 4 the explained variable is *Technology adoption*. Models 1 and 3 include only the control variables; Models 2 and 4 include the explanatory variable. We used the results in Table 4 to test hypotheses 1 and 2. All coefficients are significant at the 1% level with the exception of gender and motivation in Models 3 and 4. McKelvey and Zavoina’s R^2 are relatively small but are consistent with comparable empirical studies. In addition, as Hoetker (2007) suggested, R^2 for probit estimates cannot be interpreted intuitively or compared to those of OLS estimates. To facilitate interpretation of the results, we calculate the marginal values of probit estimates in Table 4. Marginal values indicate the observed result for the dependent variable when the explanatory variable changes from 0 to 1. Thus, starting from Model 2, we see that senior entrepreneurs are 1.8% less likely to offer a new product. Similarly, we observe that senior entrepreneurs are 1.6% less likely to use a new technology. These findings confirm our hypotheses.

The estimated coefficients for the control variables are also interesting. The estimated coefficient for gender is negative for process and product innovation. This suggests that female entrepreneurs are more innovative in terms of both product and technology. As expected, the higher education coefficient is positive for product innovation, suggesting that educated entrepreneurs are more likely to be innovative

Table 4 Logit regression models (Author’s own table)

	Model 1	Model 2	Model 3	Model 4
Variables	Dependent variable: New product (<i>product innovation</i>)		Dependent variable: New technology (<i>Technology adoption</i>)	
Third-age		−0.499*** (0.009)		−0.080*** (0.012)
Gender	−0.021*** (0.007)	−0.019*** (0.007)	−0.019** (0.009)	−0.019** (0.009)
Higher education	0.138*** (0.007)	0.137*** (0.007)	0.015 (0.009)	0.014 (0.009)
Opportunity	0.214*** (0.007)	0.212*** (0.008)	0.006 (0.009)	0.002 (0.009)
Technological sector	0.231*** (0.017)	0.229*** (0.016)	0.153*** (0.020)	0.150*** (0.020)
Country dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Pseudo R ²	0.104***	0.104***	0.07***	0.07***
Log likelihood	−91738.063	−91722.75	−52054.018	−52030.307
Nb. observations	148,908	148,908	148,908	148,908

Notes: *** $p < 0.01$, ** $p < 0.05$. Standard deviation is in parentheses. The number of observations is less than the total number of observations in the sample because of the missing data for control variables. Estimated coefficients of country dummies, year dummies, and constant are not reported

in terms of products. The estimated coefficients for the variable opportunity are particularly interesting. They are positive and significant for product innovation, but not significant for technology innovation. This clearly indicates that innovative entrepreneurs exploit product opportunities rather than technology opportunities. The estimated coefficients for technology sector indicate that innovative entrepreneurship is more common in areas of medium and high technology. This result is intuitive but important. In fact, innovation can occur in all sectors, including agriculture and retail.

6 Discussion and Conclusion

The aim of this study was to compare the innovativeness of older and younger entrepreneurs. Our empirical analysis shows that older entrepreneurs are less innovative than their younger peers with regard to both product and process innovation. These results support our hypotheses. Several explanations may clarify these results. From the gerontological perspective, third-age individuals suffer from a loss of cognitive functions, which reduces their ability to offer innovative products or to adopt innovative technologies. In addition, older business people are more reluctant to adopt new technologies and to obtain training in this area. They are therefore at a disadvantage when creating a new business, as they are less innovative. This reduced ability to innovate may affect the success of older entrepreneurs, as several studies have shown that the survival of young firms is largely dependent on their ability to innovate (Cefis and Marsili 2006; Buddelmeyer et al. 2010). Harada (2003) has also shown the existence of a negative relationship between the probability of success of an entrepreneur and his/her age, although the author does not suggest any particular reason for this. A lack of innovative ability could be an explanation.

The results of this research should however be nuanced for several reasons. First, the deterioration of cognitive abilities and reluctance to adopt new technologies do not affect all people the same way. As emphasized by Desjardins and Warnke (2012), the evolution of people's cognitive abilities depends on interactions between multiple factors: biological characteristics, education, family and social environment, occupation, cognitive stimulation, and physical exercise. For example, those who exercise an intellectual profession that requires them to adapt frequently to technological change suffer less from the cognitive losses associated with aging (Valenzuela and Sachdev 2006). In contrast, recent studies show that retirement accelerates cognitive decline (Bonsang et al. 2012). Second, the propensity to innovate also depends on economic, social, and cultural development, which can be more or less favorable to innovative entrepreneurship. Thus, Koellinger (2008) shows that entrepreneurs are more likely to innovate in developed, high-income countries. Lee et al. (2004) show that a socially and culturally diverse environment facilitates the influx of specific human capital and the dissemination of information for innovation and entrepreneurship. Finally, the results of this research are valid over the study period but cannot be generalized to other periods. They may be

affected by cohort effects, that is to say, by the specific characteristics of a generation or a structural change caused by specific major events, such as the development of IT or the Internet (Desjardins and Warnke 2012). Thus, being 50 years old today is not comparable to being 50 years old 10 years ago, especially in terms of entrepreneurship and innovation. Therefore, the results of this study should be interpreted with caution and positioned in the current context.

This study has several limitations, mainly due to the limitations of the database, which in turn open up possibilities for future research. First, the empirical analysis is based on survey data, a possible source of bias. In particular, the variables innovative products and technologies are based on the statements of entrepreneurs, although, as Koellinger (2008) suggested, innovation is a subjective concept that depends on the viewpoint of the observer. This limitation is particularly significant in the context of studies on generational differences, where the perception of innovation may be affected by the respondent's age. Second, this study is based on the actual age of the entrepreneurs rather than their perceived age. However, perceived age may differ from actual age, especially for seniors, depending on their state of health, life expectancy, or the place of older people in society. A recent study by Kautonen et al. (2011) has shown that seniors' entrepreneurial intentions depend among other things on their perception of entrepreneurship at different ages. Future research could examine the impact of perceived age on the propensity to create firms, particularly innovative firms. This development would be extremely relevant, as it would take into account the role of the economic and social environment in age perceptions. Third, this study does not specifically identify the reasons for the reluctance of third-age people to innovate. To complement this research, it would be interesting to analyze the barriers faced by seniors wishing to start an innovative company. In fact, studies on this topic are rare and do not focus on innovative entrepreneurship. Kibler et al. (2015) and Wainwright et al. (2011) show that society's negative perception of older entrepreneurs, real or perceived, is a significant barrier to the development of third-age entrepreneurship. Other barriers that deserve investigation include funding difficulties generated by older entrepreneurs' shorter time horizons. Fourth, this research includes product and process innovation but not organizational innovation, yet this could be important, particularly among older entrepreneurs because of their experience.

The study has practical implications for third-age entrepreneurs and public authorities. The most important recommendation is that people's skills should be maintained or improved throughout life. Steps in this direction would limit the cognitive decline related to aging but also facilitate the adoption of new tools by seniors. Periods of inactivity, especially in later life, should not cause a loss of skills. Training or activities to maintain intellectual and physical activity should be promoted. Strengthening intergenerational knowledge transfers might also effectively combine fluid and crystallized intelligence. Finally, it is necessary to establish specific policies to promote and support third-age entrepreneurship, taking into account the particular challenges they may encounter in their entrepreneurial projects, such as negative perceptions of the company or access to financial resources. All these measures can be implemented by support organizations but also internally by companies wishing to help their employees to start a business.

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