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**Entrepreneurship by Ph.D. students: Intentions, Human Capital, and University Support Structures**

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## Entrepreneurship by Ph.D. students: Intentions, Human Capital, and University Support Structures

### ABSTRACT

#### Research purpose:

Doctoral students are promising entrepreneurial actors in university-based ventures, that positively impact the external environment and create value for their universities. In this article, we extend current research on academic entrepreneurship by shedding light on the role of university support in the early stage of Ph.D. entrepreneurship. Based on social information processing theory, we posit that academic entrepreneurship results from the interplay between doctoral students' human capital and university-level support. A multilevel model is proposed and empirically tested to shed light on the cradle of doctoral students' entrepreneurship by explaining the variance of their entrepreneurial alertness and intentions.

#### Research design:

A model is proposed that explains the combined effect of specific human capital and different forms of university support on doctoral students' cognitive transition from entrepreneurial alertness to intentions. The model was then tested through structural equation modeling (SEM) and multigroup analysis (MGA) on a sample of 187 doctoral students enrolled in Italian universities.

#### Findings:

Our SEM results reveal that doctoral students' entrepreneurial alertness is influenced by perceived educational support and human capital. The MGA demonstrates that those who perceive a higher level of support for concept and business development from universities are more likely to convert their alertness into intentions than those who perceive lower support.

#### Originality/value:

The present paper brings to the stage doctoral students as an extremely promising entrepreneurial target. In so doing, it extends academic entrepreneurship studies by detailing how and when the different forms of university support influence their entrepreneurial decisions, along with individual dimensions.

**Keywords:** Entrepreneurial university; Knowledge Transfer; Academic entrepreneurship; Doctoral students; Entrepreneurial intentions; Structural Equation Modeling (SEM); Multi-group analysis (MGA)

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1. INTRODUCTION

Universities have become essential players in social and economic development due to their role as knowledge producers (Bedó *et al.*, 2020). Consequently, these institutions embraced an entrepreneurial path for responding to the call of being able to translate knowledge into impact for local stakeholders (Fuller and Pickernell, 2018), which is the essence of the so-called third mission (Audretsch, 2014; Klofsten *et al.*, 2019). In this framework, academic entrepreneurship should be conceived as an individually enacted transfer mechanism that allows the translation of research findings and specific expertise into social and economic impact (Fini *et al.*, 2018). Accordingly, academic entrepreneurs, whether they are tenured scholars, undergraduates, or doctoral students, are those who use research and specific skills to identify and exploit an entrepreneurial opportunity to generate economic, social, and political change (Mars and Rios-Aguilar, 2010). In recognizing the potential of academic entrepreneurship as a tool for realizing their third mission, universities are enacting specific policies to nurture and support academic actors’ entrepreneurial initiatives (Guerrero and Urbano, 2012; Trivedi, 2016).

Past inquiry has identified primarily tenured professors (Urban and Chantson, 2019; Hayter *et al.*, 2021) and graduate students (Varamäki *et al.*, 2015; Krichen and Chaabouni, 2021) as potential academic entrepreneurs. However, a recent research trend is emerging that recognizes the great potential of doctoral students as a promising target in academic entrepreneurship (Muscio and Ramaciotti, 2019). This is due to their specific characteristics that make doctoral students particularly attractive for the development of entrepreneurial projects (e.g., Lean, 2012; Mars and Moravec, 2022). Moreover, empirical contributions have demonstrated that doctoral students have a relevant role at the forefront of university-based ventures (e.g., Hayter *et al.*, 2017; Rizzo, 2015). As a result, universities are increasingly interested in supporting doctoral students in developing entrepreneurial ventures, making entrepreneurial support a priority (Bienkowska *et al.*, 2016). However, recent inquiry has

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3 mostly focused on specific aspects, such as the effect of the university environment on doctoral  
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5 students' propensity to become entrepreneurs (e.g., Muscio and Ramaciotti, 2019), rather than  
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7 on specific forms of entrepreneurship education that could be applied to this specific target  
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9 (Klofsten *et al.*, 2021; Rippa *et al.*, 2022). As a result, a comprehensive understanding is still  
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11 missing of whether and how the university structures can support doctoral students' decision to  
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13 become entrepreneurs.  
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17 The present study identifies the emergence of doctoral students' entrepreneurship as a  
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19 cognitive transition from entrepreneurial alertness, which is an individual's proactive stance  
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21 toward entrepreneurial opportunities (Ardichvili *et al.*, 2003; Kirzner, 1979; Tang *et al.*, 2012),  
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23 to entrepreneurial intention, defined as "self-acknowledged conviction by a person that they  
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25 intend to set up a new business venture and consciously plan to do so at some point in the  
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27 future" (Thompson, 2009, p. 676). Thus, the study of the phenomenon is approached through a  
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29 social information processing lens (Salancik and Pfeffer, 1978), according to which the  
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31 interplay between the individual dimension and the support they perceive from universities is  
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33 the main driver towards their entrepreneurial transition (Moog *et al.*, 2015; Wright *et al.*, 2017).  
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35 In so doing, the gap is addressed by proposing and empirically testing a conceptual model that  
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37 explains how and when university support facilitates doctoral students' decision to become  
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39 entrepreneurs, considering both university support and the individual dimension. Our results  
40  
41 show that the support in terms of entrepreneurship education influences the entrepreneurial  
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43 alertness of doctoral students along with their human capital. Moreover, doctoral students who  
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45 perceive higher levels of university support for concept and business development are more  
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47 likely to convert their alertness into intentions than their counterparts who perceive lower levels  
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49 of support.  
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56 These results have threefold implications for research. First, our findings illuminate the  
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58 dynamics underlying the early stage of entrepreneurship among doctoral students, who  
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represent a promising though understudied target. Second, they clarify how and when university support plays a role in the academic entrepreneurship process. Third, it sheds light on how different forms of support facilitate the transition from alertness to intention. Finally, the present findings offer valuable policy insights for universities by providing them with tools based on empirical research to facilitate the entrepreneurial development of doctoral students.

The following section provides the theoretical contextualization of the study, followed by a description of the methodology adopted. The results are then presented - articulated into descriptive statistics, measurement, and structural model assessment. The paper concludes by outlining and discussing the main theoretical and practical implications of our results.

**2. THEORETICAL FRAMEWORK**

**2.1. Entrepreneurship as a tool for modern universities**

The vital role of universities in promoting societal progress is widely recognized (Audretsch, 2014; Culkin, 2016), as they produce new knowledge that is the fuel for social and economic growth in local communities (Martin *et al.*, 2019; Unger *et al.*, 2020). However, getting the knowledge produced to transcend the boundaries of academia is a great challenge (Culkin, 2016), which has prompted universities to create conditions to facilitate entrepreneurship among academic actors (Pittaway *et al.*, 2020). Indeed, higher education institutions see the full potential of entrepreneurship as a tool implemented at the individual level to translate research produced within the "ivory tower" into social and economic growth (Fini *et al.*, 2018; Johannisson, 2022). Consequently, academic entrepreneurs are agents in higher education institutions who exploit entrepreneurial opportunities from within or outside the organization to generate social and political change (Mars and Rios-Aguilar, 2010).

This is the reason why universities, in pursuing their third mission, have sought to provide support in many forms (Fayolle and Redford, 2014) to promote entrepreneurship as a



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3 tool to facilitate the transfer of knowledge and technology to external stakeholders (Fini *et al.*,  
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5 2018).  
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## 10 **2.2 Doctoral students as a promising entrepreneurial target**

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12 The debate on the relevance of doctoral students as an entrepreneurial target goes through a  
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14 great emphasis on the potential of academic entrepreneurship, particularly the creation of  
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16 university-based ventures, as a means to maximize the economic and social impact of research,  
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18 but also to generate internal benefits within the university (Miranda *et al.*, 2018). First, it is a  
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20 fact that universities exert a role in the development of local communities through the  
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22 production of new knowledge (Klofsten *et al.*, 2019; Valero and Van-Reenen, 2019). In doing  
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24 so, the creation of university-based ventures is particularly relevant because it enables new job  
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26 creation, increases tax incomes, and generates an indirect effect that contributes to the region's  
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28 economic growth (Guerrero *et al.*, 2015; Visintin *et al.*, 2014). Nonetheless, venturing within  
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30 academia contributes to generating resources for the university, which can be used to fund  
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32 further research (Dalmarco *et al.*, 2018; Wood, 2011).  
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38 Among all academic actors, doctoral students have specific characteristics that make  
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40 them a high-potential target for universities to connect with the external environment through  
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42 knowledge and technology transfer (Lean, 2012; Hayter *et al.*, 2017; Klofsten *et al.*, 2021). As  
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44 evidence of the potential of this target, doctoral students have been increasingly concerned by  
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46 scholarly research and policy reports (e.g., Boman *et al.*, 2021; European Science Foundation,  
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48 2017; Hayter *et al.*, 2017; Rippa *et al.*, 2022), which highlighted a number of reasons why this  
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50 academic target warrants consideration as an entrepreneurial target. First of all, higher  
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52 education has taken on a broader meaning in a society that regards knowledge as a valuable  
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54 asset for economic and social growth (Casey, 2009; Gould, 2015). This has inevitably led  
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56 universities, policymakers, and doctoral students themselves to rethink the postgraduate degree,  
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which has shifted from being exclusively conceived as the pathway to an academic career to being recognized as a learning path that generates highly specialized profiles capable of making meaningful contributions to society, most importantly by means of entrepreneurship (Shin *et al.*, 2018). As a result, universities are increasingly integrating the curriculum of their doctorates aiming to provide them with skills with which to navigate their entrepreneurial way (Shin *et al.*, 2018; Klofsten *et al.*, 2021; Rippa *et al.*, 2022). Moreover, entrepreneurship could be a pursuable and promising career for doctoral students, as they do not have already defined career paths (Rizzo, 2015) and thus they are ripe for developing professional identities (Sweitzer, 2009). Several surveys of Ph.D. career trajectories have been conducted in Europe, and the data seem to converge toward an increase in the share of graduates opting for entrepreneurial careers. In 2015, 1 percent of Ph.D. holders were choosing entrepreneurship as a career (European Science Foundation, 2015). Two years later, the share rose to 2 percent (European Science Foundation). Interestingly, in 2021, the share of self-employed PhDs in Europe rose to 6.8 percent (Boman *et al.*, 2021). These dynamics support the idea that the knowledge, skills, and abilities acquired during doctoral studies represent an asset that is not exploitable just in the academic setting but can also be enhanced in the outside world through entrepreneurship.

In light of this, recent inquiry is devoting growing attention to the career expectations of Ph.D. holders (e.g., Hnatkova *et al.*, 2022; Mangematin, 2000), as well as to their role as potential academic entrepreneurs (e.g., Hayter *et al.*, 2017; Muscio and Ramaciotti, 2019). There is an increasing amount of thought being given to the contribution, not necessarily just economic, that Ph.D. graduates can make to society (Casey, 2009; Halse and Mowbray, 2011). Entrepreneurship is a tool through which doctoral students can make a breakthrough in speeding up the social and economic impact of the knowledge produced (Klofsten *et al.*, 2021; Rippa *et al.*, 2022), while at the same time supporting their research activities by maximizing their social impact (Mars and Moravec, 2022). In response to these changing needs, universities are

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3 increasingly investing resources to provide them with tangible and intangible facilities to  
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5 smooth the entrepreneurial exploitation of research results and specific skills (Bienkowska *et*  
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7 *al.*, 2016; Muscio and Ramaciotti, 2019). Increasing attention from educational institutions and  
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9 policymakers has stimulated empirical research on the role of university entrepreneurial support  
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11 in fostering entrepreneurship among doctoral students, which, however, is still in its infancy  
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13 (Bienkowska *et al.*, 2016). However, there are meaningful exceptions, which indicate that the  
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15 scientific community is becoming aware of the potential of doctoral students as entrepreneurs  
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17 and is converging on the need to investigate the dynamics behind their entrepreneurial  
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19 initiatives and the role of the university support system in nurturing these initiatives.  
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21 Interestingly, Feola *et al.* (2019) found that cognitive factors such as entrepreneurial attitudes,  
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23 perceived behavioral control, and social norms positively influence doctoral students'  
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25 entrepreneurial intentions, while only government support and external funding opportunities  
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27 influence their entrepreneurial intentions. Similarly, Baena-Luna *et al.* (2022) and Muscio and  
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29 Ramaciotti (2019) explored the emergence of doctoral students' entrepreneurship by  
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31 considering the individual and university dimensions, respectively, both recognizing the great  
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33 potential of the target. Adopting an intrapreneurial perspective, Baena-Luna *et al.* (2022) found  
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35 that differences in doctoral students' entrepreneurial intentions can be traced to their gender.  
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37 Muscio and Ramaciotti (2019) showed that university- and department-level factors have a  
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39 positive effect on doctoral students' decision to found entrepreneurial ventures. These examples  
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41 show that the increasing scientific focus on doctoral students as entrepreneurs is influencing  
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43 recent research. However, a gap persists in understanding the combined role of individual  
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45 factors and the university support system in doctoral students' decision to become entrepreneurs  
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47 (Muscio *et al.*, 2021).  
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**2.3. The emergence of academic entrepreneurship: individual vs university support**

Social information processing theory posits that individual behavior in a given organization results from an interplay between individual and organizational dimensions (Salancik and Pfeffer, 1978). This idea is also not new in the field of academic entrepreneurship, with the seminal contribution of Turker and Selcuk (2009) paving the way to approach the phenomenon through this perspective, by highlighting the importance of considering both structural and individual factors to explain the formation of entrepreneurial intentions. Subsequently, several empirical works in the field of academic entrepreneurship have combined these two dimensions (e.g., Feola *et al.*, 2019; Goethner *et al.*, 2012). Although interesting, the proposed models have the limit of being focused on the mere formation of entrepreneurial intentions.

Any investigation of an entrepreneurial phenomenon, both within and outside the university, cannot ignore the individual dimension (Bercovitz and Feldman, 2008). Because of this, the notion of specific human capital, defined as the set of skills and competencies specifically useful for performing a given task (Becker, 1962), fits this theoretical lens. As a proxy for an individual's entrepreneurial potential (Wheadon and Duval-Couetil, 2019), it influences individuals' ability to recognize entrepreneurial opportunities (Adel-Rastkhiz *et al.*, 2019). Its role has been demonstrated by existing research in academic entrepreneurship, suggesting that such human capital plays a role early in the process (e.g., Foo *et al.*, 2016; Goethner *et al.*, 2012; Solesvik *et al.*, 2013).

We embedded human capital within a broader theoretical framework to explain how doctoral students' entrepreneurial processes arise and to understand whether individuals with high levels of specific human capital are more alert to entrepreneurial opportunities and, as a result, more likely to pursue entrepreneurship. Entrepreneurship-oriented human capital is defined as knowledge derived from prior experience that can be useful for acting

entrepreneurially, in light of the individual's ability to transform prior experience into knowledge (Politis, 2005; Ucbasaran *et al.*, 2008; Wheadon and Duval-Couetil, 2019). On the other hand, human capital oriented toward academic engagement is conceived as the set of prior experiences involving interaction with nonacademic organizations (Perkmann *et al.*, 2021). Therefore, we formulated the following hypothesis:

*H1: Entrepreneurship-oriented human capital positively affects doctoral students' entrepreneurial alertness.*

*H2: Academic engagement-oriented human capital positively affects doctoral students' entrepreneurial alertness.*

Applying the scheme of social information processing to academic entrepreneurship, the university environment was expected to interact with the background of doctoral students, thus influencing their decision to become entrepreneurs. It is a fact that universities provide a wide range of entrepreneurship training tools as a form of support for academic actors (Fayolle and Redford, 2014). Moreover, it is recognized that receiving entrepreneurship training endows students and young scholars with a set of skills and competencies that make them potentially alert to entrepreneurial opportunities (Solesvik *et al.*, 2013). On the base of these considerations, we also expected that the extent to which doctoral students perceive that they are supported in terms of entrepreneurship education, as a form of entrepreneurial support from universities, would be directly related to their entrepreneurial alertness. Therefore, we proposed a third hypothesis:

*H3: Perceived educational support positively affects doctoral students' entrepreneurial alertness.*

Previous empirical work has studied the formation of entrepreneurial intentions as a static phenomenon that occurs overnight (e.g., Feola *et al.*, 2019; Knockaert *et al.*, 2015; Wegner *et al.*, 2019). In contrast, we argue that the decision to act entrepreneurially should be

framed in a broader conceptual framework to capture its complexity and multi-level nature (Thompson, 2009). Consistently with previous literature which widely recognized these two outcomes as the pillars of the entrepreneurial process (Ardichvili *et al.*, 2003; Shane and Venkataraman, 2000; Thompson, 2009), our study focused on the relationship between entrepreneurial alertness and entrepreneurial intentions as a cognitive transition underlying the arising of the entrepreneurial process (Obschonka *et al.*, 2017; Gielnik and Wang, 2018). Consequently, this study argues that this transition should be studied as the cradle of academic entrepreneurship, as stated in our fourth hypothesis:

*H4: Entrepreneurial alertness positively affects doctoral students' entrepreneurial intentions.*

**2.4 University support system as a booster for Ph.D. entrepreneurship**

Scholars have mostly studied university support as a predictor of entrepreneurial intentions (e.g., Laudano *et al.*, 2019; Saeed *et al.*, 2015; Wegner *et al.*, 2019; Turker and Selkuk, 2009). However, it is still unclear how these forms of support play a role beyond reinforcing entrepreneurial intentions at the early stage of the entrepreneurial process. Moreover, the positive effect of university support on entrepreneurial intentions has not always been confirmed by empirical findings, which themselves are often conflicting (e.g., Laudano *et al.*, 2019; Trivedi, 2016; Wegner *et al.*, 2019). Accordingly, our general expectation was that two distinctive forms of perceived entrepreneurial support matter in doctoral students' decision to become entrepreneurs: concept development (i.e., in a very early stage of the entrepreneurial process) and business development (i.e., in a later stage approaching the founding of the new venture). Therefore, we hypothesized that when doctoral students perceive strong entrepreneurial support from their universities, their decision to join entrepreneurship is facilitated by a supportive university environment that supports their entrepreneurial journey (Bienkowska *et al.*, 2016). More formally:

*H5: The relationship between entrepreneurial alertness and entrepreneurial intentions is stronger for doctoral students who perceive higher levels of support for concept development.*

*H6: The relationship between entrepreneurial alertness and entrepreneurial intentions is stronger for doctoral students who perceive higher levels of support for business development.*

Our conceptual model proposes that doctoral students' human capital, expressed as human capital oriented toward entrepreneurship and academic engagement, and the perceived educational support provided by universities influence their entrepreneurial alertness. Furthermore, it is suggested that doctoral students' entrepreneurial alertness, in turn, influences their entrepreneurial intentions, although with differences depending on how much support for concept development and business development is perceived by their universities.

### 3. METHOD

#### 3.1. Sample

For our research, we surveyed 187 doctoral students enrolled in 15 Italian universities. The Italian data are illuminating for understanding the entrepreneurial potential of the target. Muscio and Ramaciotti (2018) provided a clear and comprehensive portrait of doctoral students' entrepreneurial endeavors in the Italian context, pointing out that 6 percent of their sample had already started a business, while 5 percent of the respondents were actively engaged in the creation of a new venture. Overall, an effervescent environment emerged, in which doctoral students are becoming increasingly aware of their entrepreneurial potential and are exploring new career paths outside academia.

As shown in Table I, 54.01 percent of the respondents identify themselves as women, while the rest are distributed between those who identify as men (45.45 percent) and those who do not fall into a binary gender division (.54 percent). Most of the respondents (64.70 percent) are aged between 20 and 29. In terms of home university, our sample appears to be distributed

throughout the country, with a slight preponderance toward the north of the country - 56.71 percent of the respondents are doing their doctoral studies in the northern part of Italy. Interestingly, a heterogeneous composition is observed in the sample for what concerns the research field: 26.2 percent in social sciences, 33.1 percent in technology-related research fields, 4.8 percent in humanities, and 23.5 percent in biological sciences. The remainder are pursuing doctoral studies in the physical sciences. Overall, it can be said that the sample is representative of the entire national context and belongs to different research areas.

We assessed the adequacy of the sample size through an *a priori* power analysis using G\*Power software (Faul *et al.*, 2009). As suggested in the methodological literature (Cohen, 1988), we expected a minimum  $R^2$  value of .10, a statistical power of 80 percent, and six predictors (a number referring to entrepreneurial intentions, which is the latent variable with the largest number of predictors). The *a priori* calculation of G\* power indicated that a sample size of 119 would be required, meaning that our final sample size was adequate to test the hypotheses.

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Insert Table I around here  
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3.2 Data collection

The present study adopts a cross-sectional research design to investigate the relationships among latent constructs and to assess differences among different subsamples. This approach has been strongly criticized for its alleged limitations in proving causal processes, but it is still extremely useful for empirically demonstrating relationships between latent variables (Spector and Meier, 2014). Following the philosophical and methodological suggestions proposed by Spector (2019), we examined the relationships based on the existence of statistically significant



correlations among the variables in our model, as shown in Table II. In addition, having considered the control variables secures our results from being influenced by other factors outside the model. Finally, before administering the questionnaire, we implemented remedies to minimize common method bias and conducted Harman's single-factor test to show that our study was not exposed to that risk.

Data were collected through an online survey administered in English through Microsoft Forms<sup>®</sup>, which can be found in Appendix I. As suggested in the methodological literature (Forza, 2002), data collection was preceded by a pilot phase in July 2021, during which 19 doctoral students at the University of Cagliari (Italy) were asked to complete the questionnaire and provide feedback on question comprehensibility and logical structure.

### 3.3. Measures

The measures of each construct were designed based on a review of existing literature. As done in previous empirical contributions (e.g., Obschonka *et al.*, 2012; Feola *et al.*, 2019; Othman and Othman, 2020), entrepreneurial alertness, entrepreneurial intentions, and the three forms of entrepreneurial support are conceived as reflexive constructs. Conversely, we followed Dimov (2017) to define human capital as a formative variable. All measures were operationalized as follows.

**3.3.1. Human capital.** The indicators of entrepreneurship-oriented human capital were derived from published empirical work (e.g., Ucbasaran *et al.*, 2008). The construct was designed as consisting of three binary indicators: (i) previous entrepreneurial experience, (ii) previous work experience, and (iii) having at least one parent who is an entrepreneur (e.g., running a family business). On the other hand, indicators of academic engagement-oriented human capital were constructed based on existing literature (Perkmann *et al.*, 2021). Four

binary indicators form the latent variable: (i) consulting, (ii) contract research, (iii) patents, and (iv) training experience.

**3.3.2. Entrepreneurial alertness.** Entrepreneurial alertness was operationalized using the scale developed by Kuckertz *et al.* (2017) to measure opportunity identification, as done in previous research (e.g., Maran *et al.*, 2021; Rahman *et al.*, 2021). All six scale items were included in the questionnaire and, following the original wording, were rated on a 7-point Likert scale ranging from 1 (total disagreement) to 7 (total agreement). For example, item 3 was "I search systematically for business opportunities", while item 4 was "I look for information about new ideas on products or services".

**3.3.3. Entrepreneurial intentions.** We operationalized entrepreneurial intentions by adopting the six-item questionnaire on entrepreneurial intentions developed by Liñán and Chen (2009). The questionnaire has been widely adopted in existing studies on entrepreneurship (Feola *et al.*, 2019; Gieure *et al.*, 2020). Following the original wording, we again used a 7-point Likert scale ranging from 1 (total disagreement) to 7 (total agreement). The scale includes items such as "I am ready to do anything to become an entrepreneur" and "I have the firm intention to start a business someday."

**3.3.4. Entrepreneurial support from universities.** The construct of university entrepreneurial support was measured with the three-dimensional scale developed by Kraaijenbrik *et al.* (2010), as done in previous contributions (e.g., Trivedi, 2016; Wegner *et al.*, 2019). The scale includes fourteen questions: six related to educational support, four related to perceived support for concept development, and four related to support for business development. Following the original version, we used a 7-point Likert scale ranging from 1 (total disagreement) to 7 (total agreement). Examples of items for educational support, concept development, and business development support are, respectively, "My university offers

elective courses on entrepreneurship," "My university motivates students to start a new business," and "My university serves as a lead customer for students starting a new business".

**3.3.5. Control variables.** Recognizing that specific individual and contextual characteristics can influence the emergence of academic entrepreneurship (Goethner *et al.*, 2012; Bienkowska *et al.*, 2016; Baena-Luna *et al.*, 2022), we had to consider the effect of respondents' demographic characteristics, as well as their affiliation and field of study. For this purpose, we used age, gender, university, and field of research as control variables to exclude the effect of respondents' specific characteristics on the relationships studied in the model (Spector, 2021). While age was recorded by considering each respondent's age (in years) at the time of data collection, gender was studied as a categorical variable (coded as 0 = male, 1 = female, 2 = non-binary), as were university and field of research. The former was coded by assigning a number to each university (e.g., University of Catania = 1; Polytechnic University of Turin = 8), while for the latter, a number was assigned to each research area (e.g., social sciences = 1; humanities = 3).

### 3.5 Common method bias.

All variables in this paper were collected from the same respondents during the same time period, and this exposes our results to the risk of common method bias (Spector, 2019). To minimize this risk, we implemented a procedural remedy before administering the questionnaire and then conducted a statistical test after concluding the survey. The first is to present the items of each construct separately in the questionnaire so that the constructs are psychologically separated for the respondents. The other remedy is to conduct Harman's single-factor test (Harman, 1976) following the methodological suggestions provided by Podsakoff *et al.* (2012). A single-factor principal component analysis was conducted with all constructs included in our model. It was found that one single factor explained 44.07% of the overall

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variance, which is well below the 50% threshold proposed in the methodological literature by Podsakoff *et al.* (2003). The results of this test assisted us in minimizing the risk of common method bias.

**3.6 Correlation matrix**

As shown in the correlation matrix (Table II), a strong and statistically significant linear correlation was observed between entrepreneurship-oriented human capital and entrepreneurial alertness ( $r = .362, p < .05$ ), as well as between academic engagement-oriented human capital and entrepreneurial alertness ( $r = .434, p < .05$ ). Similarly, a statistically significant correlation links educational support and entrepreneurial alertness ( $r = .234, p < .05$ ). This implies that high levels of both types of human capital are associated with high levels of entrepreneurial alertness, paving the way for an inquiry into relationships between these constructs (Spector, 2019). In addition, a high and statistically significant correlation is also observed between entrepreneurial alertness and intentions ( $r = .804, p < .05$ ). Similar considerations can be extended to the relationship between these constructs.

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Insert Table II around here  
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The control variables deserve some separate considerations. First, we observed a weakly significant correlation between age and entrepreneurial alertness ( $r = .188, p < .10$ ), as well as with entrepreneurial intentions ( $r = .144, r > .10$ ). Moreover, no statistically significant correlations were found between university and research fields and the other constructs in the model (e.g., university and entrepreneurial alertness  $r = .116, p > .10$ ; research field and entrepreneurial intentions  $r = -.093, p > .10$ ). The only statistically significant linear correlation is measured between age and entrepreneurship-oriented human capital and academic

engagement (respectively,  $r = .751$ ,  $r < .05$  and  $r = .258$ ,  $r < .05$ ), but this is rooted in the relationship between past experience and human capital (Becker, 1962; Marvel and Lumpkin, 2017). All this considered, the results of the correlation matrix demonstrate that the control variables (age, gender, university, and research field) do not influence the relationships studied in our model.

### 3.4. Data Analysis

Employing the statistical software SmartPLS 3<sup>®</sup> (SmartPLS GmbH, Bönningstedt, Germany), the relationships between latent variables were tested using the partial least squares structural equation modelling (PLS-SEM). In addition, we looked for differences in the cognitive transition between entrepreneurial alertness and entrepreneurial intentions by conducting a multi-group analysis (MGA).

PLS-SEM is highly recommended when there are formative constructs in the structural model and when complex relationships between variables are examined (Hair *et al.*, 2017), as in our research. Moreover, this method has already been used for studies aimed at unraveling the multilevel dynamics underlying the pursuit of the third mission by entrepreneurial universities (e.g., Feola *et al.*, 2019; Guerrero and Urbano, 2012). On the other hand, MGA is a useful tool to test for differences in the relationships between variables due to individual-specific characteristics rather than different perceptions of the surrounding environment (Matthews, 2017). Recent contributions (e.g., Bienkowska *et al.*, 2016) have shown that perceptions of university support may be deeply subjective in nature, due to personal differences that influence doctoral students' attitudes toward entrepreneurship. In light of this, it was needed to assess before the analysis whether perceived university support implied a difference in entrepreneurial alertness and entrepreneurial intentions. To do so, we calculated two different variables measuring perceived university support through a median split. Thus,

two groups resulted for each variable: low vs. high support for concept development and low vs. high support for business development. Next, we tested for significant differences between the mean values of each group using a t-test performed with SPSS® (IBM Corp. Released 2020. IBM SPSS Statistics for Windows, Version 27.0). The 93 participants who perceived a high level of support in concept development showed higher entrepreneurial alertness ( $M = 3.25$ ,  $SD = 1.45$ ) and higher entrepreneurial intentions ( $M = 3.31$ ,  $SD = 1.79$ ) than the 94 participants who perceived less of the same support and showed lower entrepreneurial alertness ( $M = 2.73$ ,  $SD = 1.29$ ) and lower entrepreneurial intentions ( $M = 2.67$ ,  $SD = 1.68$ ). Between-group differences for alertness,  $t(185) = -2.065$ ,  $p = .04$ , and entrepreneurial intentions,  $t(182) = -2.121$ ,  $p = .035$ , were significant.

Similarly, the 93 participants who perceived a high level of business development support showed higher entrepreneurial alertness ( $M = 2.99$ ,  $SD = 1.48$ ) and higher entrepreneurial intentions ( $M = 3.00$ ,  $SD = 1.81$ ) than the 94 participants who perceived less of the same support and showed lower entrepreneurial alertness ( $M = 2.56$ ,  $SD = 1.39$ ) and lower entrepreneurial intentions ( $M = 2.48$ ,  $SD = 1.60$ ). Between-group differences in entrepreneurial alertness,  $t(185) = -2.065$ ,  $p = .04$ , and entrepreneurial intentions,  $t(182) = -2.121$ ,  $p = .035$ , were also significant. The results from this test revealed that there is heterogeneity in the sample in terms of perceived support for concept and business development. In such cases, assuming homogeneity in the sample in terms of perceptions of the surrounding environment would have resulted in a bias in the analysis (Sarstedt *et al.*, 2011). Therefore, we conducted an MGA to further investigate how concept development and business development support influence the relationship between entrepreneurial alertness and intention. Similarly to our work, this method has been used by other published works in entrepreneurship to assess differences in the relationships between latent variables (e.g., Ramadani *et al.*, 2022).

## 4. RESULTS

Our PLS-SEM model consisted of a measurement model and a structural model, and its evaluation required analysis and interpretation of both (Henseler and Sarstedt, 2013). Below are the descriptive statistics and assessment of the measurement and structural models.

### 4.1. Descriptive Statistics

Table III presents the descriptive statistics.

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### 4.2. Measurement Model

Reflexive constructs were assessed by average variance extracted (AVE) - the ratio of summed square loadings to the number of indicators (Nunnally and Bernstein, 1994) -, composite reliability (CR) - the ratio of the true variance to the observed variance in the model (Brunner and Süß, 2005) -, and to Cronbach's alpha - which indicates how closely a set of items is related as a group by relating the number of test items and the mean intercorrelation between them (Cronbach, 1951). Convergent validity and reliability measures were unsuitable to assess formative constructs because they are co-causes of the latent variables and therefore not necessarily correlated (Hair *et al.*, 2012). Therefore, formative measures were evaluated using external weights and the variance inflation factor (VIF), which is the quotient between the variance of an indicator estimate in a model that considers multiple indicators and the variance of a model created using only one indicator term (Bollen and Ting, 2000). This measure is usually used to test collinearity (Diamantopoulos and Winklhofer, 2001).



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Insert Table IV around here  
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As shown in Table IV, the values of Cronbach's alpha ( $> .70$ ), CR ( $> .70$ ) and AVE ( $> .50$ ) all exceeded the thresholds suggested by Hair *et al.* (2017). Thus, all reflexive constructs demonstrated sufficient internal consistency. All indicators used to measure the reflexive constructs were found to be statistically significant. Finally, given the high levels of correlation between entrepreneurial alertness and entrepreneurial intentions, the heterotrait-monotrait ratio was calculated to test the constructs' discriminant validity (Henseler *et al.*, 2015). We obtained a value of .855, which is below the suggested threshold of .90 for conceptually similar constructs (Henseler *et al.*, 2015), and thus supports the discriminant validity of the indicators.

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Insert Table V around here  
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Table V reports the results of the assessment of the formative constructs. The outer weights were all found to be significant, with the exception of one indicator for entrepreneurship-oriented human capital (i.e., family business) and one for academic engagement-oriented human capital (i.e., patent experience). However, as suggested in the methodological literature (Cenfetelli and Bassellier, 2009; Hair *et al.*, 2017), the indicators were not removed from the model because their correlations with the constructs to which they belonged were statistically significant - specifically,  $\rho = .521$ ,  $p < .01$  for family business and  $\rho = .324$ ,  $p < .01$  for patenting experience. For VIF, we observed values between 1.004 and 1.070, clearly below the threshold value of 5.0 (Hair *et al.*, 2011). Thus, we concluded that collinearity was not a problem for any of the human capital formative constructs.

### 4.3. Structural Model

In line with the literature (Hair *et al.*, 2017; Hair *et al.*, 2012), we performed bootstrapping with 5,000 samples to evaluate the statistical significance of the path coefficients. Figure 1 shows the results obtained in evaluating the structural model.

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The coefficient of determination ( $R^2$ ) indicates that the proposed model explains 30.7 percent of the variance in entrepreneurial alertness ( $R^2 = .307$ ) and 65.5 percent in the variance in entrepreneurial intentions ( $R^2 = .655$ ). All  $Q^2$  values for endogenous constructs were greater than zero, confirming the predictive significance of endogenous latent variables (Geisser, 1974; Stone, 1974). Entrepreneurial intentions had the highest  $Q^2$  value ( $Q^2 = .553$ ), followed by entrepreneurial alertness ( $Q^2 = .224$ ).

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Insert Table VI around here  
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As shown in Table VI, human capital related to academic engagement exerted the strongest effect on entrepreneurial alertness ( $\beta = .328$ ), followed by entrepreneurship-oriented human capital ( $\beta = .288$ ) and educational support ( $\beta = .170$ ). Last, our model exhibited a standardized root mean square residual (SRMSR), the standardized difference between the correlation predicted by the model and the one observed (Hu and Bentler, 1998), of .057. The value exceeded the cutoff value of .08, indicating a good model fit (Hu *et al.*, 1999).

Overall, the path coefficients expressing the relationships between exogenous and endogenous variables were all significant.

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3 **4.4. Multi-group Analysis**  
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5 An MGA with SmartPLS 3 was applied to test whether a different level of support for  
6 entrepreneurship results in a statistically significant difference in the path coefficient between  
7 entrepreneurial alertness and intentions (Hair *et al.*, 2017). Table VII shows that a statistically  
8 significant difference was found for concept development (path coefficient difference = -.118;  
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10 T = .950; p = .043) and business development support (path coefficient difference = -.137; T =  
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12 2.170; p = .031).  
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28 **4.5. Hypotheses testing.**  
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30 The results of PLS-SEM supported hypotheses H1, H2, H3, and H4. A positive relationship  
31 was shown between entrepreneurship-oriented human capital and entrepreneurial alertness,  
32 corroborating the first hypothesis proposed (H1,  $\beta = .288$ , T = 4.612). Similarly, a statistically  
33 significant relationship was observed between academic engagement-oriented human capital  
34 and entrepreneurial alertness, inducing us to accept the second hypothesis (H2,  $\beta = .195$ , T =  
35 5.003), as well as a positive relationship emerged between educational support and  
36 entrepreneurial alertness (H3,  $\beta = .170$ , T = 2.965). Finally, the relationship between  
37 entrepreneurial alertness and intentions supports H4 (H4,  $\beta = .809$ , T = 25.893).  
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49 MGA analysis validated H5 and H6, providing empirical evidence that when concept and  
50 business development university support is higher, the relationship between entrepreneurial  
51 alertness and intentions becomes stronger. Table VIII provides a summary of the hypothesis  
52 tests.  
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## 5. DISCUSSION

The present study aimed to understand whether and how the university support system could facilitate the very early stage of doctoral students' entrepreneurial process, which is their cognitive transition from entrepreneurial alertness to intentions. In doing so, we were inspired by a social information processing perspective, envisioning this decision as resulting from the interplay between the individual dimension and the university support. A conceptual model integrating doctoral students' human capital and three forms of perceived entrepreneurial support - entrepreneurship education, concept development support, and business development support - was proposed and empirically tested. The results revealed that the more human capital doctoral students have and the higher the perceived educational support, the more alert they will be to entrepreneurial opportunities. In addition, doctoral students who perceive a high level of concept and business development support are more likely to move from entrepreneurial alertness to intention.

### 5.1. Limitations and future research

Some limitations of this study should be addressed in future research. First of all, we are aware that our sample consisting exclusively of doctoral students is both an element of originality of the work and its limitation. Indeed, we have devoted considerable effort to explaining the potential and uniqueness of doctoral students as promising academic entrepreneurs, but we realize that the model should be tested with other academic targets, such as undergraduate students and tenured faculty. It would be worthwhile to understand whether there are

differences in the ways through which institutional support might support the early stage of the academic entrepreneurial process for different groups of academic actors. In addition, we know that our model, while methodologically robust, is cross-sectional. In this regard, it would be interesting to extend our results through a longitudinal study to test the causal relationships between latent variables, taking into account the temporal perspective of the entrepreneurial process.

**5.2. Theoretical and practical implications**

This work joins a growing scientific conversation on doctoral students' entrepreneurship, addressing recent calls for further research on the target. Hayter *et al.* (2017) pointed out that doctoral students should be studied further because of their great potential to transform research results into economic and social impact. Similarly, Muscio *et al.* (2021) called for more research on how the university context can influence doctoral students' entrepreneurial initiatives. In response to these calls, the present study joins and expands the ongoing scholarly debate on the entrepreneurial university by demonstrating how the entrepreneurship support system can facilitate doctoral students' entrepreneurship. Specifically, it explains whether and how different forms of support actually facilitate doctoral students' entrepreneurial decision-making, responding to research calls on the topic (Bienkowska *et al.*, 2016; Muscio and Ramaciotti, 2019). Compared to current models that have studied institutional support as predictors of entrepreneurial intentions (Bienkowska *et al.*, 2016; Feola *et al.*, 2019), the present model showed that the university support system fuels the early stage of doctoral students' entrepreneurship in different ways. Indeed, our results showed that concept and business development support is useful for doctoral students only when they are already attentive to entrepreneurial opportunities. Our results showed that attentiveness essentially depends on the human capital and entrepreneurial training of doctoral students. Moreover, this work extends

current studies on entrepreneurial universities, which have focused on the study of specific institutionally provided facilities, such as technology transfer offices, academic incubators, or entrepreneurship training, mostly as predictors of the formation of entrepreneurial intentions (Urban and Chantson, 2019; Guerrero *et al.*, 2020). Our model brought to attention the relevance of faculty perceptions regarding university support for entrepreneurship. In doing so, we went beyond considering the mere presence of a technology transfer office, incubator, or entrepreneurial training programs as facilitating the emergence of academic entrepreneurship.

Moreover, the present work contributes to understanding how entrepreneurship education can influence doctoral students by taking part in a scientific conversation that has been growing particularly in the recent period (e.g., Klofsten *et al.*, 2021; Rippa *et al.*, 2022). Our results showed that perceptions of educational support positively affect doctoral students' entrepreneurial alertness along with their human capital, demonstrating that for doctoral students to become entrepreneurship-minded requires not only that they perceive that they are educationally supported by the university, but also a background of prior experience that makes them potential entrepreneurs.

Finally, this paper provides practical implications for universities, which are particularly pressed by local governments and policymakers because of their role in regional economic and social growth (Dinnetz, 2018). In particular, our findings suggest promoting educational support among doctoral students if universities aim to increase supervision. Once doctoral students have received adequate educational support, universities should promote concept and business development support to accompany doctoral students in implementing their ideas. Knowing that the university offers this kind of specialized assistance helps doctoral students move toward entrepreneurship. Consequently, the entrepreneurial university needs to communicate these supports by making them more visible within the doctoral student

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Table I - Sample Characteristics

|                       | Description                            | N   | Percent |
|-----------------------|----------------------------------------|-----|---------|
| <b>Gender</b>         | female                                 | 101 | 54.01   |
|                       | male                                   | 85  | 45.45   |
|                       | non-binary                             | 1   | .54     |
| <b>Age</b>            | 20-29                                  | 121 | 64.70   |
|                       | 30-39                                  | 59  | 31.55   |
|                       | 40-49                                  | 6   | 3.21    |
|                       | 50-59                                  | 1   | .54     |
| <b>University</b>     | University of Trento                   | 40  | 21.39   |
|                       | University of Padua                    | 33  | 17.65   |
|                       | University of Cagliari                 | 19  | 10.16   |
|                       | University of Bologna                  | 13  | 6.95    |
|                       | University of Florence                 | 13  | 6.95    |
|                       | University of Palermo                  | 13  | 6.95    |
|                       | University of Catania                  | 11  | 5.88    |
|                       | University of Modena and Reggio Emilia | 11  | 5.88    |
|                       | University of L'Aquila                 | 10  | 5.34    |
|                       | University of Turin                    | 9   | 4.81    |
|                       | University of Calabria                 | 7   | 3.74    |
|                       | University of Macerata                 | 4   | 2.15    |
|                       | University of Camerino                 | 2   | 1.07    |
|                       | University of Naples                   | 1   | .54     |
|                       | University of Pisa                     | 1   | .54     |
| <b>Research field</b> | Social sciences                        | 49  | 26.2    |
|                       | Technology                             | 62  | 33.1    |
|                       | Humanities                             | 9   | 4.8     |
|                       | Life sciences                          | 44  | 23.5    |
|                       | Physical sciences                      | 23  | 12.4    |

Table II – Correlation Matrix

|                                              | 1      | 2      | 3      | 4      | 5       | 6       | 7     | 8     | 9     | 10    | 11 |
|----------------------------------------------|--------|--------|--------|--------|---------|---------|-------|-------|-------|-------|----|
| 1. Entrepreneurship-related human capital    | 1      |        |        |        |         |         |       |       |       |       |    |
| 2. Academic engagement-related human capital | .350** | 1      |        |        |         |         |       |       |       |       |    |
| 3. Educational support                       | -.017  | .165*  | 1      |        |         |         |       |       |       |       |    |
| 4. Entrepreneurial alertness                 | .362** | .434** | .234** | 1      |         |         |       |       |       |       |    |
| 5. Entrepreneurial intentions                | .292** | .346** | .246** | .804** | 1       |         |       |       |       |       |    |
| 6. Concept development support               | -.012  | .168*  | .878** | .223** | .225**  | 1       |       |       |       |       |    |
| 7. Business development support              | -.037  | .131   | .757** | .241** | .249**  | .812**  | 1     |       |       |       |    |
| 8. Age                                       | .751** | .258** | -.004  | .188*  | .114    | .003    | .031  | 1     |       |       |    |
| 9. Gender                                    | -.056  | .079   | .256** | .296** | -.248** | -.199** | -.139 | -.051 | 1     |       |    |
| 10. University                               | -.082  | .035   | -.001  | .116   | .050    | .054    | .087  | -.058 | -.125 | 1     |    |
| 11. Research field                           | -.173* | .118   | -.079  | -.099  | -.093   | -.054   | .040  | -.059 | .104  | -.095 | 1  |

\* p < .10    \*\*p < .05    \*\*\*p<.01

Table III - Descriptive Statistics

|                                           | Mean  | Standard<br>Deviation |
|-------------------------------------------|-------|-----------------------|
| Entrepreneurship-related human capital    | .665  | .920                  |
| Academic engagement-related human capital | .329  | .261                  |
| Entrepreneurial intentions                | 2.746 | 1.727                 |
| Entrepreneurial alertness                 | 2.775 | 1.449                 |
| Educational support                       | 3.954 | 1.359                 |
| Concept development support               | 3.646 | 1.372                 |
| Business development support              | 3.440 | 1.390                 |

Table IV - Measurement Model Assessment (Reflective Constructs)

| Variables                  | item | Outer loadings | AVE  | CR   | Cronbach $\alpha$ |
|----------------------------|------|----------------|------|------|-------------------|
| Educational Support        | ES_1 | .791           | .672 | .924 | .905              |
|                            | ES_2 | .805           |      |      |                   |
|                            | ES_3 | .787           |      |      |                   |
|                            | ES_4 | .797           |      |      |                   |
|                            | ES_5 | .876           |      |      |                   |
|                            | ES_6 | .856           |      |      |                   |
| Entrepreneurial Alertness  | EA_1 | .880           | .763 | .941 | .922              |
|                            | EA_2 | .907           |      |      |                   |
|                            | EA_3 | .883           |      |      |                   |
|                            | EA_4 | .804           |      |      |                   |
|                            | EA_5 | .890           |      |      |                   |
| Entrepreneurial Intentions | EI_1 | .895           | .855 | .973 | .966              |
|                            | EI_2 | .921           |      |      |                   |
|                            | EI_3 | .933           |      |      |                   |
|                            | EI_4 | .955           |      |      |                   |
|                            | EI_5 | .898           |      |      |                   |
|                            | EI_6 | .946           |      |      |                   |

**Table V - Measurement Model Assessment (Formative Constructs)**

| Variables                                 | Item                         | Outer weights | VIF   |
|-------------------------------------------|------------------------------|---------------|-------|
| Entrepreneurship-related human capital    | Entrepreneurial experience   | .870          | 1.025 |
|                                           | Family business              | .149          | 1.004 |
|                                           | Work experience              | .357          | 1.027 |
| Academic engagement-related human capital | Consultancy experience       | .511          | 1.014 |
|                                           | Contract research experience | .455          | 1.073 |
|                                           | Patenting experience         | .214          | 1.028 |
|                                           | Training experience          | .489          | 1.070 |

**Table VI - Structural model results using t values and percentile bootstrap 95% confidence interval (n = 500 subsamples)**

| Relationship                                                       | $\beta$ | 95% CI | Std error | t      | p    | Decision  | f <sup>2</sup> |
|--------------------------------------------------------------------|---------|--------|-----------|--------|------|-----------|----------------|
| Entrepreneurship-related human capital → Entrepreneurial alertness | .288    | .158   | .063      | 4.612  | .000 | supported | .107           |
| Engagement-related human capital → Entrepreneurial alertness       | .328    | .195   | .066      | 5.003  | .000 | supported | 1.133          |
| Educational support → Entrepreneurial Alertness                    | .170    | .029   | .057      | 2.965  | .003 | supported | .040           |
| Entrepreneurial alertness → Entrepreneurial Intentions             | .809    | .747   | .031      | 25.893 | .000 | supported | 1.894          |



Table VII - Multi-group Analysis results

| Business development support |               |                 |       |         | Concept development support |               |                 |      |         |
|------------------------------|---------------|-----------------|-------|---------|-----------------------------|---------------|-----------------|------|---------|
| $\beta$ (high)               | $\beta$ (low) | $\beta$ - diff. | T     | p-value | $\beta$ (high)              | $\beta$ (low) | $\beta$ - diff. | T    | p-value |
| .868                         | .731          | .137            | 2.170 | .031    | .862                        | .744          | .118            | .950 | .043    |

Table VIII – Synthesis of results

| HYPOTHESIS | STATEMENT                                                                                                                                                                                     | DECISION |
|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| H1         | Entrepreneurship-related human capital positively affects doctoral students' entrepreneurial alertness                                                                                        | Accepted |
| H2         | Academic engagement-related human capital positively affects doctoral students' entrepreneurial alertness                                                                                     | Accepted |
| H3         | Perceived educational support positively affects doctoral students' entrepreneurial alertness                                                                                                 | Accepted |
| H4         | Entrepreneurial alertness positively affects doctoral students' entrepreneurial intentions                                                                                                    | Accepted |
| H5         | The structural relationship between entrepreneurial alertness and entrepreneurial intentions is stronger for doctoral students who perceive higher levels of support for concept development. | Accepted |
| H6         | The structural relationship between entrepreneurial alertness and entrepreneurial intentions is stronger for doctoral students who perceive higher levels of support for business development | Accepted |

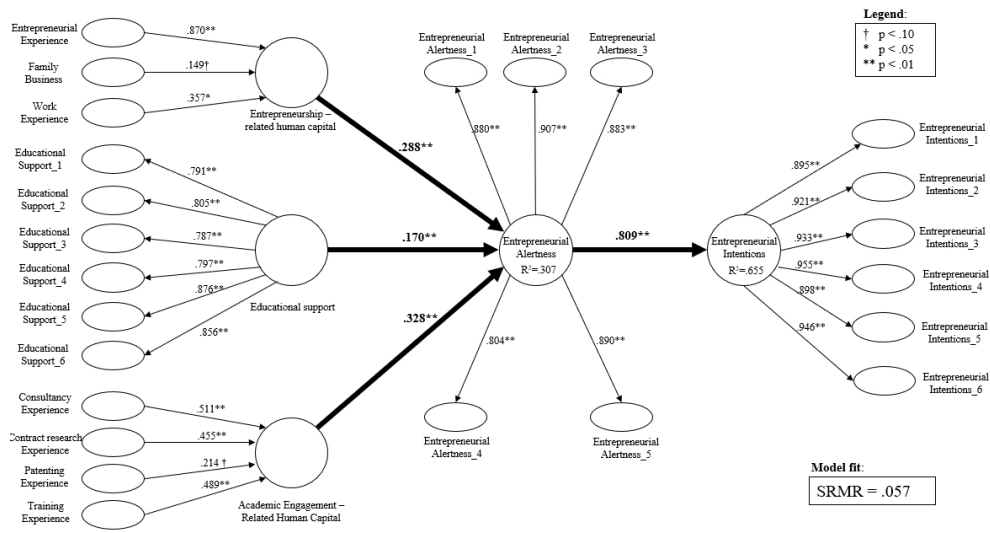


Figure 1 - Results of PLS-SEM analysis

794x438mm (38 x 38 DPI)