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Mechanisms for facilitating academic entrepreneurship in higher education

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Abstract

Purpose – The commercialization of research produced by universities constitutes a core facet of academic entrepreneurship (AE). Academic literature reveals the need to shed light on entrepreneurial processes in higher

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education institutions (HEIs). This study intends to fill this gap by researching the mechanisms for facilitating AE and the variables that can moderate the relationship between such mechanisms and AE in Portuguese HEIs.

Design/methodology/approach – Our research model aims to assess the mechanisms of academic entrepreneurship (AE) within a sample of 125 Portuguese public higher education institutions (HEIs). To test our research hypotheses, we employed a structural equation model (SEM) using the partial least squares (PLS) method. Additionally, our evaluation examines the potential moderating effects of incubator programs, support initiatives, and proof-of-concept programs (PoCs). Our research model seeks to evaluate the mechanisms for facilitating AE and explore the effects of including incubator programs, support initiatives, and PoCs as moderators. The seven variables (Research mobilization, Unconventionality, Industry collaboration, University policies, Incubator programs and support initiatives, Proof-of-concept programs, and academic entrepreneurship) were measured using a 7-point Likert scale.

Findings – The results revealed that different drivers of AE influence the creation and development of entrepreneurial activities. Our findings also show the moderating effects of incubator programs, support initiatives, and proof-of-concept programs on AE. We find that incubator programs, other support initiatives, and PoCs maintain a moderating effect on AE and benefit their respective HEIs.

Research limitations/implications – The study examines only the Portuguese HEI context. Therefore, generalizing these results necessitates reservations. However, the responses came from various actors in HEIs, from different academic backgrounds and research interests. This makes the results more generalizable. Limitations are evident in external validity, given that we gathered the data over a relatively short period.

Practical implications – Observed factors are explored to gain a deeper understanding of their influence on the mechanisms of AE. The implications arise from the new perspective presented and the methodology used to identify mechanisms capable of fostering AE. We hope this research will encourage other researchers to study this topic further.

Social implications – the engagement of universities at the global level should be emphasised in future policy. While universities in innovation systems often have a local focus, their engagement in innovation ecosystems transcends the boundaries of geographic locations.

Originality/value – PoCs had a significant positive moderating effect on the impact of research mobilization and university policies on AE. Thus, we find interactions between universities and industry boost AE. This study demonstrates how AE benefits HEIs by extending orientation towards mobilizing research, unconventional approaches, cooperation with industry, and university policy implementation. We thus advocate a new approach, demonstrating the influence that the mobility of research, unconventionality, industry collaboration, and university policies hold over AE.

Keywords Universities, Higher education institutions, Academic entrepreneurship, Moderating factors

Paper type Research paper

1. Introduction

In knowledge-based societies, universities increasingly act as drivers of local development as they play a fundamental role in producing/disseminating knowledge and exploiting it for commercial purposes (Guerrero and Urbano, 2012; Etzkowitz, 2013; Guerrero *et al.*, 2015).

The university mission has evolved over recent decades, and it continues to adapt to economic changes and expectations related to innovation and economic development (Todorovic *et al.*, 2011; Dabic *et al.*, 2016; Dabić, 2021). The university mission does not only extend to teaching and research (the first and second university missions) (Etzkowitz *et al.*, 2000) but also to a third mission: the entrepreneurial university, which guarantees the transfer of knowledge to the local community through entrepreneurial activities (Etzkowitz *et al.*, 2000; Rothaermel *et al.*, 2007). This third university mission contributes significantly to social and economic development in host regions (Davey, 2017). Government incentives and public policies that foster economic development (Benneworth and Charles, 2005; Mian *et al.*, 2016), alongside the demand for technology-based economies (Markuerkiaga *et al.*, 2014), have driven universities to undertake significant transformation and engage in entrepreneurial activities (Ivanova and Leydesdorff, 2014; Bukhari *et al.*, 2021).

In literature, the term academic entrepreneurship is defined and developed in various ways. For instance, Beckman and Cherwitz (2009) define academic entrepreneurship (AE) as an intellectual enterprise, where universities collaborate with local communities to generate new ideas or values. Therefore, we can define AE as the dynamic process through which individuals, often within the context of universities or research centers, leverage the knowledge generated within

research activities to create new ventures or spin-off companies (Miranda *et al.*, 2017), and it is part of universities' third mission to impact industry and society (Reymen, 2019). Thus, HEIs promote AE through organizational arrangements, such as innovation programs, incubators, and accelerators, implementing the university's third mission (Ar *et al.*, 2021; Mäkinen and Esko, 2022).

The need to establish entrepreneurial cultures among students and staff, integrating entrepreneurial education into study programs, and carrying out interdisciplinary research has received widespread discussion (Riviezzo *et al.*, 2012; Lopes *et al.*, 2021; Roncancio-Marin *et al.*, 2022). Academics seem to agree that when universities aspire to adopt an entrepreneurial model, they need to implement radical strategic changes (Urbano and Guerrero, 2013). Consequently, research outputs for entrepreneurial universities have risen over recent years (Leih and Teece, 2016; Schmitz *et al.*, 2017), expanding into various interconnected areas, such as entrepreneurship education and AE (Fayolle and Redford, 2014).

According to Guerrero and Urbano (2012), entrepreneurial universities need to become entrepreneurial organizations, and members must become entrepreneurs that display entrepreneurial patterns. Entrepreneurial universities serve as substantial knowledge bases, acting as sources of entrepreneurial opportunity to the university community, allowing academics and students to embark on new intellectual and commercial ventures (Fayolle and Redford, 2014; Guerrero and Urbano, 2014). This relates to the process by which individuals integrate into universities or research centers. The knowledge generated in these locations results in business ventures and spinoffs that serve as examples of AE (Miranda *et al.*, 2017).

In turn, Ahmad *et al.* (2018) refer that the transfer of research oriented to the entrepreneurial university, which is oriented to AE, is now considered one of the most important paradigm shifts in the educational system. Fuchs *et al.* (2023) identify AE as an emerging set of activities that raise questions about the idea of the university and its role in society. The same authors refer that AE is an extension of research and teaching activities committed to the promotion of knowledge and learning, and guided by this internal vision, universities can act as agents of change, participate in the search and implementation of solutions to society's problems, and, in this way, participate in responsible innovation and go beyond the dissemination of academic knowledge.

Promising an entrepreneurial university concept, Gibb and Hannon (2006) and Gibb *et al.* (2013) suggest the inclusion of entrepreneurship programs in student curricula, along with pedagogic support for departmental innovation, in conjunction with active student participation in entrepreneurial activities. Incorporating entrepreneurship courses into university study programs and encouraging students to participate in entrepreneurship-related activities is vital (Leih and Teece, 2016), especially when it comes to boosting levels of individual innovation and proactivity and increasing willingness to take risks (Simoes *et al.*, 2012; Efrata *et al.*, 2021). Entrepreneurial activities, therefore, not only span the arbitration of opportunity but also lead individuals to consider training and apply new ideas presented by universities (Acs *et al.*, 2013). AE exploits the knowledge that academics (students, lecturers, and researchers) establish through patents, licenses, start-ups, spinoffs, and industrial collaboration (Guerrero and Urbano, 2012, 2014). To better explore these knowledge enhancement activities, scholars have recognized the vital role played by individual academics (Wright and Phan, 2018).

Todorovic *et al.* (2011) propose the ENTRE-U scale, which is used to measure the following determinants of AE: mobilization of research, non-conventionality, industrial collaboration, and university policies. The authors show how industrial collaboration is concentrated in universities through teaching staff, departments, and the active industry engagement of students. They add that university policies may support departmental aspirations and encourage or hinder innovation and non-conventionality.

Studies on AE cover a range of diverse approaches and fields. Some focus on individual personalities and how these influence entrepreneurial intentions (Tlaiss, 2015; Antoncic *et al.*, 2015); interactions between individuals and contextual factors regarding entrepreneurship

and innovation (Karimi *et al.*, 2017; Hossain *et al.*, 2019); individual characteristics, such as entrepreneurial mentalities, characteristics, and personalities (Zhao *et al.*, 2010); and gender (Reissová *et al.*, 2020). Others consider family history when studying AE, including parental occupations and occupational situations (Taylor, 1996; Fellnhofer and Kraus, 2015), prior exposure to family firms (Carr and Sequeira, 2007), and socio-environmental factors, such as regional policies (Wagner and Sternberg, 2004). Despite the significant contributions of these previous studies, research on the facilitation mechanisms of AE is still scarce. For instance, which mechanisms facilitate AE in HEIs? What dimensions have moderating effects on the relationship between these mechanisms and AE?

Our study aims to contribute to overcoming gaps regarding the scarcity of empirical studies examining the facilitating mechanisms of AE. It also evidences the moderating effects of proof-of-concept programs, incubator programs, and support initiatives when developing AE mechanisms. After researching Higher Education Institutes (HEIs), we found a gap in the Portuguese public HEIs. Portugal is a part of the European Higher Education Area, which was established after the Bologna Process. This process aimed to adopt measures in European Union countries to ensure greater quality and competitiveness in the Higher Education System. We believe that our study is an opportune one and it can be adapted to other countries that have a similar educational system.

The study adopts a quantitative approach. A questionnaire was sent to deans, presidents, and directors of Portuguese public HEIs, gathering a sample of 125 responses. We tested the research hypotheses by applying structural equation models, as per the PLS (partial least squares) method.

This study makes three key contributions. Firstly, the findings expand upon recent research on AE in HEIs. Specifically, it sheds light on the mechanisms that HEIs can actively explore to capitalize on entrepreneurial opportunities and foster AE. These mechanisms serve as catalysts for enhancing the overall entrepreneurial activities within the academic context. In summary, this study not only contributes to the existing body of knowledge on AE but also provides actionable insights for HEIs to nurture entrepreneurial mindsets, facilitate knowledge transfer, and drive economic impact through collaborative ventures and spin-offs. Secondly, we examine the moderating effects of incubator programs and other support initiatives and proof-of-concept programs on academic entrepreneurship, namely research mobilization, unconventionality, and university politics. Thirdly, this study contributes by providing valuable insights that can inform the formulation of new research questions within the field of AE. Scholars can build upon these findings to explore uncharted territories, address gaps, and advance the theoretical foundations of AE. Beyond academia, the empirical study conducted here holds relevance for practitioners and policymakers - such as entrepreneurs, industry professionals, and business leaders - can gain practical insights from the identified enabling mechanisms of AE. These insights can guide their strategic decisions, foster collaboration with HEIs, and enhance their own entrepreneurial endeavors.

2. Academic entrepreneurship mechanisms and hypotheses development

2.1 Research mobilization

Entrepreneurship-oriented universities are more open to cooperating with external stakeholders. They uncover new commercial opportunities, form closer and more effective bonds with particular industries, and establish organizational structures to support these bonds. Universities increasing their entrepreneurial commitments have led to a greater focus on AE (Guerrero and Urbano, 2012; Seguí-Mas *et al.*, 2018).

Academics have assumed high-profile roles in developing knowledge societies, and they are increasingly involved in entrepreneurial activities (Davey *et al.*, 2016). Entrepreneurship has been attracting more and more interest in our current globalized and knowledge-based economy (Lopes *et al.*, 2018; Mei *et al.*, 2020). According to Miranda *et al.* (2017), AE constitutes the process by which individuals in universities and research centers integrate knowledge

arising from research into entrepreneurial ventures and spin-offs, being that AE is part of the third mission of universities to impact industry and society (Reymen, 2019). In this way, universities need to contribute to academic innovation and entrepreneurship processes (Siegel and Wright, 2015). Thus, the mobilization of research leads us to academic entrepreneurship because the mobilization of research represents a change in the traditional sense of knowledge, implying a change of systems that support the creation of knowledge and innovation at the level of the individual for groups, organizations, or communities (Todorovic *et al.*, 2011).

Approaches to AE focus are geared towards a market point of view, with a particular emphasis on commercializing knowledge (Mars and Rios-Aguilar, 2010). The results of Wibowo *et al.* (2020) have expanded entrepreneurial activities to include the deployment of innovative teaching methods, research contracts, and consultancy.

Ferretti *et al.* (2020) argue that AE has become a challenge for universities worldwide, as individual activities are not appropriately interconnected and need better structuring. Following Nabi *et al.* (2017), teaching entrepreneurship involves improving students' business abilities, enabling them to launch their own entrepreneurial ventures. The results of Guerrero *et al.* (2020) showed the role of educational programs in the acquisition of specific competencies/skills (the identification of business opportunities and work under uncertainties) that are essential to reaching the highest level of tolerance to the work effort necessary to become successful as an academic entrepreneur. With this in mind, our first hypothesis is as follows:

H1. Research mobilization positively influences academic entrepreneurship

2.2 Unconventionality

Unconventionality refers to the capacity of a university to identify opportunities outside of the traditional academic environment, focusing on unconventional approaches to financing research, problem-solving, relationships with external organizations, and so forth (Todorovic *et al.*, 2011).

According to Ahmad *et al.* (2018), spinoff launches are demonstrative of the willingness of universities to engage in entrepreneurship. Hayter (2011) affirms that academics often consider spinoffs as platforms for gaining access to research financing. The same author (Hayter, 2015) reconfirmed these results at a later date, revealing that academics launch spinoffs to apply for awards, sector research contracts, or consultancy jobs. Walter *et al.* (2018) subsequently corroborated these results. Access to financing for research acts as the motive behind entrepreneurial intentions (Ankrah *et al.*, 2013; Bodas Freitas and Verspagen, 2017).

When government financing falls short, universities are motivated to diversify their sources of revenue, become more innovative, and target their resources towards better commercializing their knowledge (Todorovic *et al.*, 2011). Establishing technology transfer offices and subjects including entrepreneurship are vital steps for universities seeking to become entrepreneurial (Ahmad *et al.*, 2018).

Academics are thus more likely to identify commercial opportunities based on their research, generating economic value through patents or spinoffs (Liñán *et al.*, 2011; Guerrero *et al.*, 2014; Brennan and McGowan, 2006; Galati *et al.*, 2020). Within this framework, entrepreneurial universities strengthen their cooperation with external organizations, significantly improving respective research activities (Ahmad *et al.*, 2018).

The concept of unconventionality significantly impacts AE. As posited by Todorovic *et al.* (2011), unconventionality focuses on research practices, particularly in the pursuit of novel opportunities and the practical applicability of research outcomes for various stakeholders. In sum, unconventionality fuels academic entrepreneurship by fostering a dynamic environment where creativity, utility, and stakeholder impact intersect. It encourages researchers to think beyond the ordinary, leading to transformative outcomes.

Based on these findings, we put forward our second hypothesis:

H2. Unconventionality positively influences academic entrepreneurship

2.3 Industry collaboration

It has been suggested that the level of collaboration between industries and universities, including teachers, departments, and students, can influence the success of Academic Entrepreneurship (AE) (Todorovic *et al.*, 2011). Research collaboration between universities and industries plays a pivotal role in fostering AE. When teachers, departments, and students engage in collaborative efforts, it creates a fertile ground for knowledge exchange, innovation, and entrepreneurial activities (Bozeman *et al.*, 2013). In summary, fostering collaboration between industries and universities is essential for nurturing AE. Therefore, it is important to evaluate the extent of industry collaboration as it can have an impact on AE.

In recent decades, organizational entrepreneurship has attracted interest from different regional actors in the global economy (Lopes *et al.*, 2018; Mei *et al.*, 2020). Entrepreneurship is a driver of sustainable regional economic development and is a catalyst for innovation, which drives job creation (Belz and Binder, 2017; Dentoni *et al.*, 2021). In this context, policymakers are now generally aware that entrepreneurship is a priority for each region's development.

AE falls within the scope of the third mission of universities. This multidisciplinary approach is framed by the economic and social mission of an institution and its contribution to the social, economic, and cultural development of its region through the transfer of knowledge and technology (De Jong *et al.*, 2014; Compagnucci and Spigarelli, 2020).

The lines between science, industry, and government become increasingly blurred, and the role knowledge transfer and technology play in influencing research results becomes more significant (Todorovic *et al.*, 2011). With this in mind, both scientific and political communities must pay more attention to AE (O'Shea *et al.*, 2008; Sinell *et al.*, 2015).

Literature on AE stresses that networking connections and government support agencies foster entrepreneurialism (Landry *et al.*, 2006; Goethner *et al.*, 2012; Karlsson and Wigren, 2012). Landry *et al.* (2006) discuss the propensity of researchers to launch spinoffs whenever they involve consultancy activities on behalf of private sector companies, government agencies, or organizations related to these companies (Landry *et al.*, 2006; Prodan and Drnovsek, 2010).

Governments and organizations have challenged universities to become increasingly entrepreneurial (Todorovic *et al.*, 2011). Researchers have become entrepreneurs, developing new products and launching businesses to commercialize knowledge stemming from their research/inventions (Wood, 2011). Universities operate in a competitive context. Governments seek to promote funding policies and programs for entrepreneurship and innovation education as mechanisms supporting higher education students, accelerating the development of business ecosystems (Benneworth and Charles, 2005; Miller *et al.*, 2016).

We thus formulate our third hypothesis:

H3. Industry collaboration positively influences academic entrepreneurship

2.4 University policies

University policies encapsulate the views of university leaders as to what hinders or facilitates innovation across different departments (Todorovic *et al.*, 2011).

According to Rodrigues *et al.* (2019), the perceptions of lecturers and researchers regarding university policies act as a pro-entrepreneurship incentive and impact AE. The main items contributing to policies relate to the general culture of the university, especially its "receptivity to new ideas and innovative approaches," whether or not it takes a "bottom-up" approach to policy development, and the alignment of university policies, department objectives, and lecturers' opinions.

According to Efrata *et al.* (2021), entrepreneurship education programs in higher education enable innovation, increase proactivity, and allow each academic to make accurate risk assumptions. According to Bedő *et al.* (2020), universities with entrepreneurship

programs can improve entrepreneurship ecosystems. A critical review of the literature highlights that academic entrepreneurship initiatives face challenges due to conflicting goals and weak incentive structures for universities and academics. Alternative mechanisms, such as contract research, licensing, consulting, and increased labor mobility among researchers, may enhance technology transfer from universities (Sandström *et al.*, 2018).

Prodan and Drnovsek (2010) propose that entrepreneurial cultures in universities are susceptible to improvement through entrepreneurship-focused courses and seminars, specifically adapting entrepreneurship to the needs of universities, departments, students, and researchers. In many universities, research activities combine with education to better apply education programs (Mallick and Chaudhury, 2000; Todorovic *et al.*, 2011). The results of the study by authors Kariv *et al.* (2019) confirmed the significant impact of the "traditional" essence of academic (e.g. knowledge) and non-academic (e.g. funding) programs on entrepreneurs' growth intentions. The authors also proved the relevance of academic programs for experienced entrepreneurs and non-academic programs for nascent/want entrepreneurs' intentions regarding the growth of their businesses.

Some variables specific to this institutional context have received more attention, in line with their ability to hinder or facilitate entrepreneurial activities, such as the level of economic development, measured in terms of GDP per capita (Hussler *et al.*, 2010; Liñán *et al.*, 2011; Munari *et al.*, 2016; Fini *et al.*, 2017; Guerrero *et al.*, 2018; Shirokova *et al.*, 2018); the culture of innovation and government support, measured in terms of research and development investment (Klofsten and Jones-Evans, 2000; Powers, 2004; O'Shea *et al.*, 2008; Hussler *et al.*, 2010; Van Looy *et al.*, 2011; Fini *et al.*, 2011; Autio *et al.*, 2014; Fini *et al.*, 2017); and the social legitimacy of entrepreneurship (Kibler *et al.*, 2014, 2015; Kibler and Kautonen, 2016), measured in terms of levels of self-employment (Autio *et al.*, 2014; Sternberg, 2014; Shirokova *et al.*, 2018). In countries with higher rates of entrepreneurship, this is a more common career option, and more individuals are in contact with entrepreneurs and small business owners.

Krabel (2018) studied how universities make academics more entrepreneurial, linking this with the occupational choices of academics and concluding that the probability of entering autonomous employment significantly and positively relates to the environmental orientation of universities. Soetanto and Geenhuizen (2019) contribute to this debate by revealing that factors such as research, entrepreneurial orientation, and levels of market hostility encourage spinoffs to keep their source universities in close proximity.

Measuring AE enables researchers to understand the organizational cultures of universities and the antecedents to meaningful commercial results. This pertains to how universities and broader society, according to Todorovic *et al.* (2011), can value, support, and benefit from the resources they bring to the knowledge economy.

University entrepreneurship needs to be extended through different faculties/schools, departments, and the entire leadership chain – from the rector and/or dean to the students (Cleverley-Thompson, 2016) – to achieve success. Academic spinoffs arising from AE can then provide further economic benefits to universities (Su and Sohn, 2015).

One of the critical challenges university managers face relates to influencing the attitudes of academics (Dabic *et al.*, 2015) and aligning them with the strategic interests of the university (Sandström *et al.*, 2018). Riviezzo *et al.* (2019) examined the relationship between entrepreneurial orientation and the capacity of university departments to generate patents and spinoffs. The researchers found that this relationship has a significant and positive impact on the results of AE. Also, Todorovic *et al.* (2011) state that university policies are sensitive to new ideas and innovative approaches, which will certainly influence AE. Therefore, our fourth hypothesis is as follows:

H4. University policies positively influence academic entrepreneurship

2.5 The moderating effect of incubator programs and other support initiatives

Montiel-Campos (2018) analyzed the moderating effects of the relationship between entrepreneurial university HEIs and their ability to launch spinoffs, on the number of patents registered and concluded that incubator programs and support initiatives generate a positive moderating effect on AE, specifically, they enhance the number of patents registered, contributing to the overall success of AE. In turn, Riviezzo *et al.* (2019) explored the relationship between entrepreneurial orientation and entrepreneurial performance in terms of the results of AE (spinoffs), concluding that entrepreneurial orientation has a significant positive impact on AE (and on the number of research-generated spinoffs). In other words, universities that exhibit a strong entrepreneurial orientation tend to produce more successful spinoff ventures.

Also, Soetanto and Geenhuizen (2019) emphasize the role of innovative university policies to create an environment that supports new ideas, experimentation, and creative solutions in the search for competitive advantages, facilitating the launch of spinoffs. In summary, these studies highlight the importance of supportive programs, entrepreneurial orientation, and innovative policies in driving successful AE and the creation of spinoff companies.

We, therefore, put forward the following hypothesis:

H5. Incubator programs and other support initiatives moderate the relationship between (a) the mobilization of research and academic entrepreneurship, (b) non-conventionality and academic entrepreneurship, (c) industrial collaboration and academic entrepreneurship, and (d) university policies and academic entrepreneurship

2.6 The moderating effect of proof-of-concept programs

The role of proof-of-concept programs (PoCs) in supporting technology transfer activities has recently gained recognition (Munari *et al.*, 2017). PoCs help overcome technological uncertainties surrounding inventions in their initial phases of development, helping to validate the technical and commercial viability of research-based innovations by combining three different factors: financing, experience in the domain of application (of the external stakeholders/company owners), and business training (for scientists and researchers) (Gulbranson and Audretsch, 2008; Munari *et al.*, 2017; Battaglia *et al.*, 2021). The exchange of ideas/information between the industrial and academic sectors is encouraged through the intermediation of mentors and specialists who advise scientists on how to refine the market alignment of their technologies (Battaglia *et al.*, 2021).

The limited literature on PoCs has obtained some consolidated results, demonstrating the efficiency of these programs (Kochenkova *et al.*, 2016; Munari and Toschi, 2021) and showing that PoCs are an effective tool when it comes to knowledge transfers, commercializing inventions based on academic research, and driving growth for spinoffs based on inventions/research produced by universities and technologies licensed by universities to companies (Bradley *et al.*, 2013; Hayter and Link, 2015).

PoCs enable researchers to minimize the relational barriers that lead to disconnections with industrial contexts or conflict arising with interested external parties. PoCs currently facilitate the commercialization of inventions based on research, fostering facilitating factors of an institutional, cultural, and relational nature (Battaglia *et al.*, 2021). Gulbranson and Audretsch (2008) show that the PoC success stems from how these instruments give scientists the opportunity to expand their networks beyond academia, thereby boosting the likelihood of commercializing future research-based inventions. We thus arrive at the following hypothesis:

H6. Proof-of-concept programs moderate the relationship between (a) the mobilization of research and academic entrepreneurship, (b) non-conventionality and academic entrepreneurship, (c) industrial collaboration and academic entrepreneurship, and (d) university policies and academic entrepreneurshi.

The focus of this study is reflected in the research model shown in Figure 1.

3. Methodology

3.1 Measurements

Our research model seeks to evaluate the mechanisms of AE. This evaluation also explores the effects of including incubator programs and support initiatives, as well as PoCs, as moderators. The seven variables (*Research mobilization, Unconventionality, Industry collaboration, University policies, Incubator programs and support initiatives, Proof-of-concept programs, and academic entrepreneurship*) were adapted from Todorovic *et al.* (2011), Riviezzo *et al.* (2019), and Sidrat and Boujelbene (2020). These variables were measured using a 7-point Likert scale, from 1 (totally disagree) to 7 (totally agree). Table 1 summarizes the measures and scale items for each of the constructs.

3.2 Sample and data

After conducting a pre-test at a Portuguese public HEI (Polytechnic) and obtaining approval from the president and respective school directors, the questionnaire was sent to the participants via a Google form. The questionnaire was directly emailed to the rectors, faculty

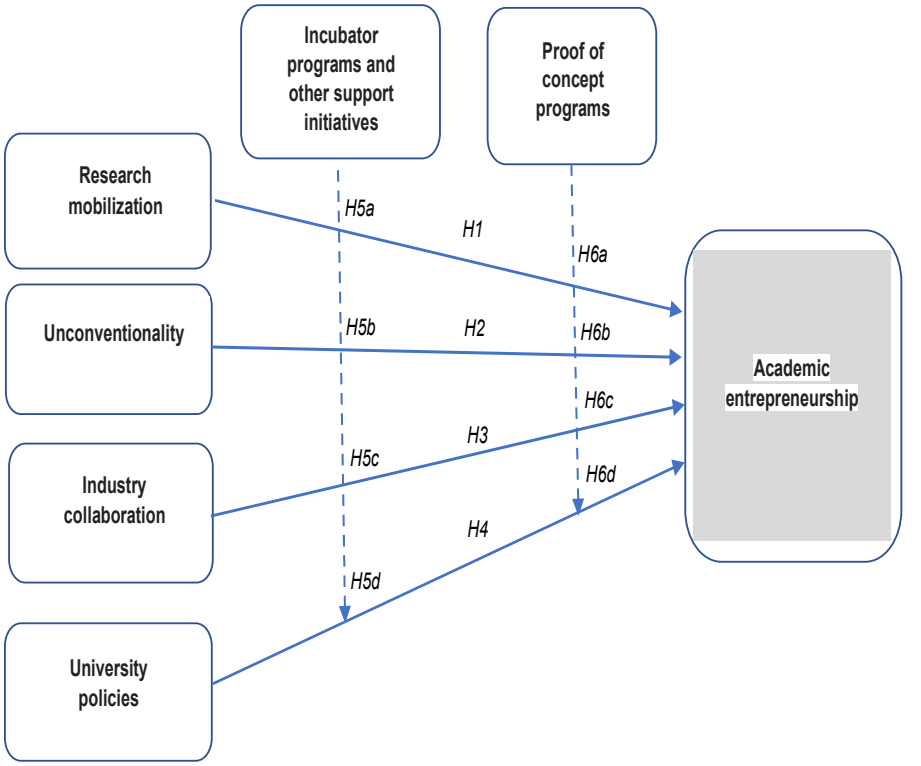

Figure 1.
Conceptual research model

Constructs	Measurement variables	Sources
Research mobilization	(1) We encourage students to get involved in research with significant implications either in industry or for society; (2) We encourage students to seek out practical applications for their research; (3) The teaching staff at our institution advocate for applied research; (4) In comparison with other similar institutions in our region, our institution has a reputation for the contributions it makes either to industry or society; (5) Many of our lecturers undertake research in partnership with non-academic professionals; (6) Teaching staff are expected to make substantial contributions to industry or society	Adapted from Todorovic *et al.* (2011)
Unconventionality	(1) In comparison with similar institutions in the region, we are good at identifying opportunities; (2) We support our staff in collaborating with non-academic professionals; (3) We attempt to generate benefits beyond the campus based on our research projects; (4) We seek significant financing from sources other than state entities (financial policies for supporting research and study grants at HEIs); (5) Cooperation with organisations outside of our own significantly improves our research activities; (6) Teaching staff frequently seek out research opportunities outside of the traditional university environment; (7) In comparison with similar institutions in the region, our staff are renowned for being highly efficient, productive researchers; (8) When we come up with an unconventional idea, we generally let another person try it out and see what happens	Adapted from Todorovic *et al.* (2011)
Industry collaboration	(1) We are recognised in industry and by society for our flexibility and innovation; (2) Our students often gain high-quality positions in industry; (3) Our institution holds a strong reputation in industry; (4) We encourage the involvement of industry in the research activities of our staff; (5) We believe that our institution should build relationships with organisations from both the public and private sectors	Adapted from Todorovic *et al.* (2011)
University policies	(1) We feel that the university policies of our institution contribute substantially to enabling us to reach our goals and objectives; (2) In comparison with the majority of other institutions, our institution is open to new ideas and innovative approaches; (3) Our university policies are developed from the "bottom upwards", incorporating feedback from every level of the university; (4) Our institution provides significant latitude in evaluating the performance of faculty members	Adapted from Todorovic *et al.* (2011)

(*continued*)

Table 1. Measurement variables

Constructs	Measurement variables	Sources
Incubator programs and other support initiatives	(1) The operational application of innovation is reflected through our new programs and pedagogies; (2) The operational implementation of innovation results in the launching of spinoffs; (3) The creation and development of entrepreneurial universities emerges through means of all returns from contracts, projects, and patents to the academic departments	Adapted from Riviezzo *et al.* (2019), Sidrat and Boujelbene (2020)
Proof-of-concept programs	(1) The operational implementation of autonomy incorporates financial freedom in research fund management, contributing to the success of commercialisation, in which the scope of action is important in enabling individuals to develop new ideas; (2) The operational implementation of innovation extends to means such as new programs and pedagogies; (3) The operational implementation of innovation incorporates the application of new working methods; (4) The operational implementation of proactivity emerges through the university's identification of opportunities; (5) The operational implementation of competitive aggressiveness shows that the university strives to develop creative and original approaches, attracting the increasingly demanding public by providing them with multiple opportunities; (6) The operational implementation of assuming risks is related to the university's willingness to invest in lucrative projects	Adapted from Riviezzo *et al.* (2019), Sidrat and Boujelbene (2020)
Academic entrepreneurship	(1) Establishing and developing entrepreneurial universities incorporates means of publicising studies and works with practical implications; (2) Establishing and developing entrepreneurial universities includes the implementation of a strategic plan; (3) Establishing and developing entrepreneurial universities incorporates the total returns from contracts, projects, and patents going to academic departments; (4) Establishing and developing entrepreneurial universities extends to enacting an entrepreneurial culture through study programs	Adapted from Sidrat and Boujelbene (2020)

Table 1.

deans, polytechnic presidents, and school directors of all 244 state HEIs in Portugal. The contact list was compiled by surveying the websites of the respective HEIs and utilizing the existing contact list available to our research team. Since there are different faculties or schools within the same university or polytechnic, multiple responses were possible from each HEI. Our sample consists of 125 validated respondents representing each district and autonomous region where the HEIs are located. The questionnaire was open from 2/2/2022 to 20/4/2022.

To assess non-response bias, we compared the characteristics of the HEIs that responded to the survey with those that did not respond. We considered the type of education (university vs polytechnic), owner (public vs private), and region as the relevant characteristics. Information on these characteristics was collected for both the responding and non-responding HEIs, and a comparative analysis was conducted to identify significant differences between the two groups.

Chi-Squared tests were performed to determine the significance of the differences in the distribution of characteristics between the responding and non-responding HEIs. The results of these tests indicate a non-response bias related to the type of education, owner, or region.

Table 2 provides a summary of the sample characteristics. The total number of respondents was 125, with the majority falling in the age range of 51–60 years (52%). Of the respondents, 64% were male. 56.8% belonged to the polytechnic education system. Data was collected from institutions located in every district and autonomous region.

3.3 Data analysis

To validate the hypotheses, we deployed a structural equation model (SEM) and the partial least squares method (PLS) for the estimates – a method widely applied throughout the behavioural sciences (Hair *et al.*, 2020). PLS-SEM was used as an alternative to covariance based SEMs (CB-SEM) because the items did not follow a normal distribution, the sample was small, and two characteristics were unacceptable for data calculated using CB-SEM (Freeman and Styles, 2014; Sarstedt *et al.*, 2019; Hair *et al.*, 2019, 2020).

To confirm the factorial structure of the instrument applied, we first had to examine the reliability and validity of the indicators used to represent and measure the theoretical concepts (Sarstedt *et al.*, 2019; Hair *et al.*, 2019, 2020).

		N	%
Age	41–50	44	35.2
	51–60	65	52.0
	+60	16	12.8
Gender	Female	45	36.0
	Male	80	64.0
Type of education	Polytechnic	71	56.8
	University	54	43.2
District hosting the HEI	Azores	4	3.2
	Aveiro	9	7.2
	Beja	4	3.2
	Braga	4	3.2
	Bragança	3	2.4
	Castelo Branco	6	4.8
	Coimbra	9	7.2
	Évora	2	1.6
	Faro	4	3.2
	Guarda	6	4.8
	Leiria	5	4.0
	Lisbon	29	23.2
	Madeira	3	2.4
	Portalegre	4	3.2
	Oporto	10	8.0
	Santarém	8	6.4
	Setúbal	4	3.2
	Viana do Castelo	5	4.0
	Vila Real	2	1.6
	Viseu	4	3.2
Qualifications	Master's Degree	23	18.4
	Aggregation	1	0.8
	Doctoral Degree	101	80.8
Length of academic career (number of years)	11–20	4	3.2
	21–30	62	49.6
	31–40	51	40.8
	+40	8	6.4

Table 2.
Sample characteristics

The validity of a construct stems from the size by which a set of items reflects the latent theoretical construct under measurement, the reliability of the instrument encapsulating the properties of consistency, and the reproducibility of the measurements (Sarstedt *et al.*, 2019; Hair *et al.*, 2019, 2020).

The study approached construct validity through: (1) composite reliability (CR), (CR > 0.70), as this is not subject to the influence of the number of items existing in each construct, to the contrary of Cronbach's Alpha, as the former applies loads of the items extracted from the estimated model; (2) factorial validity (factorial loads of over 0.5, ideally greater than 0.7); (3) convergent validity through the Average Variance Extracted (AVE), accepting the existence of convergent validity whenever (AVE> 0.50); and (4) discriminant validity was assessed using the Heterotrait-Monotrait ratio (HTMT) criterion, which should be less than 0.85, and Fornell and Larcker criterion, which the square root of the AVE of two constructs should be higher than the correlation between these two factors (Fornell and Larcker, 1981; Hair *et al.*, 2010; Barroso *et al.*, 2010; Henseler *et al.*, 2015; Sarstedt *et al.*, 2019). Table 3 summarises the criteria used to analyse the validity and reliability of the data collection instrument deployed.

For the structural model's evaluation, we examine the estimated model's overall fit, path coefficient estimates, and statistical significance based on the bootstrap percentile, effect size f^2 and coefficient of determination (R^2) (Sarstedt *et al.*, 2019; Hair *et al.*, 2019, 2020). The first step in the analysis is to assess the overall fit of the estimated model by evaluating the discrepancy between the variance-covariance matrix of the empirical indicator and the implicit counterpart of the estimated model. We used three discrepancy measures (SRMR - standardised root mean squared residual, dULS, and dG) and 95% (HI95) and 99% (HI99) quantiles of their corresponding distribution, and all discrepancy measures should be lower than HI95 and the approximate model fit given by the SRMR value should be lower than 0.08.

In calculating these structural models to uncover *t* statistics and their respective statistical significance, we applied the bootstrapping procedure (with a sample of 2000). We completed all calculations through recourse to the following software programs: SmartPLS versão 3.3.2 (Ringle *et al.*, 2015) and IBM SPSS version 28.0 for Windows (IBM Corporation, New York).

4. Results

4.1 Construct validity and reliability

For all these constructs, the factorial loads and composite reliability return values were above the limits of 0.5 and 0.7, respectively. Similarly, the AVE results for all constructs were also above the 0.5 limit.

To test whether these constructs displayed sufficient mutual differences, we inspected the discriminant validity, applying the Fornell and Larcker (1981) criteria, which requires the AVE of any construct to be greater than the square root of the highest correlation of any construct (Table 4). Discriminant validity was also assessed using the Heterotrait-Monotrait ratio (HTMT), which should be less than 0.85 (Table 5).

Table 3.
Instrument validity indicators

Statistics	Reference values
Factorial validity	≥0.5, ideally ≥0.7
Convergent validity	$AVE_j \geq 0.5$
Discriminant validity	$AVE_j \geq R^2$
Composite reliability	CR ≥ 0.7
Cronbach's alfa	≥0.60

	Mean	SD	Range	Factor loading	CR	AVE	AVE > Corr^2
Research mobilization	*5.5*	*2.3*	*2.5–7*		*0.78*	*0.53*	*0.53 > 0.33*
MP1	5.3	0.9	2–7	0.78			
MP2	5.4	0.9	1–7	0.80			
MP3	5.6	0.9	1–7	0.75			
MP4	5.6	1.0	2–7	0.77			
MP5	4.7	1.2	2–7	0.59			
MP6	5.6	1.0	2–7	0.64			
Unconventionality	*5.1*	*0.7*	*2.5–7*		*0.72*	*0.54*	*0.54 > 0.39*
NC1	5.4	0.8	3–7	0.84			
NC2	4.9	1.0	2–7	0.55			
NC3	5.4	0.9	2–7	0.82			
NC4	4.9	1.0	2–7	0.73			
NC5	5.6	0.9	3–7	0.64			
NC6	5.0	0.9	2–7	0.69			
NC7	5.1	0.9	2–7	0.87			
NC8	3.3	1.6	1–7	0.70			
Industry collaboration	*5.1*	*0.7*	*1.7–6.8*		*0.77*	*0.55*	*0.55 > 0.23*
CI1	5.1	1.0	1–7	0.88			
CI2	4.9	1.0	1–7	0.76			
CI3	4.9	0.9	1–7	0.74			
CI4	5.2	1.0	1–7	0.69			
CI5	5.8	1.0	3–7	0.60			
University policies	*5.0*	*0.7*	*2.7–6.3*		*0.82*	*0.54*	*0.54 > 0.39*
PU1	5.4	0.9	2–7	0.70			
PU2	5.3	0.8	3–7	0.84			
PU3	4.7	0.9	1–6	0.58			
PU4	4.7	0.9	2–6	0.78			
Incubator programs and other support initiatives	*5.4*	*0.7*	*2.7–7*		*0.84*	*0.63*	*0.63 > 0.43*
IIA1	5.0	1.1	2–7	0.82			
IIA2	5.7	0.7	3–7	0.76			
IIA3	5.4	1.0	2–7	0.80			
Proof-of-concept programs	*5.4*	*0.6*	*3.4–6.8*		*0.82*	*0.51*	*0.51 > 0.45*
PC1	5.2	1.1	2–7	0.58			
PC2	5.5	0.8	3–7	0.79			
PC3	5.6	1.0	3–7	0.75			
PC4	5.6	0.8	4–7	0.77			
PC5	5.5	1.0	1–7	0.68			
PC6	3.8	1.2	1–7	0.70			
Academic entrepreneurship	*5.2*	*0.8*	*1.5–7*		*0.89*	*0.68*	*0.68 > 0.45*
EA1	5.14	1.08	2–7	0.86			
EA2	5.46	1.01	1–7	0.90			
EA3	4.59	1.05	2–7	0.77			
EA4	5.51	0.92	1–7	0.77			

Note(s): Corr^2 = square root of the highest correlation among the model constructs

Table 4.
Construct validity and reliability

Table 4 sets out the results of the descriptive, reliability, and validity statistics for the latent constructs. The various constructs display high levels of reliability, good factorial loads, and convergent and discriminant validity.

Table 5.
The Heterotrait-Monotrait (HTMT) ratio

	Unconventionality	Industry collaboration	University policies	Incubator programs and other support initiatives	Proof-of-concept programs	Academic entrepreneurship
Research mobilization	0.822	0.808	0.518	0.339	0.323	0.221
Unconventionality		0.815	0.757	0.488	0.564	0.290
Industry collaboration			0.580	0.258	0.379	0.232
University policies				0.661	0.736	0.409
Incubator programs and other support initiatives					0.773	0.607
Proof-of-concept programs						0.827

The results in Table 5 show that all constructs met the requirements of discriminant validity. They are therefore valid and reliable.

Table 6 presents three discrepancy measures (SRMR - standardised root mean squared residual, d_{ULS}, and d_G) and 95% (HI95) and 99% (HI99) quantiles of their corresponding distribution. The results reveal that the model's quality fits in this study and meets all the criteria. Thus, the model was not rejected at the 5% significance level, providing empirical support for the proposed approach.

4.2 Testing the hypotheses

Table 7 and Figure 2 show the results of the structural model testing the validity of the hypotheses. The R^2 had a value of 0.610, indicating a good model fit. Furthermore, Cohen's f^2 of the path supporting H5d) (0.299) presented a high effect size. In the paths related to the hypotheses H5a) and H6a) the effect size on AE was small. Finally, the f^2 values associated with the remaining hypotheses indicate a moderate effect on Academic entrepreneurship.

For H1, our results demonstrate that research mobilization positively influences AE ($\beta = 0.41$; $p < 0.01$). For H2, we see that unconventionality positively influences AE ($\beta = 0.36$; $p < 0.05$). For H3, the findings show the significant positive impact of industry collaboration on AE ($\beta = 0.44$; $p < 0.01$). For H4, we again observe a significant positive impact of university policies on AE ($\beta = 0.39$; $p < 0.01$).

The results for H5 did not show any significant moderating effect for incubator programs and support initiatives on the relationship between industrial collaboration and AE (H5a: $\beta = 0{,}07$; $p = 0.704$). On the contrary, the results show that these programs and initiatives generate significant positive moderating effects for research mobilization (H5b: $\beta = 0.35$; $p < 0.05$), unconventionality (H5c: $\beta = 0.38$; $p < 0.05$), and university policies (H5d: $\beta = 0.48$; $p < 0.01$) and AE. These results show that the greater the perceptions of the incubator

Discrepancy	Value	HI95	HI99
SRMR	0.075	0.079	0.087
d_{ULS}	0.589	0.645	0.879
d_G	0.545	0.568	0.712

Table 6. Results of the overall fit of the estimated model

Hypothesis		β	SE	*p*	f^2
H1	Industry collaboration	*0.41*	*0.12*	*0.001***	*0.202*
H2	Research mobilization	*0.36*	*0.14*	*0.012**	*0.149*
H3	Unconventionality	*0.44*	*0.13*	*0.001***	*0.240*
H4	University policies	*0.39*	*0.11*	*0.001***	*0.179*
	Incubator programs and other support initiatives (IIA)	*0.59*	*0.14*	*0.000***	*0.534*
	Proof-of-concept programs (PoCs)	*0.29*	*0.13*	*0.020**	*0.092*
H5a)	Industry collaboration × IIA	0.07	0.19	0.704	0.005
H5b)	Research mobilization × IIA	*0.35*	*0.15*	*0.020**	*0.140*
H5c)	Unconventionality × IIA	*0.38*	*0.17*	*0.027**	*0.169*
H5d)	University policies × IIA	*0.48*	*0.19*	*0.011**	*0.299*
H6a)	Industry collaboration × PoCs	0.14	0.17	0.413	0.020
H6b)	Research Mobilization × PoCs	*0.43*	*0.21*	*0.038**	*0.227*
H6c)	Unconventionality × PoCs	0.29	0.24	0.227	0.092
H6d)	University policies × PoCs	*0.38*	*0.18*	*0.036**	*0.169*

Note(s): *$p < 0.05$; **$p < 0.01$; β – Standardized Coefficients; SE – Standard Deviation; f^2 – Effect size

Table 7. Standardised model coefficients

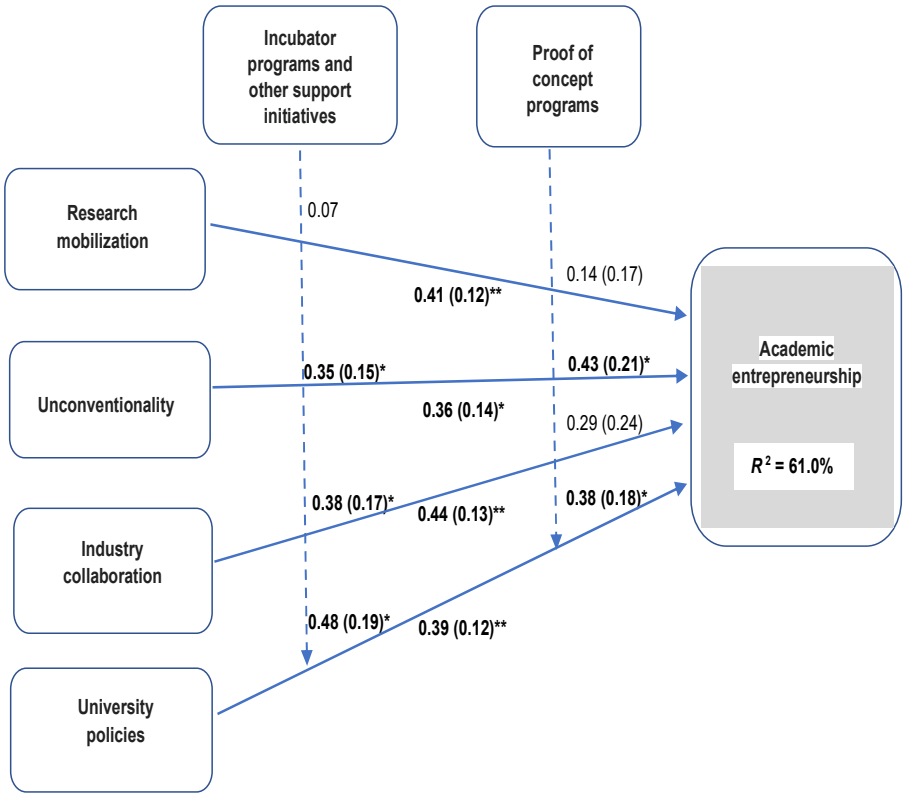

Figure 2.
Trajectory of standardised coefficient estimates (standard deviation)

Note(s): *$p < 0.05$; **$p < 0.01$

programs and support initiatives, the greater the impact of research mobilization, unconventionality, and university policies on AE.

For H6, our findings revealed no significant moderating effect for PoCs on the relationship between industry collaboration and AE (H6a: $\beta = 0.14$; $p = 0.413$) or unconventionality and AE (H6c: $\beta = 0.29$; $p = 0.227$). This shows that PoCs generate a significant positive moderating impact on research mobilization (H6b: $\beta = 0{,}43$; $p < 0{,}05$) and university policies (H6d: $\beta = 0.38$; $p < 0.05$) on AE. The better the perception of PoCs, the greater the impact of research mobilization and university policies on AE.

Since the moderating factor that revealed a greater impact on the facilitating mechanisms of AEwere incubator programs and other support initiatives, this factor having a positive impact on research mobilization, unconventionality and university policies.

5. Discussion

This study aimed to shed light on the mechanisms facilitating AE (academic entrepreneurship). Research mobilization, unconventionality, industry collaboration, and university policies were found to positively influence AE. Incubator programs and support initiatives did not have a significant moderating effect on the relationship between industry

collaboration and AE. Instead, incubator programs and other initiatives had a positive moderating effect on the impact of research mobilization, unconventionality, and university policies on AE. Regarding PoC (proofs of concept), no significant moderating effect was observed on the relationship between industry collaboration or unconventionality and AE.

PoCs had a significant positive moderating effect on the impact of research mobilization and university policies on AE. Thus, we find that interactions between universities and industry boost AE. This study demonstrates how adopting entrepreneurial orientation benefits HEIs (higher education institutions) by extending orientation towards mobilizing research, unconventional approaches, cooperation with industry, and university policy implementation. We find that incubator programs, other support initiatives, and PoCs maintain a moderating effect on AE and benefit their respective HEIs.

Our study shows that research mobilization positively influences AE (H1), confirming prior studies. Davey *et al.* (2016) show that academics assume key roles in developing knowledge societies. Ferretti *et al.* (2020) argue that AE has become a challenge for HEIs worldwide, having evolved into a series of unconnected individual activities undertaken by academic institutions that require greater structuring.

The results show that unconventionality positively influences AE (H2). It was found that the department's ability to identify new opportunities outside the traditional academic environment, focusing on unconventional approaches in research funding, problem-solving, and relationships with external organizations influence AE. Liñán *et al.* (2011) and Guerrero *et al.* (2014) show that academics are prone to identify commercial opportunities arising from their research, thereby generating value through patents or spinoffs. Hayter (2011) affirms that academics often perceive spinoffs as platforms to access funding. Todorovic *et al.* (2011) maintain that when state financing falls short, universities are encouraged to diversify income sources, innovate, and focus resources on advancing knowledge commercialization. The results show improvements in cooperation with organizations outside the institutional context. This confirms the findings of Ahmad *et al.* (2018), showing that entrepreneurial universities strengthen cooperation with external organizations to improve research activities.

There is a significant positive impact of industry collaboration on AE (H3). Thus, this confirms prior studies, further reinforcing the importance of this moderating factor in the influence of AE. Our study is in line with De Jong *et al.* (2014) and Compagnucci and Spigarelli (2020), who show that AE nurtures regions' social, economic, and cultural development through large-scale knowledge and technology transfer. Goethner *et al.* (2012) and Karlsson and Wigren (2012) show that AE literature highlights the role that networking in industry-focused groups and government support agencies play in fostering entrepreneurial careers. Ahmad *et al.* (2018) show that universities focusing on entrepreneurship cooperate well with organizations and improve their research activities.

Our findings are in line with both Riviezzo *et al.* (2019), who reveal a positive impact on AE (H4), and Efrata *et al.* (2021), who show that entrepreneurship education in higher education boosts innovation, proactivity, and risk assumption. HEIs are sensitive to new ideas and innovative approaches influencing AE. This position also receives support from Dabic *et al.* (2015) and Sandström *et al.* (2018), who show that one of the most critical challenges faced by university managers stems from their capacity to influence academics' attitudes and align them with the university's strategic interests.

Our study goes beyond these determinants of AE, analyzing the moderating effect that incubator programs and support initiatives have on the relationship between research mobilization, unconventionality, industry collaboration, university policies, and AE. Our results evidence that the corresponding moderating effects of the incubator programs and other support initiatives do not significantly impact these factors regarding the relationship between industry collaboration and AE (H5). These findings contradict Montiel-Campos

(2018), who researched factors determining spinoff launches, concluding that incubator programs and support initiatives serve as moderators. On the contrary, this study finds that these factors have a significant positive moderating effect on the impact of research mobilization, unconventionality, and university policies on AE, revealing that the greater the perception of the incubator programs and support initiatives, the greater the impact of research mobilization, unconventionality, and university policies on AE. This study corroborates findings by Riviezzo *et al.* (2019), who found that entrepreneurial orientation positively impacts AE (and therefore the number of research-generated spinoffs). Our study also concurs with Soetanto and Geenhuizen (2019), who also found that innovation actively supports new ideas, experiments, and creative solutions in the search for competitive advantages. Innovative universities can come up with new programs, create new courses, incorporate new ideas, implement new pedagogies, foster the development of internal motivation systems, facilitate spinoff launches, integrate new working methods, deploy new structures, and propose new management methodologies.

Our study tests the moderating effect that PoCs have in the relationship between research mobilization, unconventionality, industry collaboration, and university policies with AE (H6). However, for H6, PoCs generated no significant moderating effect on the relationship between industry collaboration and AE and between unconventionality and AE. Our findings do not support Munari *et al.* (2017), who find that PoCs support the technology transfer activities of universities, helping them to reduce technological uncertainties around inventions in their initial development phases. We find that PoCs have a significant positive moderating effect on the impact of research mobilization and university policies on AE, showing that the more ingrained the perception of PoCs, the greater the impact of research mobilization and university policies on AE. This drives growth in the number of spinoffs based on university-developed inventions and research, as well as the number of technologies licensed and/or patented by universities to companies.

We thus advocate a new approach, demonstrating the influence that the mobility of research, unconventionality, industry collaboration, and university policies hold over AE. We show that this relationship is subject to moderation by the aforementioned moderators, incubator programs, other support initiatives, and PoCs. It is essential for universities to actively work on new ideas, novelties, experimentation, and creative solutions in the search for a competitive advantage (Soetanto and Geenhuizen, 2019; Efrata *et al.*, 2021). In addition to having new programs, creating new courses, implementing new pedagogies, promoting the development of an internal motivation system, integrating new working methods, using new structures, and proposing new management methods. Moreover, universities should use PoCs as it is concluded that they represent an effective tool to transfer the commercialization of research-based inventions from academia to industry (Bradley *et al.*, 2013; Hayter and Link, 2015).

5.1 Theoretical implications

Academic institutions worldwide face challenges with Adult Education due to disjointed activities developed by different organizations. There is a need for systematic organization to be implemented (Rodrigues *et al.*, 2019). To incorporate different dimensions of AE, HEIs require restructuring (Zhao *et al.*, 2010; Karimi *et al.*, 2017; Hossain *et al.*, 2019; Reissová *et al.*, 2020). Even though AE has been extensively researched, studies on the mechanisms that facilitate it are scarce. This research aimed to fill this gap. In summary, addressing the challenges, restructuring HEIs, and understanding the underlying mechanisms are essential steps toward fostering a vibrant AE ecosystem.

Our main contributions stem from the study's empirical evidence of the role played by AE, interrelated with the determinants of entrepreneurship: industry collaboration, research

mobilization, unconventionality, and university policies. Research mobilization positively influences AE in conjunction with unconventionality, industry collaboration, and university policies. Incubator programs and other support initiatives positively moderate the impact of research mobilization, unconventionality, and university policies on AE, contributing to the launch of spinoffs. PoCs have a positive moderating effect on the impact of research mobilization and university policies on AE, supporting technology transfer.

This study provides additional support for research on AE, contributing to theories on the applicability of the determinants of entrepreneurship and the moderating factors studied, which enhance understandings of the role of entrepreneurship in HEIs. It sheds light on the determinants that drive AE, such as research mobilization, industry collaboration and university policies. AE is not just about startups; it is about transforming knowledge into economic and social impact. Thus, this research contributes to the broader discourse on how HEIs can actively participate in economic development through entrepreneurship.

5.2 Practical implications

This study holds practical implications for entrepreneurial HEIs. Our results suggest that AE is influenced by a set of determinants that enable HEIs to become more entrepreneurial. The results also reveal that incubator programs, other support initiatives, and PoCs moderate this influence. Given this, HEI rectors, deans, and directors should nurture these moderating effects by launching spinoffs and supporting technology transfer activities.

Public policies are useful and necessary when creating an adequate framework for scaling a business and investing, filling gaps that the private sector does not and ensuring competitiveness in the face of regulatory frameworks in foreign countries. Entrepreneurship activities depend on social and political conditions (GEM, 2022). Therefore, the government must support startups by implementing programs to foster entrepreneurship. HEIs should also include entrepreneurship topics in curricula. Addressing these issues aids public entrepreneurship strategies, ensuring startups and existing entrepreneurs can thrive in a competitive, inclusive, and sustainable ecosystem.

Our study offers new methodologies for identifying factors that foster AE, serving as an important touchstone for other researchers evaluating this theme. Through this study, we hope to inspire other academics to examine this emerging field. It is important to establish a strong entrepreneurial mentality among lecturers, researchers, and students to encourage orientation towards AE. Efforts need to be made to identify the best practices for improving the AE of HEIs and supporting this new pattern of development, focused on innovative environments.

Considering the importance of HEI entrepreneurship, rectors, deans, and directors need to act on our findings to benefit their institutions. In this sense, creating a positive workforce and a work environment that encourages more teamwork and the search for consensual interests is essential. Entrepreneurial HEIs can promote frequent trust and communication by organizing team-building activities that implement cognitive and social skills.

5.3 Limitations and future research

This research has certain limitations, which can be addressed in future studies. The study examines the Portuguese HEI context. Therefore, generalizing these results necessitates reservations. However, the responses came from a diverse range of actors in HEIs, not only from different academic backgrounds but also with different research interests. This makes the results more generalizable. Limitations are evident in terms of external validity, given that we gathered the data over a relatively short time period, and the use of specific scales to measure some complex and multidimensions dimensions that may condition the results.

Future researchers should extend the study to include other countries – especially other European countries – and verify the differences between different HEIs, governance structures, and contexts, ensuring the rectors, deans, and directors come from different backgrounds. Furthermore, the use of other constructs and other scales to measure them would be a suggestion for future researchers. Longitudinal studies could observe AE over longer periods of time, observing the impact of variations in the economic conditions of each country, such as the fallout from the ongoing global pandemic. We used a quantitative questionnaire, but future researchers could apply qualitative methodologies to obtain a deeper understanding of AE.

The conceptual model could also be expanded to include other variables, further advancing research on AE by incorporating the role of other moderating factors. This study charts a course for further research and inspires debates on the role of AE.

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