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Academic engagement in Portugal: the role of institutional diversity, individual characteristics and modes of knowledge production

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ABSTRACT

Higher Education Institutions (HEIs) play a crucial role in knowledge society by providing and disseminating knowledge. In this regard, academics have been encouraged to collaborate with society, leading to the emergence of new modes of knowledge production. Several institutional and individual factors have been identified as determinants of the academic engagement. Hence, using data from a survey delivered to a representative sample of Portuguese academics, this paper analyses the influence of different modes of knowledge production, institutional diversity and individual characteristics on distinct dimensions of academic engagement (*Formal Research Collaboration; Informal Dissemination of Knowledge; Commercialization of Knowledge; and Teaching-related Activities and Supervision of Students*). We propose as research hypotheses the existence of an influence of individual academics' values, identity and types of knowledge on the engagement with society, addressing them using a linear regression. Results suggest the influence of CUDOS, (i.e. communalism, disinterestedness and organized scepticism) and PLACE, (i.e. proprietary, local, authority, commissioned and expert) on academic engagement, although this influence differs according to distinct dimensions. The findings also reveal differences according to the type of institutional affiliation. Moreover, the study confirms the relevance of individual characteristics in explaining different forms of academic engagement, such as gender, discipline and seniority. Since the results do not align entirely with the theory, this paper may be of particular relevance to launch a discussion around the type of engagement higher education institutions intend to promote and how far their own characteristics and those of their academics may influence such engagement.

KEYWORDS

Academic engagement;
modes of knowledge
production; university;
polytechnic;
commercialisation

Introduction

Higher Education Institutions (HEIs) play a central role in the production and dissemination of knowledge (Kogan 2000; David and Foray 2003). Although this knowledge has always been considered an important asset for any society (Hüther and Krücken 2018), the importance of research production has been particularly emphasized by the technological pervasiveness and the consequent increasing

need for specific competencies. At the same time, knowledge is perceived as a valuable production factor, namely the technological advances in automation, digitalization and artificial intelligence, which have introduced a disruption that can be compared with the industrial revolution witnessed in the nineteenth century (David and Foray 2003; Hüther and Krücken 2016). This is particularly true for European countries where the idea of *Knowledge Society* has been interpreted as a meta-narrative or a governance tool in the context of European integration (Santiago, Carvalho, and Ferreira 2014; Carvalho and Diogo 2018; Chou and Gornitzka 2014). The challenges arising from scientific and technological development have been reshaping the relationships between academia, industry, government and society in general. Consequently, new rules and practices regarding the production of knowledge were established and a new paradigm emerged (Santiago, Carvalho, and Ferreira 2015). In this context, HEIs became a 'meaningful social actor', capable of empowering the society through the progressive engagement of the academic community in highly socially relevant issues (Dlouhá, Huisingh, and Barton 2013).

It has been discussed how academic engagement (AE), understood as knowledge-related collaborations with non-academic actors (Perkmann et al. 2013), contributes to the emergence of new modes of knowledge production, with some authors sustaining that it demands more interdisciplinary and applied research, particularly in what concerns knowledge transfer and commercialization (O'Brien, Marzano, and White 2013; Donina, Seeber, and Paleari 2017). Studies have also been explaining the different likelihood of academics to engage with the society based on individual characteristics, such as discipline, gender and seniority (Peksen et al. 2021; Schneijderberg et al. 2020). Others have emphasized the role of cultural organization in promoting entrepreneurial attitudes among academics (Perkmann et al. 2021). There are, however, some doubts concerning how institutional diversity influences the way academics engage with society. In other words, does the type of activities academics develop with non-academic partners differ according to the type of institution they work in? Or is engagement mainly driven by academics' intrinsic factors, leading to the development of different forms of engagement within the same institution? In this text, we present a broader perspective of AE and analyse the potential role on engagement played by the modes of knowledge production academics tend to privilege, academics' individual characteristics and their institutional affiliation. These aspects are analysed in relation with a number of defined dimensions, considering AE may take many forms (i.e. *Formal Research Collaboration; Informal Dissemination of Knowledge; Commercialization of Knowledge; and Teaching-related Activities and Supervision of Students*). The study focuses on Portugal Academia, which is integrated into what is called a binary system, providing an example of institutional diversity.

In the next sections, the major issues regarding AE and its main dimensions are reviewed, as well as their potential explanatory variables, through which we propose research hypotheses. Then, data and methods are presented. This is followed by the analysis and discussion of the main results, which are contrasted with the hypotheses. In the last section, the main conclusions are drawn and possible policy implications for HEIs in the frame of the knowledge society are suggested.

Academic engagement and its main dimensions

Academic engagement is a process in which both the academic community and society (at the local, regional, national or global level) exchange knowledge and practices (Thune et al. 2016). The earlier literature on the topic focused on the transfer of knowledge produced in HEIs to the economy through commercial-driven activities, such as patenting, licencing and the creation of spin-offs (Siegel et al. 2004; Crespi et al. 2011). Nevertheless, the spectrum of AE can be broadened to consider all the interactions and collaboration with non-academic partners, including informal relationships and activities intending to disseminate knowledge (Perkmann et al. 2013). From this perspective, one might suggest different dimensions of AE (Grimpe and Hussinger 2013; Rossi, Rosli, and Yip 2017).

Accordingly, one may consider as *formal research collaboration*, activities which allow the production and exchange of knowledge between academic and non-academic organizations, involving a formal contract and usually a financial return. This typically includes consultancy, joint research with external partners and research contracts (D'Este and Patel 2007).

However, as many authors have been stating (Perkmann et al. 2013; Grimpe and Hussinger 2013), AE may also occur through *informal dissemination of knowledge* activities, based on personal interactions and driven by a network of contacts. The relevance of this dimension is increasingly evidenced by the authors, as it facilitates the technological transfer and contributes to building bridges between organizations (Rossi, Rosli, and Yip 2017; Azagra-Caro et al. 2017).

As aforementioned, an extensive strand of literature has been highlighting the *commercialization of knowledge* produced in universities, which include patenting and licencing or the creation of private enterprises (Perkmann et al. 2013). In this type of activities, the academic usually pursues a financial return. HEIs have been encouraging and supporting this dimension by creating several structures, such as 'knowledge transfer offices' (KTO), incubators, science parks and others.

Finally, one can also identify a dimension that encompasses *teaching-related activities and supervision of students*, which takes place under the teaching mission of HEIs.

Academic engagement and the modes of knowledge production

The increasing emphasis placed on the collaboration between HEIs and society contributes to the emergence of new modes of knowledge production. The traditional disciplined-based science dynamics associated with 'Mode 1' have evolved to an inter and multidisciplinary knowledge production in collaboration with several actors ('Mode 2') (Gibbons et al. 1994).

The so-called *Mode 1* refers to a set of norms and values intended to guide the conduct of academics, which form the 'ethos' of science dominated by an academic agenda. This canon of values, intended to guide the scientific research, is also described by the acronym *CUDOS*, which means 'Communism' (the scientific output has a sense of common ownership); 'Universalism' (the statements should be subject to impersonal criteria); 'Disinterestedness' (the institutions should promote an altruistic behaviour from academics); and 'Organized Skepticism' (scientific claims should be subject to empirical and logical criteria) (Gibbons et al. 1994; Merton 1973).

Notwithstanding, according to Ziman (2000), the increasing importance of knowledge to the economic and social development leads to the emergence of a new mode of knowledge production, described by *Mode 2* or the acronym *PLACE*: 'Proprietary' (based on patents and intellectual rights); 'Local' (contributing to a specific problem), 'Authority' (controlled by the sponsors), 'Commissioned' (by specific institutions) and 'Expert' (highly specialized knowledge) (Santiago, Carvalho, and Ferreira 2015; Ziman 2000). This new mode of knowledge takes place within a collaborative context between the academic and society, driven by a broad range of interests (Gibbons et al. 1994).

Furthermore, one can also identify a 'Mode 3' of knowledge production, which emphasizes the existence of an 'innovation ecosystem' that encourages the co-evolution of different knowledge and innovation modes, balances non-linear innovation modes in the context of multi-level innovation systems and hybrid innovation networks and knowledge clusters tying together universities, commercial firms and other actors/stakeholders. 'Mode 3' emerges from the need to translate the complex, non-linear and dynamic processes of knowledge creation, diffusion and use that take place in the context of a 'glocal' knowledge economy and society. This perspective is also combined with the 'Quadruple or N Helix', which is an extension of the 'Triple Helix' model. Accordingly, at least one component (civil society and media) is added to the framework of interactions between academia, the government and industry (Etzkowitz and Leydesdorff 2000; Miller, McAdam, and McAdam 2016). In fact, the 'N Helix' model can better describe the challenges posed by the 'glocal' society, stressing the role of the public sphere in the knowledge exchange process (Leydesdorff 2012; Carayannis and Campbell 2009). In the remainder of this text, these issues will be explored empirically, in the Portuguese context.

Hence, from the literature, we can establish the following hypothesis:

H1: Academics that identify themselves more with the values of the CUDOS mode of knowledge production are more prone to be involved in *informal dissemination of knowledge*, while academics that identify themselves more with the values of the PLACE mode of knowledge production are more prone to be involved in *formal research collaborations, commercialisation of knowledge and teaching-related activities and supervision of students*.

The relevance of the institutional diversity in academic engagement

The literature explaining AE development in different types of HEIs is relatively scarce. Regarding this topic, authors stress the influence of the institutions' dimension, antiquity and location (rural or urban, inland or coastal areas) on the engagement with society (Thune et al. 2016). Moreover, the institutional and organizational culture is also emphasized as a determinant of academics' behaviour towards collaboration with society. The norms and values established in HEIs (Kalar and Antoncic 2016; Skute 2019), as well as the preciseness of an entrepreneurial behaviour from the peers (Tartari and Salter 2015), may encourage academics to pursue a more collaborative attitude.

A cross comparative study between 3 European countries (Portugal, Finland and Germany), to determine whether national differences in the institutionalization of the binary system lead to different outcomes in academics' societal engagement, reveals that while there is a general tendency for academics in polytechnics to be more engaged with society, there are relevant differences between countries, with Portugal showing a tendency for a convergence of academics societal engagement practices between academics from universities and academics from polytechnics (Götzea, Carvalho, and Aarvevaara 2021).

In Portugal, HEIs are integrated into what is called a binary system, characterized by the co-existence of polytechnics and universities, with different missions and goals. The institutionalization of universities follows the Humboldtian Model as they are expected to be focused on teaching and research, contributing to knowledge production. Polytechnics, in turn, are expected to have a more vocational orientation and to contribute to the local and regional development. Moreover, the research conducted at polytechnics is expected to be more applied, addressing specific and concrete problems (Lepori and Kyvik 2010; Carvalho and Diogo 2020). Additionally, Portuguese HEIs can be either public or private. In the case of private institutions, the development of research is not significant, both in universities and polytechnics (Teixeira et al. 2013). Following this perspective, it is expected that private institutions engage less with society, at least in the context of knowledge production. Although knowledge production is mainly developed in research centres, these are organizational units either located within HEIs (especially within universities) or affiliated with them (Heitor and Horta 2012).

Considering the above, we argue that there is a gap in the literature concerning the influence of the different subsystems and subsectors where HEIs' academics belong to AE (Perkmann et al. 2013; Abreu and Grinevich 2013). Taking into account the different missions of the existing types of HEIs, we derive the following hypotheses:

H2: Academics from private institutions are less prone to be involved in the 4 types of academic engagement (*Formal Research Collaboration; Informal Dissemination of Knowledge; Commercialization of Knowledge; and Teaching-related Activities and Supervision of Students*).

H3: Academics from polytechnics are more prone to be involved in the 4 types of academic engagement (*Formal Research Collaboration; Informal Dissemination of Knowledge; Commercialization of Knowledge; and Teaching-related Activities and Supervision of Students*).

The influence of individual characteristics on academic engagement

To better understand this phenomenon, literature has identified some individual characteristics explaining the likelihood of academics to collaborate with society (De Wit-de Vries, Dolfmsa, and

van der Windt 2019). In this regard, gender, discipline and seniority are commonly pointed out as factors determining AE (Pekşen et al. 2021).

Regarding gender, Abreu and Grinevich (2013, 2017) show that women are less likely to carry out entrepreneurial activities. In the same vein, Tartari and Salter (2015) confirm men tend to engage more with industry.

The career position seems to have a positive impact on engagement (Abreu and Grinevich 2013) as senior academics tend to have a more established reputation, social capital and a broader network of contacts (Kalar and Antoncic 2016; Fudickar, Hottenrott, and Lawson 2018). However, this effect should be analysed cautiously, as earlier-career academics may reveal some additional motivation to engage with external partners, namely to increase their visibility and recognition (D'Este and Patel 2007). Furthermore, evidence shows that younger academics from more innovative countries are more committed to these activities (Schneijderberg et al. 2020), particularly in the creation of spin-offs (Pekşen et al. 2021).

The discipline plays a key role in AE, since the dimensions used depend, to a great extent, on the type of knowledge exchanged. In this context, the findings of Abreu and Grinevich (2013) suggest that more applied areas, such as engineering, natural sciences and medicine, tend to develop more commercialization of knowledge, whereas social sciences tend to favour the informal dissemination of knowledge more.

The relationship between AE and other individual factors, such as scientific productivity, age, previous work outside academia (Perkmann et al. 2021) and even psychological characteristics (Skute 2019), has also been studied by several authors revealing somewhat ambiguous results.

Considering the above, the following hypotheses are derived:

H4: Senior academics (positioned in higher career ranks) are more prone to be involved in the 4 types of academic engagement (*Formal Research Collaboration; Informal Dissemination of Knowledge; Commercialization of Knowledge; and Teaching-related Activities and Supervision of Students*).

H5: Male academics are more prone to be involved in *formal research collaborations* and *commercialisation of knowledge*.

H6: Academics from hard sciences (natural sciences, mathematics and engineering) are more prone to be involved in the *commercialisation of knowledge* and *formal research collaborations*, whilst academics from social sciences and humanities are more prone to be involved in the *informal dissemination of knowledge*.

Data source

This empirical study is part of a research project under development in Portugal. The data were gathered through a survey designed within the international APIKS project – Academic Profession in the Knowledge-Based Society, which was delivered in 25 countries. The questionnaire contains different sections, meant to collect data on academic professionals' perceptions about different aspects of their career and work.

The questionnaire was distributed online to a representative sample of Portuguese academics (lecturers and researchers having a contract with a HEI) at the end of 2018. A stratified sampling technique was used to select this representative sample. It is worth to mention the representativeness of all types of institutions (universities, polytechnics, private and public), career positions (comprising Assistant, Associate and Full Professors) and disciplines was ensured.

The questionnaire was sent to 16,066 academics, and a total of 3199 responses was obtained. Although the response rate was rather high (ca. 20%), it should be noted that not all academics completed all the survey sections. As such, and for the purpose of this paper, we adopted a stricter approach by considering only those respondents that have completed the relevant questions for the study ($n = 1114$ – ca. 7%). Some of the groups corresponding to the characteristics considered in the sampling process present slight differences comparing with the population due to a response

Table 1. Dimensions of academic engagement and external activities included.

Formal research collaboration	Informal dissemination of knowledge	Commercialization of knowledge	Teaching-related activities and supervision of students
Consultancy	Evaluation (of policies and developments of companies, governments, regions, countries, etc.)	Patenting and licencing Creation of a spin-off/start-up company	Curriculum development for external agencies
Contract research	Writing publications for a broader range of readers	Use of infrastructure and (technical) equipment	Supervision of student internships and/or student work placements
	Participation in external board(s) and committee(s) (e.g. expert council, board of directors, board of trustees)	Test and construct prototypes	Joint supervision with industry of bachelor, master and/or doctoral thesis
	Public lectures and speeches Volunteer-based work/ consultancy in an honorary capacity	Work in a research laboratory, science incubator organization (e.g. think tank organization), and/or a science park	Executive, contract tailor-made programmes and courses

bias. However, we consider that the differences found are not significant. The sample is described in Table 1.

Variables definition and analysis

The dependent variables resulted from self-reported activities they had been involved in the past 3 years, from a list of possibilities. The listed activities were grouped into the 4 'dimensions of academic engagement' (see Table 2), defined according to the literature review. Consequently, an index intending to measure the level of engagement in each dimension was created. These index scores (ranging from 0 to 1) were calculated as a proportion of the activities selected by each academic from the total number of activities in each dimension. It is assumed that the higher the index is, the higher is the involvement of academics in that dimension.

Regarding the independent variables, different criteria were considered. The diversity of institutions in the Portuguese higher education system leads to the definition of 2 categorical variables: one to designate the subsector (public or private) and another to account for the subsystem (university or polytechnic). Considering the main individual determinants suggested in the literature, we included a categorical variable for gender, an ordinal variable for the academic rank (from the lowest to the highest position in the academic hierarchy) and a dummy variable for each discipline.

Since this study also aimed at testing how the different modes of knowledge production influence the dimensions of AE, a Likert scale, ranging from 1 to 5 (1 – strongly disagree and 5 – totally agree), was used, enabling respondents to rate their agreement with several statements reflecting different values and norms that might guide the scientific community. The statements were grouped around academics' relationship with the CUDOS and PLACE modes of knowledge production discussed in the literature review.

The statements describing the CUDOS' values (or Mode 1) are the following: 'Academics openly share new findings with colleagues; Academics evaluate research only on its merit, i.e. according to accepted standards of the field'; 'Academics are motivated by the desire for knowledge and discovery, and not by the possibility of personal gain'; 'Academics are responsible for the direction and control of science through governance, self-regulation and peer review'; 'Academics consider all new evidence, hypotheses, theories and innovations, even those that challenge or contradict their own work'.

Table 2. Characterization of the sample by type of institution, career rank, gender and discipline.

		Sample		Population	
		N	%	N	%
Types of Institution	University	744	68%	15,188	65%
	Polytechnic	357	32%	8293	35%
Career	Public	944	86%	18,638	79%
	Private	157	14%	4843	21%
Gender	Assistant Professor	763	69%	17,821	76%
	Associate Professor	261	24%	4069	17%
	Full Professor	77	7%	1591	7%
Discipline	Male	548	50%	13,159	56%
	Female	553	50%	10322	44%
Discipline	Education	100	9%	(n.a.)	5%
	Humanities and arts	151	14%	(n.a.)	12%
	Social sciences	155	14%	(n.a.)	24%
	Business and administration, economics	89	8%	(n.a.)	
	Law	18	2%	(n.a.)	
	Life sciences	69	6%	(n.a.)	15%
	Physical sciences, mathematics	41	4%	(n.a.)	
	Chemistry	33	3%	(n.a.)	
	Computer sciences	42	4%	(n.a.)	
	Medical sciences, health-related sciences, social services	147	13%	(n.a.)	18%
	Engineering, manufacturing and construction, architecture	112	10%	(n.a.)	17%
	Agriculture, forestry	31	3%	(n.a.)	4%
	Others	113	3%	(n.a.)	5%
	Total	1101			

Source: Statistics of population are from DGEEC 2018/2019.

Note: Number of academics in each discipline is not available. For the sampling process, we assumed the percentages on the grouped areas.

The statements regarding the PLACE's values (or Mode 2) are the following: 'Academics protect their newest findings to ensure priority in publishing, patenting, or applications'; 'Academics evaluate research only on its merit, i.e., according to accepted standards of the field'; 'Academics choose research projects only on its practical merit, i.e., according to societal, environmental and/or commercial problems'; 'Academics compete with others in the same field for funding and recognition of their achievements'; 'Academics conduct/pursue research in accordance with the profile of the organization/institution'.

The variables measuring the level of agreement with the 2 modes of knowledge production were calculated as the average of the answers given by the academics to each group of statements (CUDOS and PLACE). Descriptive statistics (see Tables 3 and 4) and multiple regression were used to treat and analyse the collected data. Specifically, 4 multiple regression models were estimated to analyse the influence of institutional diversity, individual characteristics and modes of knowledge production on each one of the AE dimensions.

To verify the hypotheses posed, a linear regression model with an Ordinary Least Squares (OLS) approach was proposed. The regression model is suitable since it provides a good test for causality between the dependent variables and the explanatory variables. Since each of the 4 models estimated has multiple explanatory variables, the effect estimated was isolated from every other

Table 3. Indexes measuring compliance with CUDOS and PLACE's norms.

	Mean	SD	Min	Max
CUDOS	3.63	0.72	1.00	5.00
PLACE	3.39	0.65	1.20	5.00

Table 4. Index scores reporting each academic engagement dimension.

	Mean	SD	Min	Max
Formal research collaboration	0.30	0.33	0.00	1.00
Informal dissemination of knowledge	0.39	0.26	0.00	1.00
Commercialization of knowledge	0.07	0.15	0.00	1.00
Teaching-related activities and supervision of students	0.25	0.22	0.00	1.00

explanatory variable, thus providing a clearer estimate of the effect of each explanatory variable in the dimensions of AE. Equation (1) presents the linear form adopted for the 4 models.

$$\text{Engagement} = \beta_1 + \beta_2 * \text{Modes} + \beta_3 * \text{Institutional} + \beta_4 * \text{Individual} \quad (1)$$

where 'Engagement' refers to the different dimensions of engagement estimated separately as dependent variables (Formal Research Collaboration; Informal Dissemination of Knowledge; Commercialization of Knowledge; and Teaching-related Activities and Supervision of Students); 'Modes' refers to the 2 variables that measure the CUDOS and PLACE characteristics of the academics; 'Institutional' and 'Individual' refer to the set of variables that are used to capture the institutional and individual characteristics of academics, respectively; and β are the estimated coefficients that establish a relationship between the dependent and the corresponding explanatory variable. Estimating this equation by OLS seems a better option than using count models, such as Poisson, since even though the dependent variables are proportions of a count variable, they refer to different engagement activities that are being summed on to form the variable, therefore resulting in a different situation than the one associated with count models.

Findings

Table 5 presents the coefficients and the level of statistical significance resulting from each model tested.

Regarding the effects of the modes of knowledge production and the different AE dimensions, Hypothesis 1 is tested. There is a positive and statistically significant effect of the norms and values associated with CUDOS (or Mode 1) and the development of *formal research collaboration* and *informal dissemination of knowledge*. On the other hand, the norms and values associated with PLACE (or Mode 2) positively impact on the development of *commercialization of knowledge* activities. Therefore, the results are coherent with H1, except in the dimension of *formal research collaboration*, where researchers that are more aligned with CUDOS engage more with this type of activities, contrarily to what was expected.

In terms of the impact of the institutional diversity that exists in the Portuguese HE system on the way academics interact and collaborate with society, hypotheses H2 and H3 are tested. Regarding the different types of institutions, the findings indicate that the AE activities vary according to the subsector (H2) and subsystem (H3) of HEIs. More specifically, academics from private institutions tend to be less involved in activities comprising the *informal dissemination of knowledge*. In H2, it was hypothesized that the private sector would have a lower involvement in all dimensions of engagement, but contrarily to what was expected, the *informal dissemination of knowledge* is the only dimension where that happens.

Additionally, the subsystem seems to have an important effect on the dimensions of AE, as there is a negative relationship between working in a polytechnic and the development of both *formal research collaboration* and *informal dissemination of knowledge*, comparing to working in a university. On the other hand, the engagement with society performed by academics from polytechnics tends to be more focused on *teaching-related activities and supervision of students*. In H3, we hypothesized that academics from polytechnics would have a higher engagement in all dimensions due to the nature of these institutions. However, this hypothesis only holds for 1 of the 4 dimensions.

Table 5. Estimation of a multiple linear regression model for each academic engagement dimension.

	Model	Formal research collaboration	Informal dissemination of knowledge	Commercialization of knowledge	Teaching-related activities and supervision of students
Modes of knowledge production	CUDOS	0.032*	0.027*	0.043	-0.002
	PLACE	0.019	-0.001	0.058*	0.015
Type of Institution	Private (a)	-0.029	-0.052*	-0.019	-0.015
	Polytechnic (b)	-0.012***	-0.048**	-0.049	0.36*
Individual characteristics	Career	0.068***	0.093***	-0.019	0.005
	Man (c)	0.072***	0.034*	0.149**	0.014
	Education (d)	0.100*	0.071*	-0.247**	0.020
	Humanities and arts (d)	-0.003	0.023	-0.201*	-0.029
	Social sciences (d)	0.089*	0.078**	-0.272**	-0.024
	Business and administration, economics (d)	0.039	0.052	-0.039	0.046
	Law (d)	0.0105	0.069	-0.364*	-0.073
	Life sciences (d)	-0.060	0.021	0.080	0.021
	Physical sciences, mathematics (d)	-0.046	-0.061	-0.117	-0.074*
	Chemistry (d)	-0.045	-0.061	0.204	0.030
	Computer sciences (d)	0.112*	-0.007	0.581***	0.091*
	Engineering, manufacturing and construction, architecture (d)	0.115**	-0.080*	0.405***	0.048
	Agriculture, forestry (d)	0.220***	0.021	0.010	0.073
	Others (d)	0.073	0.111***	-0.072	0.024
Model fit	Global significance	***	***	***	***
	N	1101	1101	1101	1101
	R ²	0.084	0.096	0.111	0.031

a – Ref. Public institutions. b – Ref. Universities. c – Ref. Women. d – Ref. Medicine and health sciences; Dependent variable: proportion of the activities developed in total of each dimension; Significance level: **p* .05; ***p* .01; ****p* .001.

When exploring the impact of individual characteristics on AE, career position (H4), gender (H5) and discipline (H6) produce statistically significant effects. The findings suggest that senior academics tend to be more involved in both *formal* and *informal* dimensions of AE. However, and contrarily to H4, the hierarchical position in the career ladder does not statistically influence neither the *commercialization of knowledge* nor the *teaching-related activities and supervision of students*, as differences in the several academic ranks are not evidenced.

As for the gender variable, it significantly impacts on AE, as men tend to engage more than women in *formal research collaboration*, *commercialization of knowledge* and *informal activities of knowledge dissemination to society*. Hypothesis 5 holds true, except for the dimension of *informal activities of knowledge dissemination*, where male academics were expected not to behave differently from female researchers.

Finally, the discipline emerges as a determinant of the type of AE. Medicine and health sciences were taken as a reference to compare the engagement of academics from different disciplines as they are not included in our hypothesis. In this regard, academics from education, social sciences, computer sciences, engineering and architecture and agriculture tend to engage more in activities comprising *formal research collaboration*. This goes against our hypothesis, as differences between the exact and social sciences were expected to be found in this dimension. Moreover, academics from

teaching training and education and social sciences also seem to develop more *informal activities of knowledge dissemination* than their counterparts from medicine and health sciences. The disciplines related to engineering and architecture are negatively associated with this type of collaboration, as expected in H6. In what concerns *the commercialization of knowledge*, an opposite result was found. Academics from education, arts and humanities and social sciences tend to engage less in the *commercialization of knowledge*, contrasting with the academics from computer sciences and engineering and architecture, who stand out in such collaborations, also as expected in H6. Regarding *teaching-related activities and supervision of students*, a positive and statistically significant relationship is found in computer sciences. On the other hand, academics from physical sciences and mathematics tend to engage less in this type of activity. This is the opposite of our hypothesis, as we expected no significant differences between fields of study in this dimension. [Table 6](#) summarizes the results obtained regarding the verification of hypotheses formulated per dimension of AE activities.

Discussion

According to the results, the CUDOS values seem to be compatible with the HEIs' relation with society since there is a significantly positive relationship between these and AE dimensions (both formal and informal). The CUDOS values encourage the adoption of altruistic behaviour by academics, extending the sense of common ownership of the knowledge to the broader society. In the last 3 decades, we

Table 6. Verification of hypotheses per dimension of academic engagement activities.

Hypothesis	Formal research collaboration	Informal dissemination of knowledge	Commercialization of knowledge	Teaching-related activities and supervision of students
[H1] Academics more identified with CUDOS mode of knowledge production are more prone to be involved in informal dissemination of knowledge, while academics more identified with PLACE mode of knowledge production are more prone to be involved in formal research collaborations, commercialization of knowledge and teaching-related activities and supervision of students	Not verified	Verified	Verified	Not tested
[H2] Academics from private institutions are less prone to be involved in the 4 types of academic engagement	Not verified	Verified	Not verified	Not verified
[H3] Academics from polytechnics are more prone to be involved in the 4 types of academic engagement	Not verified	Not verified	Not verified	Verified
[H4] Senior academics are more prone to be involved in the 4 types of academic engagement	Verified	Verified	Not verified	Not verified
[H5] Male academics are more prone to be involved in formal research collaborations and commercialization of knowledge	Verified	Not verified	Verified	Not tested
[H6] Academics from hard sciences are more prone to be involved in the commercialization of knowledge and formal research collaborations, whilst academics from social sciences and humanities are more prone to be involved in the informal dissemination of knowledge	Partially verified	Verified	Verified	Not tested

have been assisting to an increasing influence of New Public Management and managerialism in HEIs in Portugal, with a retreat of state funding (Cardoso, Carvalho, and Videira 2019). This may have pressured academics more oriented by the CUDOS values to engage more in formal relations with society to obtain alternative funding sources for their research. With respect to the PLACE values, the findings confirm their relationship with the *commercialization of knowledge*. PLACE values the intellectual property of the scientific output, the application of knowledge as a response to a specific industrial need and the control of the research agenda according to the interests of the main sponsors.

Despite being subject to the same political pressures under the knowledge society narratives, the different missions pursued by HEIs seem to play a role in shaping the way institutions are developing their relationship with society. The results confirm the polytechnics' vocational and training orientation, as the academics from this institutional type stand out in the development of *teaching-related activities and supervision of students*. The polytechnics were created as teaching institutions specialized in addressing the regional labour market needs. As a result, the collaboration with external partners occurs more frequently through the supervision of students' internships or dissertations in the industrial context. Contrarily to what was expected, universities have a higher engagement than polytechnics in the *informal dissemination of knowledge*. In a great extent, this may be a result of a longer presence of universities in the system, which may contribute to strengthen informal relations with their stakeholders, in particular through *alumni*. On the other hand, universities' approach seems to occur via the dissemination of the knowledge produced within the institution to society. This dissemination, or exchange of knowledge, takes place under the context of what Perkmann et al. (2013) defined as AE, without necessarily implying the commercialization of the scientific output.

The AE seems to differ more between HE subsystems (university or polytechnic) than HE subsectors (private or public). In this regard, only the *informal dissemination of knowledge* is significantly influenced by the subsector, as private institutions tend to engage less in informal interactions between academics and non-academic actors. In H2, we expected that public institutions would present a higher involvement in all dimensions of AE. In fact, as public institutions are older in the system, it is possible that private institutions started developing isomorphic mimetic behaviours, trying to reproduce the strategies public institutions are following to diversify their funding sources. The tendency for private institutions to develop isomorphic behaviours has been internationally recognized in the literature (Levy 1999; Teixeira et al. 2017).

As suggested by the literature, factors related to the institutional diversity and individual characteristics explain different attitudes towards the collaboration with external partners. Seniority emerges, in this study, as a determinant of the type of AE. The higher the academic category, the higher is the likelihood of establishing formal or informal interactions with non-academic partners. As the personal interactions play a significant role in AE, this can be explained by the fact that more senior academics have more social capital (Kalar and Antoncic 2016) and have had more opportunities to create a wider network of contacts (Fudickar, Hottenrott, and Lawson 2018). In addition, external organizations seek to work with well-established academics to benefit from their innovations. However, the results of this study do not show statistically significant differences in the development of *commercialization activities* or *teaching-related activities and supervision of students* by academics in different positions in the career ladder. The existence of gender differences in AE is also suggested, with men more likely to engage in formal and commercial-driven activities.

The results confirm that the type of AE varies across disciplines. More technological disciplines, as is the case of engineering and computer sciences, are positively associated with formal activities, which imply a contract and financial returns. This seems to confirm the relationship between more applied research and the development of patenting, licencing and creation of start-ups/spin-offs, suggested by the literature (Leišytė and Sigl 2018). Findings also indicate that these fields stand out in the development of *teaching-related activities and supervision of students*, which comprises the supervision of students' internships and theses with industry, underlining the closer relationship established between academia and industry in these fields (D'Este and Patel 2007). Academics from fields related to education and social sciences engage with society via

formal and informal activities, which can be included in what Perkmann et al. (2013) defined as ‘academic engagement’, stressing the contribution of social sciences for the third mission of HEIs through the development of non-commercial activities with external partners (see also Kalar and Antoncic 2016 and Abreu and Grinevich 2017).

Conclusion

This study analyses how institutional diversity, individual characteristics and modes of knowledge production influence AE in Portugal. The literature highlights individual characteristics as effectively affecting the dimensions of AE, but, so far, the if and how AE can be influenced by the type of HEIs academics work in has not been sufficiently explored. Furthermore, and to the best of the authors’ knowledge, no study has looked at the effect of different modes of knowledge production in AE, although there is evidence that knowledge transfer and commercialization is associated with interdisciplinarity (O’Brien, Marzano, and White 2013; Donina, Seeber, and Paleari 2017). Although the literature suggests the emergence of a new mode of knowledge production, the engagement with society seems to be compatible with the more traditional values guiding the academic community. The sense of freedom and common ownership of science can be extended to the broader society.

The study presents some limitations, namely methodological. First, each AE dimension considered includes a wide range of activities. The different relevance that each activity can assume for the dimension is not taken into consideration in the analysis. It is assumed that a higher involvement means the development of several activities and not, for instance, the frequency attached to one type of collaboration. Furthermore, the *R*-squared of each model is rather low. Thus, the factors included in this study are insufficient to explain the different dimensions of engagement. A wide range of personal and intrinsic factors, such as motivations, beliefs, previous experience with non-academic organizations can also influence AE. In the future, it would be relevant to add these and other personal characteristics to the debate.

Despite those limitations, it is believed that this study is particularly relevant due to its policy implications in the context of the knowledge society. In fact, the promotion of the collaboration between HEIs and society should take into consideration the alignment with the missions pursued by the institutions and integrate all the engagement dimensions. More than a rhetorical tool used in HEIs discourses, it is relevant that a reflection emerges on the type of engagement these institutions intend to promote with society. Is it a formal or informal engagement? Which are the main purposes of that engagement? Academics in Portugal tend to engage less in commercial activities, which are the ones that are more privileged by institutional and political decision-makers. Further studies to analyse potential measures to overcome this inconsistency are needed, accompanied by a reflection on the potential impact of a stronger emphasis on commercial initiatives for HEIs’ mission and role in society. In the same line, political decision-makers should also reflect on the organization of the system as a whole. Should all HEIs have the same strategies regarding this domain? Or can they specialize more in some dimensions according to a path dependency perspective? Furthermore, diversity within the academics group should be considered. It is relevant to discuss how the AE can be stimulated amongst groups that are less involved in these activities, as it is the case of women, junior academics and academics from less applied disciplines. Is it possible that engagement with society is contributing to perpetuate inequalities that already existed within HEIs and the HE system? In addition, it is also relevant to reflect on the potential impact of the changes in knowledge production promoted by a stronger engagement with society in the production of knowledge.

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