administrative sciences

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Assessing the Impact of Universities' Entrepreneurial Activity on Regional Competitiveness

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Abstract: The aim of this study is to test the multidimensional construct of the Entrepreneurial University (EU), and therefore to confirm whether EU factors make a positive contribution to regional competitiveness. Data were collected from ten Portuguese Public Universities (PPUs) through a self-administered questionnaire. First- and second-order confirmatory factor analyses (CFA) were performed through factor and multiple linear regression analyses. The main findings show that EU related factors—perceived and combined with actual regional metrics—especially entrepreneurial supporting measures, positively contributed to regional competitiveness. This study shows policy makers that universities are not merely cost centres but provide knowledge spillovers that can have a positive influence on regional competitiveness.

Keywords: entrepreneurial university; entrepreneurial orientation; higher education institutions; regional competitiveness; knowledge spillover

Citation: Brás, Gonçalo Rodrigues, Miguel Torres Preto, Ana Dias Daniel, and Aurora A. C. Teixeira. 2023. Assessing the Impact of Universities' Entrepreneurial Activity on Regional Competitiveness. *Administrative Sciences* 13: 34. https://doi.org/10.3390/admsci13020034

Received: 1 December 2022
Revised: 17 January 2023
Accepted: 18 January 2023
Published: 28 January 2023

1. Introduction

Research on entrepreneurial universities (EU) has flourished in recent decades (Forliano et al. 2021; Galvão et al. 2019; Nguyen et al. 2021), notably in terms of case study-based research (Bronstein and Reihlen 2014; Jackson 2015; Jansen et al. 2015; Palalić et al. 2017), with academia giving increasing recognition to different research streams guiding this broad domain. Nevertheless, some doubts remain regarding the effects of the shift from traditional to entrepreneurial universities (Kalar and Antoncic 2015) on regional competitiveness.

Some studies have addressed this issue either directly or indirectly by describing the universities' role in regional competitiveness and regional development (Linzalone et al. 2020; Rubens et al. 2017). Although such studies are scarce and typically target specific countries/regions/universities, it is possible to highlight some relevant conclusions. For instance, based on a case study in Canada, Bramwell and Wolfe (2008) stated that EU might contribute to social and economic development by generating, attracting and retaining job seekers, entrepreneurs and researchers. In a study conducted in Catalonia (Spain), Urbano and Guerrero (2013) concluded that EU can attract or generate new companies that promote competition and diversity. Audretsch (2014) argued that EU can foster the creation of entrepreneurial thinking and the development of 'entrepreneurial capital'. Additionally, Guerrero et al. (2016), using data from 102 European universities to build a structural equation model, were able to conclude that the entrepreneurial activity of universities has a positive impact on regional competitiveness.

However, only four Portuguese universities were included in the above research. Therefore, one of the aims of this study is to fill the gap in the literature on Portuguese public universities (PPUs) by examining the impact of entrepreneurial PPUs on regional competitiveness within the Portuguese territory. This is relevant, since public investment in education, science and higher education has declined in Portugal in recent years; this is due to economic crises that compelled higher education institutions (HEI) to adopt a more entrepreneurial orientation in their strategies and positioning. Therefore, the findings and policy implications of the case of Portugal can be useful to other countries that have experienced the same financial constraints.

The study of the relationship between EU and regional competitiveness is complex as the outcomes of the former typically encompass not only formal and informal factors (Abreu and Grinevich 2013; Guerrero and Urbano 2012), but also commercial and non-commercial activities (Abreu and Grinevich 2013; Gür et al. 2017). Moreover, most studies show some methodological weaknesses in terms of the validity and reliability of data sources, as well as sample selection bias. Thus, our paper also seeks to propose a new methodological approach to overcome these limitations by introducing an individual perception factor to measure regional competitiveness and combine this with other formal variables observed related to regional competitiveness.

Drawing on our knowledge of PPUs and the scales previously tested by other authors, we prepared a self-administered questionnaire that was submitted to all PPUs. We performed a confirmatory factor analysis (CFA) and factor scores were computed to estimate a multivariate regression. This approach allows us to decode EU-related factors that contribute to regional competitiveness: firstly, as a perception-based measure and, secondly, as a perception-based measure mixed with real indicators of regional competitiveness.

The remainder of the paper proceeds as follows. We start by describing the main theoretical concepts. Next, the methodological section explains the research design, variable metrics, data analysis, and research procedures, while Section 4 presents the results. The discussion section analyses the results in light of the literature review. Finally, the paper concludes and addresses limitations, implications, and future research.

2. Literature Review and Development of Hypotheses

2.1. Entrepreneurial Universities

There is widespread agreement in the literature that the higher education sector has been subjected to internal and external pressures for change as a result of universities' new role in society (Clark 2003; Deem 1998; Deem et al. 2007), which has encouraged HEI to become more autonomous and entrepreneurial (Shattock 2010; Taylor 2012).

Although the OECD and European Commission (2012) state that there is no consensual definition of EU, and Klofsten et al. (2019) conclude that the interpretation of the EU concept vary according to the academic context, Urbano and Guerrero (2013) argue that an EU can provide the right environment for its researchers to generate, transform and commercialise their knowledge and technology. On the other hand, Secundo et al. (2017) use past research to conclude that EU can transcend the traditional mission of universities by commercialising science and technology. Another study takes into account the EU's ability to adapt to environmental changes and assume a risk-taker culture (Guerrero et al. 2015). Based on the conceptual model of EU proposed by Guerrero and Urbano (2012), an entrepreneurial university is the result of formal (e.g., support measures for entrepreneurship, entrepreneurship education) and informal (e.g., role models and attitudes) environmental factors, as well as internal factors (resources and capabilities). Moreover, Abreu and Grinevich (2013) emphasised the informal role of academic entrepreneurship, particularly, informal commercial (consultancy, contract research, joint research projects) and non-commercial activities (informal advice, giving public lectures, organising exhibitions, and publishing books for the general public) that are entrepreneurial in nature.

As a result of the multiple concepts of EU, diverse characteristics are attributed to this type of institution. Moreover, the diversity surrounding the concept implies analysing

them through a multidimensional approach. For example, Todorovic et al. (2011) propose four factors to explain the concept of EU, namely: research mobilisation, unconventionality, industry collaboration, and university policies. The OECD and European Commission (2012) also defend this multidimensional approach, despite considering other reflective factors for the EU construct: (i) leadership and governance, (ii) organisational capacity, (iii) people and incentives, (iv) developing entrepreneurship in teaching and learning, (v) pathways for entrepreneurs, (vi) external university/business relationships rooted in knowledge exchange, (vii) the EU as an internationalised institution, and (viii) measuring the impact of EU.

Based on these constructs (OECD and European Commission 2012; Todorovic et al. 2011) and in light of the work developed by Brás et al. (2019), we defined five first-order factors (i.e., internal processes, entrepreneurial supporting measures, international collaboration, funding strategy, organisational design) to measure the EU construct.

2.2. Regional Competitiveness

Like many other concepts, there is no consensus on the definition (Aiginger 2006; Bristow 2005; Gardiner et al. 2004) or measurement of regional competitiveness (Kitson et al. 2004). Moreover, some authors are sceptical about studying competitiveness at the regional and local level (Thompson and Ward 2005).

Gardiner et al. (2004) argue that regional competitiveness is related to a regional economy's success rate when competing for their regional/national/international market share and applying for government incentives and other resources. They state that regional competitiveness expresses the ability to mobilise domestic investments, attract external (productive) investments and/or prevent locally-based firms from shutting down and relocating their activity. Rather than focusing on some intrinsic elements of regional competitiveness (inputs), it is more relevant for our purposes herein to emphasise the outputs and effects of regional competitiveness.

Turok (2004) noted that regional competitiveness is associated with the ability to export local goods, the efficiency or productivity of local resources in producing goods of value, and the extent to which resources are used. Kitson et al. (2004) added other effects related to regional competitiveness such as a high labour occupancy rate, and high-quality job opportunities for well-paid workers. Another perspective links the concept of competitiveness to productivity (Porter 1990) and takes an income approach to regional competitiveness, particularly the productivity measured across regions (Porter 2002). In the same line, Perry (2010) states that regional competitiveness reflects the economic success of regions, which implies that higher levels of economic growth reveal greater competitiveness across regions. Fernandez et al. (2013) argue that "territorial competitiveness is based on the capacity of one geographic unit to maintain its medium- and long-term economic growth, a sustained increase in capital investment, product per capita and exportations in order to improve the income and welfare of its population". Moreover, Meyer-Stamer (2016) defines the competitiveness of a territory as the capacity of a locality or region to generate high incomes and to improve the livelihoods of the people living there.

According to Meyer-Stamer (2016), people's welfare and living standards are often a relevant part of the territorial/regional competitiveness concept. Storper (1997) describes regional competitiveness not only by means of its territorial capacity to attract and maintain companies, but also by the ability to maintain or increase the living standards of those participating in the regional economy. Kitson et al. (2004) also refer to high-quality job opportunities for well-paid workers as a condition for regional competitiveness. Within this framework, the European Commission (1999) stresses that competitiveness is the ability to generate high-level employment.

On the other hand, it is now widely accepted that knowledge generation is a key determinant of regional economic performance (Audretsch et al. 2008). Regional competitiveness is a consequence of some specific knowledge contexts, like human capital (Lucas 1988), research (Buerger et al. 2012; Romer 1986), cooperation (Franco and Esteves

2020) or entrepreneurial activities (Audretsch and Keilbach 2004). Moreover, the concept of regional competitiveness is often linked to knowledge regions (Lönnqvist et al. 2014), knowledge cities (Yigitcanlar et al. 2008) or knowledge-based urban development (Knight 1995; Yigitcanlar and Lönnqvist 2013). Knowledge may directly influence the novelty or complexity of innovations, and some studies have recognised it as a vital component of firms' innovation capacity and a way to obtain competitive advantage (Kogut and Zander 1992, 1995). Accordingly, Wu and Shanley (2009) emphasise the positive innovation output effects from their knowledge stock measures: knowledge depth and knowledge breadth. Meanwhile, Cummings and Teng (2003) focus on R&D as one of the keys to knowledge, and patents are a significant part of R&D firm outcomes (Jung and Lee 2016).

Some studies note that there are no marked differences between the competitiveness of regions within a country and the competitiveness between countries (Budd and Hirmis 2004; Malecki 2002). Thus, from a macro viewpoint, the European Commission (1999) provides an in-depth definition of competitiveness, namely the "ability to produce goods and services which meet the test of international markets while at the same time maintaining high and sustainable levels of income" or, more generally, "the ability of companies, industries, regions, nations and supra-national regions to generate, while being exposed to international competition, relatively high income and employment levels".

In short, regional competitiveness outputs or effects are felt in three main areas: income, knowledge/innovation, and employment typology.

2.3. The Entrepreneurial University and Regional Competitiveness

Although the impact of universities' entrepreneurial activity on regional competitiveness is complex, the dominant view in the literature is that universities foster economic development primarily through the commercialisation of scientific research either by means of patent licensing or creating spin-off companies (O'Shea et al. 2008) as this constitutes immediate, measurable market acceptance for outputs of academic research (Markman et al. 2008). For instance, the Technology Transfer Office is the main instrument facilitating the spillover of knowledge by commercialising the research undertaken at universities (Audretsch 2014). The Bayh–Dole Act passed in the US aims to promote the commercialisation of university science (Kenney and Patton 2009; Link and Siegel 2005b). On the other hand, the entrepreneurial behaviour associated with some European universities it is still more related to spin-offs than patents (Riviezzo et al. 2019). This university–industry alignment is not restricted to the US. In Europe, universities are now considered essential actors of economic and cultural growth in the modern knowledge society within the concept of Smart Specialisation (European Expert Network on Economics of Education 2014). European universities are expected to adjust their strategies with the region's stakeholders and contribute to technological and economic specialisation at the regional level (Romano et al. 2014). This university–industry trade-off is therefore explicitly present in the reflection made by Etzkowitz (2013), in which he argues that EU can create economic and social value for society in exchange for academic funding. Indeed, some studies have analysed the relationship between entrepreneurial activity and regional competitiveness (Audretsch et al. 2012), and others have sought to shed light on the perceptions of competitiveness (Balkyte and Tvaronavičiene 2010) and the link between entrepreneurship and regional competitiveness perceptions (Nicolae et al. 2016). Within this theoretical framework, the following hypotheses are therefore proposed:

Hypothesis 1. *Overall, the five first-order factors of the EU construct (i.e., internal processes, entrepreneurial supporting measures, international collaboration, funding strategy, organisational design) have a positive impact on the (individual) perception of regional competitiveness.*

Guerrero et al. (2016) have focused specifically on the EU across Europe and confirm this positive relationship, namely the contribution of talented human capital to regional competitiveness. Thus, both theoretical and empirical evidence suggests that universities

and industry research make a positive contribution to the region's knowledge output (Acs and Varga 2005; Klarl 2013). As above, it is widely accepted that knowledge is a determinant factor for regional economic performance (Audretsch et al. 2008).

As a source of knowledge spillover, academic research is usually measured by means of R&D spending, the number of scientific articles published, the number of employees engaged in research or the number of patents (Henderson et al. 1998; McWilliams and Siegel 2000; Varga 2000).

Lastly, under the holistic Triple Helix of university–industry–government, "university research may function increasingly as a locus in the "laboratory" of such knowledge-intensive network transitions" (Etzkowitz and Leydesdorff 2000). Moreover, the government plays a pivotal role by supporting universities and fostering a research environment in line with the policy requirements (Abbas et al. 2019; Feola et al. 2021). Cerver Romero et al. (2021) indicate that this approach could be even more complex with the introduction of a fourth or fifth helix considering other dimensions like the civil society or the environment surrounding the universities.

Innovation and research domains have both been studied as regional consequences of EU. Nevertheless, some studies confirm the relevance of HEI on generated knowledge and that research is an important trigger of economic growth (Bok 2003; Etzkowitz 1998); these institutions have the ability to enhance local intellectual capital that can foster the development of a learning region (Trequattrini et al. 2015). Despite these holistic approaches (knowledge–research–regional income), we now focus on the impact of EU on regional development from an economic viewpoint. Throughout the Triple Helix approach, the alignment of universities with regional economic development has become increasingly evident, as noted in Etzkowitz (2003) "academic entrepreneurship has also expanded from an organisational growth regime into a regional economic and social development strategy". Moreover, universities comprehend an economic impact which is contingent on the success of university spin-offs (Hayter et al. 2018).

As such, some studies have analysed EU's impact on income at the regional level; a recent example of this is the study by Cunningham and Menter (2021). Furthermore, based on R&D from Canadian universities, Martin (1998) argues these institutions have a static gross economic impact on GDP. Similarly, Mok (2015) reveals that the strengthening of EU and university–enterprise cooperation in Singapore has had a relevant impact on economic growth through innovation and entrepreneurship.

Other studies have analysed the impact of universities, EU, or other spillover institutions on regional competitiveness, mainly in the three previously mentioned domains—Table 1.

This theoretical line leads to the following hypotheses:

Hypothesis 2. *Overall, the five first-order factors of the EU construct (i.e., internal processes, entrepreneurial supporting measures, international collaboration, funding strategy, organisational design) have a positive impact on regional competitiveness.*

H2a. *Overall, the five first-order factors of the EU construct have a positive impact on regional competitiveness in the income domain.*

H2b. *Overall, the five first-order factors of the EU construct have a positive impact on regional competitiveness in the knowledge/innovation domain.*

H2c. *Overall, the five first-order factors of the EU construct have a positive impact on regional competitiveness in the employment typology.*

Table 1. Synthesis of variables used in studies on the relationship between universities and regional development.

	Income				Knowledge/Innovation							Employment Typology		
	GDP *per* Worker	GDP *per capita*	Gross Value Added *per capita*	GDP Growth (*per capita*)	R&D Expenditures	Research Activity	Knowledge Based Firms	Patent	New Technology-Based Firms	Spin Offs	Employment Density	High Technology Employment	Employment Level of Persons with High Degree
Audretsch et al. (2012)	X		X										
Link and Siegel (2005a)					X								
Lindelöf and Löfsten (2004)					X								
Friedman and Silberman (2003)					X								
Audretsch and Lehmann (2005)		X											
Acs and Varga (2005)					X	X		X			X		
Baptista et al. (2011)							X						
Henderson et al. (1998)								X		X			
Varga (2000)						X						X	
Guerrero et al. (2015)		X		X					X				X
Audretsch et al. (2005)									X				
O'Shea et al. (2008)								X		X			
Sterlacchini (2008)				X									

3. Research Methods

3.1. Instruments

An initial survey was prepared based on the entrepreneurial orientation scale (EO), ENTRE-U, which was proposed by Todorovic et al. (2011) within the scope of the OECD and European Commission (2012), and in light of the work developed by Brás et al. (2019). Piolot testing of the survey was conducted to assess the survey instrument and data collection procedure before starting data collection. The survey was previously tested on PPUs, and 190 responses were collected; minor changes were made to the initial survey, which used a seven-point Likert type scale ranging from 1 (strongly disagree) to 7 (strongly agree) and included 33 questions; see Appendix A.

3.2. Data collection and Origin of Respondents

The primary data were gathered through a self-administered survey submitted by email to students, staff, and professors from all PPUs between December/2016 and June/2017. The authors drew up and administered the survey instrument online and a total of 619 valid survey responses were obtained after three waves of emails. Data were collected from ten of the fifteen PPUs.

In addition to the primary data, our analysis is complemented by secondary data collected from diverse official Portuguese sources on the real indicators of regional competitiveness in three domains: income, knowledge/innovation, and employment typology. This option allows us to give a more realistic setting to our study as "decision-relevant

information is a mixture of measurements and perceptions" (Pal 2004). These secondary data were collected on a regional basis (NUTS3 or Portuguese Districts in which PPUs are located), mainly through official sources such as Statistics Portugal or the Portuguese Institute of Industrial Property, but also from Dun & Bradstreet Portugal. Whereas NUTS 1 and NUTS 2 refer to larger socio-economic regions, NUTS 3 identifies the smaller regions in Portugal, so it allows us to capture specific regional effects in which PPUs are located. We chose to work on the NUTS 3 level or based on Portuguese Districts, because "using a finer geographical scale may reveal local spatial effects that are not evident at NUTS 2 level" (Postiglione et al. 2020).

Overall, Portugal has 14 public universities, one PPU for each NUTS 3 level (or for each District). The exception to this rule in higher education system is the Lisbon metropolitan area (Lisbon District), where we find four PPUs. Every single PPU was invited to participate in this study, although we only received data from 10 PPUs. However, the Lisbon metropolitan area is covered by two universities; thus, only two Portuguese regions (NUTS 3 level) with universities embedded in their regional areas are missing from our sample. Table 2 shows the distribution of valid responses by region (NUTS 3 level or Portuguese Districts) and by PPUs.

Table 2. Distribution of responses.

NUTS 3 Level	Portuguese Districts	PPUs	Valid Responses
'Algarve'	Faro	University of Algarve	98
'Região de Aveiro'	Aveiro	University of Aveiro	180
'Região de Coimbra'	Coimbra	University of Coimbra	44
'Alentejo Central'	Evora	University of Evora	74
'Área Metropolitana de Lisboa'	Lisbon	University of Lisbon and 'Universidade Aberta'	56
'Região Autónoma da Madeira'	Funchal	University of Madeira	13
'Cávado'	Braga	University of Minho	29
'Área Metropolitana do Porto'	Porto	University of Porto	93
'Beiras e Serra da Estrela'	Castelo Branco	University Beira Interior	32

3.3. Factor Analysis

First, each reflective first-order factor was validated through CFA after performing the Bartlett spherical test and KMO (Kaiser–Meyer–Olkin) test to determine whether the data are suitable for factor analysis. As CFA confirms the theoretical assumptions, according to Zhang and Preacher (2015), while factor rotation is an essential step in exploratory factor analysis, it is unnecessary in CFA. As such, it was decided to work with unrotated factors.

Data are normally distributed, and maximum likelihood (ML) was chosen as the extraction method, in line with Fabrigar et al. (1999). The internal consistency of the constructs was evaluated by calculating the Cronbach's alpha, but also the reliability of Tarkkonen's rho (Tarkkonen and Vehkalahti 2005). Moreover, the composite reliability was calculated for each of the six factors, as well as discriminant validity by the heterotrait–monotrait ratio of correlations (HTMT), which has a superior performance to the Fornell–Larcker criterion for accessing discriminant validity (Henseler et al. 2015).

Having confirmed the validity and reliability of the factors, we estimated the factor score coefficients for both the five above-mentioned first-order factors that aimed to reflect the EU construct and the first-order factor 'Perception-based measure of regional competitiveness'. This procedure was carried out using the regression factor scores method for the five first-order factors, because it provides the cumulative maximum validity and

non-correlated factors (Gorsuch 1983); meanwhile, the Bartlett method is used for the factor 'Perception-based measure of regional competitiveness', because it provides the cumulative maximum unbiasedness and non-correlated factors (Bartlett 1937).

Thus, a second-order CFA was conducted to test whether the five first-order factors (i.e., internal processes, entrepreneurial supporting measures, international collaboration, funding strategy, organisational design) reflected the EU construct; and several model fit indices and their criteria were used to examine the goodness-of-fit of the model. Considering the assumption on the consistent model specification and the normality (Appendix A) of the data, as well as the relatively large sample (619 observations), an ML estimation was performed; according to Lei (2007), this does not produce biased parameters. Based on the standardised regression weights, squared multiple correlations (individual reliability) and the model fit, we were able to obtain some second-order CFA results.

3.4. Regressions

In line with studies from wide-ranging research areas (Eyduran et al. 2010; Keskin et al. 2007; Sangun et al. 2009), we used the computed EU construct factor scores under a cross-sectional regression to estimate their contribution to (perceived) regional competitiveness (measured by the computed factor score 'Perception-based measure of regional competitiveness').

Given that heteroscedasticity is a common problem in cross-sectional data analysis, and makes ordinary least squares (OLS) inefficient (Long and Ervin 2000), as confirmed by the White test (p-value = P(Chi-square(20) > 43.340796) = 0.001843), a weighted least squares estimator (WLS) was used, which is in line with Greene (1997), in addition to a generalised least squares estimator (GLS), as proposed by Demidenko (2013). To determine multicollinearity, a wide measure of the degree of multicollinearity was used (O'Brien 2007), namely the variance inflation factor (VIF).

Thus, the basic model (Model 1) has the following specifications:

$$PBMRC_i = \beta_0 + \beta_1 IP_i + \beta_2 ESM_i + \beta_3 IC_i + \beta_4 FS_i + \beta_5 OD_i + \mu_i \quad (1)$$

$$\mu_i \sim \text{i.i.d.}\ (0, \sigma_\mu^2)$$

Given the specifications of Model 1, the computed factor scores are as follows: PBMRC—Perception-based measure of regional competitiveness; IP—Internal processes; ESM—Entrepreneurial support measures; IC—International collaboration; FS—Funding strategy; and OD—Organisational design. The error term is represented by μ.

To measure regional competitiveness by the perceptions of respondents, we blended these perceptions using real (secondary) data from three main areas of regional competitiveness: income, knowledge/innovation, and employment typology.

Even though the secondary data are from the recent past, this mix is undoubtedly relevant, because, as argued by Hague (2004), regional identity is oriented towards the perceived past, and regional identity is closely related to regional competitiveness (Paasi 2013).

As such, a standard interpretation of coefficients from these three different areas of regional competitiveness is obtained by using a log transformed variable to specify the following three log-lin models (Models 2, 3, and 4, respectively):

$$\ln(PBMRC_i * l_k) = \beta_0 + \beta_1 IP_i + \beta_2 ESM_i + \beta_3 IC_i + \beta_4 FS_i + \beta_5 OD_i + w_i \quad (2)$$

$$w_i \sim \text{i.i.d.}\ (0, \sigma_w^2)$$

where l_k represents actual income data per Portuguese region (NUTS3 to which PPUs belong); we used either measures such as: (i) Gross Domestic Product (GDP) per worker, (ii) GDP per capita, (iii) Gross Added Value (GAV) per worker, or (iv) GAV per capita.

$$\ln(PBMRC_i * Kl_k) = \beta_0 + \beta_1 IP_i + \beta_2 ESM_i + \beta_3 IC_i + \beta_4 FS_i + \beta_5 OD_i + z_i \quad (3)$$

$$z_i \sim \text{i.i.d.}\ (0, \sigma_z^2)$$

where Kl_k represents actual knowledge/innovation data per Portuguese region; we used measures such as (i) Innovation requests, (ii) R&D expenditure per workplace, (iii) R&D expenditure by GDP percentage, (iv) Number of technology-based firms, or (v) Percentage of high-technology exports.

$$\ln(PBMRC_i * El_k) = \beta_0 + \beta_1 IP_i + \beta_2 ESM_i + \beta_3 IC_i + \beta_4 FS_i + \beta_5 OD_i + \alpha_i \quad (4)$$

$$\alpha_i \sim \text{i.i.d.}\ (0, \sigma_\alpha^2)$$

where El_k represents actual employment typology data per Portuguese region; we used measures such as (i) Employment in R&D activities (ii) Employment in technology-based firms, (iii) Proportion of employed population with higher education, or (iv) Proportion of employed population with a Ph.D. degree.

4. Results

4.1. First- and Second-Order CFA

Overall, the descriptive statistics show that the assumption of univariate normality is not violated—Appendix A. Under criteria based on the suggestion by Kline (2011), no skewness values exceeded the absolute value of three and no kurtosis values exceeded the absolute value of ten. Moreover, none of the computed factor scores or observed variables (items) were even close to the thresholds defined by Kline (2011).

The main results regarding construct reliability and discriminant validity of factor analysis are presented in Table 3.

Table 3. Reliability analysis.

Factors	Cronbach's α	T_Rho	Composite Reliability
PBMRC	0.841	0.842	0.843
IP	0.914	0.914	0.913
ESM	0.872	0.877	0.873
IC	0.752	0.776	0.767
FS	0.757	0.766	0.755
OD	0.641	0.653	0.642

Considering the internal consistency, measured by Cronbach's α and Tarkkonen's rho, the overall results are relatively robust. Only the 'Organisational design' factor has a Cronbach's alpha coefficient below the well-known threshold fixed at 0.70 by Nunnally (1978). However, this issue may not be of relevance as it could be the result of the small number of questions or poor interrelatedness between items (Field 2007). Furthermore, some authors consider 0.6 acceptable for the Cronbach's alpha coefficient (DeVellis 2003; Hair et al. 2005). Tarkkonen's rho coefficients are similar to Cronbach's alpha coefficients.

As regards the composite reliability of the factors, the values were above the 0.7 threshold suggested by Hair et al. (2005), except for 'Organisational design'. The results on the validity can be seen in Table 4.

Table 4. Validity analysis.

Factors	KMO	Bartlett's Test	*p*-Value	HTMT Ratio (Max. Values)
PBMRC	0.857	1123.849	0.000	0.840
IP	0.938	3005.679	0.000	0.801
ESM	0.891	2141.905	0.000	0.840
IC	0.758	612.471	0.000	0.773
FS	0.692	442.993	0.000	0.703
OD	0.652	235.789	0.000	0.680

Note: HTMT matrix is provided in Appendix B.

Firstly, measuring the proportion of variability that is shared among items that might have common variance, Table 4 shows that KMO values are greater than 0.5, which is defined by Kaiser (1974) as acceptable.

Secondly, assuming the null hypothesis that the original correlation matrix is an identity matrix, the P-values of Bartlett's test allow us to reject the null hypothesis. As such, there is statistical evidence to conclude that there are correlations or observable variables among the items of each first-order factor.

Discriminant validity is lacking if the value of the HTMT ratio is higher than the defined thresholds. Considering the 0.9 threshold defined by Kline (2011), it can be concluded that discriminant validity comes from the factor covariances, all of which are statistically significant.

In summary, internal consistency, validity, and composite reliability (with the exception of 'Organisational design') are ensured for all first-order factors.

A second-order CFA was performed, and the main results are presented in Table 5.

Table 5. Results of second-order CFA.

			Estimate	S.E.	C.R.	*p*-Value	Standardised Regression Weights	Squared Multiple Correlations
IP	<—	EU	1.026	0.055	18.810	***	0.849	IP = 0.720
ESM	<—	EU	0.869	0.048	18.206	***	0.945	ESM = 0.893
IC	<—	EU	0.947	0.055	17.359	***	0.811	IC = 0.658
FS	<—	EU	0.700	0.046	15.298	***	0.754	FS = 0.568
OD	<—	EU	0.451	0.051	8.804	***	0.549	OD = 0.302

Note: ***, indicates that coefficients are statistically significant at 1% level.

Given a statistical significance level of 0.01, there is evidence to conclude that each of the first-order factors is reflective of the EU construct. Moreover, second-order CFA confirms high standardised regression weights ($\lambda \geq 0.5$) and adequate individual reliability (measured by squared multiple correlations; ($R^2 \geq 0.25$) from each factor).

When checking the model fit, it is relevant to measure how accurately the observed data correspond to the assumed second-order CFA model. Several of the fit tests were performed and most of the indexes indicate a good model fit, for example:

$$\frac{\chi^2}{DF} = 2.67; TLI = 0.91; PCFI = 0.85; RMSEA = 0.05; CFI = 0.917; TLI = 0.910; GFI = 0.885$$

4.2. Regressions

Having confirmed the reliability and validity of reflective factors of EU as well as the 'Perception-based measure of regional competitiveness' factor, the six-factor scores were computed to perform regressions to test the EU factors' contribution to regional competitiveness, whether based on perception, actual data or a combination of the two.

Firstly, given the nature of cross-sectional data, the presence of heteroscedasticity was tested (and confirmed) using the White test, and the absence of multicollinearity within explanatory variables (reflective factors of EU) was confirmed by VIF (IP = 2.600; ESM = 2.487; IC = 1.812; FS = 1.539; OD = 1.374). As such, GLS and WLS estimations were performed with the specification given in Model 1, and the results are presented in Table 6.

Table 6. Estimation results—Model 1.

	WLS Estimation				GLS Estimation			
	Coeff.	**t-Ratio**	***p*-Value**	**Sig**	**Coeff.**	**t-Ratio**	***p*-Value**	**Sig**
Cons	0.019	0.084	0.933		−0.120	−0.524	0.600	
IP	0.220	3.079	0.002	***	0.279	5.501	0.000	***
ESM	0.544	7.432	0.000	***	0.462	8.384	0.000	***
IC	0.177	2.935	0.004	***	0.199	4.465	0.000	***
FS	0.090	1.639	0.102		0.134	3.221	0.001	***
OD	−0.007	−0.129	0.898		−0.021	−0.496	0.620	
Adj. R^2	0.538				0.460			

Note: ***, indicates that the coefficients are statistically significant at the 1% level.

Table 6 shows that, in both estimations, 'Entrepreneurial supporting measures' has the greatest (positive) influence on the perception of regional competitiveness at the 1% significance level. Performing a GLS estimation, the 'Funding strategy' factor also makes a positive contribution to the perceived regional competitiveness at the 1% significance level. In the framework of EU reflective factors, 'Organisational design' is the only factor that has no statistical significance to explain regional competitiveness from a perception viewpoint.

The next tests go beyond analysing the contribution of EU computed factor scores based merely on the individual perceptions of regional competitiveness. As previously noted, actual variables of regional competitiveness were introduced in three main areas: income, knowledge/innovation, and employment typology Models 2, 3 and 4, respectively. Table 7 shows the GLS estimation results of Model 2.

Table 7. Estimation results—Model 2.

	Product of PBMRC with Regional Income Variables in log Form, as Dependent Variables of Regional Competitiveness							
	Ln (PICR * GDP per Capita)		**Ln (PICR * GDP per Employment)**		**Ln (PICR * GAV per Capita)**		**Ln (PICR * GAV per Employment)**	
	Coeff.	***p*-Value**	**Coeff.**	***p*-Value**	**Coeff.**	***p*-Value**	**Coeff.**	***p*-Value**
Cons	**10.139**	0.000	**10.957**	0.000	**10.004**	0.000	**10.817**	0.000
IP	**0.059**	0.000	**0.059**	0.000	**0.059**	0.000	**0.059**	0.000
ESM	**0.097**	0.000	**0.094**	0.000	**0.097**	0.000	**0.094**	0.000
IC	**0.046**	0.000	**0.048**	0.000	**0.046**	0.000	**0.048**	0.000
FS	**0.033**	0.005	**0.035**	0.002	**0.033**	0.005	**0.035**	0.002
OD	0.001	0.918	0.003	0.817	0.001	0.918	0.003	0.817
Adj. R^2	0.43		0.42		0.43		0.42	

Notes: The bold values indicate statistically significant coefficients at 1% significance level. "*" means multiplication.

Excluding the 'Organisational design' factor, Table 7 shows that, from a regional income perspective, all EU factors contribute positively to regional competitiveness (at the 1% significance level), whether including GDP or GAV as components of the dependent variable. All estimations show that the 'Entrepreneurial supporting measures' factor has the greatest (positive) influence on regional competitiveness from an income perspective.

Model 3 also uses a GLS estimation to test the impact of EU factors on regional competitiveness from a knowledge/innovation standpoint. Indeed, several variables related to knowledge/innovation were included as components of the dependent variable in natural logarithm form—Table 8.

Table 8. Estimation results—Model 3.

	Product of PBMRC with Regional Knowledge/Innovation Variables in log Form, as Dependent Variables of Regional Competitiveness									
	Ln (PBMRC * R&D Expenditures per Workplace)		**Ln (PBMRC * R&D Expenditures by GDP Percentage)**		**Ln (PBMRC * Percentage of High-Technology Exports)**		**Ln (PBMRC * Innovation Requests)**		**Ln (PBMRC * Number of Technology-Based Firms)**	
	Coeff.	***p*-Value**	**Coeff.**	***p*-Value**	**Coeff.**	***p*-Value**	**Coeff.**	***p*-Value**	**Coeff.**	***p*-Value**
Cons	**4.212**	0.000	**0.226**	0.083	**1.988**	0.000	**3.796**	0.000	**6.826**	0.000
IP	**0.048**	0.001	**0.101**	0.008	−0.021	0.656	**0.160**	0.005	**0.107**	0.054
ESM	**0.113**	0.000	**0.160**	0.000	0.058	0.213	**0.140**	0.022	0.070	0.245
IC	**0.058**	0.000	**0.055**	0.078	**0.141**	0.000	0.049	0.322	**0.106**	0.032
FS	**0.026**	0.026	**0.063**	0.058	0.028	0.507	**0.086**	0.058	0.053	0.265
OD	−0.009	0.409	−0.025	0.404	−0.037	0.399	−0.065	0.133	−0.039	0.333
Adj. R^2	0.45		0.27		0.05		0.15		0.09	

Notes: (i) The grey cells in the second line include secondary data from Portuguese Districts in which PPUs are located. (ii) The white cells from the second line include secondary data from Portuguese NUTS3 in which PPUs are located. (iii) The bold values indicate statistically significant coefficients, whether at the 1%, 5% or 10% significance level. "*" means multiplication.

Table 8 reveals that the 'Organisational design' factor is not statistically significant to explain regional competitiveness from the knowledge/innovation viewpoint even at the 10% significance level. All statistically significant coefficients are positive, which means that four EU factors make a positive contribution to regional competitiveness from a knowledge/innovation perspective.

It can also be seen that 'Internal processes' and 'International collaboration' show a statistically significant positive contribution to regional competitiveness in four of the estimations performed. However, 'Entrepreneurial supporting measures' is only statistically significant in three of the estimations performed, its coefficient weights are high, and their sum is similar to the total coefficient weights of the 'Internal processes' and 'International collaboration' factors. 'Funding strategy' is the statistically significant factor with the lowest impact, despite its positive contribution to regional competitiveness from this perspective.

The most robust estimation was the one in which 'R&D expenditures per worker' was included as a dependent variable component. It is possible to conclude that four EU factors make a positive contribution to regional competitiveness from the R&D perspective.

In Model 4, we also use a GLS estimation to test the impact of EU factors on regional competitiveness from an employment typology perspective. Thus, several variables related to literacy among employees or the employment sector were included as components of the dependent variable in log form—Table 9.

Similarly to previous estimations, the results reveal that 'Organisational design' is not statistically significant to explain regional competitiveness from the employment typology standpoint. All statistically significant coefficients are positive, which means four EU factors make a positive contribution to regional competitiveness from this perspective.

'International collaboration' is the only statistically significant factor in all estimations, indicating its robustness to explain regional competitiveness from an employment typology standpoint. With the exception of the third estimation (in which the 'proportion of employed population with a Ph.D. degree' was included as a component of the dependent variable), all other factors, namely 'Internal processes', 'Entrepreneurial supporting measures' and 'Funding strategy' show statistical significance to explain regional competitiveness from this employment typology perspective. These three EU factors therefore contribute (positively) to regional competitiveness within this framework.

The estimations which tested the impact of EU factors on regional competitiveness are the most robust for the employment sector (R&D activities or Technology-based firms) but not for literacy among employees.

Table 9. Estimation results—Model 4.

	Product of PBMRC with Regional Employment Typology Variables in log Form, as Dependent Variables of Regional Competitiveness							
	Ln (PBMRC * Proportion of Employed Population with Higher Education)		**Ln (PBMRC * Employment in Technology Based Firms)**		**Ln (PBMRC * Proportion of Employed Population with a PhD Degree)**		**Ln (PBMRC * Employment in R&D Activities)**	
	Coeff.	***p*-Value**	**Coeff.**	***p*-Value**	**Coeff.**	***p*-Value**	**Coeff.**	***p*-Value**
Const.	**3.145**	0.000	**2.257**	0.000	**3.253**	0.000	**2.413**	0.000
IP	**0.076**	0.000	**0.060**	0.000	0.046	0.182	**0.057**	0.000
ESM	**0.091**	0.000	**0.112**	0.000	0.049	0.170	**0.106**	0.000
IC	**0.051**	0.001	**0.050**	0.000	**0.133**	0.000	**0.056**	0.000
FS	**0.048**	0.002	**0.031**	0.012	0.027	0.352	**0.033**	0.007
OD	−0.012	0.452	−0.001	0.892	−0.005	0.849	0.000	0.951
Adj. R^2	0.33		0.47		0.15		0.49	

Notes: (i) The grey cells from the second line include secondary data from Portuguese Districts in which PPUs are located. (ii) The white cells from the second line include secondary data from Portuguese NUTS3 in which PPUs are located. (iii) The bold values indicate statistically significant coefficients, whether at the 1%, 5% or 10% significance level. "*" means multiplication.

5. Discussion

Within the theoretical framework and given the formulated hypotheses and the results described in the previous section, we note the following findings. First of all, the scales adapted from Todorovic et al. (2011) and the OECD and European Commission (2012) are suitable for measuring EU in the Portuguese context.

Secondly, considering only the GLS estimation, each of the factor component scores related to the EU construct makes a positive contribution to the perception of regional competitiveness, except for the 'Organisational design' factor. Thus, hypothesis 1 should only be partially accepted. Furthermore, there is strong evidence confirming 'Internal processes', 'Entrepreneurial supporting measures', 'International collaboration' and 'Funding strategy' as factors with a positive impact on the (individual) perception of regional competitiveness.

Regarding the regressions in which the dependent variable (perceived regional competitiveness) was blended with real data on regional competitiveness in three main areas (income, knowledge/innovation, employment typology), the regressions from an income perspective were perceptibly more robust. All GLS estimations showed that the four EU factors had a significant impact on regional competitiveness from the income point of view; this is advocated by Porter (2002) and recently confirmed by Guerrero et al. (2016).

As such, there is strong evidence that, except for 'Organisational design', EU factors have a positive impact on regional competitiveness from the income perspective, thus allowing us to partially accept hypothesis 2a.

The GLS estimations performed to test the impact of EU factors on regional competitiveness from the perspective of knowledge/innovation were the least robust. The EU factors only showed a positive impact for the estimations in which R&D expenditures were added as components of regional competitiveness (per work post or by GDP percentage); this is in line with studies by Friedman and Silberman (2003) and Link and Siegel (2005a). Hence, as 'Organisational design' has no impact and there is little evidence of EU factors having a positive impact on regional competitiveness from the knowledge/innovation perspective, once again we can only partially accept hypothesis 2b.

Regarding the GLS estimations performed to test the impact of EU factors on regional competitiveness from the employment typology perspective, it is plausible to argue that three (out of four) estimations are robust. With the exception of 'Organisational design', all EU factors showed a positive impact on regional competitiveness from the employment perspective. The 'International collaboration' factor was statistically significant in all GLS estimations, and cumulatively with the 'Entrepreneurial supporting measures' factor displayed the largest positive impact on regional competitiveness in this domain. Like the preceding GLS estimations, even though EU factors were found to make a positive

contribution to regional competitiveness from the employment typology perspective, in line with other studies (Guerrero et al. 2015; Varga 2000), we can only partially accept hypothesis 2c. More specifically, there is strong evidence the 'International collaboration' factor of the EU construct has a positive impact on regional competitiveness in the employment typology, and the 'Organisational design' factor of the EU construct does not have a significant positive impact on regional competitiveness in the employment typology.

Figure 1 provides a more conclusive overview of the impact of EU factors in the three main areas of regional competitiveness (income, knowledge/innovation, employment typology) based on the sum of the statistically significant coefficients from these areas; it shows that the 'Entrepreneurial supporting measures' factor of the EU construct has the greatest impact on regional competitiveness.

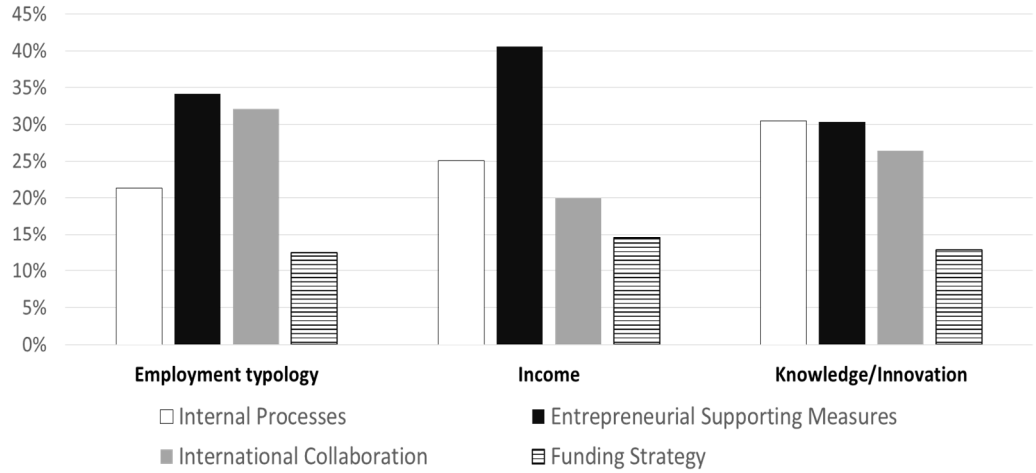

Figure 1. Overall impact of EU factors on regional competitiveness.

6. Conclusions

Considering our results, the entrepreneurial orientation of PPUs makes a positive contribution to the perception of regional competitiveness. Furthermore, regardless of the domain of regional competitiveness (knowledge/innovation, income, or employment typology), when we combine perceptions with real data on regional competitiveness, we can conclude that EU factors make a relevant contribution to regional competitiveness, in particular, the 'Entrepreneurial supporting measures' factor, which has the strongest effect on competitiveness at the regional level.

These findings demonstrate to policymakers that PPUs are hubs of knowledge spillover that can act as a positive stimulus on regional competitiveness. 'Organisational design' does not have a robust performance in any of the data analyses performed in our research. This outcome might be expected, since the organisational structure of the PPUs tend to be similar.

Regarding the limitations of this study, the sample of PPUs is relatively small and asymmetric between institutions; moreover, our cross-sectional approach represents only a single moment in time.

Our study raises additional research questions that could act as starting points for future research: (i) Is the reconfiguration of universities towards a stronger market-orientation in recent years' imperative for the results obtained? (ii) Is the EU's contribution to regional competitiveness structural or conjunctural? (iii) Will the tendency to 'do more with less' in Portuguese academia affect the efficient performance of universities and therefore their long-term contribution to regional competitiveness? (iv) Are we moving toward a university system as a source of technological commercialisation? (v) From an academic point of view, could the pressure for economic competitiveness detract from the university offer, namely by focusing more on engineering areas than for the humanities or social sciences, for example?

Author Contributions: Conceptualization, G.R.B., M.T.P., A.D.D. and A.A.C.T.; methodology, G.R.B., M.T.P., A.D.D. and A.A.C.T.; formal analysis, G.R.B., M.T.P., A.D.D. and A.A.C.T.; writing—original draft preparation, G.R.B., M.T.P., A.D.D. and A.A.C.T.; writing—review and editing, G.R.B., M.T.P., A.D.D. and A.A.C.T.; funding acquisition, M.T.P., A.D.D. and A.A.C.T. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by FEDER—Fundo Europeu de Desenvolvimento Regional funds through the COMPETE 2020—Operacional Programme for Competitiveness and Internationalisation (POCI) and by FCT—Fundação para a Ciência e a Tecnologia grant number PTDC/IVC-PEC/5514/2014 and CEECINST/00026/2018.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data presented in this study are available on request from the corresponding author.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. Scales and descriptive statistics.

	Mean	Std. Dev.	Skewness	Ex. Kurtosis
Perception-based measure of regional competitiveness	4.2859	1.2323	−0.126	−0.348
it1—My university encourages professors and students to participate in research projects with practical results for industry or society	4.5089	1.69937	−0.334	−0.739
it2—My university has strong links with business incubators. science and technology parks and/or other similar organisations	4.0630	1.58499	0.045	−0.594
it3—My university is recognised for its link to industry and to society	4.1648	1.60157	−0.043	−0.583
it4—Many professors of my university conduct research in collaboration with companies. governmental and non-governmental institutions.	4.5460	1.58749	−0.457	−0.522
it5—The entrepreneurial activity of my HEI improves economic and regional development	4.1454	1.50561	−0.080	−0.152
Entrepreneurial Supporting Measures	3.8644	0.99565	−0.012	0.719
it6—My university establishes clear targets to achieve in the entrepreneurial framework. such as the number of new patents or the number of new spin-offs.	2.9871	1.16440	0.815	2.096
it7—My university regularly controls the compliance of objectives established in the entrepreneurial framework.	3.1244	1.12015	1.146	2.979
it8—My university supports the entrepreneurial activity of their members (students, researchers, professors and staff) by training. consulting. industrial propriety information. etc.	3.8611	1.47583	0.047	−0.120
it9—In my university there are support facilities for entrepreneurial activity (e.g., Incubators. science and technology parks. support office for entrepreneurship. etc.).	4.0129	1.58057	0.016	−0.353
it10—My university provides their members (students, researchers, professors and staff) with access to funding sources to develop entrepreneurial activity (e.g., Information about national and international funding programmes. support for applications to funding programmes. organisation of events that improve links between entrepreneurs and potential funders. etc.).	4.0598	1.41923	0.024	0.102

Table A1. *Cont.*

	Mean	Std. Dev.	Skewness	Ex. Kurtosis
it11—At my university innovative teaching methods are used (e.g., case studies. experimental classes. games. simulations. etc.).	4.0662	1.54033	0.041	−0.339
it12—At my university the teaching of entrepreneurship is included in the curricular plans of several courses.	4.1583	1.58190	−0.050	−0.249
it13—My university encourages and supports the participation of their members (students, researchers, professors and staff) in extracurricular and other activities (e.g., Ideas completion. voluntary work. etc.).	4.5299	1.63507	−0.433	−0.595
it14—My university supports and encourages its members (students, researchers, professors and staff) to create new businesses (spin-offs. start-ups).	3.8853	1.31635	−0.048	0.625
International Collaboration	4.6539	1.1359	−0.337	−0.140
it15—My university supports the international mobility of their members (students, researchers, professors and staff).	5.1422	1.47662	−0.643	−0.041
it16—My university plays with international institutions to create courses (bachelor. master and PhD degrees).	4.8078	1.53604	−0.618	−0.031
it17—The staff (professors and non-professors) of my university comes from many different cultures.	3.8562	1.56737	0.217	−0.417
it18—My university links with international institutions to develop research projects.	4.8982	1.49031	−0.572	−0.025
Funding Strategy	4.0984	1.0228	−0.013	1.620
it19—My university gets funding from sources apart from public sector.	3.9968	1.27078	−0.051	0.768
it20—The faculties/departments of my university have autonomy to attract their own funding sources.	4.1502	1.32625	0.048	0.902
it21—The top management of my university plays an active role in obtaining funds and alternative incomes.	3.9806	1.22657	0.021	1.546
Internal Processes	4.3611	1.1109	−0.207	0.185
it22—In my university teamwork and multidisciplinary work are valued.	4.6381	1.56568	−0.470	−0.385
it23—In my university dialogue and the exchange of experiences among all its members (students, researchers, professors and staff) are stimulated.	4.3473	1.63909	−0.046	−0.722
it24—My university values its members (students, researchers, professors and staff) that seek alternative and innovative solutions to difficult situations or problems.	4.2876	1.46304	−0.025	−0.211
it25—My university supports the efforts of individuals and teams that work autonomously.	4.2100	1.36217	−0.107	0.334
it26—The top management of my university values research and innovation.	5.1454	1.50130	−0.790	0.306
it27—In my university there is access to information in a clear and transparent way.	4.6446	1.57848	−0.459	−0.419
it28—The members (students, researchers, professors and staff) of my university who support or develop entrepreneurial activities are recognised and rewarded by the institution.	4.0275	1.30380	−0.095	0.611
it29—My university actively improves and innovates its organisation and the services that it provides.	3.9499	1.43096	−0.015	−0.103

Table A1. *Cont.*

	Mean	Std. Dev.	Skewness	Ex. Kurtosis
it30—At my university all members (students, researchers, professors and staff) contribute to the development of the strategy and policies.	3.8530	1.36509	0.064	0.105
Organisational Design	3.5240	0.99597	0.204	0.563
it31—At my university there are few hierarchical levels.	3.9144	1.43379	−0.031	0.015
it32—At my university the power and responsibility of decision-making is decentralised.	3.6769	1.26144	−0.175	0.479
it33—At my university there is not too much bureaucracy.	3.1470	1.28573	0.686	0.710

Note: Number of observations = 619; minimum value = 1; maximum value = 7.

Appendix B

Table A2. HTMT matrix.

	ESM	FS	IC	IP	OD	PMC
ESM	1					
FS	**0.70286**	1				
IC	**0.772794**	0.654565	1			
IP	**0.800833**	0.598202	0.709308	1		
OD	0.474189	0.424226	0.299025	**0.679753**	1	
PMC	**0.83999**	0.656239	0.721386	0.721982	0.414782	1

Note: The bold values indicate the maximum levels.

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