EXTENDED ABSTRACT

Title: What is your region's favourite kind of university?

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Introduction

Universities play an important role in innovation processes and are crucial actors for the competitiveness of a region (García-Álvarez-Coque et al., 2021; Mas-Verdú, et al., 2020). While it is true that the role of universities in promoting regional development has already been studied, this research aims at focusing on different categories of these institutions. Thus, the research question is the following:

RQ: What typologies of university systems do contribute the most to regional competitiveness?

The debate focuses on the role of the regions as key locations in the organization and governance of economic growth and wealth creation (Kitson et al., 2004). Regional competitiveness (RC) is not only a topic of academic interest, but also has important implications for policy deliberation and formulation.

Regional Competitiveness and the Universities Role

Competitiveness has acquired special importance in the world. In the United States, competitiveness has been established as a "growth strategy" to close the competitiveness gap. In the European Union, this strategy is based on more dynamic and competitive knowledge-based economies that promote social cohesion in the most lagging regions.

Numerous private organizations and consultancies (World Economic Forum -Genova, Switzerland-, Competitiveness Institute -Barcelona, Spain-, Council on Competitiveness- Washington DC-, Institute for Strategy and Competitiveness - Harvard, MA, USA-), are interested in measuring and put pressure on the competitive performance of regions. But how to measure the competitive performance of the regions? Human capital, in regional competitiveness, has a transcendental role. Policy implications should provide information on how human capital affects the business environment and how it can be improved. According to Kitson et al. (2004), it is necessary to focus more on the environmental conditions that promote economic growth and development than on the result that is presented with GDP.

In this sense, human capital is believed to be the basis for growth and future wealth of a region (Januškaitė, & Užienė, 2018). Thus, the role of universities is crucial in sustainable regional growth that helps educate people and promote a more inclusive lifestyle.

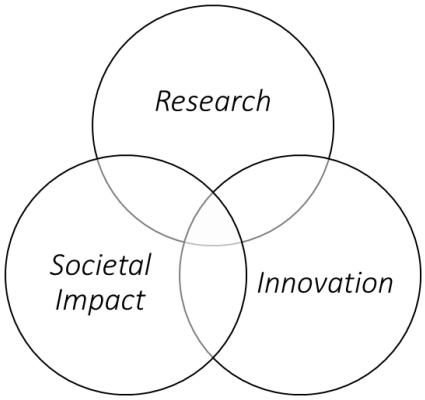
Universities play a significant role in the production, acquisition, absorption, reproduction, and dissemination of knowledge that favours competitive dynamics and innovative activity in the regions (Audretsch, et al., 2012).

The production of regional knowledge can explain the competitiveness of the regions (Levin, et al., 1987). It is estimated that the main source of tacit knowledge is the research-intensive universities, as producers of human capital and research that overflows to the regional industry. The existence of universities, therefore, increases regional competitiveness and fosters business activities and regional development and

growth. For Abreu et al. (2016) regional competitiveness and university research production are close substitutes in shaping the behaviour of companies. Although regional competitiveness influences the innovation behaviour of companies, the greatest impact occurs only if research-intensive universities are located in this region.

The classification of academic institutions prepared by SCImago (SIR) aims to reflect the scientific, economic, and social characteristics of the institutions based on three sets of indicators based on the performance of research, the results of innovation, and the social impact (figure 1).

Figure 1. The role of the Universities by SCImago



The **research factor** measures: i) the number of excellent documents in which the main institution contributes; ii) the number of publications in journals indexed in Scopus; iii) the number of documents not published in its journals, iv) the number of journals published by the institution; v) high-quality publications (Q1); vi) the amount of scientific production of an institution that is included in the top 10% of the most cited articles in their respective scientific fields; vii) number of articles in which the corresponding author belongs to the institution; viii) percentage of documents published in open access journals or indexed in the Unpaywall database, and; ix) the total number of different authors of an institution in the total publication production of that institution during a given period.

The **innovation factor** is calculated taking into account: i) innovative knowledge; ii) technological impact, and; iii) patents.

The **Societal Impact** factor is measured from the following indicators: i) altimetric which is calculated on the 10% of the best documents for the normalized value; ii) number of Backlinks, that is, the number of networks from which inbound links to the institution's website come, and; iii) the size of the network, number of pages associated with the URL of the institution according to Google.

Model: Method and Data

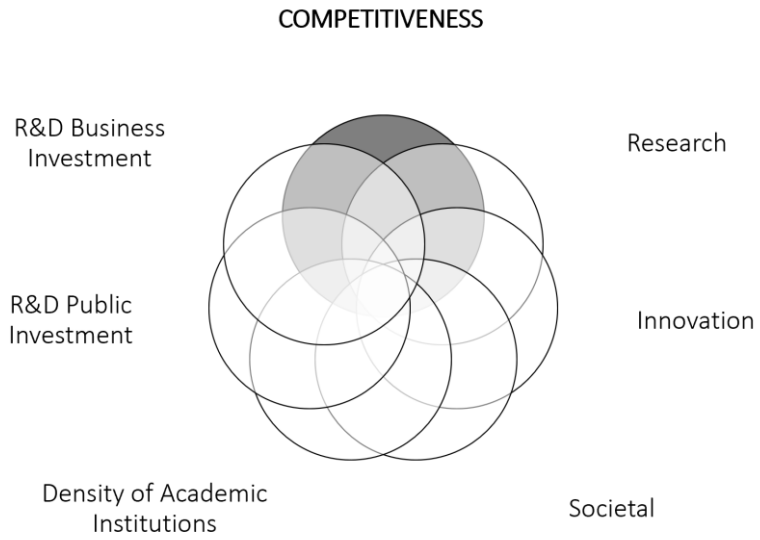
The model used in this research is based in the Triple Helix framework (Zhou & Etzkowitz, 2021; Cai & Etzkowitz, 2020; Ranga & Etzkowitz, 2013; Etzkowitz & Zhou, 2006). The Triple Helix model is structured around the interactions between universities-industry-government, which favours the transmission of knowledge through cooperation between the parties (Farinha, Ferreira & Gouveia, 2016). In the first stage where knowledge is created through the interaction between the three institutional spheres (universities-industry-government). This knowledge is transferred through cooperation and the process ends with the placement of innovation activities in the market (Kalenov & Shavina, 2018). In this scenario, universities play a relevant role as a partner that provides technology/knowledge and has access to public and private funds. With which the companies benefit from this mixed collaboration and with the generation of links that favor innovation and, therefore, the competitiveness of the regions.

Specifically, to conduct this research, conditions from SCImago Rankings (SIR) and Regional Competitiveness Index (RCI) from European Commission has been used. Figure 2 shows the conditions related to the Triple Helix model. The outcome is measured by the RCI.

The conditions associated to the University are Research, Innovation and Societal, as they have been previously defined. The Government conditions are the R&D Public investment and the density of higher institutions (defined as number of institutions per millions of inhabitants). Finally, the Business role is reflected using the R&D business investment in the region.

Taking as reference 251 European regions at NUTS-2 level and performance indicators of 741 Universities, fuzzy set qualitative comparative analysis (fsQCA) is used. fsQCA is an appropriated method dealing with the complex causality in the regional context (Garcia-Alvarez-Coque et al., 2021a). fsQCA identifies causal configurations that lead to high regional competitiveness, considered as an outcome. The necessary and sufficient conditions that can lead a region to be competitive are examined.

Figure 2. Conceptual Model.



fsQCA Results

To conduct a fsQCA research, the first step is calibrating the data. After, the analysis of necessary conditions and sufficient conditions must be done. Finally, we include a cluster and robust test proposed by Oana and Schneider (2021). The SetMethods R Package for Advanced QCA in R was used (Oana and Schneider, 2018).

Table 1. Analysis of Necessity

	Cons.Nec	Cov.Nec	RoN
R&D Public Investment	0.727	0.772	0.817
R&D Business Investment	0.805	0.842	0.862
Research Impact	0.760	0.731	0.755
Innovation Impact	0.612	0.813	0.891
Societal Impact	0.810	0.710	0.696
Concentration Acad. Inst.	0.726	0.632	0.641
~ R&D Public Investment	0.456	0.476	0.652
~R&D Business Investment	0.380	0.402	0.628

~ Research Impact	0.378	0.439	0.683
~Innovation Impact	0.570	0.496	0.566
~ Societal Impact	0.318	0.418	0.721
~ Concentration Acad. Inst.	0.429	0.570	0.780

Note: (~) means absence of the condition

Table 1 shows the analysis of necessity. As can be noted, none of the conditions exceed the consistency value of 0.9, so there are not conditions necessary to achieve the regional competitiveness.

Table 2 shows the casual configurations that reach to RC. First, we can observe that there are 5 patterns. In other words, there is more than one way to be competitive. The overall results of the model are appropriate: consistency value is 0.832 (higher than 0.75) and the coverage is the 84.6% of the cases. Furthermore, conducting a robust test protocol proposed we can observe that the results are robust (Cons.Suf: 0.832; Cov.Suf: 0.846 and PRI: 0.775).

Table 2. Analysis of Sufficiency

		inclS	PRI	covS	covU
1	RD_Public*RD_Business	0.912	0.871	0.619	0.042
2	RD_ Public *Research* Innovation*Societal	0.883	0.829	0.516	0.061
3	RD_ Business *Innovation Imp.	0.909	0.863	0.534	0.003
4	RD_ Business *Societal Imp.	0.899	0.860	0.670	0.063
5	RD_ Business *~Concentration	0.892	0.825	0.369	0.029
	Model Results	0.832	0.775	0.846	

Note: (~) means absence of the condition; (*) is the logical operator AND. Inclusion cut-off: 0.8; n.cut: 1; pri.cut: 0.5 and directional expectations: (1,1,1,1,1,1)

Specifically, there are 2 groups of patterns: Group 1 with configurations 1 and 2. Group 2 with configurations 3, 4 and 5. Group 1 considers regions that have high R&D public and private investment (pattern 1) or regions with public investment and high-quality institutions that are focused in the three pillars of specialization (research, innovation and societal) (pattern 2). Group 2 considers regions that have high R&D private investment and institutions that are focused on innovation aspects or the societal role (patterns 3 and 4). Finally, pattern 5 contains regions with low concentration rate of institutions but with high R&D private investment.

Related to the typology of the universities, there is not only one type of university that is contributing to the RC. In any case, a kind of investment must be present (Public or Private). However, when the regions have only a public investment, they need institutions that are top in the three pillars. However, when the regions receive a private investment, they need institutions that put the focus in the societal or innovative role.

Table 3 shows a cluster diagnostic of the results. The cluster diagnostic analyses each pool of countries related with the casual configurations (1 to 5) in order to check which configurations fit or not with the regions of each country. Specifically, we can observe that the solutions proposed do not fit with the Italian, Greek and Hungarian regions (consistencies < 0.75).

Table 3. Cluster Diagnostic

	Consistencies					**Coverages**				
Nº. Config.	1	2	3	4	5	1	2	3	4	5
Overall	***0.912***	***0.883***	***0.909***	***0.899***	***0.892***	***0.619***	***0.516***	***0.534***	***0.670***	***0.369***
AT (8)	0.951	1.000	1.000	0.962	0.942	0.811	0.514	0.697	0.639	0.300
BE (9)	0.962	0.969	0.856	0.869	0.867	0.928	0.640	0.675	0.761	0.608
BG (6)	0.967	0.974	0.784	0.784	0.303	0.806	0.259	0.432	0.432	0.565
CZ (7)	0.843	1.000	1.000	1.000	1.000	0.591	0.137	0.145	0.286	0.164
DE (37)	0.994	0.983	0.995	0.995	1.000	0.597	0.610	0.623	0.738	0.449
DK (5)	1.000	0.949	1.000	1.000	1.000	0.718	0.712	0.610	0.718	0.358
EL (13)	0.507	0.260	0.643	0.530	0.442	0.925	1.000	0.925	0.925	0.477
ES (19)	0.791	0.543	0.700	0.698	0.953	0.752	0.772	0.648	0.808	0.499
FI (5)	0.821	1.000	1.000	0.863	1.000	0.855	0.532	0.563	0.749	0.048
FR (22)	0.827	1.000	0.924	0.907	0.988	0.765	0.493	0.649	0.649	0.347
HR (2)	0.370	1.000	1.000	1.000	0.370	0.644	0.370	0.267	0.267	0.644
HU (6)	0.578	0.599	0.256	0.256	0.341	0.378	0.417	0.423	0.423	0.913
IE (3)	0.916	1.000	0.858	0.858	0.954	0.536	0.432	0.699	0.702	0.185
IT (21)	0.675	0.423	0.538	0.508	0.617	0.744	0.803	0.874	0.894	0.673
LT (2)	1.000	1.000	1.000	1.000	1.000	0.234	0.104	0.104	0.104	0.234
NL (11)	1.000	0.993	1.000	0.998	1.000	0.415	0.556	0.384	0.508	0.437
PL (17)	0.722	1.000	1.000	1.000	0.611	0.620	0.188	0.189	0.246	0.685
PT (7)	0.619	0.684	0.798	0.598	1.000	0.791	0.661	0.566	0.726	0.120
RO (8)	1.000	0.783	0.842	0.876	0.503	0.520	0.228	0.235	0.312	0.329
SE (8)	0.991	0.983	1.000	0.999	1.000	0.718	0.512	0.533	0.778	0.057
SI (2)	0.866	1.000	1.000	0.527	0.680	0.673	0.098	0.208	0.479	0.335
SK (4)	1.000	1.000	1.000	1.000	1.000	0.403	0.087	0.087	0.089	0.103
UK (29)	1.000	1.000	0.974	0.965	1.000	0.429	0.376	0.378	0.698	0.271

Regarding the Spanish regions, they are represented by the patterns 1 and 5. Furthermore, as we can observe in the appendix, Spain has 2 Deviant Cases (ES22- Comunidad de Navarra; ES51- Catalunya). It means that these regions have the potential to be competitive but they do not.

Conclusions

Analysis of necessity suggests that there is no necessary type of university for driving regional competitiveness. The analysis of sufficiency selects five causal configurations that reflect the synergies among factors. Our findings show that relatively high levels of R&D expenditure must be present in all configurations, independently of the type of university present in a region. Two main patterns are found: (i) regions that have substantial business R&D expenditure, but also contain an innovative or societal oriented university system; (ii) regions that have substantial public R&D expenditure that needs to be completed by high-level university system focused on its three main pillars: research, innovation and societal. The implications of this work can help the design of regional innovation policies and identifies the role of university missions other than the merely related to research.

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Appendix: Ideal and Deviant cases

Ideal Cases	Deviant Cases
AT00; AT11; AT21; AT22; AT31; AT32; AT33; AT34; BE00; BE21; BE22; BE23; BE25; BE33; BE34; BE35; CZ00; CZ06; DE00; DE11; DE12; DE13; DE14; DE21; DE22; DE23; DE24; DE25; DE26; DE27; DE50; DE60; DE71; DE72; DE73; DE80; DE91; DE92; DEA1; DEA2; DEA3;	BE32; ES22; ES51; FI1D; FRC1; FRC2; FRI2; FRI3; FRJ1; IE04; ITC1; ITC3; ITC4; ITH2; ITH3; ITH4; ITH5; ITI2; ITI4; PL82; PL92; SI03;

DEA4; DEA5; DEB3; DEC0; DED2; DED4; DED5; DEE0; DEF0; DEG0; DK01; DK03; DK04; DK05; ES21; ES30; FI19; FI1B; FI1C; FR10; FRB0; FRG0; FRH0; FRI1; FRJ2; FRK2; FRL0; IE05; IE06; NL00; NL11; NL12; NL21; NL22; NL31; NL33; NL34; NL41; NL42; PL91; SE11; SE12; SE21; SE22; SE23; SI04; UKD3; UKD4; UKD7; UKF1; UKF2; UKF3; UKG1; UKG2; UKG3; UKH1; UKJ1; UKJ2; UKJ3; UKJ4; UKK1; UKK2; UKK4; UKN0;	