Life below excellence: Exploring the links between top-ranked universities and regional competitiveness

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Abstract

This paper examines interactions between the presence of top-ranked universities and other conditions that encourage regional competitiveness. Fuzzy-set qualitative comparative analysis (fsQCA) was conducted to assess the combined effect of the conditions. The analysis yields several noteworthy conclusions. First, no single condition is necessary for a region to be competitive. Second, R&D expenditure is important for regional competitiveness. Third, different configurations of conditions are sufficient for high competitiveness in different regional clusters. Furthermore, some of these configurations do not include the presence of top-ranked universities. A 'magic recipe' consists of the combination of a private research system, an inter-firm collaboration network and high levels of human capital. The analysis shows that university excellence is valuable. However, in terms of its contribution to regional development, it is not crucial and must always be contextualized. This conclusion is important for smart strategic planning of local knowledge systems.

Keywords

Knowledge-based economy; regional development; top-ranked universities; public and private R&D; fsQCA

JEL codes

O38, I23, I25, I28

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1. INTRODUCTION

There is a growing consensus that the knowledge-based economy adds value and creates competitive advantages for countries and regions (World Bank, 2004). Unsurprisingly, therefore, governments seek to include universities in their development strategies to support the development of this knowledge economy (Goddard & Chatterton, 2003). Universities play a key role as 'knowledge factories' (Wolfe, 2005), creating knowledge that can potentially be exploited and adopted by firms and then transformed into innovations.

To analyse the impact of universities on regional development, three points must be considered. First, the contribution of universities to economic and innovative development cannot be automatically simplified. Universities act as multifaceted economic agents embedded in regions. They not only produce codified knowledge and human capital but also participate as institutional actors in the generation and upkeep of regional networks and knowledge flows (Bramwell & Wolfe, 2008). Second, the effect of universities on regional growth requires the transfer of knowledge. This knowledge transfer is a fluid, iterative process (Boucher, Conway, & Van der Meer, 2003; Bramwell & Wolfe, 2008) that involves numerous agents such as firms, institutions and government and that depends on certain conditions such as public and private investment in R&D and inter-firm collaboration. Third, not all universities are equal in terms of their functions, their performance or the strategies that govern the way they relate to their environment. Until recently, however, most studies of the factors that affect regional competitiveness considered universities as a homogeneous group (Harrison & Turok, 2017; Pinheiro, Benneworth, & Jones, 2012). Yet the rankings that classify universities by various criteria distinguish between different types of universities. In this paper, we focus on the research role of universities. We evaluate the extent to which this role promotes regional development by examining a university ranking that lists universities according to research performance.

This paper contributes to explaining how top-ranked universities in terms of research performance affect regional development. Specifically, we present the following findings. First, the interactions between the presence of top-ranked universities' and other conditions enhance the role of the innovation system in regional competitiveness. Second, the contribution of highly ranked universities to regional development varies across different regional contexts.

The rest of the paper proceeds as follows. Section 2 reviews the literature on the role of universities and university rankings and explores the impact of universities on regional development. Section 3 introduces the method, variables and data set. Section 4 presents and discusses the results. Section 5 concludes by highlighting the primary policy implications.

2. BACKGROUND AND LITERATURE REVIEW

2.1. The changing role of universities

In recent decades, the university's function has evolved from that of conventional research and teaching. Universities must now also provide a knowledge hub that promotes innovation (Youtie & Shapira, 2008). Nevertheless, teaching and conducting research that produces knowledge continue to form the core of the university's activities.

Acknowledging these two conventional and essential roles of the university, scholars have reported how the university's role has shifted from that of a knowledge warehouse and factory to a catalyst for knowledge (Harrison & Leitch, 2005). This shift does not mean that some functions have replaced others. Instead, the university has taken on new roles. Previous roles do not necessarily disappear as new functions are added. Moreover, the specific roles of each university may vary depending on the institutional environment of that university's country or region.

In an emerging model of the university, each university functions as a knowledge hub that stimulates and catalyses socioeconomic development and innovation, especially in the local region (Shapira & Youtie, 2008). In this model, universities are actively integrated into regional innovation systems, promoting connections with other agents within the system and linking research to applications through innovation. The processes of generating, acquiring, diffusing and expanding knowledge form the core of the university's functions, hence the term *knowledge hub*.

In short, universities not only train highly qualified personnel and conduct research but also perform two other functions that are crucial for regional development (Bramwell & Wolfe, 2008). First, universities generate knowledge through basic research whilst providing knowledge-intensive services and technical expertise in business R&D activities (Grossman, Reid, & Morgan, 2001). Second, universities operate as global pipelines using international academic research networks (Bathelt, Malmberg, & Maskell, 2004). This role extends beyond the mere transfer of technology at the regional level and can in fact attract talent from other areas to the region. There is growing evidence that excellent universities, coupled with a regional innovation system that promotes inter-firm collaboration and business–university interaction, boost regional competitiveness (Garcia-Alvarez-Coque, Mas-Verdu, & Sanchez García, 2015).

2.2. University rankings

International rankings are used to categorize and benchmark universities. Since the turn of the century, internationalization, overcrowding and intense competition in higher education have helped increase the prominence of university rankings. Universities strive to achieve a high ranking not only because of the prestige associated with academic quality but also because of the implications in terms of attracting scholars and students and accessing public and private funding (Hazelkorn, 2008).

Governments increasingly focus on measuring and evaluating the effectiveness and efficiency of publicly funded university research. Improving scientific productivity, distributing research funds and strategically defining new lines of research should be based on the systematic assessment of academic institutions.

However, university rankings have certain weaknesses. Some relate to viewing the university as a single unit and failing to differentiate between specific fields of study or research within a given subject. Other weaknesses stem from institutional characteristics such as age and size that distort comparability. These factors affect, amongst other things, classifications by region or area of knowledge. As Olcay and Bulu (2016) remark, there may be huge disparities in the position of the same university in different rankings.

Specifically, when interpreting rankings, three factors should be considered. First, it is important to consider the number and nature of the countries or regions that are included in the classification. Discrepancies arise between rankings in terms of their geographical coverage. For example, the QS World University Rankings and the Times Higher Education Rankings focus on Anglo-Saxon countries, whereas ARWU (Academic Ranking of World Universities) focuses on North America. Second, several authors have discussed the methodological and conceptual problems with university rankings (Van Raan, 2005) as well as their statistical properties (Paruolo, Saisana, & Saltelli, 2013). Third, a recent study by Olcay and Bulu (2016) showed that few rankings consider indicators that measure income from industry due to knowledge transfer activities. Only one index, the Times Higher Education World University Ranking, considers the knowledge transfer activities of institutions, although this factor accounts for just 2.5% of the overall score.

Nevertheless, university rankings have improved. They now differentiate between different types of universities using several criteria. Some authors note that universities that strive for high research standards are crucial for opening knowledge spaces that address both global competition and regional development (Harrison & van Turok, 2017). In some cases, the pursuit of research excellence may involve a bias against local and applied knowledge (Hicks, Wouters, Waltman, De Rijcke, & Rafol, 2015). Undeniably, however, many regional and national governments seek to foster universities that rank highly in world research rankings. Therefore, in this study, the Scimago research ranking is used to evaluate the relationship between universities and regional competitiveness. The Scimago ranking uses a bibliometric assessment tool to characterize research institutions by measuring the institutional affiliation of documents included in Scopus. The Scimago ranking offers another key advantage for this study: Its comprehensive coverage of institutions enables identification of the top 1,000 universities in the world in terms of research.

2.3 Exploring the impact of universities on regional competitiveness

Numerous studies have examined the relationship between universities and regional competitiveness. Much of this research has sought to demonstrate this relationship using cross-sectional data. In general, these studies document a strong relationship between university research activity and industrial development (Cowan & Zinovyeva, 2013). However, these approaches have methodological issues. Many policy implications have been inferred from analyses that have endogeneity problems and limitations associated with the use of cross-sectional analysis. The relationship between a region and its universities may be affected by factors of business demand, factors of knowledge supply from universities or other factors (Mairesse & Mohnen, 2010).

Two difficulties arise when analysing the relationship between research conducted in universities and the transformation of this research into industrial innovation and competitiveness. First, the incentives that drive scientific research differ from incentives in private companies (Cowan & Zinovyeva, 2013). One of the primary missions of universities and one of the fundamental functions of university faculty is research, whose output is usually measured in publications. The goal of university research is to advance the frontier of knowledge. The human capital requirements in this area are highly specific. This can create barriers to interaction between firms and universities, hindering the transformation of knowledge into innovation. As noted earlier, however, numerous countries implement policy actions to allow scholars to convert their scientific knowledge into innovations.

Second, the type of knowledge that is generated in universities (codified knowledge) can, by its very nature, be easily transmitted. In contrast, tacit knowledge, which is a crucial component of the conversion of knowledge into industrial innovations, is more difficult to transmit (Cowan, David, & Foray, 2000). Patents are a clear example of codified knowledge, and their diffusion often follows a territorial pattern that is sustained over time (Jaffe, Trajtenberg, & Henderson, 1993). Diffusion problems seem to have a distance component that is more cognitive and social than physical (Breschi & Lissoni, 2009).

Recent research (Cowan & Zinovyeva, 2013) suggests that a university's effect on development depends on the economic characteristics of the university's region. Regions with low levels of R&D and human capital can obtain clearer benefits from a university's presence. Accordingly, one of the functions of universities is to cover deficits in R&D infrastructure.

3. METHOD, CONDITIONS AND DATA

3.1. Method: Fuzzy-set qualitative comparative analysis (fsQCA)

In this study, fuzzy-set qualitative comparative analysis (fsQCA) is used to identify recipes or pathways that are necessary or sufficient for an outcome to occur. In this case, the outcome is regional competitiveness.

A condition is sufficient if it explains the outcome by itself. In other words, the presence of a sufficient condition is enough to cause the outcome of interest. Nevertheless, different combinations of conditions may explain the same outcome. This is called multicausality Ragin, (2008).

A condition is necessary if this condition is present whenever the outcome occurs. Given that few real-life phenomena are explained by a single condition, most solutions consist of combinations of conditions. FsQCA identifies all combinations of conditions that cause the same outcome (García Álvarez-Coque et al., 2017)

FsQCA was originally developed by Charles Ragin (Ragin, 2000, 2008, 2014). It is a novel research method that is attracting growing interest from the academic community. Evidence of this growing interested has been documented in bibliometric studies by Berger (2016) and Roig-Tierno et al. (2017). FsQCA is a variant of qualitative comparative analysis (QCA) and is one of three approaches to QCA: csQCA, mvQCA and fsQCA. Ragin (2008) has explained why fsQCA is superior to the other variants.

Based on Ragin's (2008, 2014) theoretical summary of the characteristics of fsQCA, the main aspects of the method are as follows: (i) fsQCA is based on set theory and Boolean logic rather than a correlation-based approach; (ii) fsQCA relies on qualitative evidence based on small or medium-sized samples, although there is no limitation that prevents researchers from working with large data sets (Vis, 2012); (iii) fsQCA allows for multiple conjoint causality, which is non-linear and non-probabilistic; it rejects permanent causality and allows for equifinality (equifinality implies that more than one path can lead to a specific outcome); (iv) fsQCA is used in regional analysis, amongst other disciplines, because of its advantages over correlation-based methods (Fan, Li, & Chen, 2017; García Álvarez-Coque, et al., 2017).

The main steps to conduct an analysis using fsQCA have been described by Ragin (2008) and Schneider and Wageman (2012). First, researchers must identify the sample of relevant cases and the list of causal conditions (which can be thought of as variables) that are involved in a specific outcome. In our case, the causal conditions are private investment in R&D, total investment in R&D by the public sector and higher education institutions, collaboration between SMEs in research and innovation projects, tertiary education, and regional presence of top-ranked universities. Our outcome is regional competitiveness.

Second, the authors must calibrate the conditions and the outcome. Calibration means identifying whether a condition (for a certain characteristic) is present or absent by assigning a value between 0 and 1 to the case. In other words, raw data are transformed to fuzzy-set data. FsQCA permits the use of continuous values ranging from 0 (fully-out) to 1 (fully-in). The recommended calibration method is direct calibration (Ragin, 2008). The value 0 is assigned to denote the absence of the condition, 1 is assigned to denote presence, and 0.5 is assigned to denote the point of maximum ambiguity (Ragin, 2008).

Following the example provided by Ragin (2008), we can generate a condition called 'developed country' based on national GDP. Considering the approximate GDP per capita in US dollars (World Bank, 2017) of three countries (raw data) with high, medium and low incomes (e.g. Canada = 45.000, Chile = 15.000 and India = 2.000), we can create the fuzzy set. We then establish the threshold based on our theoretical knowledge. As noted earlier, the direct method of calibration requires three anchors to identify whether the conditions are present or absent. Thus, we could establish the following thresholds: 30,000 USD if the country is fully developed, 1,000 USD if development is fully absent in the country and 18,000 USD (maximum ambiguity) if the country is on the border of the set. The result of this calibration is the following list of fuzzy values: Canada = 1.0, Chile = 0.37 and India = 0.06. The interpretation is that Canada fully belongs to the set of developed countries, Chile is more outside than inside this set and India is fully outside the set of developed countries. The values and the explanation of the thresholds for our model are provided in Section 3.3.

After the calibration process, the third step is to generate the truth table. The truth table contains all logically possible combinations of the available conditions. The size of the truth table is 2^k, where *k* is the number of conditions. The configurations (combinations) that are not covered by real or observed cases are called *logical remainders*. A logical remainder is a logically possible combination that is not covered by our cases (Schneider & Wageman, 2012).

Finally, the truth table is reduced using a minimization algorithm. We performed the analysis using the R package developed by Medzihorsky, Oana, Quaranta, and Schneider (2016). Therefore, in this study, the minimization algorithm was the Quine-McCluskey algorithm. Depending on how the logical remainders are dealt with, fsQCA provides three different solutions: parsimonious, complex and intermediate. Note that the three solutions never contradict each other. These solutions supply the possible combinations of conditions that lead to the outcome (Ragin, 2014).

In sum, fsQCA enables the comparison of cases to identify factors that cause a certain outcome. Unlike other methods, fsQCA is used to analyse the combined effect of variables on an outcome rather than isolated effects (dominant correlational approaches).

Regarding the parameters of fit, fsQCA has two main indicators: coverage and consistency. The coverage of a configuration refers to the percentage of cases that can be explained by that configuration. Consistency reflects the degree of membership of a condition to a configuration. A minimum level of both measures is required to accept a solution as valid (Fiss, 2011; Ragin, 2008). Therefore, fsQCA is suitable for studying our research question.

3.2. Conditions

The first condition is the presence of top-ranked universities in the region. The theoretical framework and prior research (Domenech, Escamilla, & Roig-Tierno, 2016; García Álvarez-Coque et al., 2017) highlight three additional conditions that are related to regional performance: (i) public and private investment in R&D, (ii) business collaboration and (iii) education level.

Public and private investment in R&D

Several studies have estimated the economic impact of investment in R&D and the relationship between public and private R&D investment in different OECD countries. The general consensus is that the rate of return on investment in R&D is high (Soete, Verspagen, & Ziesemer, 2017; Soriano & Garrido, 2015). Specifically, Jaumotte and Pain (2005) provide evidence of a significant complementarity between public and private investment in R&D. Choi and Lee (2017) report that public support for R&D can facilitate private investment in R&D. Marino, Lhuillery, Parrotta, and Sala (2016) provide evidence that there are no substitution effects between public and private R&D expenditure.

Collaboration

Collaboration between organizations enables access to external knowledge (Miozzo, Desyllas, Lee, & Miles, 2016) and constitutes a key element for generating competitive advantages. Through interactions in collaborative networks and interactive learning processes, firms can access various types of knowledge and information (Bjerke & Johansson, 2015).

The transaction costs of external knowledge may be lower if the agents involved are located in the same region. An ideal option for smaller firms to collaborate is to use intermediaries to find the right partner (Lee, Park, Yoon, & Park, 2010). In fact, collaboration with research institutes and universities has proved positive for business performance (Lasagni, 2012; Tobiassen & Pettersen, 2018).

Education

The literature shows that education generally aids economic performance. Various theoretical papers have highlighted two elements through which education contributes to economic and social well-being (Lilles & Rõigas, 2017; Baumann & Winzar, 2016). First, education develops the human capital of the workforce, which increases labour productivity and growth. Second, from the perspective of endogenous growth, education increases the capacity of the economy to innovate in products and processes and thereby promotes regional competitiveness.

The extent to which education is associated with a country's competitiveness has been the subject of several empirical studies. Using a sample of 118 countries, Baldacci, Clements, Gupta, and Cui (2008) showed the positive effect of investment in education and education itself on economic growth. Likewise, Baumann and Winzar's (2016) study provides empirical support for the theoretical argument that education drives competitiveness. Suri, Boozer, Ranis, and Stewart (2011) showed that the level of human capital is important for determining the economic growth trajectory.

3.3. Sample, data and calibration

We analysed 266 NUTS 2 European regions using data for 2016. Table 1 provides the source and description for the outcome and conditions that were used in the study.

[Table 1 near here]

Table 2 shows the primary statistics and cut-off points for the calibration of the conditions and the outcome. As mentioned earlier, direct calibration (Ragin, 2008) was used. The calibration and remaining analyses were conducted using the R package developed by Medzihorsky et al. (2016).

The conditions PRIV, PUB, COL and EDU were calibrated based on the criteria of the Regional Innovation Scoreboard (2016). The TOP100, TOP200, TOP300, TOP500 and TOP1000 conditions (presence of local universities amongst the top 100, 200, 300, 500 and 1,000 universities in the Scimago ranking) were calibrated as 1 (presence) and 0 (absence). Finally, the outcome (RCI) was calibrated using 0 as the point of maximum ambiguity, 0.2 as the threshold for membership in the set of competitive regions and -0.2 as the threshold for absence from the set of competitive regions.

[Table 2 near here]

4. RESULTS AND DISCUSSION

FsQCA was conducted to test the general propositions that competitive regions have knowledge-related attributes. Competitiveness is a multidimensional concept, so we cannot claim that our findings explain competitiveness, nor can we claim that this study identifies all determining factors that have been extensively examined in the regional development literature (Camagni, 2017; Camagni & Capello, 2013; Kitson, Oana, Quaranta, & Schneider, 2004). Instead, we inquire whether the presence of certain knowledge-related characteristics in a given region are necessary or sufficient for that region to be competitive or non-competitive. Competitiveness was defined using the regional competitiveness index (RCI). RCI denotes competitive regions, and ~RCI denotes non-competitive regions (~ means absence of the condition). As Figure 1 shows, competitiveness index values above 0.7 are limited to Northern and Central EU regions. But is there an association between the quality of the knowledge system and regional competitiveness? And, if this is the case (as we expect) what is the role of universities?

[Figure 1 near here]

According to the conceptual framework, the following conditions are relevant: public R&D expenditure (PUB), private R&D expenditure (PRIV), the relative predominance of firms that collaborate in innovation activities (COL), the share of the population with higher education (EDU) and the presence of excellent universities.

What makes a university 'excellent' is debatable (Lim, 2017). Assuming that excellence should be based on the university's presence in research rankings would probably lead to a discussion that lies beyond the scope of this study. We assume that having highly ranked universities is valuable for regional development strategies (Duvivier, Polèse, & Apparicio, 2017; Maria, Freitas, Rossi, & Geuna, 2014). Based on this assumption, the question is whether having top-ranked universities is effective or at least consistent with the region's membership in the set of competitive regions.

But what level of excellence must a university attain? We explore what level of excellence is suitable in competitive regions. Therefore, successive rounds of fsQCA were carried out to apply different definitions of excellence. The strictest definition required the university to be ranked amongst the world's top 100 universities (TOP100), whereas the broadest definition required the university to be ranked amongst the world's top 1,000 universities (TOP1000). Intermediate definitions were also applied, considering universities ranked amongst the world's top 200, 300 and 500 universities (TOP200, TOP300 and TOP500, respectively). Thus, in these successive rounds of fsQCA, we evaluated the level of university excellence for a given region using presence in (or absence from) the top 100, 200, 300, 500 and 1,000 universities worldwide.

Are there any individual necessary conditions?

We first considered whether the presence or absence of each of the aforementioned knowledge-related attributes was a necessary condition for EU regions to be competitive or non-competitive. The analysis of necessity shows that in no case was the presence of a single attribute a necessary condition for competitiveness. For a condition to be considered necessary, consistency must be greater than 0.9 (Ragin, 2008; Schneider, Schulze-Bentrop, & Paunescu, 2010). We identified no single necessary condition for competitive regions. Similarly, having excellent universities did not emerge as a necessary condition. However, further analysis showed that the absence of universities from the TOP300 was a necessary condition for the absence of competitiveness. Consistency was 0.908, coverage was 0.576 and relevance on necessity (RoN) was 0.476 (see Table 3). This result suggests that although having a university amongst the world's top 300 is not a necessary condition for a high RCI value, the absence of universities in the top 300 is a necessary condition for the absence of competitiveness. Therefore, the presence of excellent universities does seem to be relevant, although not when considering only the highest-ranked universities (TOP100 or TOP200).

[Table 3 here]

The key role of R&D expenditure

According to Dusa (2010), 'Ragin (2000) posits that under the necessity relation, instances of the outcome constitute a subset of the instances of the cause(s)'. We were unable to identify a single necessary condition for the presence or absence of competitiveness, except TOP300 for the absence of competitiveness. Next, we explored the same question for combinations of attributes. Table 4 shows the combinations of conditions that characterized competitive regions from the same SuperSubset. These combinations were pairs or trios of attributes that were necessary for the presence of a high RCI value. These SuperSubsets had an inclusion value (incl.) that was greater than 0.9 and RoN and raw coverage values that were greater than 0.5.

R&D expenditure (PRIV + PUB) was consistently relevant in each round of fsQCA. Private R&D expenditure, or public R&D expenditure as a substitute, was a necessary combined condition. Collaboration between firms was also a component of necessary combinations, but only in cases where this collaboration was supported by high rates of private R&D expenditure or public R&D expenditure (COL + PRIV or COL + PUB). This was the case regardless of the criteria used to define excellent universities.

[Table 4 near here]

Are excellent universities necessary?

The analysis indicates that the role of higher education is undeniable. According to the results, higher education complements private R&D expenditure because the pair of attributes EDU + PRIV was a necessary combination of complementary attributes in all rounds of fsQCA (table 4).

When the definition of excellence was restricted to the world's top 100 universities, the presence of excellent universities was not a necessary condition for the presence of a high RCI value. This finding makes sense. Only 15 of the 266 regions that were included in this study had universities amongst the world's top 100. However, when the world's top 200, top 300 and top 500 universities were considered, the presence of excellent universities was part of necessary pairs or trios of complementary attributes. If excellence was defined as being amongst the top 200, membership in this set was complemented with COL or EDU. If excellence was defined as being amongst the top 300 or top 500, COL complemented the presence of top-ranked universities. This finding suggests that combining a high standard of universities with a healthy collaborative business system may be a key ingredient for building competitive regions. Competitive regions are a subset of a larger set of regions with the following attributes: (i) presence of universities amongst the world's top 300 and top 500 or (ii) if no university is amongst the world's top 300 or top 500, a high level of collaboration between companies.

TOP500 + PRIV could be considered an alternative to the EDU + PRIV combination for the SuperSubset TOP500. When excellence was defined as belonging to the TOP1000 set, the presence of an excellent university was not part of a necessary configuration. Of the regions included in this study, 233 (87.5% of the sample) had universities that were amongst the top 1000, so membership in the TOP1000 set did not determine competitiveness. As noted earlier, the presence of a high percentage of the population with higher education (EDU) combined with PRIV was a necessary combined configuration in all rounds of fsQCA (Table 4).

Magic recipes: Analysis of sufficiency

Observing which combinations of attributes are present in subsets of competitive regions illustrates the strategies or recipes that lead to regional competitiveness. These recipes are configurations that are sufficient for the presence of a high RCI value (see Table 5).

[Table 5 near here]

The values for three fit measures are shown in Table 5. These measures are inclusion (incl.), which is the same as consistency (Thiem, 2016), proportional reduction in inconsistency (PRI) and coverage. Numerous authors consider consistency values that are greater than 0.8 to be acceptable (Crilly, 2011; Fiss, 2011). All three models had consistency values that surpassed this threshold. There is no established minimum value for PRI or coverage. However, some authors use 0.75 as an acceptable minimum value for PRI. Coverage indicates empirical relevance, so greater coverage implies greater empirical relevance of the solution (Crilly, 2011; Ragin, 2008).

Again, different rounds of fsQCA were performed using different definitions of university excellence (TOP100 to TOP1000). The results for TOP500 and TOP1000 are not presented here because they provide no additional information to the information provided by TOP100, TOP200 and TOP300.

Table 5 shows the successful pathways to regional competitiveness. Some of these pathways do not include the presence of excellent universities. The sufficient configuration PRIV*COL*EDU stands out as a 'magic recipe' for regional competitiveness (see Figure 2). These characteristics form a trio of factors that the literature describes as crucial for regional competitiveness (García Álvarez-Coque et al., 2017; Hewitt-Dundas & Roper, 2011). Thus, a knowledge-based system built on private research, collaboration and high levels of human capital offers a sufficient pathway for regional competitiveness. The recipe PRIV*PUB*COL is another sufficient pathway that does not require universities to be ranked amongst the world's top 100 or top 200. Consequently, there exist recipes for regions to achieve a high RCI value despite not having universities that are ranked amongst the world's top 100 or 200 universities.

[Figure 2 near here]

The existence of alternative ways for regions to achieve a high RCI value without having excellent universities raises the following question: Are excellent universities a component of several magic recipes for achieving high regional competitiveness? The answer is yes: any region with a university amongst the world's top 100 is competitive. Nevertheless, regions need not maintain such a high standard of excellence. Having universities amongst the world's top 200 or 300 is an ingredient of recipes that are sufficient for regional competitiveness. In both cases, the recipe is combined with COL, leading to the clusters highlighted in Figure 3. These clusters correspond to the successful recipes TOP200*COL and TOP300*COL, which can be expressed using the fsQCA notation as follows: COL*(TOP200 + TOP300). Even having universities amongst the world's top 500 (137 of the sampled regions) is an ingredient of a sufficient recipe if combined with private R&D expenditure and collaborative firms (TOP500*PRIV*COL). This recipe is consistent with the aforementioned magic recipe PRIV*COL*EDU.

[Figure 3 near here]

Regional strategies should seek to ensure that universities are ranked amongst the world's top 300. This condition does not guarantee that the region will be highly competitive, but, as discussed earlier, the absence of universities amongst the world's top 300 is a recurring attribute of non-competitive regions. Combining the TOP300 condition with a policy that promotes business collaboration (COL) yields one of the magic recipes. This magic recipe applies to 11 European regions (ES51, FR81, ITC1, ITF1, ITF3, ITH3, ITH5, ITI1, ITI4, PT11, PT17), which are located primarily in Southern Europe. Conversely, 18 European regions (BE32, BE34, CZ03, CZ04, CZ05, CZ06, CZ07, EL30, EL52, EL53, EL61, EL63, EL64, FR53, FR63, IE01, SI03, UKN0) that have high levels of business collaboration but that lack universities that are ranked amongst the world's top 300 could aspire to improve their university systems, possibly by increasing R&D expenditure, to achieve the magic recipe TOP300*COL, which applies to 51 regions.

There is life below excellence

Despite the limitations of the fsQCA method applied in this study, our findings reveal that excellence is valuable. However, it must be contextualized. Certain configurations in competitive regions do not require universities to be ranked amongst the world's top 100 or top 200 as a necessary condition. This does not mean that improving tertiary education is not a desirable policy target. A well-educated population is a component of some successful recipes. Also, pursuing university improvement is highly recommended because of the relevance of configurations that include the TOP300 condition. Given the costs associated with the university system, our findings are relevant for enabling the smart strategic planning of the knowledge system.

5. CONCLUSIONS

In this study, we examined how excellent universities can contribute to regional competitiveness in different contexts. Given the multidimensional nature of competitiveness, the contribution of excellent universities must be complemented by other conditions that promote regional development. Specifically, we considered public R&D expenditure, private R&D expenditure, the prevalence of firms that collaborate in innovation activities and the percentage of the population with higher education.

We investigated what level of university excellence would contribute the most to regional competitiveness. Successive analyses were carried out using different definitions of university excellence. The strictest definition considered excellent universities as those ranked amongst the best 100 universities in the world (TOP100), whilst the broadest definition considered universities that were ranked amongst the world's 1,000 best universities (TOP1000).

The analysis yields four conclusions. First, no single necessary condition guarantees overall regional competitiveness. Therefore, not having excellent universities in the region does not appear to constrain regional competitiveness. However, a lack of universities ranked amongst the world's top 300 is a necessary condition for non-competitiveness. This conclusion is valuable: Excellent universities are relevant for competitiveness, but they need not be ranked amongst the top 100 or 200 in the world.

Second, R&D expenditure consistently emerged as a relevant condition for regional competitiveness across all analyses. Public R&D expenditure or private R&D expenditure as a substitute is a necessary condition when combined with other attributes. Likewise, higher education is a relevant attribute for regional competitiveness. Higher education complements private R&D expenditure.

Third, to enable the design of regional competitiveness strategies, we identified the configurations of conditions that are sufficient for high competitiveness in different groups of regions. Some of these successful configurations do not include the presence of excellent universities. A magic recipe consists of the combination of a private research system, inter-firm collaboration and high levels of human capital as an effective combination to build competitive regions.

Fourth, the presence of excellent universities is a complementary condition for different necessary configurations. The combination of a high university standard (TOP300 or TOP500) and a collaborative business structure may be crucial for regional competitiveness. Although there are ways of achieving high regional competitiveness without excellent universities, such universities are part of certain configurations that lead to competitiveness.

In short, despite the methodological limitations of the analysis, the findings show that university excellence makes a valuable contribution to regional development.

Nevertheless, the presence of excellent universities must be contextualized. Certain configurations that characterize competitive regions do not include the presence of universities amongst the world's top 100 or 200 as a relevant condition.

These conclusions are important for smart strategic planning of the knowledge system. For example, the absence of universities ranked amongst the world's top 300 is a recurring feature of regions with low competitiveness. For certain regions, ensuring the presence of universities amongst the world's top 300 could be combined with actions to strengthen inter-firm collaboration to achieve a combination of conditions that are conducive to improving competitiveness. Conversely, regions with high levels of firm collaboration but without universities ranked amongst the world's top 300 could try to improve their university systems by increasing R&D investment.

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