THE CONTRIBUTION OF COLLABORATION WITH UNIVERSITY AND GOVERNMENT TO THE COMPETITIVENESS OF CLUSTERS: MODEL PROPOSITION AND COMPARISON BETWEEN CASES IN THE BIOMEDICAL INDUSTRY IN BRAZIL AND THE UK

ABSTRACT

Academic and governmental collaboration influence competitiveness and not frequently addressed in the business cluster literature. It is the theoretical gap we cover. The refinement of a cluster competitiveness model is the contribution to the literature. We propose the addition of university and government collaboration to a competitiveness cluster model. The multiple case study approach is employed, with qualitative variables as clusters being the units of analysis. We conclude that in two competitiveness factors (CF) in which Oxfordshire cluster appears to be more competitive than Ribeirao Preto, the University of Oxford plays an identifiable role. Government also plays a role.

Keywords: cluster competitiveness, university, government

INTRODUCTION

The business cluster literature comprises of works that identify the competitiveness drivers of high technology organizations; nevertheless, firms often lack the capacity to innovate by themselves (Geldes & Felzestein, 2013; Geldes, Heredia, Felzensztein, & Mora, 2017). This condition encourages cooperation with other organizations, be they firms, universities, governments, or other actors (such as innovation networks) surrounded by their territory (Cantù, Corsaro & Tunisini, 2015; Dagnino, Levanti, Mina, & Picone, 2015; Geldes et al., 2017). The presence of universities and government actions are often regarded as relevant, as already pointed out by the Triple Helix literature (Etzkowitz & Leydesdorff, 1995; Etzkowitz & Leydesdorff, 2000; Etzkowitz & Ranga, 2010).

In the literature, we do not often find further research on how (and the nature of) collaborative actions between universities and government influence the competitiveness of the high technology cluster. This is the theoretical gap this article aims to cover.

In the original formulation, the Triple Helix approach paid little attention to spatial aspects other than the broad national one (D'Este, Guy, & Iammarino, 2013). Subsequently, the critical importance of sub-national levels of analysis has enabled the 'national bias' to be overcome, introducing more fine-grained geography into these analytical frameworks (D'Este et al., 2013). In this line, the main contribution that we expect to offer to the literature is in refining a cluster competitiveness model, adding the dimension of collaboration between academia and government.

To delineate the application criteria for the model, we performed a cross-case study in two clusters of biomedical or health sciences. One is located in the United Kingdom, in Oxfordshire, and the other in Brazil's Ribeirao Preto region, which is situated in the countryside of the state of São Paulo. The application has the goal of illustrating how different forms of interaction may bring distinct results to competitiveness. It is also useful for a first empirical validation of the proposed model. The premise here is that high technology clusters innovate more than other profiles of agglomeration.

Our main research question is: How might differences in collaboration with universities and governments influence the competitiveness of a high technology cluster? This question is relevant to theory due to the importance of clusters being considered an integral part of sustainable regional development strategies (Connell, Kriz, & Thorpe, 2014) and, consequently, economic development (Porter, 1990). Thus, the objective of this article is to propose adding to a cluster competitiveness model the collaboration between university and government. The secondary objective is to verify how such collaboration may influence the competitiveness of two high technology clusters.

Although it is important that clusters exist, they need to be competitive (Zaccarelli, Telles, Siqueira, Boaventura, & Donaire, 2008). The premise of this model is that competitiveness can be observed and measured.

Differences exist between the two countries' clusters competitiveness level - Oxfordshire is more competitive than Ribeirao Preto. In the literature, Oxfordshire is considered a successful case of innovation in Europe (Farinha, Ferreira, Lawton-Smith, & Romeo, 2017). Thus, understanding in more depth the origin of this competitiveness gap is important and stresses the empirical relevance of this article.

The importance of these high technology clusters to the economic development of the region has been recognized in recent works (Ketels, 2013; Resbeut & Gugler, 2016). The latter argue that the Swiss precision industry forms a trade cluster in three different regions, and the model they propose reveals that those regions perform better than others. The results of the investigation show that industries located in, or close to, regions with a strong cluster environment experience higher employment growth rates.

LITERATURE REVIEW

Competitiveness of clusters

Although the cluster characterization (Marshall, 1890) and its contribution to the competitiveness of countries and regions (Porter, 1990) has been discussed in the literature for a considerable period, the origin of competitiveness and its explanation is relatively more recent (Connell & Voola, 2013; Feldman & Martin, 2005; Pinch, Henry, Jenkins, & Tallman, 2004; Tallman, Jenkins, Henry, & Pinch, 2004). This article uses the approach proposed by Newlands (2003), which refers to the innovative milieux. This relationship between competitiveness, innovation, high technology industries, research universities, and regional development has been investigated in the literature for a while (Saxenian, 1985; Castells & Hall, 1994; Storper, 1993).

Regarding competitiveness and collaboration, recently published literature also confirms that enhancing collaboration across different types of actors in clusters improves innovation and financial performance among the involved cluster firms (Morgulis-Yakushev & Sölvell, 2017). Arikan and Schilling (2011) propose four archetypes of cluster, arguing that the competitive advantage of two is associated with the logic of the benefit derived from the intra-district competitive advantage. This results in firms within this profile of cluster can gain an advantage over more isolated businesses because the labor, supplier, and knowledge externalities are present. Depending on the type of policies and practices imposed by the district's governing body, some districts may reap even greater knowledge externalities or supply-sourcing advantages. Frequently, these policies and practices are defined or at least influenced by local government.

Triple Helix

In today's knowledge economy, the main institutions are the government, industry, and universities (Etzkowitz & Leydesdorff, 1995). This model is known as the Triple Helix. This article adopts a simplified perspective of the Triple Helix, which may be useful to facilitate the model's applicability (Ranga & Etzkowitz, 2013). It is believed that part of the Triple Helix model – business being excluded - is useful here, as the model has been used to analyze cluster competitiveness, even successful ones such as Silicon Valley (Etzkowitz, 2013). The influence of universities in the knowledge economy is now higher than ever before (Etzkowitz & Ranga, 2010). Regarding government, few studies in strategic management have explicitly modeled its role to understand the origin of competitive advantage (Lazzarini, 2015).

University and government.

Although the role of university and government collaboration has been deemed as being in the early stages (Etzkowitz, 2012), the importance of the existence of universities in the neighborhood to biotech-pharma (health science) firms has already been recognized (McKelvey, Alm, & Riccaboni, 2003). As firms raise their technological level, they move closer to an academic model, engaging in higher levels of training and knowledge-sharing (Etzkowitz, 2003). Universities and other knowledge-producing institutions play a role in cluster development and, often, government programs support the infusion of new knowledge into existing clusters and the creation of new clusters from a knowledge base (Etzkowitz, 2012). A necessary condition for a research-based triple helix model in the biotech sector (health science) would be distinguished research universities that are funded by government, not-for-profit organizations such as those in the biomedical field, like cancer charities, and by industry to undertake research in the field (Lawton-Smith & Bagchi-Sen, 2010).

The effectiveness of universities in playing a more active role in the creation and dissemination of new knowledge is highly dependent on the country-specific institutional context and the regional framework. Despite the abundant literature on technology transfer by universities, there is still room for a better understanding of how these specificities impact on the ability of universities to engage in effective interactions and how policy-makers may favor these interactions (Mello, De Fuentes, & Iacobucci, 2016).

The Triple Helix approach has instead placed the university at the center of a triadic relationship, together with industry and government, to create knowledge, innovation, and economic development (D'Este, et al., 2013). In this new world of knowledge, government acts as a public entrepreneur and venture capitalist (Etzkowitz, 2003). Government has an important role to play, not only from the national level, top-down, but also from the local level – bottom-up – often in collaboration with civil society organizations. When researching European regions, Sanz-Menendez and Cruz-Castro (2005) found that regional authorities have become directly involved in the design and implementation of regional science and technology (S&T). Government intervention, particularly in small nations, can no longer be expected to steer these developments. Governments, nevertheless, are under pressure to develop programmatic incentives (Park & Leydesdorff, 2010). More recently, Lazzarini (2015) observes the importance of bringing industrial policy (IP) into strategic management discussions. Mello et al. (2016) suggest that governments in emerging countries, in addition to providing appropriate incentives to universities and researchers to engage in technology

transfer activity, are expected to directly intervene to promote and support the creation of university–industry links.

The importance of academic and government collaboration within the competitiveness of clusters has been empirically proven; for example, in Norway where locally-sited, state-owned higher education and research institutions have adapted activity to the needs of key local industries (Isaksen, 2009).

Cluster competitiveness model

Regarding the cluster competitiveness model used in the present article, the authors have opted for that developed by Zaccarelli et al. (2008), due to it being more complete than other models. Although this model encompasses many aspects, there is space to refine it, adding university and government role to competitiveness enhancement. Armando, Todeva, Boaventura, and Pereira (2017) used a model based on the Triple Helix to analyze differences in cluster competitiveness in Brazil and Chile that were found by Sarturi, Vargas, Boaventura, and Santos (2016).

Zaccarelli et al.'s (2008) model aims to explain the origin of cluster competitiveness through the presence and respective intensity degree of 11 factors that are outlined below. To each one of these factors a metric is proposed that indicates whether the factor is present in the cluster, along with its intensity. The model proposes the following 11 factors to analyze cluster competitiveness: (1) Geographic concentration; (2) Scope of viable and relevant businesses; (3) Firm specialization; (4) Balance without privileged positions; (5) Complementarity due to by-product utilization; (6) Cooperation among cluster firms; (7) Selective substitution of firms; (8) Uniformity in technological prowess; (9) Community culture adapted to the cluster; (10) Evolutionary character through new technology introduction; and (11) Strategic actions, taking into account the whole cluster performance. The existence of the first nine factors is viable only with self-organization. However, for factors (10) and (11) to occur, the cluster must be self-governing.

The cluster business model proposed by Zaccarelli et al. (2008) has its strategic approach based upon the conception of supra-enterprise governance, in which the cluster is understood as "the exercise of the strategy-oriented influence of supra-enterprise entities, facing the vitality of the cluster, composing competitiveness and the aggregate result and affecting all of the organizations comprising the supra-enterprise system" (Zaccarelli et al., 2008, p. 52). The explanation for business clusters is presented in three steps: (1)

Comprehension that clusters are a self-evolving system capable of having strategic orientation; (2) Comprehension that the constitution of these systems is based on strategic thinking; and (3) Comprehension that the basis for the existence and operation of a cluster reflects observable evidence of a competitive advantage over firms operating outside the cluster.

Proposed model

The model proposed has similarities to that used by Armando et al. (2017). The difference is the focus on the university and government roles. Figure 1 shows the focus of the present article. The application being proposed, although also in clusters, is distinct due to the different cluster and country profiles.

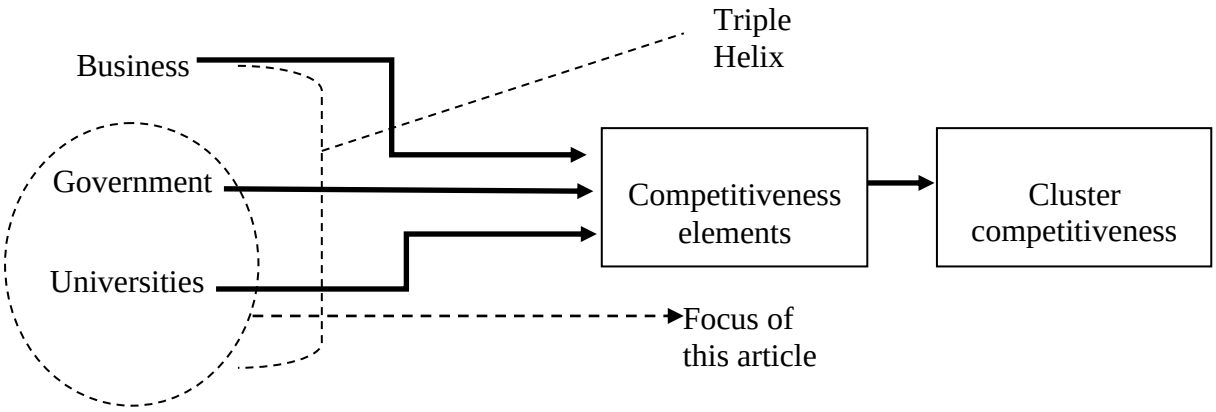

Figure 1
Focus of the article

METHODS

The multiple case study method is herein employed. The variables used are qualitative. This choice is anchored in the fact that strategic variables are less measurable than others. Most strategic variables can only be measured by their effects (Dunning, 1995). Patton (1990) suggests other reasons for utilizing case studies, while Yin (1994) notes that the case study may be the most appropriate method to analyze complex organizational phenomena. This is the main reason for justifying the method choice in this research. Among the reasons for selecting the case study method is the idea that it is the intimate connection with empirical reality that permits the development of testable, relevant, and valid theory (Eisenhardt, 1989). Clusters are the units of analysis.

Growth has been observed in the number of studies that analyze complex configurations using multi-case studies, sometimes with more than one method or technique.

Going deeper, using cross-case display aims to understand how these cases are influenced by local conditions, thus enriching phenomena explanation with greater sophistication and more powerful descriptions. The cross-case display is also useful to mitigate interpretation flaws as well as superficiality (Miles & Huberman, 1994).

The model developed by Zaccarelli et al. (2008) proposes that competitive analysis be carried through specific metrics to each one of its factors. Some of the factors may be measured through the observation of data available in secondary sources such as databases, allowing statistical techniques to be used. Some factors, however, require access to primary data sources, such as expert opinion.

We have used the metrics first proposed by Zaccarelli et al. (2008), along with some others that have been adapted to this study. Table 1 presents details on the metrics, their origin, and the data source that has been used.

Table 1

Competitiveness factors, metrics and their origin and sources of data

Source: Pereira (2016)

CF	Metric	Parameter	Origin of metric	Data source
1	Location quotient (LQ)	LQ>1 The higher the LQ, the more concentrated the cluster	Adapted from Boasson, Boasson, MacPherson, &Shin (2005)	Secondary
2	Identification of economic activity codes of cluster firms and how they are connected.	Larger the number of economic activity codes, the wider the scope …	Adapted from Todeva (2008)	Secondary
3	1) Number of economic activity codes for each cluster firm. 2) Adaptation of method developed by Todeva	1) The lower the number of codes for each cluster firm, the more specialized the firm.	Adapted from Todeva (2008)	Secondary

	(2008) to analyze relations and groups formed by economic activity codes of the cluster	2) The higher the number of groups, the higher the specialization		
4	Number of businesses in the same industry	The higher the number of businesses in the same industry, the higher the balance	Zaccarelli et al. (2008)	Secondary
5	Qualitative indicator based on the opinion of experts regarding the existence of projects and actions of firms and supporting institutions to by-product utilization by cluster firms	The higher the number of actions and projects aiming at by-product utilization, the higher the complementarity.	Adapted from Pereira et al. (2014)	Primary
6	Perception of efforts aimed at cooperation	The higher the perceived efforts are, the higher the competitiveness	Developed for this research	Primary
7	1) Proportion of new business in the cluster based on firm age 2) Age of firms in each economic activity	Growing number of new firms in 1) and 2) indicates substitution of less competitive firms	Adapted from Sarturi et al. (2016)	Secondary
8	Qualitative indicator based on the opinion of experts on the diversity of technological level	More homogeneous in terms of technology, the more homogeneous the technological level	Developed for this research	Primary
9	1) Investigation of historical origins of the	1) The looser the connection to the	Developed for this research	Primary

	cluster and its connection with relevant research universities. 2) Perception of the industry's importance to the region	universities, the higher the competitiveness. 2) The higher the perception, the more adapted the culture		
10	1) Existence of innovation supporting entities 2) Presence of startups and spinoffs as well as favorable conditions to their development	1) If there are innovation support entities, there is evolution. 2) The higher the presence, the higher the consequences of evolution and the possibilities to spread them	Adapted from Pereira et al. (2014)	Primary
11	1) Perception of experts regarding the existence of supra-enterprise governance 2) Presence of supporting institutions within the cluster, representing firms' interests and performing actions that benefit them	1) The more it is perceived, the higher the chance of being effective. 2) The more they act, the better the results for the cluster	Adapted from Pereira et al. (2014)	Primary

Data sources

Both primary and secondary data sources were accessed. Secondary data sources retrieved included documents such as reports, articles, news published in the press, webpages

of entities relevant to the studied clusters, as well as other documents. Primary data was collected in interviews with experts in both countries.

The secondary data was collected through access to the British Library's Business & IP Resources, through which it is possible to retrieve data from Fame and Orbis data sources (both part of Bureau Van Dick). Data on the Oxfordshire Health Science Cluster was obtained from the Fame database, while data on the Ribeirao Preto health cluster was obtained from Orbis.

Firms were selected using the following filters: (1) Location - Oxfordshire and Ribeirao Preto; (2) Economic activity codes, using NACE rev.2, which is the Statistical Classification of Economic Activities.

The primary data was obtained via semi-structured interviews with individuals in each of the studied cases. A previously created protocol for the interviews was based on the factors to be analyzed. It was necessary to adapt this protocol in order to include factors that emerged in the first round of interviews. Interviewees were purposely selected. This selection technique is useful in situations where the researchers are interested in maximizing comprehension about the issue under investigation.

Overall, 13 interviews with experts were conducted: seven in Oxfordshire (identified as Oxf) and six in Ribeirao Preto (identified as RP). Interviews were conducted from March to September 2015 and in the first semester of 2016. To maintain the anonymity of participants, their names, birthdates, and position in the organization are not disclosed in this article. Interviews were numbered according to when they occurred, meaning that interview number one took place before interview number two and so forth. The interviewees were affiliated to the following entities: (1) Ribeirao Preto: Fundação Pólo Avançado da Saúde (FIPASE), APL da Saúde (Association), Serviço de Apoio às Micro e Pequenas Empresas de Ribeirao Preto (SEBRAE-RP), Agência USP de Inovação, Instituto Nacional de Ciência e Tecnologia para inovação farmacêutica (INCT-if) and Núcleo de Pesquisas em Inovação, Gestão Tecnológica e Competitividade (InGTeC). (2) Oxfordshire: Oxford Academic Health Science Centre (OAHSC), Oxford Academic Health Science Network (OAHSN), Oxford Business Network (OBN), Isis Innovation, Oxford Institute of Biomedical Engineering (IBME), Oxfordshire Economic Observatory, and the Biomedical Research Centre (BRC) – National Institute for Health Research (NIHR).

Table 2 presents the data source categories, detailing where data from each category was collected along with its relationship to the factors in Zaccarelli at al.'s (2008) competitiveness model.

Table 2

Collected data source category and relationship to the competitiveness factor developed by Zaccarelli et al. (2008)

Data	CF	Source
Number of firms in operation in each country of the analyzed clusters	3	Inter views
Economic activity code in the health science industry (NACE, ISIC, NAICS, and CNAE) in which cluster firms can be classified	2 and 4	
Number of firms in the cluster that perform the selected economic activity in the health industry	4	
Age of the firms in each analyzed cluster	8	
Total area of each analyzed cluster	1 and 3	
Total area of the countries in which analyzed clusters are located	3	
Main universities related to the health science industry in each cluster	6	
Projects and actions aimed at using by-products by firms or support institutions in the analyzed clusters	7	
Evidence of cooperation among firms, such as joint projects, specially research	5	Inter views
Perception of experts on the technology levels of cluster firms	10	
Collective actions, such as organization or participation in health science industry trade shows, by cluster firms	9	
Collective actions to enhance infrastructure or urban aspects to cluster firms	9	

Data analysis

We analyzed each competitiveness factor in order to classify whether or not it is applicable to a high technology cluster. Out of the 11 factors, we concluded that nine are applicable to a high technology cluster. In these nine competitiveness factors, we searched for evidence that indicated which cluster, Oxford or Ribeirao Preto, is more competitive. Focusing on these nine applicable competitiveness factors, we verified whether it is possible to advance an argument for the cause of the cluster competitiveness advantage, be that the university or government. Thus, for each of the competitiveness factors there is an argument and supporting evidence. Both the arguments and evidence were drawn from the literature in addition to information and data obtained from the primary and secondary data sources. Table 3 was developed by employing this logical description and exhibits the competitiveness advantage analysis of the studied clusters, as well what is influencing the factors.

STUDIED CLUSTERS

The purpose of this section is to present a brief description of the studied health clusters in Brazil and the UK. The idea is not to provide a full description of either the industry or its clusters, but rather to help readers understand the application proposed in this paper. Both clusters can be classified under the archetype proposed by Arikan and Schilling (2011) as being associated with the logic of benefitting from the intra-district competitive advantage.

Ribeirao Preto health cluster

The city of Ribeirao Preto, 315 kilometers from the capital of São Paulo, is found to have a Human Development Index (HDI) at 0.80 (Fundação Sistema Estadual de Análise de Dados – SEADE, 2017). This number may be considered high not only in Brazil, but also when compared to the other 644 municipalities of the state. Part of this relatively high development index is due to the fact that Ribeirao Preto is an important health hub, with infrastructure in the field, notably the University of São Paulo (USP) campus. The USP medical school in Ribeirao Preto offers graduate and post-graduate courses in Medicine, Odontology, Pharmaceutical Sciences, Nursing, and Physical Education. Also important is the Hospital das Clinicas, located on the university campus. In 2003, SUPERA was founded. A business incubator focused on high tech firm creation, it is a non-profit that provides support to new businesses. SUPERA offers physical infrastructure, services, counselling, and networking. It is in partnership with FIPASE, USP, the Ribeirao Preto municipal government,

and SEBRAE (SUPERA, 2017). However, these facts, regardless of being important in the Brazilian context, still do not bring the country on par with the United Kingdom.

The "health industry polygon" in the state of São Paulo concentrates a great number of firms, human resource development centers – for technical and highly specialized workers - hospitals, research centers, and a support infrastructure to physical distribution and connections abroad (Souza, Cappa, & Neves, 2008). Among the cities that concentrate on health industry activities, the state's administrative capital, São Paulo, is the largest producer in not only the state, but the entire country. Ribeirao Preto, located in the countryside, is the second largest health industry pole within the state, ranking fifth countrywide (Dias & Porto, 2011).

The health cluster that has its center in the city of Ribeirao Preto employed 2,000 people according to data gathered a few years ago (Souza et al., 2008) and drives firm concentration in the countryside of São Paulo state (Santana & Porto, 2009; Dias & Porto, 2011).

Oxfordshire health science cluster

In the UK, according to the Office for Life Sciences (2011), the pharmaceutical, medical biotechnology, and medical technology sectors together comprise around 4,500 firms, employing 165,000 staff with an R&D spend of nearly £5 billion and an annual turnover of over £50 billion (around 9.1% of the nation's GDP, according to Emergo, 2018). The UK's strength in precision medicine comprises a dynamic healthcare industry, global competitiveness, alongside a history of innovation with pioneering discoveries. One example of a cluster that indicates the strength of the UK health ecosystem is the Oxford/Cambridge/London triangle that houses the nation's largest biomedical cluster, with hundreds of companies linked to universities and other organizations (Office for Life Sciences UK, 2011). The Oxfordshire region (or county, as administrative entity within the UK regional structure) is located some 60 miles from London and classified by the Regional Innovation Scoreboard (RIS) as a European region "innovation leader" (Farinha et al., 2017). Oxfordshire is the national center of the biomedical sector, having the key ingredients of a concentration of universities and government laboratories that are heavily supported by government, along with a growing number of biotech firms. The distinctive feature of the Oxfordshire variant is the role of Oxford University, a world center for biomedical research.

As in other countries, much of the new growth in the life sciences is likely to emerge from clusters wherein strong scientific activity is adjacent to small and emerging companies

in attractive areas for large companies to also co-locate (UK Government, 2017). The location of health industry firms coincides with metropolitan areas due to the presence of universities (Carlsson, 2002). The main reason for geographic concentration is the dependence of the industry on research and development (R&D) activities, particularly scientific research developed within academia.

In England, there are 406 geographic areas in the region known as the Great South East (GSE), hosting firms that belong to what is referred to as the core of the British medical device cluster. The GSE region has a strong concentration of universities and state- as well as privately-funded research institutions. Overall, 61 organizations benefitted from research funds and in excess of 700 commercial firms focused on R&D (Todeva, 2008).

The city of London registers the presence of several leading universities and research hospitals that altogether account for a third of state-funded research and more than 25% of graduates in the country. Many regulatory bodies are located in the city of London, not only those from the United Kingdom (UK) but Europe (EU) as well (before Brexit, at least). Among the bodies named by the UK Department of Trade and Industry (1999) are the Medicines Control Agency, the Medical Devices Agency, and the European Medicines Evaluation Agency. Beyond that, the concentration of specialized services in the city of London is higher than in any other UK geographic area.

In the GSE region, there is a great number of university spin-offs. The predominance of those relating to science, technology, engineering, and medicine is notable, but above all, spin-offs in the health industry are significant (Lawton-Smith & Ho, 2006; Lawton-Smith et al., 2014). The combination of production and services related to the pharmaceutical industry, biotech, and health account for 47% of spin-offs. This should be expected due to the importance of London in medical research, not only for the UK but also worldwide. London is an area with enormous potential that can benefit from the unique advantages offered by a health industry cluster.

FINDINGS AND DISCUSSION

Considering that two competitiveness factors were not applicable to high technology clusters – factor five, concerning complementarity due to by-product utilization, and factor 8, which is uniformity in technological prowess – Table 3 exhibits the five factors, outlining the more competitive cluster in the factor, either Oxfordshire or Ribeirao Preto, and the reasons for this advantage. In four out of the nine factors, the results are similar (CF 6, 7, 9 and 11), therefore they are not exhibited in Table 3. Thus, these four factors of competitiveness that show similar results were not analyzed. Out of the five factors that had either Oxfordshire or

Ribeirao Preto showing an advantage, in three the advantage is to Oxfordshire and two occur in Ribeirao Preto. However, in three of these five competitiveness factors, it has not been possible to appoint the cause for the advantage, either university and/or government. This is the case in one factor in which Oxfordshire has the advantage and in two where Ribeirao Preto has the advantage. Thus, the analysis as to how collaboration between university and government may influence the competitiveness of two high technology clusters has been performed for factors number 3, which is firm specialization, and number 4 - balance without privileged position.

Table 3

Results of competitive advantage analysis of the studied clusters and influencing factors

Cause			Effect	
Helix responsible for the effect	Argument	Evidence	Competitiveness factor #	Cluster in advantage
Not possible to tell	UK is much smaller in area than Brazil,		1–Geographic concentration	Oxf
Not possible to tell	This may happen due to other issues		2-Scope of viable and relevant businesses	RP
University	Research universities form specialized human resources to startup firms	Interviewee Oxf-6 discourse, UK Trade & Investment(2007), Oxfordshire Lep (2014)	3-Firm specialization	Oxf
University and government	More firms start up and operate in the area, driving the balance among them	Interviewee Oxf-6 discourse, UK Trade & Investment, (2007), Oxfordshire Lep (2014) National policy (Lawton-Smith et al.,	4-Balance without privileged positions	Oxf

		2013)		
Not possible to tell			10-Evolutionary character through new technology introduction	RP

Regarding competitiveness factor number 3, the university is appointed as influencing this competitiveness factor. In this, Oxfordshire has the advantage. The argument is that research universities form specialized human resources that then start up firms. The USP's presence in Ribeirao Preto is very important, with multiple course offering, along with research centers linked to the university, all focused on health (FIPASE, 2015); indeed, USP medical and dentistry schools act as human resource providers of highly specialized personnel who have then established several firms within the industry that are located in the region. However, the University of Oxford is way stronger in this regard. In Ribeirao Preto, many of these entrepreneurs were previously working in either research labs or as faculty at the university (Telles, 2002).

Oxfordshire, by turn, has the presence of the University of Oxford, one of the main centers for biomedical research in Europe. It ranks first worldwide in clinical and pre-clinical issues, as well as in health, with 23 Nobel laureates in medicine and chemistry. The region has an impressive set of mature firms positioned in the health sector, with science parks linked to the university, as well as a strong funding network for innovative business start-ups (UK Trade & Investment, 2007). The universities greatly enhance the attractiveness of the location to those looking for work and a place to live and, more recently, through formal entrepreneurship programs (Lawton-Smith, Glasson, Romeo, Waters, & Chadwick, 2013). This said, it should be noted that the city of Ribeirao Preto is recognized nationwide in Brazil for its excellence in the health industry.

In terms of competitiveness factor number 4, which concerns balance without privileged positions, it is possible to see that it is influenced by both the university and government. The argument here is that more firms start up and operate in the area, driving the balance among them. For this factor, Oxfordshire also had the advantage.

Although the proposal is not to analyze competitiveness factors showing similar results for both clusters, it noteworthy to mention that cooperation not only among cluster firms, but also evident between universities and government-funded bodies . In Oxfordshire,

examples as the Science Vale UK - which is a collaboration among scientific and technological parks, such as Harwell, Milton Park, the county's largest park, and two district councils - may be contributing to the cluster's competitiveness. In the UK case, the central role played by national policy is key to those conditions. The emphasis on collaboration between major local actors, especially the universities as part of the local governance system, has been framed by national policy directives. Initiatives such as the nationally-funded City Deal are identified as having been important to Oxfordshire (Lawton-Smith et al., 2013). Still regarding collaboration, generically speaking, it was found in interviews in Oxfordshire that companies compete but collaborate, sharing staff, and developing projects together (Interviewee Oxf-2). In Ribeirao Preto, as firms more complement one another's activities rather than competing directly, they meet to discuss common matters (Interviewee RP-5). It was noted by interviewee Oxf-1 that informal collaboration exists with universities and knowledge is transferred through this route. However, as technological development is of such importance to this cluster profile, many of the collaborations that occur have the intermediation of innovation support agencies, which are usually partly funded by government. In Ribeirao Preto, an example of this formal collaboration is the intermediation by Agência USP de Inovação (University of São Paulo innovation agency). In Oxfordshire, Isis Innovation is the bridge between investors and university researchers. The academic group is often rich in ideas but poor in capital to invest and with these agreements, both sides may benefit when an idea is successful. Frequently, the collaboration between investors and researchers goes beyond the capital invested, with the exchange of ideas (Interviewee Oxf-6). Collaboration with government was identified through evidence of financial incentives fostering the partnership between business and researchers. In Ribeirao Preto, one interviewee mentioned the Programa da Lei da Informática (Information Technology Law Program), in which the Brazilian Federal government uses mechanisms to incentivize investments in innovation related to hardware and automation by the local industry (Lei da Informática, 2016).

In competitiveness factor number 4, which details the scope of viable and relevant business, although it is not possible to tell whether it is influenced by university or government, it is intriguing that Ribeirao Preto appears to rank ahead of Oxfordshire. Although, Ribeirao Preto is also home to several firms producing medical devices, pharmaceutical, dentistry, veterinarian and biotechnological products (FIPASE, 2015), it cannot be compared to Oxfordshire and its ample base of industries that are knowledge

intensive; this list includes, among others, biomedical engineering, pharmaceutical products and others that involve sophisticated production forms such as medical software for managing technology and health services. The Oxfordshire cluster is strong across four overlapping technologies: (1) Life, biosciences, medical technologies, and pharmaceutical; (2) Physics; (3) Engineering and electronics; and (4) Telecommunications and hardware/software computing (Oxfordshire Lep, 2014).

CONCLUSIONS

The objective of adding to the cluster competitiveness model the collaboration with university and government, which are two of the three elements of the Triple Helix model, has been delivered in the combination of Figure 1 and Table 3. The secondary objective to verify how collaboration between university and government may influence the competitiveness of two high technology clusters was achieved in Table 3.

It is possible to conclude that due to the helix universities, namely the University of Oxford, the UK cluster is ahead in two factors of competitiveness. It should also be observed that numerous collaboration initiatives were identified among the actors in both clusters. These collaborations encompass researchers, universities, hospitals, firms, and support institutions. Cluster actors interact in several different ways and target developing technologies that enhance cluster competitiveness.

This finding is a first validation of the cluster competitiveness model which includes academia and government as influencers. The discourse of the interviewees also suggests that this collaboration is more structured in the UK than Brazil, and is also more frequent.

There are, nevertheless, analytical and methodological constraints to this paper that may lead to distortions. In terms of analytical constraints, the qualitative and somewhat subjective and superficial analysis may have been one of the issues making it impossible to understand in more depth seven out of the nine competitiveness factors.

Future research should detail the several different segments that exist in each one of the studied agglomerations in order to enable researchers to offer recommendations for enhancing competitiveness in both clusters.

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