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EGIONAL INNOVATION SYSTEMS AND UNIVERSITY COMPETITIVENESS

¹ Borislava Borisova Stoimenova



ABSTRACT

This paper outlines the importance of university competitiveness as part of the regional innovation systems (RIS) and identifies some criteria and indicators for measurement of this type of competitiveness. A regional innovation system is defined as an interactive learning engagement among a network of various actors within an institutional framework, which is directly related to university competitiveness on global level. The identified knowledge gap in the literature is the link between both concepts. The development of RIS is fostered by the European Commission in its attempts to make Europe and the EU the world's most competitive and dynamic economy by embracing the whole innovation chain from education to economic impact, popular as the "knowledge triangle" of education, research and innovation. This vision is currently spreading as an idea to many other countries out of the Union. Universities contribute to the creation and dissemination of new knowledge and the generation of intellectual capital. The results from the research contribute by summarizing via a literature review the most frequently cited criteria, used for measurement of university competitiveness as part of RIS. These are knowledge transfer and regional engagement. Knowledge transfer for its part is measured by industry income, patents, co-publications with industrial partners, and spin-offs, while regional engagement – by graduates working in the region, student internships in the region, regional joint publications and income from regional sources.

Keywords: Regional Innovation Systems. University Competitiveness. University Rankings.

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¹ University of National and World Economy, Sofia (Bulgaria).
Email: < borislava_stoimenova@abv.bg >

INTRODUCTION

In today's globalized and competitive world with a fast-changing environment and constant challenges, factors like knowledge, learning, creativity and innovation have become central to the technological and economic progress, competitiveness and well-being (Erkkilä 2013; Hazelkorn 2015; Minola et al. 2016). Generally, university rankings misrepresent the nature and dynamism of the "knowledge triangle" process and higher education's role as part of the innovation eco-system. Hazelkorn (2015) suggests that rather than just ranking institutions, governments should focus on benchmarking systems, built around the "knowledge triangle" principles of education, research and innovation, in order to identify world-class systems rather than world-class universities. The world-class universities play an important role in shaping the competitive profile of nations and regions. The more competitive the universities within RIS are, the better they benefit different actors (governmental authorities, funding agencies, media, business entities and NGOs, students, researchers and employees) by producing excellent outputs including cutting-edge research through licenses, patents and publications; producing skilled and professional graduates; offering a rich learning and research environment; encouraging strategic vision and innovation, responding effectively to the demands of a fast changing global market, etc.

The **purpose of this paper is to outline via a literature review the concept of regional innovation systems** and to identify some criteria and indicators for measurement of university competitiveness within these systems.

Literature background of regional innovation systems

Regional innovation systems (RIS) date back to the 1990s and since then they have been defined as interactive learning engagement among a network of various actors within an institutional framework (Cooke 1992). RIS play important role in regional sustainable development. Hazelkorn (2015) presents

evidence that innovation stems from interactions within a network of different actors and that it is rarely the result of efforts within a single firm or university. In such context, universities contribute to the creation and dissemination of new knowledge and the generation of intellectual capital - factors that are crucial for innovation and competitiveness in an entrepreneurial society (Minola et al. 2016). According to Vătămănescu et al. (2016), high organizational competitiveness results from value creation processes driven by a knowledgeable, intelligent and creative workforce. The three main components of intellectual capital are human capital, relational capital and structural capital:

- The human capital describes the individual knowledge and skills stock of a certain organization, which is represented by its employees with their expertise, skills and talents, capacities, competencies and knowledge. It is seen as an innovation source and comprises institutions' non-tangible assets such as processes, capacity for innovation and patents, etc.
- The relational capital stands for the relationships with internal and external entities like internal stakeholders, partners, customers, suppliers, etc. The relational capital of an organization is measured by its network of contacts and collaborators, the recognition of society, the quality of its relationships with stakeholders. It relies on the idea that organizations are not isolated systems, but active and open systems, which greatly depend on their connections with the environment.
- The structural capital refers to all the non-human repositories of knowledge in organizations such as databases, organizational charts, processes manuals, strategies, plans, routines and anything with value to the company higher than its material value. The structural capital includes intellectual assets, a reification of the tacit knowledge pertaining to each individual.

Jiao et al. (2016) present the idea that the concept of regional innovation systems consists of two parts: the regional production structure or

knowledge exploitation subsystem (mainly firms), and the regional supportive infrastructure or knowledge generation subsystem (public and private research laboratories, universities and colleges, technology transfer agencies, vocational training organizations, and other research organizations). Universities are important actors within these systems of regional innovation, especially in providing knowledge for the business and the community (Minola et al. 2016; Zhang et al. 2016) and eventually in shaping the competitive profile of nations and regions.

Nowadays, the higher education policy is directed towards more entrepreneurial management, including innovation activities and development of institutional relations, establishment of joint research schemes, user innovation networks and university-to-business relations (Yordanova, 2018), as well as different joint programs for improving university performance as a relevant factor in shaping competitiveness in each specific region (Guerrero et al. 2014; Jiao et al. 2016; Jurášková et al. 2015; Zhang et al. 2016). The current transition to the knowledge-based economy and adaptation to constant environmental changes created the concept of “the entrepreneurial university”, characterized by innovation through its research, knowledge exchange and external relations (Vătămănescu et al. 2016). Wächter et al. (2015) identified key entrepreneurial university activities related to teaching and learning such as lifelong learning, flexible learning paths, e-learning, blended learning and massive open online courses, student-centered learning approaches, interdisciplinary programmes, collaboration with the sectors of industry and business, and internationalisation of education. The entrepreneurial universities develop regular and strong collaborations with businesses to find mechanisms to transfer and share knowledge, which is expected to lead to economic progress and competitiveness (Vătămănescu et al. 2016).

Potential advantages that students could gain from the cooperation between a university and employers are: applied education, wide opportunities for internships in firms, where students are able to apply their academic knowledge, better quality of alumni careers. Despite this, the role of business-related activities is disputable. Research indicates that academics,

who are actively involved in business activities tend to be either more committed to teaching, or they might treat teaching less serious or even neglect their responsibilities because of entrepreneurial activities (Łaszkiwicz et al. 2016).

To identify entrepreneurial universities, Guerrero et al. (2014) adopted a criterion that the university must have been listed in the Times Higher Education World Ranking (because of the indicator industry income or knowledge transfer, explained in table 1). Alternatively, Minola et al. (2016) measure the extent to which students have been exposed to entrepreneurial education by the use of the GUESSS survey (Global University Entrepreneurial Spirit Student’s Survey) and rely on the theoretical grounds that:

- Entrepreneurship courses provide students with the newest technological opportunities, access to research resources and techniques to generate and disseminate business ideas, to analyse markets and to develop business plans, to acquire new resources and manage new ventures.
- Industry or business linkages are explicitly provided to students in the form of mentoring, coaching and networking, presentations held by industry partners, workshops, contact platforms with potential investors, business plan competitions, extracurricular training, counselling and contacts with venture capitalists or with entrepreneurially minded peers, venture planning workshops and boot camps, innovation incubators to support students in the formation and growth of start-up companies.

Methodology

The purpose of the research is to make an analysis of the measurement methods of university competitiveness within RIS. It was conducted on the base of an initial collection of 162 articles, indexed in Elsevier’s Scopus data bases. The articles were chosen by the use of key words such as competitiveness of universities, university rankings, university performance indicators. A review of their abstracts outlined key research areas and 68 articles were selected for further investigation. The selection criteria included the relevance of the content, the impact of the article and the credentials of the authors.

Based on the literature analysis, the most popular global university rankings were identified. Those of them, which apply criteria for measurement of university competitiveness within RIS, were selected and their methodologies were further analysed for identification of key university competitiveness indicators.

Results: measurement of university competitiveness within ris

A major critique of global university rankings is that they direct their attention primarily to research, while at the same time drawing it away from teaching quality, quality of students experience and learning outcomes, social responsibility, social and economic impact of knowledge and technology transfer, or the contribution of regional or civic engagement with communities (“third mission” activities) – despite these aspects being a major policy objective for many governments and the mission focus for many higher education institutions (Baty 2013; Marginson and van der Wende 2016). The main criteria that define the competitiveness of universities are research and teaching (Baty 2014; Taylor and Braddock 2008; Tee 2016). In addition, some authors suggest other criteria such as entrepreneurial activities (Łaszkiwicz et al. 2016), international collaboration with different forms of university research networks, university alliances or international research consortia (Deem et al. 2008), social and environmental responsibility (Lukman et al. 2010), academic and managerial excellence (Soh 2015). The two most frequently cited criteria used to measure the university competitiveness within regional innovation systems are knowledge transfer and regional engagement.

Knowledge transfer is generally measured by the indicators industry income (Hazelkorn 2015; Jiao et al. 2016; Vătămănescu et al. 2016; Wächter et al. 2015; Zhang et al. 2016) and patents (Casani et al. 2013; Hazelkorn 2015; Jiao et al. 2016; Leydesdorff and Meyer 2009; Wong and Singh 2009) but the indicators co-publications with industrial partners and spin-offs are also used (Wächter et al. 2015). According to Vătămănescu et al. (2016), knowledge transfer can be facilitated in environments that lack

competition, that value and reward knowledge sharing with others. In order to create such a climate that could emphasize collaboration, the university management has to offer opportunities for personal development, reduced overload, employee consultations in regard with research tasks and management decisions, social activities between co-workers, mutual aid and informal communication at cross-organizational levels. To sum it up, knowledge transfer can be stimulated by social interaction and network structures. This will result in the creation of new knowledge and ultimately in innovation. This is why many studies address the process of knowledge transfer at interpersonal, inter-unit or inter-organizational levels.

- Industry income. This indicator shows how much research income an institution earns from the industry, scaled against the number of the academic staff. It indicates a university’s ability to help the industry with innovations, inventions and consultancy. The degree, to which research is funded by external, private organisations, is believed to reflect aspects of its quality.

- Patents. Innovation is also measured by the number of patents awarded to the industry and universities. Patenting by universities is taken as evidence of their contribution to commercial technology development. Jiao et al. (2016, p.3) state that “although patent applications have been noted as an imperfect measure of innovation, and not all innovations are patented, alternative indicators of innovation output, such as new product sales and literature-based innovation counts, are associated with similar drawbacks and subject to even more criticism”. Leydesdorff and Meyer (2009) describe university patenting as a symbol of changing relations between universities and their social environments. The authors express concerns that since the 2000s university patenting in the most advanced economies has been on the decline, partially because of the fact that the institutional incentives for university patenting have disappeared with the new regime of university rankings. Despite these critiques, a strong body of literature on innovation research shows that patent application is a solid measure of innovation

performance and that there is a positive relationship between the quality of research output and patents of individual researchers.

- Co-publications with industrial partners.

Another indicator for knowledge transfer is co-publications with industrial partners, which show the percentage of all the university's research publications that list an author from the private sector.

- Spin-offs. The number of spin-offs counts the number of firms established on the basis of a

formal knowledge transfer arrangement between the university and the firm.

Regional engagement is a criterion, included in U-Multirank, to measure the extend of engagement and collaborations of a university with institutions from a particular region, thus contributing for the competitiveness of that region. Regional engagement is measured by the following indicators: graduates working in the region, student internships in the region, regional joint publications and income from regional sources (see table 1).

Table 1. Indicators for university competitiveness within RIS

Ranking	Criterion	Indicator	Description
SIR	Innovation Factor	Innovative knowledge	Scientific publication output from an institution cited in patents based on PATSTAT (http://www.epo.org).
SIR	Innovation Factor	Technological impact	Percentage of scientific publication output cited in patents. This percentage is calculated considering the total output in the areas cited in patents based on PATSTAT (http://www.epo.org).
THE-TR	Knowledge transfer	Industry income	Industry income indicates a university's ability to help the industry with innovations, inventions and consultancy. It seeks to capture such knowledge-transfer activities by looking at how much research income an institution earns from the industry (adjusted for Purchasing Power Parities), scaled against the number of academic staff it employs. The category suggests the extent, to which businesses are willing to pay for research and a university's ability to attract funding in the commercial marketplace – useful indicators of institutional quality.
U-Multirank	Knowledge transfer	Income from private sources	Research revenues and knowledge transfer revenues from private sources (incl. not-for-profit organisations), excluding tuition fees.
U-Multirank	Knowledge transfer	Industry joint publications	The percentage of all the university's research publications that list an author affiliate with an address that refers to a business enterprise or a private sector R&D unit.
U-Multirank	Knowledge transfer	Patents awarded (absolute numbers)	The number of patents assigned to (inventors working in) the university (over the period 2002-2011).

U- Multirank	Knowledge transfer	Patents awarded (size normalised)	The number of patents assigned to (inventors working in) the university over the period 2002-2011 (per 1,000 students).
U- Multirank	Knowledge transfer	Industry co-patents	The percentage of the number of patents assigned to (inventors working in) the university over the period 2002-2011, which were co-applied with at least 1 applicant from the industry.
U- Multirank	Knowledge transfer	Spin-offs	The number of spin-offs (i.e. firms established on the basis of a formal knowledge transfer arrangement between the institution and the firm) recently created by the institution (per 1000 fte academic staff).
U- Multirank	Knowledge transfer	Publications cited in patents	The percentage of the university's research publications that were mentioned in the reference list of at least one international patent (as included in the PATSTAT database).
U- Multirank	Knowledge transfer	Continuous professional development revenues	The percentage of the university's total revenues that is generated from activities delivering continuous professional development courses and training.
U- Multirank	Regional engagement	Bachelor/Master graduates working in the region	The percentage of Bachelor/Master graduates who found their first job (after graduation) in the region where the university is located.
U- Multirank	Regional engagement	Student internships in region	Out of all the university's students, who did an internship, the percentage, where the internship was with a company or organisation located in the region.
U- Multirank	Regional engagement	Regional joint publications	The percentage of the university's research publications that list at least one co-author with an affiliate address in the same region (within a distance of 50 km).
U- Multirank	Regional engagement	Income from regional sources	The proportion of external research revenues - apart from government or local authority core/recurrent grants – that comes from regional sources (i.e. industry, private organisations, charities).

Source: University rankings SIR, THE-TR, U-Multirank

Discussion: restructuring of the higher education system

The EU has been slowly and systematically restructuring the Higher Education System through different types of institutions, ranking systems, programs and legal frameworks. The restructuring initiatives are grounded on high level debates and consultations between representatives of universities, governments, industries and other stakeholders. The quality of academic education and its relevance to the labour market requires an ongoing process of curricula content adaptation to the dynamic demand of the market as well as joint forces and commitment of local companies and authorities for regional development. The development of the European Higher Education Area (EHEA) and the European Research Area (ERA) has clearly contributed to the process of restructuring the higher education system. Among the formal initiatives to catalyse these processes are the European Institute for Innovation and Technology (EIT), European Research Council (ERC), the European Classification of Higher Education Institutions (U-Map), the multi-dimensional global university ranking U-Multirank, the Lifelong Learning Program and Erasmus + programme, as well as the EUR 80 billion research strategy Horizon 2020 (Hazelkorn 2015). The World Economic Forum and World Innovation Summit for Education (WISE), supported by the Qatar Foundation and held annually in Doha, provide additional platforms for knowledge sharing and sustainable development initiatives.

- European Institute for Innovation and Technology (EIT). EIT is an EU initiative, a part of EU's Framework Programme for Research and Innovation Horizon 2020. It is designed to stimulate innovation and entrepreneurship across Europe by supporting the development of dynamic partnerships, known as EIT Innovation Communities, between leading universities, research labs and companies. The support is carried out by creating a favourable environment and activities such as training and education programmes, innovation projects, business incubators and accelerators. The results of these partnerships are new ideas, new products and services, new companies and new generation of entrepreneurs.

- European Research Council (ERC). The ERC mission is to "encourage the highest quality research in Europe through competitive funding" - grants are awarded through open competition to projects headed by researchers of any origin, who are working or moving to work in Europe. On the economic side the ERC supports science-based industry and the establishment of research-based spin-offs. The ERC is an integral part of Horizon 2020, the EU's Framework Programme for Research and Innovation.

- The European Classification of Higher Education Institutions (U-Map). U-Map is an European multi-dimensional classification of higher education institutions (HEIs), which offers tools to assess HEIs that are comparable on individually selected characteristics and institutional activities (Profile Finder and Profile Viewer).

- The multi-dimensional global university ranking U-Multirank. U-Multirank is a multidimensional, user-driven approach to international ranking of HEIs funded by the European Commission Erasmus+ Programme. Its web tools enable comparisons at the level of the university as a whole and at the level of specific study programmes, as well as comparisons between institutions with similar institutional profiles, and allow users to compare institutions on personally selected indicators.

- The Lifelong Learning program (LLP) and Erasmus program. The LLP was created to stimulate learning experiences in an international environment across Europe for people at any stage of their life. From 2007-2013 the LLP funded a range of exchanges, study visits, and networking activities. Today, the activities of LLP continue under the new Erasmus programme from 2014-2020.

- Horizon 2020. Horizon 2020 is the biggest EU Research and Innovation programme created with the mission of enhancing Europe's global competitiveness. It is seen as a means to drive economic growth and create jobs with an emphasis on excellent science, industrial leadership and tackling societal challenges. The Horizon 2020 is designed to make it easier for the public and private sectors to work together in delivering innovation. It aims at breaking down barriers to create a genuine single market for knowledge, research and innovation.

In this fast-changing higher education landscape, Europe 2020 agenda prescribes transformation of educational institutions, which requires major institutional, organizational and legislative reforms (Avrlev and Efimova 2013; Erkkilä 2013; Jiao et al. 2016). Such reforms either result from “best practice” or from intensive knowledge-based institutional connections and collaborations between government, universities, research centres, enterprises, associations and other stakeholders (Guerrero et al. 2014; Jiao et al. 2016). An example of a “best practice” is the Finnish Research and Innovation Council, which model has been applied in several countries, among which Sweden, the Netherlands, Hungary and Estonia. The transformation processes are highlighted in the developing countries, where universities and academics have to surpass the stage of adaptive learning and strive for generative learning through innovation and continuous changes (Vătămănescu et al. 2016).

Conclusions

Universities have traditionally played an important role in shaping the competitive profile of nations and regions. The idea that today's competition is not between universities but between systems, built around the “knowledge triangle” principles of education, research and innovation, leads to the development of intensive knowledge-based institutional relationships between different educational, governmental, economic and social actors.

The results of this analysis indicate that the contribution of universities for the overall performance of these systems is generally measured by two criteria for university competitiveness: knowledge transfer and regional engagement. The analysis of the three global university rankings, which apply criteria for measurement of university competitiveness within RIS, revealed that knowledge transfer is measured by industry income, patents, co-publications with industrial partners, and spin-offs, while regional engagement – by graduates working in the region, student internships in the region, regional joint publications and income from regional sources.

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