



Collaboration of Russian Universities and Businesses in Northwestern Region

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Abstract. The main focus of this paper is the analysis of universities' embeddedness into industrial sector of the Russian Northwestern region. We use webometric approach to evaluate the collaboration of universities with the use of Social Networks Analysis, as well as the examination of co-authorship network among universities and other agents. We develop our research within the framework of Triple Helix concept, taking only two agents from there: universities and companies. As a result, we found two groups of universities: which have a lot of connections with a variety of industrial and business companies and behave as key agents for the whole network as well as some with more narrowly focused types of collaboration, having fewer links with companies.

Keywords: Russian universities · Business companies · Webometrics
SNA · Networks · Triple Helix concept

1 Introduction and Related Work

One of the main characteristics of universities is that they constitute the most significant part of all educational systems. Being a principal agent in the market, they behave in the same way as firms and industrial companies. Practices of promotion and self-positioning of universities in the market are very similar to other business agents. Hence, there is a need to study universities not only as producers of scientific knowledge but also as partners of companies. They all could collaborate in knowledge-sharing, internship possibilities, exchange of personnel and this could show universities embeddedness into the business area.

Universities embeddedness could help to analyze their behavior according to their place in the network. Moreover, universities' embeddedness into the local economics and culture reflects their orientation [7]. The concept of embeddedness includes the idea that agents behave within social context around them [2]. Even corruption activity and its spread could be analyzed through the concept of embeddedness into universities' collaboration network [15]. However, knowledge transfer analysis and universities cooperation are more common here. Regarding universities-companies' cooperation, universities embeddedness into business area improves industrial development and innovations' emergence [10]. Universities are producers and custodians of knowledge and experience, which they partially transfer to firms [5]. Moreover, new research made by universities about

firms and organizations increases the incentive for universities to work together with firms. Also, business companies could improve their innovative ability and creative potential by interacting with universities. As a result, their competitiveness, ensuring a stable position in the market niche as well [14].

The analysis of universities' performance was always a complicated process with the desire of ranking methodologies to include all possible measurements. A study of universities in the field of their collaboration and partnership could be made with the webometric approach. The idea of webometric analysis was designed by Ingwersen [3] and it focuses on assessing things through counting links of them on other web pages. In this paper, we do analyze links of universities on companies websites with the idea of revealing collaboration among them. Smith and Thelwall [11] found that the number of references to universities on the Web correlate with their off-line activity. That gives us enough degrees of freedom to consider that webometrics of universities performance, based on the business companies websites, would also reflect their off-line activity in industry and business.

Webometric analysis of companies and, what is more important for us, methodological approach, was described in *Googling Companies - a Webometric Approach to Business Studies* [9]. Authors examined co-links of companies, which were referenced on the same websites for detecting competitive companies. The idea is that if companies are referenced by the same web-pages, we could assume them as structurally similar. Taking into account this research, we applied Social Networks Analysis to universities-companies networks for revealing structurally identical universities and partly analyze their roles with text mining. As Thelwall and Wilkinson say [13], direct links to websites could be a measure of their similarity. And this also could be a measure of structure detection of the area [16]. In this way, the webometric analysis of links to the universities from the same companies could reveal their structural similarity.

As our methodological idea is clear now, our theoretical framework is concentrated around the Triple Helix concept, initiated by Etzkowitz and Leydesdorff [8]. The main idea is in the collaboration between universities, companies, and government for producing new knowledge and developing our life quality. Authors saw the potential for innovation and economic development in today's knowledge-oriented society in the more prominent role of universities and the close interaction of the university, industry, and government. These interactions should bring to the creation of new institutional and social forms of production, transfer and knowledge application. Universities in this Triple Helix concept take specific features of business and governmental structures and become the basis for innovations, scientific and practical developments and entrepreneurial projects.

This concept was partly researched by Stuart and Thelwall [12] in 2006. They used URL citation from universities, industrial and governmental agents for the analyses of their relationships. Authors found that links do not show the whole image of their types of collaboration because of different purposes of

websites (like educational or marketing). However, it still could be used as a complementary indicator of cooperation.

In this way, we assume that analysis of universities through the references on business companies websites and co-authorship network could give us an understanding of collaboration processes in the field. Analysis of universities strategies through bibliometric analysis and their references on Mass Media was made in our previous work [6]. However, in this paper, we focus on business ties and embeddedness of universities into an organizational network of top regional companies, paying more attention to network analysis.

2 Data and Methods

Our same sample is the same as we used in our previous study [6] - 51 Northwestern universities, which have specializations in the fields of Economics, Management, Business, and Finance. Here this choice is becoming more evident because of the similarity between economically oriented companies and universities. Since in the West most of these universities create separate economic schools, in Russia this institutionalization is only in the beginning. Universities which are at least partly in the field of Economics and Management, have the knowledge and experience of partnership with companies, even if their primary specificity is in STEM sciences.

Firstly, we downloaded all publications of these universities from 2012 to 2016 in fields of Economics, Management and Business from Web of Science. This is a big assumption not to take other databases; however, that should be enough for getting the overall picture.

We also took TOP 50 companies from the EXPERT rating, based on their revenue [1]. Universities' references on these websites were taken as webometric indicators as well as the context of these references. Taking into account possibility of strong ties among universities and companies, we used penalties for counting weights of links among universities and companies:

$weight_i = x_i$, where x_i - number of references of all universities by i company

$$penalty_i = weight_i / \ln(weight_i + 1)$$

Our methodological part includes bibliometric and webometric approaches. Being more precise - co-authorship network of universities from Web of Science Core Collection and references of them on the websites of TOP 50 Companies according to the EXPERT rating. Using Social Networks Analysis (SNA), we managed to found key universities and companies through centrality measures. The bibliographical network gives a representation of scientific collaboration while webometrics represent business connections and embeddedness of universities into industrial sector. Next, we used hierarchical clusterization from linkcomm R package [4] to extract groups of universities based on their references on companies websites. This method produces clusters based on similarity of links with Jaccard coefficient and subsequent hierarchical clusterization (Fig. 1).

3 Analysis and Results

Firstly we have decided to have a look at scientific collaboration among universities, companies and governmental centers. As this is Web of Science data, not all universities from our sample are presented - only 15 of them have publications in fields of Economics, Management, and Business indexed in WoS. We highlighted universities from our sample with colour and divided different types of agents manually. For example, different commercial banks or companies such as “Sberbank” or “McKinsey and Co Inc” were marked as “Companies”, laboratories like “CEFIR” or “ISIS Laboratory” as “Research Centers” and Ministries or state organizations as “Governmental Centers”. We got a wide variety of companies and governmental centers in co-authorship network around universities from our sample. These ties could represent their strong collaboration in common scientific production, knowledge and innovations. There is a possibility to examine collaboration with the government as well, but this is not the main focus of our research. However, we could still state that universities, companies and government work within the Triple Helix concept. As here are not only Russian agents

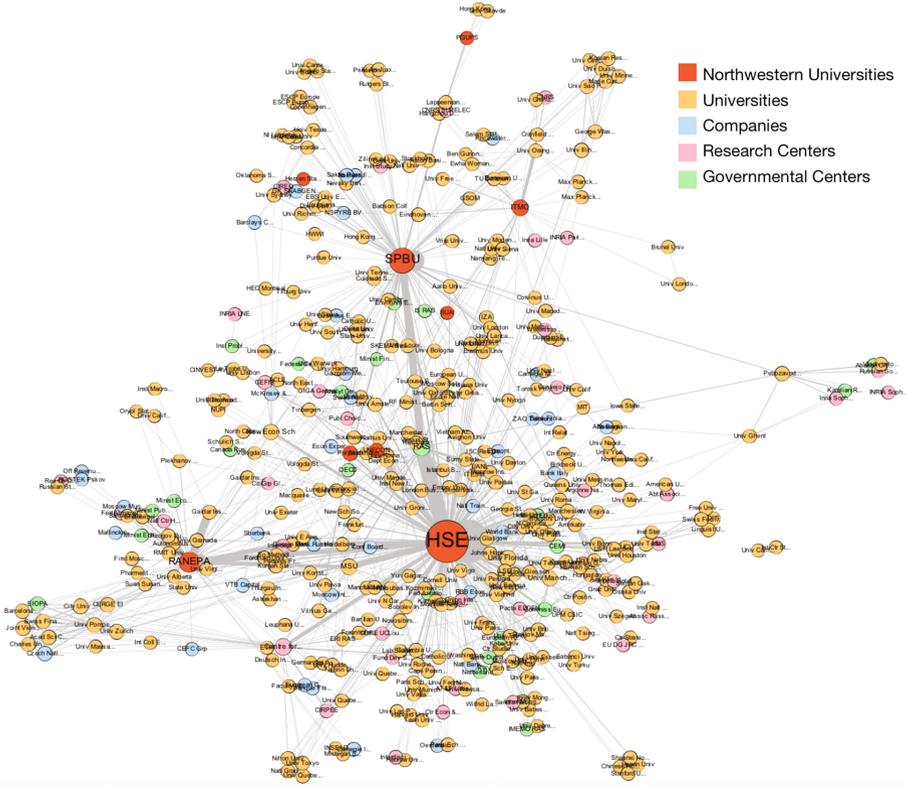


Fig. 1. Co-authorship network from Web of Science. Size - degree

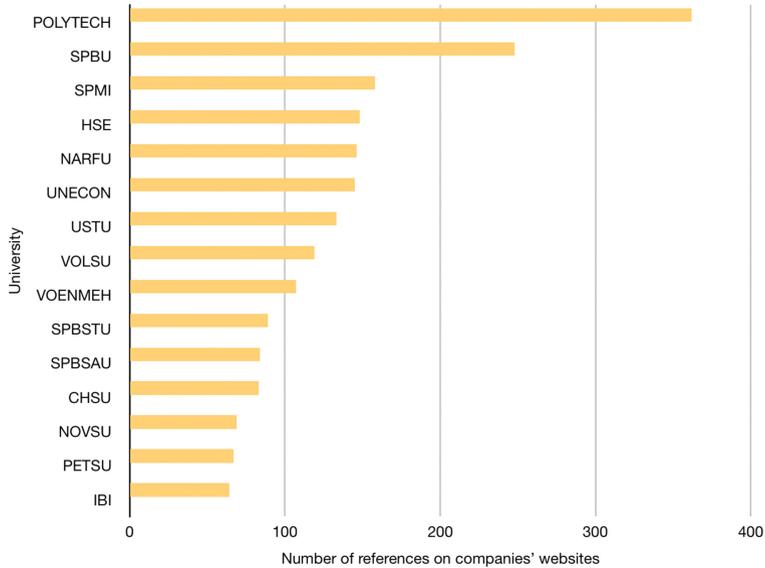


Fig. 2. The most referenced universities by companies

but also foreign ones, this bibliographical network is only the additional part of the analysis of universities-companies relationships. Though even here we could name HSE, SPBU, RANEPa as active scientific producers and partners for the industry. Moreover, these universities are embedded into the collaboration network of universities, governmental and research centers.

Next, we counted how often universities are mentioned on companies websites (Fig. 2). There are as highly popular and prominent Saint Petersburg universities - POLYTECH, SPBU, SPMI, HSE, as a variety of regional universities such as NARFU or USTU. This diversity could be explained by the different specificity of universities and companies. Some of them could be referenced as partners or providers of the labour force, while others as co-inventors of innovations.

The bipartite network of universities and companies helped us to examine key agents in the network and, respectively, in the field (Fig. 3). Technologically oriented companies like Rosseti, Lenenergo, Severstal are represented as good as different banks (Bank SPb) and industrial companies (ZAO VAD). There is no obligation for universities and companies to have the same specifications for having a collaboration because we can see these diverse ties. There are prominent universities which have connections with almost all universities, but we could also track the local industrial relationships. For example, relations among IKBFU (Immanuel Kant Baltic Federal University) and Avtotor (automobile manufacturing company located in Kaliningrad Oblast) or USTU (Ukhta State Technical University) and Ukhta Gazprom) reflects their partnership for solving regional problems and developing regional industry. Each university has its role in industrial development.

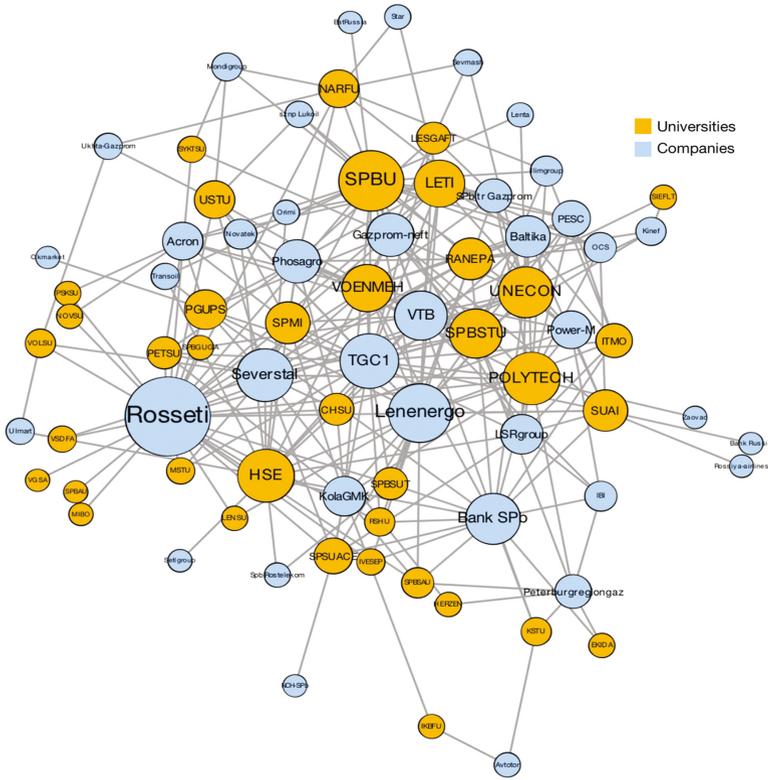


Fig. 3. Bipartite network of universities and companies. Size - degree

After hierarchical clusterization of links in the network of universities and companies projection, we got different groups of universities based on their mentions on companies' websites (Fig. 4). Hierarchical clusterization was made not only on the existence of the link but also the weight of these links - the intensity of the connection. We got 4 clusters of universities, but these communities were very nested, so here only 3 of them are visualized and analyzed. For example, there are some universities which have connections with almost all others and fall into 3 clusters - they are referenced by the same companies - these are HSE and UNECON. Both of them are considered to be the Saint Petersburg universities specialized in Economics and do have a lot in common.

Next, there are some universities which are included in 2 clusters, such as POLYTECH, SPBSAU, and SPSUACE. We could describe them as STEM universities, and they probably collaborate with companies in student internships or act as technical advisors. We assume that there are the same types of mentions with other "double-clustered" universities. However, while previously mentioned universities have a lot of companies in common, universities on the edges have more specific relationships with them. They are mentioned by a more limited

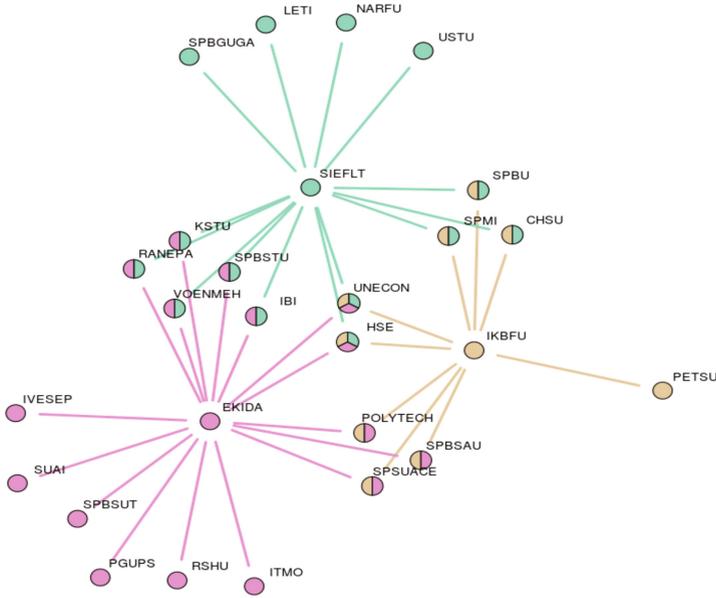


Fig. 4. Clusterization based on links of bipartite projection

number of companies, so their connections are more specific and more oriented to their common industrial or regional activity.

This part could provide us with the understanding of structural similarity of universities. As well as reflect the strong collaboration between universities and companies, corresponding to Triple Helix concept. Universities have a different level of embeddedness into the industrial sector but almost all of them cooperate with companies. This reflects mutual industrial development and emergence of innovations and new products, meeting the conditions of Triple Helix Concept. However, the governmental side is poorly illuminated, and we could not conclude that the concept works in Russian higher education completely.

4 Conclusion

In this paper, we have analyzed universities embeddedness into business ties. Relying on Triple Helix concept of university-industry-government collaboration for innovations scientific and business activity. We found that Russian Northwestern universities diverse by the level of collaboration with companies. We also got a variety of universities, which mostly contribute to industrial development, but are not oriented on knowledge production. Narrowly specialized and regional universities show collaboration with fewer companies, but they probably have stronger ties with them: for instance, among regional industrial companies and

regional head universities (NARFU and SZNP Lukoil) or narrowly oriented ones (SUAI and Russian Airlines).

The focus is on structural similarity of universities: their large and spread ties with a wide variety of companies or narrowly specialized and regional universities with fewer but stronger connections. First ones are usually big and popular universities, and others are more thematically or regionally specialized ones. We believe that they have different types of collaboration and this would be checked in our next study. For example, partnership relationships, educational services for employees, internships or the development of the city. Preliminary results show us that Northwestern universities and, more likely, all Russian universities partly behave within the framework of Triple Helix concept and are embedded into the industrial area, producing common knowledge and innovations.

Acknowledgements. The article was prepared within the framework of the Academic Fund Program at the National Research University Higher School of Economics (HSE) in 2017–2018 (grant No. 17-05-0024) and by the Russian Academic Excellence Project “5-100”.

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