Unveiling global innovation networks:

- patent citations as clues to cross border knowledge flows -

Leonardo Costa RIBEIRO[†] Glenda KRUSS[‡] Gustavo BRITTO[††] Américo T. BERNARDES[‡‡] and Eduardo da Motta e ALBUQUERQUE[††]

[†] National Institute for Metrology, Quality and Technology, Duque de Caxias – RJ, 25250-020 Brazil

[‡] Human Sciences Research Council, Pretoria, South Africa

[††] Department of Economics, Federal University of Minas Gerais, Belo Horizonte – MG, 31270-901 Brazil

[‡‡] Physics Department, Federal University of Ouro Preto, Ouro Preto – MG, 35400-000 Brazil

E-mail: [†]lcribeiro@inmetro.gov.br, [‡] gkruss@hsrc.ac.za, [††]{gustavo,albuquer}@cedeplar.ufmg.br, [‡‡]atb@iceb.ufop.br

Abstract

This paper presents a new methodology to describe global innovations networks. Using 167,315 USPTO patents granted in 2009 and the papers they cited, this methodology shows "scientific footprints of technology" that cross national boundaries, and how multinational enterprises interact globally with universities and other firms. The data and the map of those flows provide insights to support a tentative taxonomy of global innovation networks.

Keyword: multinational firms, global innovation networks, knowledge flows

1. Introduction

Multinational enterprises are drivers of international networks that create technology, by connecting the “streams of innovation” taking place in each location, and reorganizing as they internationalize them. In this new era, interactions between universities, research institutes and firms become increasingly internationalized, giving rise to “global innovation networks”.

The changing scientific and technological landscape demands new concepts and new methodologies to investigate these global innovation networks. This paper proposes how global innovation networks can be investigated and empirically demonstrated.

The hypothesis of this paper is that patent citations - more specifically, scientific non-patent references (SNPR in patents, and even more specifically, ISI-indexed SNPRs- may be used to illuminate global innovation networks. The application of statistics of ISI-indexed SNPR to measure global interactions between firms and universities is our main methodological contribution.

2. Methodology

The basic algorithm developed to map the global network works in four steps: The first step is the search and download of USPTO patents. For this paper, the database is limited to patents granted in 2009. For each patent, we store several data, including all the references. The second step is to identify the non patent references (NPR) and download all information related to those NPR. The third step is the transition from a NPR to a potential SNPR. Finally, in the fourth step we used the information on potential SNPR to search the ISI database. Using these datasets, we then prepared two lists of firms and institutions: one with all patenting firms in 2009, and another with all the institutions that authored the ISI-indexed SNPR cited in 2009 patents (full description of the algorithm can be found at Ref [1]).

3. Results

In the first step of our algorithm, 167,315 USPTO patents have been downloaded. In the second step, 86,652 patents with

1,135,582 NPR were listed. In the third step, 33,767 patents with 324,844 potentially SNPR were identified, and grouped by the names of the journals, that were then ranked. The 5,000 most cited journals had 117,770 potential SPNR that were searched. This process led to the search of the ISI database, the fourth step of our methodology. The search of those 117,770 potential SNPR resulted in the identification of 76,987 ISI-indexed papers, written by 138,712 institutional authors. Each paper may be written by authors distributed in more than one institution. Those 76,987 ISI-indexed papers were cited by 10,985 patents.

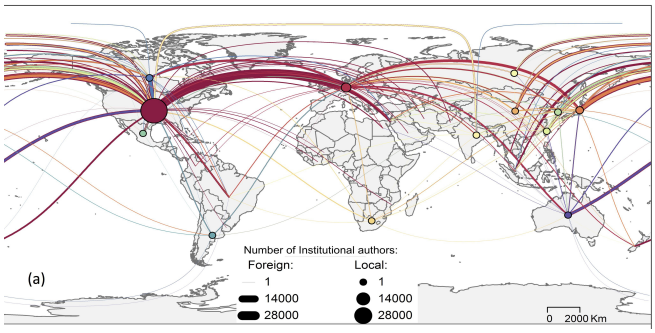
We then distributed ISI SNPR citations by countries. One may suggest at least three different categories of countries, in regard to their propensity of their patents to cite ISI-indexed SNPR. In a first group, there are the USA and some European countries: patents from the USA citing ISI-indexed SNPR are 10.16% of their total patents, and for countries like United Kingdom, France, Netherlands, Sweden and Belgium, their percentages range from 6.42% to 11. 13%. In a second group there are Japan and other East Asian countries like South Korea and Taiwan, with lower percentages that range from 1.64% to 2.80%. In a third group, with countries with fewer total patents, like Brazil, Argentina, Mexico, Greece, and Russia, their percentages are greater, ranging from 13.12% to 29.03%.

47,475 of the papers were written with USA authors. This is almost seven times the total of SNPR from Japan, in the second position, and more than twelve times the total of Germany and England, in the third and fourth positions. However, almost half are authored outside the USA (46.07% of the total), providing an important clue of the internationalization of the flows that are investigated in this paper. The leading position of USA is also observed in the list of universities in as location of their authors. Between 40 leading institutions that authored the papers with ISI-indexed SNPRs there are only five non-US universities - these institutions are from UK, Canada and Japan.

USA creates a broad global network, spanning all continents and including all different sources, which may suggest that the USA innovation system is a very efficient international learning machine. The tension between national systems and transnational technology, as Nelson and Rosenberg stress, may be a positive factor for a country that succeeds in building this kind of learning machine.

USA has the most internationally spread network of interaction with universities: 81 foreign countries are source of paper citations. It is followed by Europe, citing 68 countries and Japan citing 45 countries.

At this point, we are able to deliver a map of international flows, presented in the Figure below. The line thickness is associated with the frequency of patents from a country to citing foreign institutional authors. These are cross-border citations of ISI-indexed SPNRs. The size of the circle is associated with the frequency of citation of domestic institutional authors.



In conclusion, this paper presents an exploratory methodology to provide evidence to support a taxonomy of GINs. This methodology may be further developed to improve the identification of firms and their ownership structure. Finally, the study of network's structure is in progress.

Acknowledgements: This paper was partially funded by the European Community's Seventh Framework Programme (Project INGINEUS, GA No.225368). Financial support from Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq), Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) and Fundação de Amparo à Pesquisa do Estado de Minas Gerais (Fapemig) is also acknowledged.

References

[1] L. C. Ribeiro, G. Kruss, G. Britto, A.T. Bernardes, E. M. Albuquerque, "A methodology for unveiling global innovation networks: patent citations as clues to cross border knowledge flows", Scientometrics (2014). DOI **10.1007/s11192-014-1351-2**