Research Article

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The impact of transnational co-authorship on the scientific quality of academic researchers -Case Studies: Slovenia, Poland and Romania

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Abstract: The aim of this article is to contribute to the discussion about whether the scientific impact of an academic researcher (measured through bibliometrics indices as Hirsch score, citation scores or quantitative data about publications) can be accounted for by the presence of co-authors and the characteristics of the personal networks they are embedded in. With my study, I intend to demonstrate that there is statistical evidence between international co-authorship, measured through the number and the characteristics of international co-authors and the scientific impact of the researcher. Recent studies using bibliometrics and scientometrics approach shows that papers published with international co-authors may result in a higher citation rate than the ones written in a purely national manner (with national co-authors) (Glanzel & Schubert, 2001; Schmoch & Schubert, 2008). In the literature that addresses these issues, the main focus is put on international co-authorship, but my opinion is that the concept has undergone a series of methodological changes. I address these changes as a trend towards a transnational perspective. I explored the personal networks of university researchers, from three academic communities in the field of sociology. I analyzed the data using hierarchical regression models. This article is based on secondary data analysis starting from the data Hâncean used in 2016 (Hâncean & Perc, 2016). The data provided attribute and relational data for the focal nodes and their corresponding alters from Web of Science platform. Given the theoretical framework proposed by previous research (Adams, 2012; Hâncean & Perc, 2014; Glanzel & Schubert, 2004), I expected the scientific impact of an author to be positively influenced by the impact of the personal network he is embedded in. After running

the analysis, the presence of transnational co-authors has a moderate impact on the citation distribution, especially for the Romania case. The biggest impact on the citation distribution, for all academic communities I included in the analysis, are the number of publications and the average number of co-authors' citations. The description and the exploration of the data in all three communities of academic sociologists (Romania, Poland and Slovenia) will be used later in order to show new ways in which knowledge is transferred through the lens of a transnational perspective.

Keywords: personal networks, transnational co-authorship networks, scientific impact, H-index

Introduction

In recent years, the number of scientific collaborations has increased considerably. Of course, there are various reasons why this trend has a constant growth. It cannot be said that there is a main cause of this phenomenon precisely because of the multitude of factors that act in this respect. Starting from the structural characteristics of science, proposed by DeSolla Price (1963), and ending with specialization in the field and with a whole range of characteristics of the country to which the researcher belongs, they all have a bearing on the rate of development of scientific collaboration behaviors.

Why do people involve themselves in co-authorship structures? The process involves a number of reasons, most of them are financially motivated. Researchers collaborate to publish scientific papers because they have greater access to funds to finance their research (Ziman, 1994). However, co-authorship in general is an imperfect measure of collaboration in science. This is just one element that comes into defining scientific collaboration. The latter can be operationalized by several indicators (e.g. drafting project proposals, exchanging experience

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among researchers and so forth). Still, from a statistical point of view, there are many voices that claim that there is an almost perfect correlation between scientific collaboration and co-authorship writing behaviors (Katz & Martin, 1997; Parish, 2018; Hart, 2000).

The purpose of my approach is to find out if there is any influence provided by the presence of transnational co-authors in the ego-networks of authors on the citation distribution. The analysis is performed on three academic communities: Poland, Slovenia and Romania, considering the theoretical framework proposed by previous research (Adams, 2012; Hâncean & Perc, 2016; Glanzel & Schubert, 2004), where the scientific impact of foreign co-authors (measured by Hirsch score and number of citations) influences the academic quality of the authors, the generated effect should be positive.

The description and exploration of the co-authorship networks of all three academic sociology communities (Romania, Poland and Slovenia) will be used later on to show new ways in which science is transferred. Moreover, they can stay at the basis of the collaboration policies introduced by the competent authorities so that science becomes a common product, following the systematic effort of a research team.

The bibliometric approach

Bibliometric studies have been undertaken to map academic productivity by providing valuable information on the standards of productivity of authors, institutions and research groups. Bibliometric methods have been used to provide quantitative information on written publications. The term bibliometrics is related to the more general term of informetrics, (Egghe & Rousseau, 1990; Wolfram, 2003) and scientometrics (Bar-Ilan 2008, 2010). Also, Ellegard & Wallin (2015) propose the concept of webometrics in order to analyze the various aspects of Internet WWW resources. The field of bibliometrics is primarily related to the identification of a corpus of literature (i.e. publications dealing with a particular subject) and its analysis by means of statistical methods. Wang et al. (2015) stresses that these can be considered the best tools to track academic progress. Bibliometrics provides valuable insights into how a science or a particular field of study develops. Moreover, it allows the identification of a circuit of knowledge between two or more research domains. The field of study itself refers not only to science as purely individualized (in terms of publishing by one's own), but opens the perspective of an interdisciplinary approach where several such research

domains meet each other. Okubo (1971) considers that the main assumption to be made in bibliometric research is that scientific articles represent knowledge produced by scientific research.

The terms of bibliometrics and scientometrics were introduced almost simultaneously by Pritchard, Nalimov and Mul'chenko (Nalimov & Mul'chenko, 1969). Pritchard explained the term bibliometrics as an *application of mathematical and statistical methods for books and other media releases* while Nalimov and Mul'chenko defined scientometrics as *the application of those quantitative methods dealing with the analysis of science seen as a process of information*. The boundaries between the two specializations have almost disappeared over the last three decades, and the terms are almost interchangeable. Scientometrics analyzes the quantitative aspects of the generation, propagation and use of scientific information to help understand the mechanism of scientific research (Hood & Wilson, 2001).

Bibliometrics carries with it a number of methodological problems. Talking about measuring scientific productivity itself creates technically unsafe issues. Applying the bibliometric analysis becomes equivalent to the imposition of methodological constraints. Van Raan (2004) considers that one of the crucial goals of bibliometric analysis is the use of standardized and consistent indicators for measurement. Wallin (2005) considers that this type of analysis is guilty of two major disadvantages: i) there is always the risk of ignoring the social impact of the implemented research programs (because bibliometrics does not measure this) and ii) there is a risk that some works may be discredited, although they may be qualitative from the point of view of the field of science they come from.

Wallin (2005) emphasizes the idea that bibliometric methods are, by their very nature, quantitative, but their role is to make assertions about the qualitative aspects they measure. Thus, the role of bibliometrics is to transform intangible aspects (the scientific impact of a researcher) into flexible, easy-to-explain aspects. The quantitative targets of bibliometrics and the assertions it makes about scientific impact are not yet standardized. This seems paradoxical when bibliometric indicators are increasingly used and less criticized (i.e. the impact factor).

Bibliometric indicators

Among the bibliometrics-specific indicators, one of the most used is the number of citations. These are used (in addition to other measurement parameters) to measure scientific performance. The high frequency of their use in analyzes is due to the fact that they provide a quick

and simple impression about the quality of a research. Of course, there are cases where the number of citations depend on the type of publication, the methodology used, the field in which the work was published, including the way the authors are viewed in the scientific community. In this case, citations as the sole parameter for measuring the productivity of science, become a too weak instrument in terms of productivity explanation. Glanzel & Schubert (2004) consider that bibliometrics is more than necessary when questioning scientific productivity, but reporting on this subject needs to be reserved as the results to be true.

Bibliometric indicators have seen an impressive development in recent years due to the quantitative data that can be extracted. Downloading without many constraints or using various software such as Mendeley, made it possible to analyze the impact of scientific productivity by calling on many methods. Data is interpreted in many ways, using various calculation parameters such as the Hirsch index or similar indices (*parameter m, g* or even the impact factor of the journal in which the papers are published). Ellegaard & Wallin (2015) consider that besides these parameters, the number of co-authored publications and the extent to which the co-authorship becomes international in the sense of collaboration are also methods that can provide inferences about the scientific quality of a researcher. As a final goal, the bibliometric analysis can be used not only at the micro level (i.e. at the level of a researcher or a research department), but also at the macro level (i.e. hierarchy of higher education institutions).

Bibliometric methods have been used over time to highlight the different aspects that science and technology propose (Narin & Olivastro, 1994) or to highlight models of collaboration between researchers (Lievrouw, 1989; Hâncean et al., 2016). Methods used in bibliometrics can provide essential information about the collaborative network and its density. Showed, co-authorship networks can be fragmented. Thus, we can make inferences about the authors tendency to write alone or in co-authorship.

Research on collaboration networks between researchers highlights two levels of information. On one hand, the bibliometric analysis shows how the domain in which it is published evolves. On the other hand, it also shows how knowledge is propagated in the scientific community, taking as a reference the dissemination of citations. The bibliometric analysis should distinguish between information and knowledge. If information refers to the Hirsch score, the number of citations, authors, etc., bibliometrics knowledge refers to the knowledge that is transmitted through the publications.

Collaboration in science

Scientific collaboration has become one of the favorite subjects in bibliometric research (Wang et al., 2015). The first comprehensive study on international collaboration in science was published by Schubert & Braun (1990), whose results revealed that among ISI publication articles, collaboration between authors has become more and more preferred. The analysis was made at a macro level, and among countries not associated with this trend are Turkey, South Korea and Saudi Arabia, where the rate of collaboration tends to decrease. Glanzel & Schubert (2004) are placing themselves on the same path. They note that the co-authorship trend has changed, collaborative behaviors have intensified. Moreover, the density of collaborative networks has changed. Wang et al (2015) argues that the future of co-authorship and collaboration in science will further highlight the reasons why some authors choose to collaborate.

The scientific collaboration refers to one of the elements that make up what Solla Price (1986) called “Big Science”. Moreover, this is in fact the result of the professionalization of science-science being produced in special institutions for it (Beaver & Rosen, 1978). The benefits and merits that scientific collaboration brings from knowledge transfer between researchers, departments, institutions, countries, and is connecting researchers to a global network and increasing the visibility of scientific articles.

Collaboration in science carries a certain number of critical points. Hayati & Didegah (2010) believes that it is dominated by a number of challenges posed by both the rapid development of technology and the dynamics of the ever-increasing knowledge process. The two underline that, given the dynamics of the whole knowledge diffusion system, in very few cases there are researchers who have expertise in all areas of study and have all the resources needed to undertake a research by themselves. Thus, collaboration in science is an essential element in producing a complete knowledge, where the skills and abilities of researchers placed in the same place increase the chances of success in their scientific career (Katz & Martin, 1997).

In the present paper, the study is based on the bibliometric analysis, having as a starting point scientific collaboration, measured by scientific papers published in international journals. Subramanyan (1983) considers that we can speak of collaboration starting with the exchange of advice or opinions to sharing data by mailing or separately participating in projects and then merging the final results. Although there is research showing that

there are cases where co-authorship does not necessarily mean real collaboration (Katz & Martin, 1997, Laudel, 2002), however, the publication written in co-authorship remain one of the best indicators of scientific collaboration (Katz & Martin, 1997; Glanzel & Schubert, 2004). Moreover, most of the literature work on scientific collaboration approaches co-authorship as a measure of the scientific impact of researchers (Glanzel & Schubert, 2004, Wang et al., 2015)

The subject of collaboration is not only of interest to scientists, but also to decision-makers. In this case, one of the earliest studies that centered on scientific collaboration was undertaken in the 1970s by Computer Horizon Inc. (CHI). They have collected data on scientific collaboration in the form of international co-authors, starting with the Science Citation Index (SCI) produced by the Institute for Scientific Information (ISI). Data collected by CHI was subsequently consulted by various research councils such as the National Science Foundation or the RAWB in the Netherlands (Advisory Council for Science Policy). Generally, at international level, European research programs offer financial aid for projects that are carried out in collaboration with other states, organizations or departments. The high costs and complexity of research-related issues hinder independent researchers, institutions or even nations to work individually (Abramo et al., 2010).

Collaboration in science involves several aspects. Narin et al (1991) emphasizes that the bibliometric analyzes he conducted did not indicate any decrease in the upward trend of collaborations in science. Similarly, Miquel & Okubo (1994) noticed an increase in the co-authorship rate, especially in the international one. Archibugi & Coco (2004) highlighted the frequency with which articles written in co-authorship changed over time. Thus, between 1986 and 1991, the number of scientific articles written in co-authorship doubled for some countries, while in others it tripled (as in the case of the Netherlands, Finland or Great Britain). Zitt & Bassecoulard (2004) showed that the percentage of internationally co-authored publications increased from 10% in 1991 to almost 20% in 2000.

Glanzel (2002) emphasizes that talking about international collaboration in terms of co-authorship has already become a widely spoken notion. Among the reasons that Glanzel puts into question regarding the reasons why the authors want to write in co-authorship (e.g. geographic, economic, policy), he believes that co-authorship helps improving the number of citations an author has. Glanzel & Schubert (2001) emphasizes that those international co-authorship behaviors may result in an increase in the rate of citation higher than in articles in

which the authors wrote in co-authorship with national co-authors. Also, Suarez-Balseiro et al. (2009) suggested that international publications are much more valuable in terms of their visibility than those published nationally.

Studies on why the authors prefer to involve in co-authorship behaviors can be divided into two categories. Frequent reasons such as the transfer of knowledge between individuals, departments, institutions or nations, costs shared by the entire research team or geographical proximity, capture only part of the benefits that co-authorship produces. Abramo et al. (2010) believes that the progress of information and communication technologies, the influence the Internet has, the reduction of transport costs and international competition have clearly contributed to the adoption of international collaboration in scientific research. Moreover, knowledge sharing has the ability to change the perception of science from a national to an international level (Royal Society, 2011).

Measurements of the impact of researchers

International co-authorship

The Royal Society (2011) report shows that there is a clear difference in collaboration behavior among states. China, Turkey, Taiwan, India, South Korea and Brazil produce more than 70% of scientific publications with only national authors. Less developed countries tend to write more in co-authorship. In different areas of Africa and Southeast Asia, the percentage approaches even 100%. Thus, the trend of international collaboration is declining for countries like China or Turkey, but is steadily increasing in the US, Europe, or Japan. Increasing scientific collaboration in global terms indicates that the scientific field that is formed between domains is very well interconnected. The level of collaboration may vary from one country to another, but the frequency of collaboration becomes intrinsic to all sciences at national and global level.

Currently, evaluating the performance of scientific research is the most important application of scientometrics. Although the number of papers published by scientists indicates a measure of their productivity, it is irrelevant for the impact of the work. Publications, however, are one of the most commonly used indicators for evaluating a scientific scholar. Allison (2003) considers that there is great variability in how publications are

evaluated and the calculations can provide a brief summary of the careers of those who publish. The number of citations is another measure of the researcher's quality. For Menard (1971), citations are the only proof that a work has been used, and Cole & Cole (1972) regard citations as a valid indicator of influence.

Schmoch & Schubert (2008) considers that a proxy measure of the quality of the work may also include the international co-authorship. They point out that there are a number of elements that validate this perspective. First, there is a tacit understanding between researchers and politicians who consider that international co-authorship as an essential contributor to scientific performance. They also consider the fact that writing in this type of co-authorship is growing.

Adams et al (2005) considers that one of the main reasons would be diffusion of knowledge, but also solving some financial problems. Schmoch & Schubert (2008) considers that internationally-accredited publications attract more citations and that the potential community to which information is made is greater (meaning that more people find out about publications).

International co-authorship vs. Transnational co-authorship

Science has become increasingly marked by the growing trend of researchers to expand their collaboration network. The number of articles written in international co-authorship has thus increased, including an increase in the number of authors working together for a publication. Schmoch (2005) shows that between 1999-2003 the number of articles published by the Germans in co-authorship with other authors from countries such as Belgium or the Netherlands increased from 19% to 40%.

Adams (2012) shows that in 2010 nearly 25% of scientific articles had authors from at least two distinct countries (compared with 10% in 1990). The United States collaborates with China (being the most frequent partner with 19,141 articles co-authored in 2011), with the United Kingdom (19,090 items) and Germany (16,141). International collaboration networks can also be pursued in the case of China's singularity. Since 2000, it has intensified its scientific links with Japan, Taiwan, and South Korea, as well as with other Asia-Pacific scientifically active countries (Adams, 2012).

Studies seem to address more international than transnational co-authorship (Katz & Martin, 1997; Glanzel & Schubert, 2004), but the two concepts can quickly be confused, even used interchangeably. However, small differences are discussed, but of essence. To begin with,

an essential difference is the one that centers on the geographic boundaries. Transnationalism is presented as going beyond any type of border, including the geographic one, while the international idea underlines the existence of borders (Gerber, 2007).

The literature in this area proposes various approaches to the international co-authorship term. Jonkers (2010) considers it to be collaboration between nations rather than between individual actors in different nations and he proposes a term borrowed from Crawford (Crawford et al., 1993) referring to cross-border or transnational collaboration which fits much better, but it escapes the common sense (hence too little used).

Faist (2000) proposes an essential differentiation between internationalization and transnationalism. Drawing on migration studies, transnational transitions do not mean occasional contact or ephemeral interactions that are formed between the actors involved. With regard to transnational co-authorship networks, these can be considered as a specific type of international collaboration. Those who write in co-authorship come from societies that are in the same high-density field of cooperative relations.

Jonkers (2010) points out that, with some exceptions, the concept of transnationalism has not been used in studies on scientific collaboration. It is much more popular in the migration studies. In this respect, the concept refers to relations outside the borders of the national state, such as the role migrants have in forming trade, religious or cultural ties. Moreover, these relationships have the role of building a link between the home society and the host society (Basch et al., 1994; Portes 1999). Jonkers (2010) highlights the fact that the concept 'international research collaboration' is problematic from many points of view. Firstly, he considers that when we speak about it, it may refer to collaboration between nations rather than between individual actors in different nations. Secondly, it seems to include a series of elements identified in the research system by Van der Meulen & Rip (1998) – including the governmental level of policymakers, the intermediary level of funding agencies and the organisational level of research institutes and universities.

The literature in this area proposes two broad types of approaches to the international co-authorship term. The first goes from the perspectives of authors who consider it to be specific to co-authorship networks from certain geographic areas, and the latter considers that this behavior is in fact a characteristic of the nations. Jonkers (2010) believes that for this latter type of interaction between researchers, the term cross-border or transnational collaboration (Crawford et al., 1993) fits

much better, but it escapes the common sense (hence too little used).

Collaboration networks, with an emphasis on transnational co-authorship networks, are the main concern of this study. In the literature that addresses these issues, the transnational co-authorship continues to climb on an upward trend. Although it seems counterintuitive, given that the term dates back to the early 60s, its approach to the scientific knowledge system is relatively emerging.

Data and method

The data collection first started with choosing the countries where the analysis was conducted. According to the latest statistics provided by Eurostat for 2016, Romania is last but one in terms of its share of GDP allocated to the research and development sector, with a value of 0.48%. Considering that Romania is part of the series of countries where the percentage is very small, we chose two more countries, placed either in the middle of the ranking (Poland) or at the top of the ranking (Slovenia). As far as the situation of Poland is concerned, it falls within the middle area, so that the allocated percentage does not exceed 1%, in exact percentage of 0.97%. Slovenia is a best case, placing itself in the upper part of the hierarchy with 2% of R & D expenditure. The motivation for choosing these three countries is based also on the curiosity to see how diffusion of knowledge takes place in different countries on the basis of the allocation of funding from GDP for research activity.

In order to understand how co-authorship network has a bearing on the distribution of an author's citations, the difficulty was to consider all aspects of co-authorship. Considering I am doing secondary data analysis, the database used to analyze the impact of transnational co-authors and their network characteristics on the number of individual citations is the database used by Hâncenan and Perc in their article entitled *Homophily in co-authorship networks of East European sociologists* (Hâncenan & Perc, 2016).

Thus, the first step they made in data collection was searching for the sociology departments of Poland and Slovenia and Romania. After studying the departmental situation, they gathered data on the number of full-time sociology teachers within them. Scientific co-authorship works were used as an analysis unit for constructing the co-authorship networks, where two researchers were considered to be linked to each other if they wrote at least one paper together. In order to have an eloquent example in this case, Figure 1 and Figure 2 show structurally the

Fig 1. Personal co-authorship network structure of a researcher from University Nicolaus Copernicus sociology department, Poland.

*** The colors vary depending on the nationality of every listed alter. Thus, the green colour marks the alters that are from Poland, and the yellow one matches all foreign alters. As a practice in PNA, the ego is not represented, but here I did it with a demonstrative role. The ego is marked with blue.

Fig 2. Personal co-authorship network structure of a researcher from University Nicolaus Copernicus sociology department, Poland.

*** The colors vary depending on the nationality of every listed alter. Thus, the green colour marks the alters that are from Poland, and the yellow one matches all foreign alters. In this figure, the ego is missing as it is supposed to be connected with everyone.

way in which a co-authorship network is formed. Thus, the design of this research falls within the paradigm of network analysis (Wasserman & Faust, 1994).

In January 2016, the two departments of the Universities from Slovenia (Ljubljana and Maribor) numbered 58 authors, and the 11 departments of the Polish Universities were represented by 55 authors, the authors being understood as full-time sociology teachers who teach at the various faculties in the two countries. In Romania, there were 16 sociology departments represented by 294 full-time sociology teachers.

Hâncean & Perc (2014) created a database of researchers, after which they built the co-authorship networks using the Web of Science platform, a database of bibliographic and bibliometric data provided by Thomson Reuters, which indexes approximately 9,000 journals. It is considered one of the most comprehensive and reliable sources of information on research. It should be noted that data was collected from 2015, and as a field of study, they focused exclusively on sociology.

After this stage, they collected attribute data from 113 sociologists (58 from Slovenia and 55 for Poland) such as: genre, departmental affiliation, number of publications, the value of the Hirsch score (Hirsch, 2005; Glanzel, 2006). For each sociologist, they collected data on the number of citations per article based on the country where the journal was published, the number of co-authors and their profile (national or international), the highest value as well as the Hirsch score environment at the level of co-authors. I added as variables a transnationalism index (i.e. the ratio between the difference in the number of foreign co-authors and domestic co-authors and the total number of co-authors) and I used two structural measurements for network analysis such as density and betweenness.

Hypotheses

The central question on which this study is based refers to the impact of the transnational co-authorship network on the author's citations distribution (H1). I wanted to analyze whether there are influences from the personal network of co-authors on the author's scientific impact. Given the theoretical framework proposed by previous research (Glanzel & Schubert, 2004; Adams, 2012; Hâncean & Perc, 2016), I expect the influence to be significantly positive. Measurements that are strictly related to the personal network (density, betweenness) will form the basis of transnational analysis. Building on Faist's work

(2000), networks become transnational in conditions where interaction is not just casual, occasional, but when individuals are part of fields that share a high density of relationships.

The number of co-authors will consider each co-author with whom a particular individual in a sociology department has written at least one paper. The reason for choosing this variable resides in previous research (Glanzel & Schubert, 2001; Abramo et al., 2010; Suarez-Balseiro et al., 2009), which showed that articles written in co-authorship with international co-authors points more on citations, either have a much greater success in being published in journals with a high impact factor. Density measurements (how strong the co-authors are linked in the sense of a number of articles written together) and the External-Internal index was made available through the UCInet software (Borgatti et al., 2002). In the area of specialized literature dealing with co-authorship networks, with an emphasis on the impact that co-authors have on the author's scientific impact, such measurements have not yet been analyzed.

The scientific impact that an author may have, is influenced not only by the existence of international researchers in their co-authorship network, but also by their impact. Thus, the second hypothesis is based on the idea that the researcher benefits from the scientific co-author's impact. The higher the number of citations for transnational co-authors, the higher the number of citations of the author (H2). The hypothesis lies in the very rich literature on this topic (Schmoch & Schubert, 2008; Glanzel & Schubert, 2001).

The configuration and network structure are essential, including the case of sociology of science. In this area, the betweenness, number of co-authors, and the density of the network (the proportion of all possible links that are present) were used as predictors to explain part of the citation distribution variation. Between the characteristics of the ego (in terms of Hirsch's scores and citation) and betweenness as a specific measure of structural characteristics of the network, a positive relationship has been demonstrated (Abbasi et al., 2012). Based on these results, I wanted to see if betweenness positively influences the author's scientific impact (H3).

For testing the hypothesis, I performed a 5-step hierarchical regression with SPSS. For this, I used 5 blocks of predictive variable variables for the dependent variable expressed by the number of citations for a researcher. I ran the model for each country, keeping the same predictions and the same dependent variable.

Results

Descriptive statistics. Scientific performance and co-authorship

The case of Poland

In the case of Poland, Table 1 becomes representative of the situation for the sociology field. As we can see, the scientific impact of Polish researchers is quite small, but not as small as in the case of Romania (see Table 3). The number of citations and the Hirsch index represent eloquent evidence in this case. The maximum Hirsch score does not exceed 1, and the average number of citations is also low. In this case, the average number of co-authors for a work stops around 1.24, and the module betrays the appearance that individual authors prefer to write most often in single structures.

Concerning the type of co-authors, the data shows that there is not a very large difference between cases or at least between the preferences of Polish researchers to write in collaboration with foreign or domestic co-authors. On average, there is not such a high variation. However, there is a difference between the maximum number of foreign and domestic co-authors in the case of publications. For

a published work, the Polish researchers have up to 24 foreign authors in their collaboration structure and only 11 domestic authors.

The case of Slovenia

In the case of Slovenia, things are quite different in terms of scientific impact. By far, from all three cases analyzed, Slovenia scores best in the publications area. In comparison with Poland, it has almost double the number of publications, and compared to Romania (see Table 3), it is almost 5 times higher. As regards the scientific impact, in terms of citations, again Slovenia is significantly distant from Poland and Romania.

With a much higher Hirsch and with an equally high citations rate, we can say that the Slovenian researchers certainly have a far greater impact in the academic scientific community than the Polish ones.

There is an interesting situation regarding the level of co-authors with whom Slovenian researchers collaborate. The data provided by Table 2 show that Slovenes prefer to bring in their collaboration structure a fairly high number of domestic co-authors to foreign co-authors. Although on average they write in co-authorship with domestic authors,

Table 1. The impact of the Polish sociology community research productivity.

Poland	Publications	Citations	Hirsch Index	Total number of co-authors	Foreign co-authors	Polish co-authors
Mean	3.24	11.18	0.55	2.49	1.24	1.25
Mode	1	0	0	0	0	0
St. Dev.	3.03	64.05	0.87	5.02	3.81	2.12
Min.	1	0	0	0	0	0
Max.	15	474	4	28	24	11
N=55						

Table 2. The impact of the Slovenian sociology community research productivity.

Slovenia	Publications	Citations	Hirsch Index	Total number of co-authors	Foreign co-authors	Slovenian co-authors
Mean	6.14	31.74	2.10	4.74	1.69	2.98
Mode	1	1	1	1	0	0
St. Dev.	5.41	50.23	1.60	4.70	3.36	2.71
Min.	1	0	0	0	0	0
Max.	22	284	7	29	22	11
N=58						

Table 4. The results of the hierarchical regression involve Slovenian researchers from the sociology departments. The variables were logged before entering the assay. The table contains standardized coefficients (Beta). The dependent variable is the number of citations of the author.

Slovenia	Variables	Step 1	Step 2	Step 3	Step 4	Step 5
1	E-I Index	0.11	0.15	-0.004	0.01	-0.004
2	Ego's publications		0.61	0.50	0.54	0.50
3	Mean score of alters' citations			0.58	0.58	0.60
4	Ego's normalized betweenness				-0.07	-0.02
5	Personal network density					0.12
R ²		0.12	0.39	0.69	0.69	0.71

Table 5. The results of the hierarchical regression involve Polish researchers from the sociology departments. The variables were logged before entering in the analysis. The table contains standardized coefficients (Beta). The dependent variable is the number of citations of the author.

Poland	Variables	Step 1	Step 2	Step 3	Step 4	Step 5
1	E-I Index	-0.27	-0.18	-0.29	-0.31	-0.32
2	Ego's publications		0.47	0.47	0.42	0.42
3	Mean score of alters' citations			0.47	0.48	0.51
4	Ego's normalized betweenness				0.06	0.06
5	Personal network density					-0.48
R ²		0.20	0.20	0.40	0.36	0.32

The inclusion of the number of ego publications in step 2 increases the explanation for the citation rate by almost 27%. Also, the Beta coefficient shows that the higher the E-I index from step 1 of the regression, in step 2, the number of citations increases by 0.15 standard deviations.

In trying to explain the variance of citations, I could see that in the 3rd step of the regression, the number of citations increases by 0.50, respectively 0.58 standard deviations. Thus, even if the impact of transnationalism is quasi-inexistent (the number of citations increases just by 0.11 standard deviation), the distribution of ego's citations is positively affected by the number of publications and especially by the scientific impact of co-authors. In other words, a researcher from Slovenia must be part of a co-authorship network that includes important co-authors in terms of scientific impact (i.e. a high number of citations). In Slovenia, regardless of the number of steps of regression, the number of publications and the average number of co-authors' citations become key predictors in the distribution of researchers' citations.

The data provided by Table 5 for Slovenia shows that in step 3 of the regression, it can be seen, as in the case of

Slovenia, that the number of publications and the average number of co-author citations remain important predictors of the distribution of citations. However, out of all 5 steps of regression, only step 3 records a higher coefficient of determination, the variables included explaining approximately 40% of the variance of the dependent variable, less 29% compared to Slovenia. However, interestingly in this case is the influence of the publication and the average number of alters' citations on the distribution of citations. Step 3 of the regression for both Poland and Slovenia highlights the power the two variables have on the scientific impact of the ego. Normally, in this note, it also counts on the fact that the researcher has more and more frequent publishing behaviors. Just as it is proposed in scientometric literature (Glanzel & Schubert, 2004), Ellegaard & Wallin (2015), the number of publications is essential in order to increase the scientific impact an author may have, but this does not mean that it is enough.

In the case of Romania (see Table 6), the proposed model fits better with data. Thus, we note that the transnationalism index has a significant impact in the first two regression steps, the distribution of citations increasing by 0.40 standard deviations. If, in the first step, the presence

Table 6. The results of the hierarchical regression involve Romanian researchers from the sociology departments. The variables were logged before entering the assay. The table contains standardized coefficients (Beta). The dependent variable is the number of citations of the author.

Romania	Variables	Step 1	Step 2	Step 3	Step 4	Step 5
1	E-I Index	0.40	0.30	0.11	0.14	0.13
2	Ego's publications		0.50	0.27	0.17	0.18
3	Mean score of alters' citations			0.54	0.49	0.49
4	Ego's normalized betweenness				0.16	0.15
5	Personal network density					-0.01
R ²		0.16	0.40	0.60	0.61	0.61

of transnational co-authors explains 16% of the authors' citation distribution, in the second step, together with the number of publications, it comes to explain up to 40% of the variance of the dependent variable.

Again, step 3 of the regression is essential because, as with Slovenia and Poland, the number of publications and the average number of co-authors' citations matter to a great extent. The transnationalism index is important, but only in relation to the number of publications. If the average number of alters' citations is considered, it loses its ability of explanation. However, it is worth noting for the E-I index that the analysis in Romania was carried out on a much larger number of authors than Slovenia and Poland, and this may influence the value of the Beta coefficient.

Considering the predictors included in the analysis, we cannot say that we are encountering the same publishing behaviors in all three analyzed cases. In the case of step 1 of the regression, transnationalism does not appear to affect the distribution of authors' citations to a larger extent than in the case of Romania, whereby the higher the index, the higher the number of citations increases by 0.40 standard deviations.

As predictors, we can mention the number of publications and the average number of authors' citations for all three countries surveyed. The network characteristics (i.e. betweenness and network density) appear to have a rather low impact on the distribution of the author's citations for all three countries.

Discussion and Conclusions

The analysis I have carried out on the impact transnationalism has on the distribution of authors' citations can be framed in a long series of perspectives.

As we have seen in descriptive statistics, among all three types of analyzed sociologists, Polish, Romanians and Slovenians, the latter tends to have a high number of co-authors in their collaboration structure. In other words, Slovenian researchers have much wider collaboration structures, so sharing information is easier. Poland and Romania do not differ greatly among themselves, researchers from these countries tend to write in a rather dyadic co-authorship structure.

The results, however, contradict studies which show that authors increasingly prefer international co-authorship, and this helps them to increase their scientific impact in the academic community (Luukkonen et al., 1993; Schmoch & Schubert, 2008). The biggest impact on the citation distribution, for all academic communities I included in the analysis, are the number of publications and the average number of co-authors' citations. In other words, in order to have a high scientific impact, an author must have a very pronounced writing behavior and must be part of a powerful co-authorship networks in terms of scientific impact. These results only associate with the literature in which the scientific impact of co-authors influences the scientific impact of the authors (Glanzel & Schubert, 2001, deSolla Price, 1986). For Slovenian researchers, the rate of citations variation is higher compared to Poland and Romania.

In terms of structural network characteristics (i.e., betweenness and network density), they appear to have a very low impact on the distribution of citations. These results contradict, however, the results recorded in the literature where the scientific performance correlates positively with the betweenness score and the impact is higher (Abbasi et al., 2006, Ortega, 2014).

After the analysis, I can say that the various forms of cooperation between researchers leads to engaging co-authorship behaviors. These become crucial indicators

for the production of various types of knowledge, but above all to make inferences about how the knowledge itself propagates.

One limit of this study is linked to the methodology I employed. Being just a quantitative one, it does not give a strong information about the reasons why researchers want to collaborate, why are they engaging in these behaviors of knowledge transfer. What is more, the quantitative approach does not offer the whole picture regarding all factors that can influence one's scientific impact. I believe that a mixed approach involving both quantitative methods and qualitative methods would have formed a more complex image regarding this issue.

Also, the data was collected for a single field of study, namely sociology. Thus, the results of the research are valid only for the sociology discipline, and the extension of the analysis to other fields of scientific research represents one of the future directions of study. It should also be mentioned that the approach I have taken regarding the study undertaken is static and not longitudinal which will be also addressed in further directions of this study.

The applicative potential of the results and the dynamic nature of co-authorship networks can underpin social policies that should encourage collaboration between researchers so that the costs incurred should be shared. At the same time, it is also attempted to encourage the development of the field of applied sociology because the old concepts of scientific knowledge no longer deal with the new processes that take place in the sociology of science. Also, Bergmann et al. (2012) emphasizes that considering various publishing behaviors, openness to international, external environment, and strategic partner relationships have an essential role to play in the spread of knowledge.

Although the co-authorship behavior is viewed from different angles, often the most accepted option is that public policies should promote diplomatic care and dialogue between researchers so as to improve collaboration networks and, in particular, science in general.

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References

- Abbasi A., Chung K. S. K. & Hossain L. (2012). Egocentric analysis of co-authorship network structure, position and performance. *Information Processing & Management* 48, 671–679
- Aboukhalil, R. (2014). The rising trend in authorship. *The Winnower*, 3. [Disponibil online] la: <https://thewinnower.com/papers/the-rising-trend-in-authorship>. Accesat la 23.03.2018
- Abramo, G., D'Angelo, C. and Solazzi, M. (2010). The relationship between scientists' research performance and the degree of internationalization of their research. *Scientometrics*, 86(3), pp.629–643
- Adams, J. (2012). The rise of research networks. *Nature*, 490(7420), pp.335–336
- Adams, J., Black, G., Clemmons, J. and Stephan, P. (2005). Scientific teams and institutional collaborations: Evidence from U.S. universities, 1981–1999. *Research Policy*, 34(3), pp.259–285
- Adams, J., Gurney, K. and Marshall, S. (2007). Patterns of international collaboration for the UK and leading partners (Summary report). [online] Available at: <http://image.guardian.co.uk/sysfiles/Education/documents/2007/07/13/OSICollaborationSummaryRepo.pdf> [Accesat la 9 Mar. 2018]
- Allison, P. (2003). Inequality and Scientific Productivity. *Social Studies of Science*, 10(2), pp.163–179
- Archibugi, D., Coco, A. (2004). International partnerships for knowledge in business and academia. *Technovation*, 24(7), pp.517–528
- Bar-Ilan J. (2010). Citations to the “Introduction to informetrics” indexed by WOS, Scopus and Google Scholar. *Scientometrics*, 82(3), pp.495–506
- Bar-Ilan J. (2008). Informetrics at the beginning of the 21st century-A review. *Journal of Informetrics*, 2(1), pp.1–52
- Basch, L., Glick-Schiller, N. and Szanton-Blanc, C. (1993). Nations Unbound: Transnational Projects, Postcolonial Predicaments and Deterritorialized Nation-States 1st Edition. Routledge
- Basu, A. & Kumar, B.S.V. (2000). International collaboration in Indian scientific papers. *Scientometrics*, 48(3), pp.381–402
- Beaver, D. deB., Rosen, R. (1978). Studies in scientific collaboration. Part I. The professional origins of scientific co-authorship. *Scientometrics*, 1, pp. 65–84
- Bergmann, M., Jahn, T., Knobloch, T., Krohn, W., Pohl, C., and Schramm, E. (2012). Methods for Transdisciplinary Research, Campus, Frankfurt/M., Germany.
- Borgatti, S.P., Everett, M.G. & Freeman, L.C. (2002). Ucinet for Windows: Software for Social Network Analysis. Harvard, MA: Analytic Technologies
- Bollen, K. and Noble, M. (2011). Structural equation models and the quantification of behavior. *Proceedings of the National Academy of Sciences*, 108(Supplement_3), pp.15639–15646
- Bozeman, B., Fay, D. and Slade, C. (2012). Research collaboration in universities and academic entrepreneurship: the-state-of-the-art. *The Journal of Technology Transfer*, 38(1), pp.1–67.
- Cole, J.R. and Cole, S. (1973). Social Stratification in Science. Chicago: University of Chicago Press.
- Crane, D. (1971). Transnational Networks in Basic Science. *International Organization*, 25(03), p.585.

- Crawford, E., Shinn, T., Sörlin, S. (1993). The Nationalization and Denationalization of the Sciences: An Introductory Essay. *Denationalizing Science*, pp.1-42
- Egghe, L., Rousseau, R. (1990). Introduction to Informetrics. Amsterdam: Elsevier
- Ellegaard, O., Wallin, J. (2015). The bibliometric analysis of scholarly production: How great is the impact? *Scientometrics*, 105(3), pp.1809-1831
- Faist, T. (2006) The Transnational Social Spaces of Migration / Thomas Faist. – Bielefeld: COMCAD. (Working Papers – Center on Migration, Citizenship and Development; 10
- Faist, T. (2012). Toward a Transnational Methodology: Methods to Address Methodological Nationalism, Essentialism, and Positivism. *Revue européenne des migrations internationales*, 28(1), pp.51-70
- Freeman L. C. (2004) The development of social network analysis. A study in the sociology of science. Empirical Press, Vancouver
- Glänzel, W., Schubert, A. (2004). Analysing Scientific Networks Through Co-authorship. *Handbook of Quantitative Science and Technology Research*, pp.257-276
- Glänzel, W. (2006). On the h-index - A mathematical approach to a new measure of publication activity and citation impact. *Scientometrics*, 67(2), pp.315-321
- Glick Schiller N, Basch L, Szanton-Blanc L, eds. (1992). Towards a Transnational Perspective on Migration. Ann. NY Acad. Sci. Vol. 645
- Glick Schiller, N. & G. E. Fouron. 1999. Terrains of blood and nation: Haitian transnational social fields. *Ethnic and Racial Studies* 22:340–66
- Gerber, D. (2007). Internationalization and Transnationalization. A Companion to American Immigration, pp.225-254. In Uda, R. A Companion to American Immigration (2007). Blackwell Publishing Ltd, Oxford
- Hăncean, M., Perc, M. (2016). Homophily in co-authorship networks of East European sociologists. *Scientific Reports*, 6(1)
- Hart, R. (2000). Co-authorship in the academic library literature: A survey of attitudes and behaviors. *The Journal of Academic Librarianship*, 26(5), pp.339-345
- Hayati, Z., & Didegah, F. (2010). International scientific collaboration among Iranian researchers during 1998-2007. *Library Hi Tech*, 28(3), 433-466
- Hicks, D., & Katz, S. (1996). Science policy for a highly collaborative science system. *Science and Public Policy*, 23(1), 39-44
- Hood, W, Wilson, Concepción S. (2001). The literature of bibliometrics, scientometrics, and informetrics. *Scientometrics*, 52, pp. 291-314
- Jonkers, K. (2010). Transnational research collaboration: an approach to the study of co-publications between overseas chinese scientists and their mainland colleagues. In R. Bauböck & T. Faist (Eds.), *Diaspora and transnationalism : concepts, theories and methods* (pp. 227–243). Amsterdam: Amsterdam University press
- Katz, J. S. & Martin, B.R. (1997). What is research collaboration? *Research Policy*, 26, pp. 1-18
- King, M., Bergstrom, C., Correll, S., Jacquet, J. and West, J. (2017). Men Set Their Own Cites High: Gender and Self-citation across Fields and over Time. *Socius: Sociological Research for a Dynamic World*, 3, p.237802311773890
- Kronegger, L., Mali, F., Ferligoj, A. and Doreian, P. (2014). Classifying scientific disciplines in Slovenia: A study of the evolution of collaboration structures. *Journal of the Association for Information Science and Technology*, 66(2), pp.321-339.
- Laudel, G. (2002). What do we measure by co-authorship s?. *Research Evaluation*, 11(1), pp. 3-15
- Levitt, P. & Schiller, N.G. (2004). Conceptualizing Simultaneity: A Transnational Social Field Perspective on Society. *International Migration Review*, 38 (3), pp. 1002-1039
- Lievrouw, L. A. (1989). The Invisible College Reconsidered: Bibliometrics and the Development of Scientific Communication Theory. *Communication Research*, 16(5), pp. 615-628
- Luukkonen, T., Persson, O., Sivertsen, G. (1992). Understanding Patterns of International Scientific Collaboration. *Science, Technology & Human Values*, 17(1), pp.101-126
- McCarty, C., Jawitz, J., Hopkins, A. & Goldman, A. (2012). Predicting author h-index using characteristics of the co-author network. *Scientometrics*, 96(2), pp.467-483
- Menard, H. (1971). *Science: growth and change*. Cambridge, Mass.: Harvard University Press
- Miquel J.F., Okubo, Y. (1994). Structure of international collaboration in science: Comparisons of profiles in countries using a link indicator. *Scientometrics*, 29(2), pp. 271-294
- Munteanu, R. (2010). Centrul Național pentru Politica Științei și Scientometrie-CENAPOSS-un instrument pentru definirea ritmică a strategiei în domeniul cercetării științifice. (2016). *Revista de Politica Științei și Scientometrie*, Vol. 1(Nr.1), pp.3-12
- Molina, J. L., Petermann, S. & Herz, A. (2015). Defining and Measuring Transnational Social Structures. *Field Methods*, 27 (3), pp. 223-243
- Nalimov, V.V., Mulchenko, B.M., *Scientometrics*, Nauka, Moscow, 1969 (in Russian). Narin, F. & D. Olivastro (1992). Status report: Linkage between technology and science. *Research Policy*, 21, pp. 237–249
- Narin, F., (1991). Globalisation of research, scholarly information, and patents - ten year trends
Proceedings of the North American serials interest group (NASIF) 6th Annual Conference. *The Serials Librarian*, 21, pp. 2-3
- Nye, J. and Keohane, R. (1971). Transnational Relations and World Politics: An Introduction. *International Organization*, 25(03), p.329
- Okubo, A. (1971). Oceanic diffusion diagrams. *Deep Sea Research and Oceanographic Abstracts*, 18(8), pp.789-802
- Ortega J. L. (2014). Influence of co-authorship networks in the research impact: Ego network analyses from Microsoft Academic Search. *Journal of Informetrics* 8, 728–737
- Paisley, W. (1990). The future of bibliometrics. In C. L. Borgman (Ed.), *Scholarly communication and bibliometrics* (pp. 281-299). Newbury Park, CA: Sage
- Parish, A., Boyack, K. and Ioannidis, J. (2018). Dynamics of co-authorship and productivity across different fields of scientific research. *PLOS ONE*, 13(1), p. e0189742
- Portes, A. (1996). Globalization from Below: The Rise of Transnational Communities. In W.P. Smith and R.P. Korczenwicz, *Latin America in the World Economy*, Westport, CN: Greenwood Press
- Price, D. (1963). *Little science, big science*. New York: Columbia Univ. Press.
- Royalsociety.org. (2011). Knowledge, networks and nations Global scientific collaboration in the 21st century. [online] Available at: https://royalsociety.org/~media/Royal_Society_Content/

- policy/publications/2011/4294976134.pdf [Accessed 31 Mar. 2018]
- Schmoch, U., & Schubert, T. (2008). Are international co-publications an indicator for quality of scientific research? *Scientometrics*, 74(3), 361-377
- Schubert, A. and Braun, T. (1990). International collaboration in the sciences 1981–1985. *Scientometrics*, 19(1-2), pp.3-10
- Suares-Balseiro, C., García-Zorita, C., & Sanz-Casado, E. (2009). Multi-authorship and its impact on the visibility of research from Puerto Rico. *Information Processing and Management*, 45, pp. 469–476
- Subramanyam, K. (1983). Bibliometric studies of research collaboration: A review. *Information Scientist*, 6(1), pp.33-38
- Van der Meulen, B. & A. Rip (1998), 'Mediation in the Dutch science system', *Research Policy* 27 (8): 757-769
- van Raan, A. (2004). Sleeping Beauties in science. *Scientometrics*, 59(3), pp.467-472
- Van Raan, A. (1998). The influence of international collaboration on the impact of research results. *Scientometrics*, 42(3), pp.423-428
- Wagner, C. S., & Leydesdorff, L. (2005a). Mapping the network of global science: comparing international co-authorship s from 1990 to 2000. *International Journal of Technology and Globalisation*, 1(2), pp.185–208
- Wallin, J. (2005). Bibliometric Methods: Pitfalls and Possibilities. *Basic & Clinical Pharmacology & Toxicology*, 97(5), pp.261-275
- Wang, J., Thijs, B., & Glänzel, W. (2015). Interdisciplinarity and impact: Distinct effects of variety, balance and disparity. *Plos One*, 10(5), pp.127-139
- Wang, J., Veugelers, R. and Stephan, P. (2015). Bias Against Novelty in Science: A Cautionary Tale for Users of Bibliometric Indicators. *SSRN Electronic Journal*, pp. 68-92
- Wasserman S. & Faust K. (1994). *Social network analysis. Methods and applications*. Cambridge University Press, New York.
- West, J., Jacquet, J., King, M., Correll, S. and Bergstrom, C. (2013). The Role of Gender in Scholarly Authorship. *PLoS ONE*, 8(7), p.e66212.
- Wolfram, D. (2003). *Applied informetrics for information retrieval research*. New Direction in Information Management no. 36. Westport, CT: Greenwood Publishing Group
- Ziman, J. (1994). *Prometheus Bound: Science in a Dynamic Steady State*. Cambridge University Press
- Zitt M., & Bassecouard E. (2004). S&T networks and bibliometrics: The case of international scientific collaboration. 4th Proximity Congress: Proximity, Networks and Co-ordination, Marseille (France), 2004/06/,17–18, pp. 15