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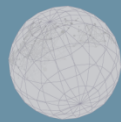
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Core-periphery relations in international research collaboration¹

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Abstract

The paper investigates core-periphery relations in the network of international scientific collaboration. We hypothesise that benefits from collaboration depend, *ceteris paribus*, on roles played by collaborators in the given collaboration. To capture the impact of various roles, we compare mean citation of collaborative papers in which authors from different countries perform a leading or a complementary role. The leading role can be attributed to scientists indicated as corresponding authors, while non-corresponding authors can be seen as complementary partners. Thus, we compare mean citations of internationally co-authored papers in which scholars affiliated in particular countries are either corresponding authors ("corresponding author paper") or non-corresponding authors ("non-corresponding author paper"). The analysis is based on Web of Science data covering the period 2000-2013. The results of the study suggest that core countries seem to benefit most from international cooperation when they lead the research (i.e. when they play the role of a corresponding author), while peripheral countries benefit most from being led (i.e. when they play the role of a non-corresponding author). This can suggest that increasing international collaboration in science strengthens persistence of the global distribution of research excellence embedded in long-term historical processes.

Key words

Scientific collaboration, core-periphery relations, co-authorship, citations.

Introduction

Scientific activity is spread unevenly across geographic space. This was true in previous centuries and continues to be the case in today's globalised world. Disparities in global scientific production reflect the socioeconomic diversification of regions, countries and continents. Despite the hopes that globalisation and digital technologies would flatten the world (Friedman, 2005), it remains uneven and spiky (Florida, 2005). In the same time, the organisation of research and scholarly work is progressively defined by multidimensional networks. The unprecedented contemporary growth of research collaboration—the

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collaborative turn—transforms scientific endeavour. For centuries, international co-authorship was extremely rare. Even in 1970, internationally co-authored papers constituted only 1.9 percent of articles indexed by Web of Science in the Science Citation Index, Social Sciences Citation Index and Arts & Humanities Citation Index. Since then, the number has been growing steadily. In 2013, almost every fourth publication had authors from at least two countries (cf. e.g., Leydesdorff, Wagner, 2008; Wagner, Park & Leydesdorff, 2015). Cooperation is particularly intense between the largest research centres that play the role of primary hubs in the global scientific cooperation network (Matthiessen, Schwarz & Find, 2010; Maisonobe, Eckert, Grossetti, Jégou & Milard, 2016).

We would expect that the unprecedented escalation of international collaboration in science is accompanied by decreasing cross-country disparities in scientific performance. However, this is not necessarily the case. The network structure of global scientific collaboration does not imply that horizontal relations among countries prevail. On the contrary, the system can be described as hierarchical. Although horizontal and hierarchical relations co-exist in this system, they are not uniformly distributed in the global space. While relations among the most scientifically developed countries are largely horizontal, the relationships between stronger and weaker science players are rather hierarchical. Hereby, the world of science reproduces the global structure of centre and periphery (Schott, 1993; Shils, 1991). This can be further explained in the light of the world-system theory crafted by the influential American intellectual, Immanuel Wallerstein (2004). Core and periphery play complementary roles in the global system. The core is at the forefront of socio-economic and technological development, while the periphery provides cheap labour and low-processed resources. In the case of science, this is manifested by the fact that new ideas are generated predominately in the centre, and then imitated in the periphery. Furthermore, the world-system is composed not only of core and periphery, but also of semi-periphery. The semi-periphery acts as a periphery to the core and as a core to the periphery. The hierarchy of the global scientific system is thus multi-level (Hwang, 2008). At the same time, the system is segmented into macro-regions connected by dense horizontal relations. They occur especially among core countries, while relations between core and periphery tend towards domination and subordination.

Research collaboration is one of the means that the centre uses—even if unintentionally—to ensure its scientific domination over the periphery (Schott, 1998). This process has various dimensions. First, core countries occupy central positions in the global scientific collaboration network, and therefore they can control knowledge flows and thus maintain a competitive advantage. Second, the core sets the rules of the game in the world scientific tournament and establishes the institutional framework in which global science operates (Ben-David, 1984; Schott, 1993). To take part in the game, peripheral countries have no option but to collaborate with the centre. Collaboration with partners from core countries helps them to acquire international financing, to catch the attention of the world scientific audience, and to publish in leading journals (Paasi, 2015). Third, the core imposes its research agenda on the periphery. The agenda is not necessarily consistent with the needs and wants of the periphery. Less developed countries often serve merely as subcontractors or routine research service providers for core countries (Kreimer, 2007). Four, core countries, due to the availability of resources and accumulated academic prestige, are able to attract talented scholars from peripheral countries. Scientific collaboration enables them to identify such individuals. For peripheral areas, this brain drain remains a severe challenge (Boeri, 2012; Trachana, 2013), even though academic mobility is increasingly portrayed as brain circulation, beneficial for both sending and receiving countries (Saxenian, 2005).

Nonetheless, it is rather the peripheries that strive for joint research and publications with core countries, not the other way round (Schubert & Sooryamoorthy, 2009). The reason is that collaboration with stronger partners boosts scientific performance and impact. Links to stronger partners are more valuable than links to less developed ones. Higher citation gains from co-authorship with more developed collaborators, as compared to co-authorship with less developed ones, can be observed on various levels: individual researchers (Pravdic & Oluic-Vukovic, 1986), organisations (Ahn, Oh & Lee, 2014), and countries (Tang & Shapira, 2011). But for stronger partners, collaboration with weaker collaborators is less attractive and can even lead to the performance decrease (Ahn, Oh & Lee, 2014; Glänzel, Schubert & Czerwon, 1999; Glänzel & Schubert, 2001; Pravdic & Oluic-Vukovic, 1986).

Research problem and empirical approach

The greater collaborative advantage for weaker partners seems contradictory to the aforementioned centre-periphery hierarchical dominance. However, this contradiction can be illusory. We hypothesise that weaker partners' benefits from collaboration with stronger ones depend, *ceteris paribus*, on what role they play in the given collaboration.

To capture the impact of various roles, we compare mean citation of collaborative papers in which authors from different countries perform a leading or complementary role. The leading role can be attributed to scientists indicated as corresponding authors (Mattsson, Sundberg & Laget, 2011), while non-corresponding authors can be seen as complementary partners. Thus, we compare mean citations of internationally co-authored papers in which scholars affiliated in particular countries are either corresponding authors ("corresponding author paper") or non-corresponding authors ("non-corresponding author paper").

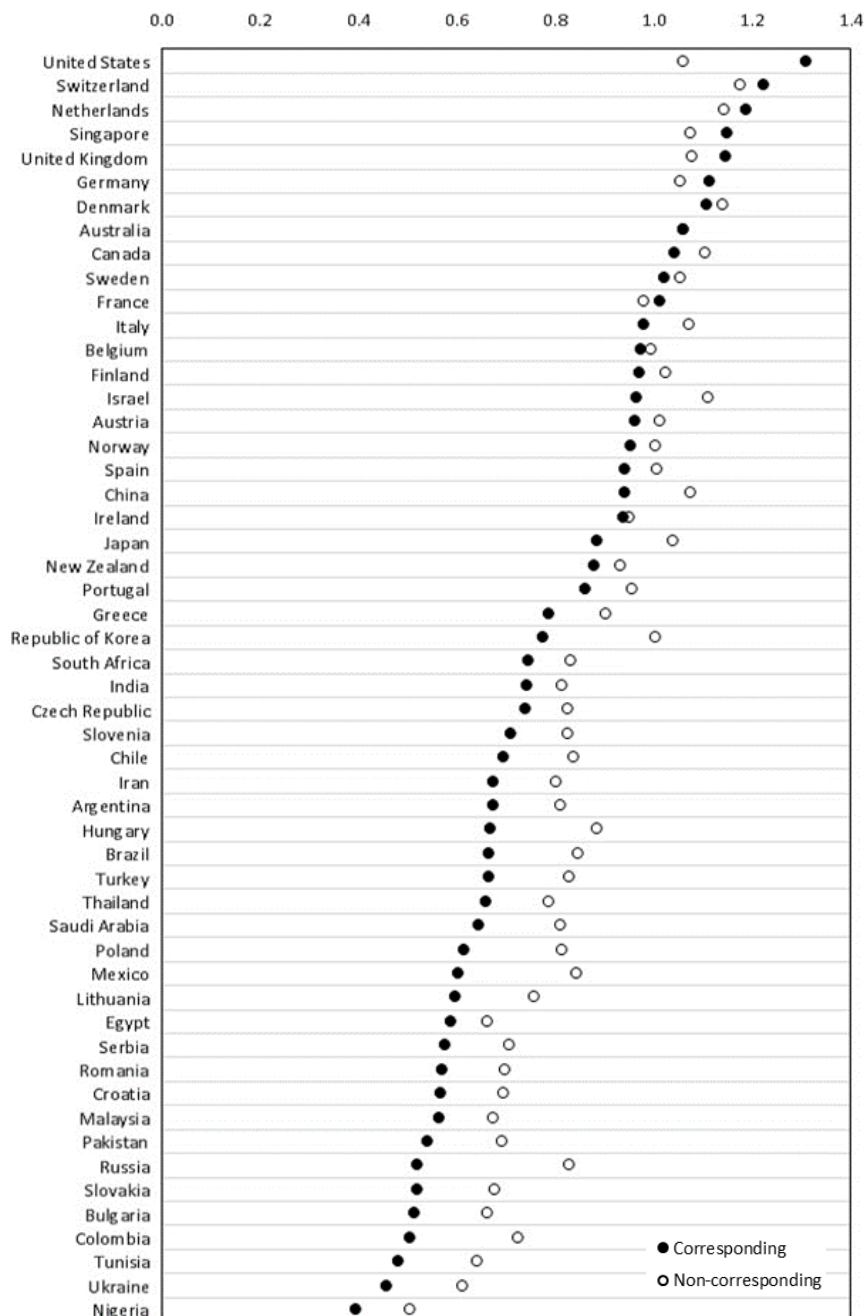
The data presented in this paper are based on the in-house Web of Science dataset hosted by Indiana University Bloomington. All presented numbers consider only publication type 'article' (i.e. book chapters, conference proceedings, reviews, letters, etc. are not taken into account). To reduce the influence of multi-country authorship and hyper-authorship, only papers co-authored by scholars from exactly two countries are taken into account—i.e. we only analyse papers assigned to pairs of countries (e.g. France-Germany, France-US, France-Poland, etc.). Moreover, we disregarded papers where scholars from two countries simultaneously serve as corresponding co-authors. To further enhance comparability, citations are normalised by field and year of publication. The analysis includes papers published in years 2000-2013. The number of such defined papers is considerably large to provide a good basis for quantitative analysis (e.g. in the case of the US it is almost 948 thousand, China—271 thousand, France—253 thousand, Hungary—71 thousand, Lithuania—4.4 thousand). Country-pair papers typically constitute a significant share of overall publication output of a given country (e.g. Switzerland—39%, the Netherlands—32%, Germany—31%, Poland—23%, the US—22%, China—20%).

Results and preliminary conclusions

In the group of 53 countries that published at least 19 thousand articles in years 2000-2013, only eight achieved higher mean citations of their corresponding author collaborative papers as compared to their non-corresponding author papers (see. Figure 1). Corresponding author collaborative papers are particularly beneficial for the US. For Singapore, the UK, Germany, Switzerland, the Netherlands and France the benefits are smaller but still significant, while in Australia corresponding author papers receive only slightly more citations than papers in which Australian scholars play a complementary role. For all other countries in the sample, it is more valuable—regarding the citation premium—to act as non-corresponding co-authors.

For some countries, in particular Belgium, Denmark, Ireland and Sweden, the difference is insignificant. But in other cases—e.g. Russia, Mexico, Colombia, Hungary, Poland or South Korea—the difference between mean citations of corresponding author and non-corresponding author papers is large. The large gap can be interpreted as a sign of structural differences among collaborating countries.

Figure 1: Normalized mean citations of papers in which scholars from a given country play the role of corresponding or non-corresponding authors (2000-2013)*



*To reduce the influence of hyper-authorship, only papers co-authored by scholars from exactly two countries are taken into account. Moreover, we disregarded papers where scholars from two countries simultaneously serve as corresponding co-authors.

Source: own elaboration based on Web of Science data.

The differences in country pair-wise citation averages between corresponding and non-corresponding author papers reveal the core-periphery structure of international collaboration in science. Core countries seem to benefit most from international cooperation when they lead the research (i.e. when they play the role of a corresponding author), while peripheral countries benefit most from being led (i.e. when they play the role of a non-corresponding author). This can suggest that increasing international collaboration in science strengthens persistence of the global distribution of research excellence embedded in long-term historical processes.

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