Research Policy 39 (2010) 662–673

Contents lists available at ScienceDirect

Research Policy

journal homepage: www.elsevier.com/locate/respol

Research collaboration at a distance: Changing spatial patterns of scientific collaboration within Europe

Jarno Hoekman[a,b], Koen Frenken[a,b], Robert J.W. Tijssen[c,*]

[a] Eindhoven Centre for Innovation Studies (ECIS), School of Innovation Sciences, Eindhoven University of Technology, The Netherlands
[b] Urban & Regional Research Centre Utrecht (URU), Faculty of Geosciences, Utrecht University, The Netherlands
[c] Centre for Science and Technology Studies (CWTS), Leiden University, The Netherlands

ARTICLE INFO

Article history:
Received 12 September 2007
Received in revised form
23 December 2009
Accepted 21 January 2010
Available online 4 March 2010

Keywords:
Research collaboration
European integration
Co-publication counts
Gravity equation
Spatial proximity

ABSTRACT

This study analyses the changing effect of physical distance and territorial borders (regional, national, language) on the intensity of research collaboration across European regions. Using data on all co-publications between 313 regions in 33 European countries for the period 2000–2007, we find that the bias to collaborate with physically proximate partners did not decrease, while the bias towards collaboration within territorial borders did decrease over time. Our results show that the ongoing process of European integration is removing territorial borders, but does not render collaboration less sensitive to physical distance. Given this general trend, there is considerable heterogeneity between regions and countries in their propensity to collaborate which we attribute to differences in size, quality and accessibility. The findings and conclusions are framed within the context of European research policies.

1. Introduction

Human activities are known to cluster in space. Scientific research is no exception. As a general rule, researchers that are in close vicinity interact more intensively than those at a distance. However, with recent advances in information and telecommunication technologies some have declared an end to "the tyranny of distance" (Castells, 1996; Cairncross, 1997). In the specific context of scientific collaboration this trend has been evidenced by an increase in long-distance collaboration activities (for a survey see Frenken et al., 2009).

A better understanding of the observed trend towards collaboration at longer distance is important for at least two reasons. First, research collaboration generates benefits in several ways (Katz and Martin, 1997). It provides opportunities to realise savings in the costs of research infrastructure and the training of personnel. Collaboration also generates intellectual benefits through the cross-fertilisation of ideas. These benefits are expected to increase with the distance over which collaboration takes place, as relevant partners are more easily found within a greater radius. Indeed, scientific articles stemming from international collaborative projects are cited more frequently, on average, than publications from national collaborative projects (Narin et al., 1991). Second, significant public expenditures are used to foster long-distance collaboration. As a prime example, the European Union's member states attempt to develop a *European Research Area* (ERA) that is dedicated to improving the internal coherence within the European research landscape by coordination of regional, national and EU research activities.[1] The *Framework Programmes* constitute one of the centrepieces of those activities. They are specifically designed to pool resources and promote R&D cooperation between the EU member states in order to improve the communication and collaboration among researchers, scholars, engineers and other technical support staff.

The present study aims at uncovering some of the changing spatial patterns of research collaboration by examining co-publication activities over time. Previous studies in this area (Narin et al., 1991; Katz, 1994; Hicks and Katz, 1996; Georghiou, 1998; Glänzel et al., 1999; Glänzel, 2001; Okubo and Zitt, 2004; Adams et al., 2005;

[1] "The concept of the 'European Research Area' centres around the idea of mobilizing a more coherent overall policy framework conducive for European research through mobilizing critical mass, reducing costly overlaps and duplications and making more use of coordination and integration mechanisms involving all levels of policy intervention in the European Union" (Commission of the European Communities, 2007, p. 93). Achieving more coherence at the level of regions within member states is one of the key policy foci (Commission of the European Communities, 2001).

* Corresponding author.
E-mail address: tijssen@cwts.leidenuniv.nl (R.J.W. Tijssen).

0048-7333/$ – see front matter © 2010 Elsevier B.V. All rights reserved.
doi:10.1016/j.respol.2010.01.012

Wagner and Leydesdorff, 2005; Jones et al., 2008) have all been descriptive. What is more, these studies analysed *either* the changing effect of geographical distance on co-publication activities *or* the changing effect of regional or national boundaries, therefore possibly confounding both effects. Given the heterogeneity of the European geographical landscape, a systematic comparison between the effect of distance and territorial borders is required to analyse the (changing) spatial patterns in research collaboration. We do so by explaining the co-publication intensity between 313 regions in 33 European countries by the physical distance between regions and by regional, national and linguistic border effects. We draw conclusions regarding the observed changes in spatial patterns of research collaboration and the extent to which these changes are in line with EU policy objectives. Doing so, we are not able to directly evaluate Europe's policy efforts as we lack data on the inputs provided by the European Union. Rather, we analyse trends in the publication system towards a desired 'European science system' and leave aside whether a possible change is brought about by the interventions of the European Union, by other factors or by a combination of both.

The remainder of this paper is organised as follows: in Section 2 we discuss the role of geography in research collaborations with a special focus on the European context; Section 3 describes the data collected from Thomson Reuters' *Web of Science* database and introduces the statistical model employed in our study which is derived from the gravity equation; key results of our statistical analysis on co-publication intensities among EU regions are reported in Section 4, while in the final section we interpret these empirical results in the light of both theory and EU's policy objectives.

2. The geography of research collaboration

Although scientific practice still invokes images of the '*lone, long-haired genius, mouldering in an attic or basement workshop. . .motivated by the flame burning within him*' (Price, 1963, p. 3), scientific knowledge creation is increasingly dependent on collaborative efforts. The rise in research collaboration is most commonly measured by the increasing number of authors on research papers as noted in early work (Price, 1963; Narin and Carpenter, 1975). Since, escalating costs of research and an increasing division of intellectual labour among researchers seem to have accelerated collaboration tendencies (Katz and Martin, 1997). We did not yet observe the 'virtual demise of the lone researcher' (Beaver and Rosen, 1979), but shares of collaborative research now lie well above 50% of all research activities in many countries and research organisations (Wuchty et al., 2007).

The increasing level of collaboration in scientific research worldwide has gone hand in hand with increasing levels of inter-organisational collaboration, international research collaboration and intra-EU collaboration (Adams et al., 2005; Tijssen and Van Leeuwen, 2007; Tijssen, 2008; Mattsson et al., 2008). Technological improvements in transportation and communication technologies are held responsible for these trends as they ease the process of research collaboration, decrease the costs and time of travel and facilitate distant communication. Furthermore, 'Big Science' has been widely supported by political strategies at multiple levels where (international) collaboration is often a requirement for funding.

In the event that travelling and communication at a distance would not require time and resources such political strategies would not be necessary; research partners would be matched based on a 'fit' between their research questions, irrespective of their geographical location. In the most extreme case we would observe a completely random spatial pattern of research collaboration that is solely guided by differences in the amount and focus of research inputs. In this study, such a system would be regarded a perfectly integrated system.

Yet, as with all human activities, physical co-presence remains important in carrying out the complex tasks associated with scientific research (Collins, 2001). Face-to-face interaction offers the possibility of having intense and complex forms of interaction in which not only language is involved but the entire behavioural complex. Contrary to modern communication media (e.g. e-mail, video conferencing) this enables the unique establishment of common reference frames through amongst others rapid feedback, pointing and referring to objects in real space, subtle communication, informal interaction and a shared local context (Olsen and Olsen, 2000). All these factors facilitate the creation of a common language, shared meaning within a research team and the passing on of knowledge that cannot easily be expressed in words or visualizations (Collins, 2001; Urry, 2002).

Such moments of co-presence between researchers do not necessarily have to be permanent, but can also be organised on a temporary base (Torre, 2008). Regular meetings at well-decided stages of a research project may be sufficient to coordinate tasks and allocate responsibilities effectively. Geographically dispersed research collaborations, however, impose search and coordination costs for bridging geographic distance and institutional differences (Hinds and Bailey, 2003; Adams et al., 2005; Cummings and Kiesler, 2007). Due to these costs, multi-institute collaborations tend to have less frequent and less effective coordination (Cummings and Kiesler, 2007). Spatially dispersed collaborations also more often experience conflict, free-riding, lack of monitoring and diverging interests (Hinds and Bailey, 2003).

The bridging of physical distance between collaborating researchers imposes two types of costs. In general, researchers have more information about the research interests of physically proximate partners. This is because researchers' embeddedness in social networks decays with physical distance (Breschi and Lissoni, 2009). It follows that the search costs for a research partner are expected to be a function of the geographical distance separating researchers. Second, coordination activities within collaborative projects tend to involve physical mobility of researchers, especially activities such as seminars, meetings, exchange of personnel, and sharing lab facilities. This imposes travel costs and time upon a collaborative project. Given that these costs tend to increase with distance, the incidence of collaborative research projects involving intensive face-to-face interaction tend to be inversely related with the physical distance between researchers' permanent locations (Adams et al., 2005).

Given the decreased costs and time of travelling, and advances in communication and information technology, one may assume that hampering effects of physical distance are diminishing—all else being equal. Indeed, for the top 110 universities in the United States a study by Adams et al. (2005) reports an increase in the mean distance over which collaboration takes place in the period 1981–1999. Moreover, the many initiatives of the European Commission, such as the Framework Programmes, to support transnational research networks and to integrate infrastructural networks one may assume that this also has contributed positively to shrinking distances. Summarizing, our first hypothesis investigated in this paper is

Hypothesis 1. Physical distance impedes research collaboration in Europe yet its effect is decreasing over time in importance.

Apart from physical distance acting as a barrier to collaborate, spatially dispersed research teams also need to bridge institutional differences. In the particular case of cross-border collaborations it becomes more difficult to allign incentives among researchers due to differences in for instance funding schemes, institutional frameworks and norms and values. In the following,