Putting the “I” Back in Team: The Rise of International Teams in Science

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In this policy brief I discuss the increasing prevalence of international teams in the production of scientific knowledge. I outline several potential factors that may explain these trends and discuss recent evidence from an original survey of coauthors on scientific papers regarding their collaboration behavior. Finally, as a notable example of increased international collaboration, I discuss the increase in scientific collaboration between Russia and the US after the end of the Cold War.

The Increase in Collaboration and Internationalization of Teams

Teams are becoming more prevalent in science. Both the share of papers produced by teams and the number of scientists working on scientific papers has increased in recent decades (Wuchty, Jones and Uzzi, 2007). Economic theory suggests that scientific research is becoming increasingly collaborative since the frontier of scientific knowledge has become more complex and specialized so that more researchers are needed to combine their expertise to make advances (Jones, 2009). Team members are also becoming more geographically dispersed: the share of papers resulting from international collaborations has increased, and within the US, scientists today are more likely to have coauthors located in a different city than before (Freeman, Ganguli and Murciano-Goroff, 2014).

These trends can be seen clearly in the graph below from the National Science Board's Science and Engineering Indicators 2012. It shows the share of both world papers and US papers from 1990-2010 that are coauthored, coauthored with domestic coauthors only, and coauthored with at least one international coauthor. Collaboration in general and international collaboration have been increasing steadily since 1990 both in the world and in the US. However, for the US, the share of domestic-only collaborations has plateaued, while it is increasing in the rest of the world. In a recent Nature article, Adams (2013) shows that this trend similarly holds for other Western countries (United Kingdom, Germany, France, the Netherlands, Switzerland), while for emerging economies (China, India, South Korea, Brazil, Poland), domestic collaborations are also increasing.
Why has Science Become More International?

There are many potential reasons for the recent increases in international collaboration. An important factor has likely been the spread of the scientific workforce and R&D activities throughout the world (Freeman, 2010). The growing number of science and engineering PhDs in developing countries, some of whom are international students and post-docs returning to their home countries has expanded the supply of potential collaborators around the world (Scellato, Franzoni, and Stephan, 2012). Another factor is funding that has shifted scientific production towards international teams, as increased government and industry R&D spending in developing countries and grant policies by the European Union and other countries have supported international cooperation.

The lower cost of travel and communication in recent decades has also reduced the cost of collaborating with people in different locations. For example, Agrawal and Goldfarb (2008) show how the expansion of Bitnet, the precursor to the Internet, led to increased collaboration between institutions within the US. Finally, the location of scientific equipment and materials, such as the CERN Large Hadron Collider, telescopes, or climatological data available only in certain parts of the world, have increased international collaboration, and in some fields, has made international collaboration a necessity.

Survey Evidence on Scientific Collaborations

In a recent paper, my coauthors and I present the results of an original survey we conducted of scientists regarding collaboration (Freeman, Ganguli and Murciano-Goroff, 2014). In August 2012 we conducted a web-based survey of the corresponding authors of scientific papers with at least one US coauthor published in 2004, 2007, and 2010 in the fields of Nanotechnology, Biotechnology, and Particle Physics.

We customized each survey to ask the corresponding author about the collaboration and individual team members. The survey questions asked about how the team formed, how it communicated and interacted during the collaboration, the contribution of each coauthor, types of research funding, and the advantages and disadvantages of working with the team. We received 3,925 responses, so that our response rate was approximately 20%.

The survey also asked the respondent which country each coauthor was “primarily based in during the research and writing” of the article. This gives us a more accurate measure of whether teams are international than can be typically gleaned from publication data, which are based on author affiliations at the time of publication. Defining international teams from author affiliations alone can produce errors if affiliations change between the time the research was undertaken and the time of publication, or because some people have affiliations from more than one country.

Our analysis of the survey data uses the respondents’ information to define US collocated, US non-collocated and international teams. One of our key results is
that face-to-face meetings continue to play an indispensable role in collaborations: most collaborators first met while working in the same institution. Teams also reported that while carrying out the research, they communicated often through face-to-face meetings, even with coauthors from distant locations.

Figure 2 below displays how the corresponding author responded about how they first met their team members. It shows that former colleagues play a very important role in the formation of international teams, followed by former students, conferences and institution visits, which equally contribute. The graph also shows the similarity between international teams and US non-collocated teams in how coauthors met. For other survey questions, our analysis also shows similarities between international teams and US non-collocated teams, suggesting that the salient issues are more about geography in general rather than necessarily about national borders.

Figure 2. How Coauthors First Met

Another key finding from our survey is that the main reason for most collaborations, whether domestic or international, is to combine the specialized knowledge and skills of coauthors. We also asked the corresponding authors their views of the advantages and challenges of their collaboration. The most often cited advantage for all types of collaborations was “Complementing our knowledge, expertise and capabilities” and “learning from each other”. For the challenges, US non-collocated and international teams tended to agree more that there was “Insufficient time for communication”, “Problems coordinating with team members’ schedules”, and “Insufficient time to use a critical instrument, facility or infrastructure”, but international teams did not report these problems more often than US non-collocated teams. Where international teams differed is that these teams were the most likely to agree that their “research reached a wider audience”.

International Collaboration After the End of the USSR

A small but significant part of the increase in international collaboration since the 1990s can be attributed to the end of the Cold War. In “Russian-American Scientific Collaboration” (Ganguli, 2012), I examine trends in international collaboration by Russian and US scientists since the end of the USSR. Given the nature of the Cold War and restrictions on travel and communication with the West, I show that there was a dramatic increase in the number of publications with at least one Russian and a US coauthor from 1985 to 2005.

In addition to the lifting of travel and communication restrictions, there are several factors that contributed to the surge in collaborations between American and Russian scientists after the end of the USSR. First, at the level of the Russian government, there was a switch to a more open and collaborative approach to science. Part of this effort included establishing international centers for research in Russia aimed at integrating Russia into the global science community. Another important factor facilitating collaborations with Western researchers were foreign grant programs. The large increase in the emigration
of Russian scientists in the 1990s to the West also contributed to international collaboration. After emigrating, many Russian scientists maintained close links to their colleagues in Russia, and coauthored papers with their former colleagues, which are counted as internationally coauthored publications.

While many of these factors have aided international cooperation after the end of the USSR, there have also been significant challenges that made cooperation difficult. Some of these challenges in the early 1990s included the political instability, organizational turnover making long-term funding agreements difficult to implement, difficulty transferring funds due to the underdeveloped banking system, high taxation and customs duties, lack of effective intellectual property rights, poor infrastructure, lack of a shared language (both linguistic and cultural), and external regulations (see further discussion in OECD, 1994). However, many of these challenges have now been overcome, leading to the continued increase in international collaboration between Russian and US scientists.

My analysis in Ganguli (2012) shows that the increase in Russian-American collaboration was more pronounced in some fields of science versus others, particularly in Physics. Figure 3 shows that the bulk of the articles published with Russian and American coauthors were Physics articles, with a sharp increase occurring immediately after 1991.

**Figure 3. Russia-United States Publications By Field, 1985-2005**

While some of the differences across the fields can be attributed to the number of scientists active in these fields, there are also other potential contributing factors. For example, it may be that there was greater emigration of scientists from certain fields abroad, and links between emigrants and those who remained in Russia persisted. Graham and Dezhina (2008: 24) suggest that over 50 percent of emigrants were physicists and mathematicians. Another reason may be that international collaboration was more important in some fields due to the knowledge or resources needed to conduct research during the economic crisis of the 1990s. As Wagner Brahmakulam, Peterson, Staheli, and Wong (2002) point out, physics research received significant amounts of US government funding for international collaboration, partly because expensive equipment that is needed and through collaboration, countries could share costs. Also, physicists from many countries often meet and work together at international research centers like CERN. Moreover, in some fields, the US and Russian governments shared priorities in funding international cooperation, like biomedical and health sciences, energy, physics, while there were gaps in some areas where Russia devoted resources and the US did not, like chemistry (Wagner et al. 2002: 24). Graham and
Dezhina (2008: 141) also discuss how Western colleagues benefited from working with Russians especially in fields like zoology, botany and the earth sciences, since the Russian colleagues provided access to data from unique regions not available previously.

**Support for International Teams?**

This policy brief has discussed some reasons for the increase in international scientific collaboration and related empirical evidence, including insights from collaboration after the end of the USSR. The growth in collaboration and the geographic dispersion of teams is likely to continue; the frontier of scientific knowledge will become more complex and specialized, so that an even greater numbers of researchers will be needed to combine their expertise, and they are likely to be spread across increasingly distant locations.

These trends raise many complex issues for policymakers. For some countries, international collaboration may be the only way to sustain the science sector as the frontier of knowledge becomes more complex and resource-intensive. For some, international collaborations may increase the emigration of home-grown talent to wealthier countries. To what extent international collaboration should be supported, and how, will be important policy questions going forward. Typically, funding for international projects has been the main policy lever, and the Russian experience suggests that grant programs did play a critical role in that case. As our survey evidence in Freeman, Ganguli and Murciano-Goroff (2014) suggests, face-to-face meetings are especially important in forming and sustaining international collaborations. Thus, funding mechanisms that include provisions for research stays and face-to-face meetings may be the most effective means for fostering international collaborations.

**References**


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