

Transnational Research Collaboration: Expatriate Indian Faculty in the United States Connecting with Peers in India

Meghna Sabharwal and Roli Varma

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Abstract In the last two decades, research collaborations inside the United States and with other countries have increased. Scholars who have studied the composition in scientific collaborations have noted demographic factors as important personal attributes. However, little scholarly work has examined how national origin affects international research collaboration in the United States. This article presents some findings from a National Science Foundation–funded study on the international research collaboration activities of fifty-one Indian immigrant faculty members from eighteen American universities. Collaboration identified in this study goes beyond coauthorship, which remains a popular measure of research collaboration in the literature. The results suggest that while international collaboration is growing, migrants do not necessarily collaborate only with those from their home country, as suggested in transnationalism literature. In fact, more than one-third of the respondents in this study collaborate only within the United States. Those who do collaborate with Indian researchers are more likely to build alliances with scholars who have been trained in the United States and have returned to India, giving credence to social network theory. Despite advances in technology, face-to-face interaction was the most preferred form of collaboration.

Keywords research collaboration · transnational collaboration · migration · immigrant faculty

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M. Sabharwal

School of Economic, Political, and Policy Sciences, University of Texas at Dallas, Richardson, TX 75080 USA

e-mail: meghna.sabharwal@utdallas.edu

R. Varma

School of Public Administration, University of New Mexico, Albuquerque, NM 87131 USA

e-mail: varma@unm.edu

Since World War II, research collaboration has been increasing in most science and engineering (S&E) fields (Gazni and Didegah 2011). This is mostly due to the complexity of research problems, growth in specialization across disciplines, the need to share expensive technical equipment and laboratory space, the development of new information technology, and affordable travel costs (Stefaniak 2001). Conducting S&E research alone has become a practice of the past. In fact, research collaboration has become a scientific value—scientists and engineers often view research collaboration positively and collaborate for its own sake (Duque et al. 2005). Funding agencies such as the National Science Foundation (NSF) promote research collaboration as a scientific good. Former NSF director Arden L. Bement has said that “scientific cooperation is not a luxury, but a necessity—and the foundation for the future” (quoted in Stolberg 2006: 1). It is therefore no surprise that scholarly literature on research collaboration has grown in the last two decades (Bozeman, Fay, and Slade 2013; Melin 2000). Research collaboration among scientists and engineers is increasingly global in nature (Carayannis and Laget 2004). Scientists and engineers who collaborate internationally enjoy a greater variety of intellectual expertise for solving complex problems (Bozeman and Corley 2004). Though studies on research collaboration in national and international settings have examined gender, little scholarly work has examined race/ethnicity and national origin in research collaboration.

Research programs in the United States have been attracting “the best and the brightest” from all over the world. The United States admits and provides financial support to international graduate students so they can attain degrees from US institutions. It allows foreign professionals to apply to faculty, postdoctoral, and research positions in the United States. The H1-B visa permits skilled foreigners to work in the US high-technology sector. Such policies have led to a dramatic increase in foreign-born scientists and engineers in the United States. In 2010, 27 percent of US scientists and engineers were foreign born; among these, 19 percent held a doctorate as their highest degree (National Science Board 2014). With its high presence of foreign-born scientists and engineers, the United States has been the center of international research collaboration. Asians make up the largest number of foreign-born scientists and engineers. In 2010, 56 percent of foreign-born scientists and engineers in the United States were from Asia, and 19 percent were from Europe. The leading country of origin among foreign-born scientists and engineers was India, which accounted for 19 percent, followed by China with 8 percent (National Science Board 2014). Most scholarly studies, however, have centered on research collaboration among scientists and engineers in the United States and Europe; few studies have examined research collaboration between scientists and engineers in the United States and Asia.

It is well recognized in migration studies that migrants maintain ongoing connections with their homelands. Since the late 1980s, such connections have become well developed partially due to faster, more economical modes of transportation and new developments in information technology. Now migrants move more quickly and maintain personal connections with family and friends. It is therefore no surprise that transnationalism has become a major focus of migration studies (Levitt and Jaworsky 2007; Waldinger and Fitzgerald 2004; Vertovec and Cohen 1999). Typically, the central concern in transnational studies has been limited to economics, namely, remittances sent by migrants. When scholars have turned their attention to noneconomic factors among migrants, they have focused primarily on how migrants

live their everyday lives across borders and the consequences of their activities for sending and receiving countries (Levitt and Waters 2002; Smith and Guarnizo 1998). Based on transnational studies, one can assume that foreign-born scientists and engineers are likely to collaborate in research with peers in their home country. Such research collaborations will connect expatriate scientists and engineers beyond family ties in their home country. However, no study has examined research collaboration between Asian scientists and engineers who have migrated to the United States and their peers back home.

We studied individual-level research collaborations with researchers in India among Indian S&E faculty in the United States. We did not separate types of collaborations, such as with researchers in university, industry, and/or government organizations in India. In the absence of any study on international research collaboration by expatriate Indian scientists and engineers, it is important to know if Indian faculty members in the United States collaborate with researchers in India and whether they feel such research collaboration is rewarding. We relied on Indian faculty to use their own definition or understanding of research collaboration, though we recognize that such self-reporting lacks operational exactness. We defined transnational research collaboration as a process whereby scientists and engineers who have migrated from one country to another collaborate across borders to produce scientific knowledge and applications that allow them to participate in professional relations in the country of birth and the country of residence.

1 Scholarly View on Research Collaboration

Initially, scholars tried to show the presence of research collaboration by using coauthorship as an indicator (Katz and Martin 1997). Coauthorship has been a popular measure primarily because measurable data are easily available (Mattsson et al. 2008; Wagner 2005). Scholars employ bibliometrics and/or scientometrics to analyze trends in coauthorship patterns and differences in coauthorship among countries/regions and sectors within the same country.

Recently, coauthorship as the main indication of research collaboration has been criticized since it represents only one type of collaborative relationship. Coauthorship neglects other forms of collaboration that have no publication outputs, such as patents and innovations; often, mentors are collaborators but not necessarily coauthors, and collaboration can collapse for all sorts of reasons without any publication output (Bozeman and Corley 2004). In some situations, coauthors may not be collaborators. For instance, a study of the biomedical literature found that a large number of authors listed on articles were not writers; instead, they were senior researchers with funding and laboratories that contributed to the publication (Cronin 2001). Due to such concerns, research collaboration has been redefined. Mary Frank Fox and Sushanta Mohapatra (2007) believe that collaboration tends to involve cooperation between scientists who have faculty or professional status—cooperation of scientists with students, technicians, and others as teamwork. Barry Bozeman, Daniel Fay, and Catherine P. Slade (2013: 3) define research collaboration as “social processes whereby human beings pool their human capital for the objective of producing knowledge.”

The bulk of scholarly literature on collaboration centers on the need for research collaboration nationally and internationally, conditions under which research collaborations are productive, and characteristics of collaborators. The basic argument for research collaboration is that it tends to increase productivity (Wuchty, Jones, and Uzzi 2007; Dietz and Bozeman 2005; Link and Siegel 2005; Franklin, Wright, and Lockett 2001). Studies show that research collaboration results in job satisfaction (Lee and Bozeman 2005). Pragmatic reasons to collaborate include gaining tenure, accessing special equipment/materials and skills, achieving visibility and recognition, efficient use of time and labor, acquiring experience and training, and enjoying the company of collaborators (Melin 2000; Beaver 2001). With international research collaboration, a competitive edge in global innovation is maintained (Peters 2006). Further, international research collaboration contributes to global agendas and global citizenship (Engels and Ruschenburg 2008). Also, scientists in developing nations seek international research collaboration as a way to build their S&E capacity (Duque et al. 2005).

Caroline S. Wagner and Loet Leydesdorff (2005b) argue that international collaborations are not merely a product of historical ties, geographic proximity, or core-periphery relationship, as suggested in mainstream collaboration literature (Hwang 2005, 2008; Schott 1998; Gibbons et al. 1994; Traweek 1992; Shils 1988; Beaver and Rosen 1978; Ben-David 1971). Wagner and Leydesdorff argue that the historical relationships and colonial ties are fading. Additionally, the Internet has helped span global boundaries, thus expanding the networks of collaborating nations. The center-periphery theory predominantly used in international collaboration studies suggests that smaller nations (at the periphery) emulate core nations that are scientifically advanced (United States and Western Europe) to advance their own scientific knowledge and capacities. However, new data suggest several centers, with various partners. According to this view, developing nations at the periphery are no longer in an apprentice-master relationship. In fact, scientists collaborate internationally to gain visibility, complementary skills, and resources. Thus, they choose to collaborate in a more participatory form of partnership that is self-organizing, driven by complementary ideas, and not driven by national systems (Wagner and Leydesdorff 2005b).

Several studies have examined the personal attributes of collaborators in both national and international settings (Bozeman and Gaughan 2011; Haeussler and Colyvas 2011; van Rijnsoever and Hessels 2011; Ponomariov and Boardman, 2010; Bercovitz and Feldman 2008; Arthur, Patton, and Giancarlo 2007; Bozeman and Corley 2004). These studies show how personal attributes are related to disciplinary, interdisciplinary, and sector collaborations. For instance, men are more likely to engage in disciplinary collaboration, and women in interdisciplinary collaboration. Since research collaboration includes a labor mix, studies focus on human capital, namely training, experience, knowledge, network ties, and resources that collaborators bring to research (Dietz and Bozeman 2005; Schartinger, Schibany, and Gassler 2001). Typically, studies view network ties to a variety of researchers as an important factor in research collaborations (Liao 2011).

In general, research collaboration is formed as a voluntary process rather than developed by administration. A classification of research collaborators has been proposed based on motives and strategies (Bozeman and Gaughan 2011; Lee and Bozeman 2005; Bozeman and Corley 2004): *taskmasters*, who tend to choose collaborators

based on work ethic and work schedule; *nationalists*, who are pulled to collaborators due to the same nationality and language; *mentors*, who tend to help junior colleagues and graduate students; *followers*, who select collaborators because they have been asked to do so by administration; *buddies*, who pick collaborators based on past interactions; and *tacticians*, who decide collaborators based on complementary skills. Irrespective to types, consensus is seen as the most important characteristic of collaboration (Chompalov, Genuth, and Shrum 2002).

Since research collaboration is valued highly, many studies demonstrate how to enhance the national and international environment (Hagedoorn, Link, and Vonortas 2000). Often such studies are prescriptive, presenting how to induce, facilitate, and manage research collaboration. For instance, having previous collaboration experience is considered important for success in future research collaboration (Bruneel, D'Este, and Salter 2010). Similarly, external relations are emphasized to develop successful research collaboration (Martinelli, Meyer, and von Tunzelmann 2008). Most important, a supportive infrastructure is considered important to develop successful research collaboration between universities and industry (Nilsson, Rickne, and Bengtsson 2010).

Without proper management, research collaboration can be undesirable and unproductive. For instance, if senior scientists get more credit than junior scientists for their contributions in research collaboration, the latter may feel they are being used. Similarly, if researchers from developed countries get more credit than researchers from developing countries, the latter may feel they are taken for granted. Also, the competitive nature of science can interfere with research collaboration—some researchers may not be willing to give up primary authorship. Bozeman and Slade (2012) have described the bad side of research collaboration, namely the dilemmas of authorship, student exploitation, and ethical issues.

Another study focused on the disciplinary identities of scientists collaborating with others belonging to different disciplines (Cummings and Kiesler 2005), based on the assumption that scientists typically belong to one well-established discipline and thus have a pure disciplinary identity. Scientists generate value and validate knowledge in their own specific ways, and in that process they distinguish themselves from other disciplines. Classic laboratory studies describe how science is constructed not as a procedure or as a set of principles but as culturally specific practices (Latour 1987), and different scientific fields such as high-energy physics and molecular biology exhibit distinct epistemic cultures (Knorr Cetina 1999). Sharon Traweek (1992) in her seminal work on high-energy physics in the United States and Japan showed how cultural differences between these two communities had a negative impact on their collaboration. Interestingly, the physicists in both countries believed their membership in a high-energy physics research community eliminated cultural practices. When scientists collaborate with others from different disciplines, such interdisciplinary or transdisciplinary research collaboration introduces new complexities and subcultures (Parker and Hackett 2012; Hessels and van Lente 2008). Scientists' identities are combined to form hybrid identities. They are both insiders of their own discipline and outsiders of their collaborators' disciplines. Studies on research collaboration focus on academic disciplinary traditions and challenges to it by interdisciplinary collaboration within the same university, between university and industry, and across borders.

2 Methodology: A Qualitative Approach

The article is based on fifty-one in-depth interviews conducted with Indian faculty members in S&E in 2013. These subjects came from 18 universities, which were selected from a pool of 108 institutions identified by the National Science Board (2014) as doctorate-granting institutions with very high research activity. It then balanced for geographical location (north, south, east, and west) with the highest Indian population. The faculty was selected on the basis of working in the US academe for a minimum of five years, with the pool balanced for various fields in S&E. Most interviews were conducted face-to-face, though some were conducted on the telephone. Typically, each interview lasted about an hour. These interviews were audio recorded, transcribed, and entered into NVivo software (version 10.0, QSR International) for data analysis. Of the forty (excluding demographic) questions asked in the interview, the following five specifically explored research collaboration and thus formed the basis for this article:

1. Do you collaborate with faculty/researchers outside the United States?
2. If yes, do you collaborate with faculty/researchers at institutions in India? Have you ever been on a visiting position in India?
3. Can you discuss your experiences (both challenges and triumphs) collaborating with faculty/researchers at Indian institutions?
4. In your opinion, what can be done to further aid collaborations across Indian and American researchers?
5. Typically in a year, how many professional trips have you made inside and outside the United States?

For some of these five questions, respondents gave more than one response; however, their responses were coded only once in a single primary category. Findings are reported with interview excerpts to highlight the complexity of concepts and by frequency to show their strength.

Most respondents (78 percent) were employed in public universities, and the rest (22 percent) in private universities. A large majority of them (78.5 percent) worked in an engineering department: aerospace, civil, computer, electrical, environmental, or mechanical; the remaining (21.5 percent) worked in biology, chemistry, or physics departments. Occupational ranking of respondents showed that close to half held full professorships (47 percent), followed by assistant professors (27.5 percent), and associate professors (25.5 percent). The respondents had lived in the United States for a mean of twenty-three years and had been in academia for a mean of fifteen and half years. About two-thirds were relatively young: 33 percent were in the thirty to thirty-nine year age group, and 31 percent in the forty to forty-nine year age group. About one-fourth (22 percent) were in the fifty to fifty-nine year age group, and the rest (14 percent), in the sixty years and above age group. An overwhelming of them reported being married (86 percent) with children (73 percent). Of those with children, the mean number was close to two. All but three were male respondents; Indian female faculty were underrepresented among the departments at universities selected for the study. This study therefore does not take gender into consideration.

3 International Research Collaborations

Respondents were first asked whether they collaborate with researchers outside the United States. Their responses were coded into three categories: (a) *yes*, when respondents said that they are collaborating with researchers who reside outside the United States; (b) *no*, when respondents said that they have not collaborated with researchers who reside outside the United States; and (c) *used to*, when respondents said that they have collaborated in the past but currently are not collaborating with researchers who reside outside the United States.

Most respondents (65 percent) have collaborated internationally with researchers, with 61 percent collaborating at the time of interviews. The respondents mentioned a range of countries or regions where they have collaborative projects, including Africa, Australia, Belgium, Brazil, Canada, China, England, Europe, France, Germany, Hong Kong, India, Italy, Japan, Middle East, Norway, Philippines, Russia, South Korea, Spain, Thailand, Turkey, Scotland, Singapore, and Switzerland. As one respondent said, "I do not know how to count. Right now, I have collaborations with people in Korea and China. I have another one in Australia. I have collaborated with people in Europe. . . . After being twenty plus years in academia, you cover the map." Similarly, another said, "Absolutely. Just about maybe with half a dozen countries: Germany, Italy, France, Spain, China, Hong Kong, and Japan. France, Germany, and Italy are the three main ones."

The respondents described their research collaborative activities in numerous ways, such as coauthoring papers, jointly seeking research grants, traveling internationally for site visits and exchange of ideas, physically spending significant amounts of time at the international institutions, working on technology development and applications, and exchanging human and physical resources. As one respondent said, "We had a very nice paper published with them using some of their chip designing techniques, and we provided our biological application, microfabrications, and put it out to the industry." Another conveyed, "I work with a research group in Europe. . . . Just recently we wrote a grant proposal." This respondent narrated, "I have a joint industry project. There are nine members and only four are from the United States; the rest are outsiders. . . . We visit them and they visit us." This respondent stated, "We collaborate with scientists in Europe, and they collaborate with people in Africa. . . . Sometimes we indirectly collaborate with African researchers through our European collaborators." This one elaborated, "There is an investigator in the UK, London. She has very specialized expertise that we do not have, and we have a tool that she does not have. So she uses our tools and in return we get her expertise." One gave an example: "One of our colleagues moved back to China. . . . His student is doing her Ph.D. in China, but she is doing her testing and analysis here, with our research group."

Over one-third of respondents (35 percent) said they do not collaborate internationally, though some expressed a desire to do so in the near future. Seventy-two percent of these respondents were collaborating inside the United States and did not see a need to go outside the United States. As one respondent said, "No, but here I collaborate with my colleagues. I wrote a proposal with Penn State. So I collaborate with other people, but not outside the USA." The geographical distance was a major concern for many. One explained, "Collaboration is much harder as distance grows. . . . It is hard to sustain long-distance collaborations." For a few, preference

was to work by themselves. As one declared, "I like to work by myself and with students." For a handful of respondents, their work was classified or dealt with sensitive areas, which prevented them from international collaborations. This respondent explained, "My work is restricted. If we need to hire some students, we need to figure out their nationality and let funding people know who is on the project. . . . So, the end result is we do not try to collaborate with outsiders."

It should be noted that even when the respondents did not collaborate internationally, they traveled outside the United States to attend conferences, workshops, and meetings. Yet there was recognition that, in a typical year, they take more professional trips inside than outside the United States. This was partially because the bigger conferences take place in the United States and because it is more cost-effective to take national than international trips.

The respondents who have international collaborations were further asked whether they collaborate with researchers in India. Their responses were coded into two categories: (a) *yes*, when respondents said that they have collaborated with researchers in India, and (b) *no*, when respondents said that they have not collaborated with researchers in India. The respondents who did not have collaborations with researchers in India were asked to elaborate their reasons for it.

Of those respondents (61 percent) who were collaborating internationally at the time of the interview, most (65 percent) reported having collaborations with researchers in India. Of these, 45 percent said their collaborations with the researchers in India were formal, and 55 percent believed it was informal. Interestingly, most of such collaborations were established with people who had moved back to India after study and work in the United States. As one respondent said, "I have good friends who are now faculty in India. We have had a productive collaborative relationship because we are friends from college days. We understand each other's strengths . . . and [have the] same professionalism." Another explained, "My collaborations with India have been primarily at [X] because there are a lot of US-trained faculty who have gone back there." Three respondents had actually spent time as visiting scholars in India.

Collaboration was seen as "formal" when it was tied with joint publications, technology development, and a faculty/student exchange program. As one respondent declared, "We are collaborating with people there [India] on a regular basis. We work on proposals, we exchange samples, and we have ongoing discussions." Another said, "All thanks to the Indian power here [United States], we are able to exchange scholars every year to give lectures and work on joint projects." One explained, "We have some collaborations with universities there [India]. These are research projects with very specific purpose, trying to change the water situation in India, which is grim." This one elaborated, "Now we have a new type of collaboration with people in India which we call user facilities. These people are working on similar research but do not have their own reactors. So, they have contracts with us to use our facilities."

Collaboration was seen as "informal" when it was tied with an exchange of ideas, meetings, and talks. As one respondent said, "I do not have an active collaboration in terms of coauthoring papers, but I am engaged with people in India to get students here." Another explained, "Not formally. I have good friends who are faculty in India. We visit each other." Similarly, this respondent stated, "I have been talking with some

people in India. . . . I am thinking to invite them to spend some time in the lab here so it develops into a concrete collaboration.”

The remaining 35 percent of respondents who were collaborating internationally at the time of interview did not collaborate with researchers in India. Interestingly, a large majority (82 percent) expressed their desire to build collaborative relations with researchers in India. The main reasons for absence of collaboration were lack of funding for projects in India, nonexistence of high-quality research in India, invisible barriers between scholars in India and United States, and the nature of the US researchers' work. As one respondent said, “I am loyal to my country, but at the end of the day I have to run my lab, pay my students, do my research, and all that. So I go for collaborations where there is more promise to get the funding. Unfortunately, India is not there yet.” This respondent believed, “It basically comes down to opportunity to interact with the faculty. Most of the conferences that I attend, the representation from India has been really low. So there has not been an opportunity to exchange personal ideas or anything like that.” Another echoed, “People [in India] work on classic problems. Many of them are out of touch with the broader scientific community. So, it makes collaborating with them very difficult.” This respondent showed his frustration: “The general feeling I got from them [Indians] was why the heck you are here [India], we can do what you do. So after that I did not even bother.” This one was unable to collaborate because “a lot of the work we do requires expensive equipment, which was not around in India until recently.”

Typically, research collaborations were formed as an ad hoc process between Indian faculty residing in the United States and the researchers who returned to India after study and work in the United States. Both sides knew each other either as students or as faculty. As one respondent said, “I have collaborated with people whom I have known for some time. They are people who have gone back. So in terms of skill and ability, they are as good as any people here.” Some collaborations began when Indian faculty met the researchers either in conferences or during their visits to Indian institutions. Even such collaborations were with the researchers who had returned to India. As one respondent said, “I met [X] group when I was visiting them. . . . I did not have any problems because they were folks trained out here so we had similar professional ethics.” A few collaborations, however, started when initiatives were taken by the administrators. Such collaborations tend to center on establishing a student exchange program. Cultural exchanges between the United States and India (and other countries) are seen as valuable by many American administrators. Typically, they are designed to provide qualified American students with study-abroad experiences. As one respondent narrated, his administrator wanted “a cultural exchange. She wanted Americans to learn from Indians and vice versa.”

4 Challenges and Opportunities in Research Collaborations

Respondents who have collaborated with researchers in India were asked to describe their experiences in such collaborations. Their responses were coded into two categories: (a) *challenges*, when respondents talked about the difficulties and hurdles they faced while collaborating with the researchers in India, and (b) *opportunities*, when the respondents talked about the benefits they got while collaborating with the

researchers in India. Of those respondents who have current collaborations with researchers in India (65 percent of those who were collaborating internationally at the time of the interview), most (81 percent) narrated various challenges they face; only a minority (19 percent) discussed benefits they receive in such collaborations. Nonetheless, there was a general agreement among all respondents that collaborations with India were sought because they were born in India, they have family and friends in India, and they would like to contribute to their birth country. As one respondent said, "You asked me earlier about moving back to India. I think the best way I contribute is by collaborating on a project in India." Another said, "My intent is not to be too critical. My intent is to identify what is distinctive here [United States] compared to there [India] rather than being overly negative about that."

The respondents described challenges they face while collaborating in India in multiple ways. For many (41 percent), funding (money or financing) for collaboration was the major hindrance. They believed that it was no longer possible to carry out research successfully without financial support. They described how research has become an expensive undertaking in the United States, where the researchers have to raise money to support laboratories, equipment, students, staff, and travel. This is complicated by the shrinking budget for research in general and for international research with India in particular. As one respondent declared, "The funding is a challenge. The US agencies rarely fund projects with India." Another echoed, "NSF programs that we looked at are not really attractive in the sense they will not fund researchers overseas." One regretted, "Since there are no funds for my India project, I am automatically pulled by the projects which are funded." Similarly, this one stated, "The only challenge is the money, because research in the end really comes down to money. . . . We can always work out other things."

Funding-related issues in India were reflected in research infrastructure, such as scientific equipment, information technology, accumulated scientific knowledge, and organizational structure to support research activities. Some respondents felt that in their fields India had rather poor equipment; a few went to the extent to say that in their fields India did not have any equipment. As one respondent said, "I think the resource capability, the infrastructure is missing in India. It would be valuable to get that to a level where they are competitive at what we do here."

Some respondents (29 percent) found that Indian institutions of higher education and research institutions were either political or bureaucratic. They viewed relationships between researchers and administrators in India as hierarchical, which creates dependence and domination. As a result, researchers end up performing tasks because they are obligated to do so. Administration supports those whom they favor. As one respondent narrated, "India is very highly hierarchical and very political. Very hierarchical in the sense that you have to know all the players and their different roles. You cannot really afford to offend anybody who is, has more a position with more responsibility than you." Another said, "They are always weighing and balancing, and it is very hard to turn them down with anything." Indian institutions were seen by respondents as, if not political, then rather bureaucratic, with complicated rules and procedures that cause unnecessary delay. They believed that Indian politics and bureaucracy make it difficult to have independent collaborative research in a timely fashion.

Geographical distance, time difference, and dissimilar working hours between the United States and India were issues for some respondents (18 percent). Because the United States has a ten- to twelve-hour time difference with India, working hours in both countries do not coincide, which leads to communication challenges. Also, the distance between India and the United States limits face-to-face discussions, joint experiments, and sharing of results. As one respondent said, “The challenges are not physically being in the same place. I get a lot more done when I discuss with them in front of a black board. I do some work, send it to them, they think about it, then they give their feedback. It works. But it is not like immediate give and take that can happen if you are together in the same place.”

Finally, for some respondents (12 percent), challenges were in professional practice, which was seen as the differences of values and perspectives between the two countries. Ranking of researchers, prestige of titles/institutions, and fame associated with names pull Indian researchers to collaborate with some and not with others. In addition, Indian researchers are seen as not working at same pace as researchers in the United States, which delays work. As one respondent noticed, “Professionals in India do not like to work with assistant professors; rather, they go after big names.” Another said, “The standards of engagement are not held to the highest level [in India]. . . . People commit to things but do not follow through. . . . You never get a straight answer. . . . The end result is that research is delayed.”

Though most respondents described various challenges they face while collaborating with the researchers in India, they look forward to such collaborations. A small group of respondents (19 percent), however, discussed only triumphs and satisfaction while collaborating with the researchers in India. They believe that good researchers and students who are very helpful are available at Indian institutions in international collaboration. As one respondent said, “India has been a source of good students to me. That has been the main benefit to me. There could be more, but there is only so much time one has.” Another said, “It is such a pleasure to work with Indian colleagues and out of mutual respect.”

5 Enhancing Collaboration between the United States and India

All fifty-one respondents were asked what can be done to further aid research collaborations between Indian and American researchers. Their responses were coded into five categories: (a) *funding opportunities* included additional funding options and resources available for US-India research collaboration on both sides; (b) *university support* comprised promotion and facilitation of research collaboration at all levels, creation of student and faculty exchange programs between the two countries, and establishment of more visiting research positions; (c) *Indian research climate* involved improvement in India’s infrastructure, better promotion of research by colleagues in India in international outlets, and changes in mindset regarding collaboration with US researchers; (d) *practical considerations* consisted of efficient processing of visas for international travel, easing security clearances, and creating venues for researchers from both countries to interact with each other; and (e) *other*, entailed no suggestion or no response.

Respondents made several recommendations on how to improve research collaborations between Indian and American researchers. Over one-third of respondents (35 percent) pointed out that supplementary funding is a must for US-India research collaboration. They believed that, theoretically, research collaborations between the United States and India are viewed as important; however, it is left to individuals' initiatives. Instead, government and universities should provide funding to support international research collaborations. There should be a dedicated budget for supporting researchers to undertake such collaborations. As one respondent said, "In terms of forging [collaborations], funding from both sides is required." Another stated, "At the end of the day, it comes down to money. . . . So to foster collaborations is to have funds available to justify collaborations." One stated, "We wanted to do something, but there was no funding to help facilitate that." This respondent gave an example: "When I go to a conference, I see maybe about 1–2 percent people actually traveling from India. So, the number of collisions that need to happen for collaborations to begin is not happening. . . . Indian universities could give money for people to travel to international conferences."

Additional funds were viewed as an important element to stimulate research collaborations between the United States and India; however, they need to be accompanied by flexibility in their use. Respondents discussed how granting organizations in both countries should become more accommodating in the use of funds outside of the country. As one respondent said, "NSF has some programs, but they do not fund researchers outside the USA." Another said, "The Indian funding agencies could have joint proposals where they are primarily funding Indian scientists, but they allow some funds for USA-based faculty to travel. Not a lot of money, but some stipend money." One respondent elaborated, "A French consulate came here, met with some faculty. . . . Literally they said, Tell us what we can do so that you will collaborate with people from France. Seed funds, travel funds, et cetera. . . . We need to incorporate some outside-the-box approach."

One-fourth of respondents (26 percent) discussed the role of universities and research organizations to enhance research collaborations between the United States and India. These institutions have large numbers of researchers and can improve the flow of ideas and people across borders. They can create an environment that supports and nurtures international collaboration in general and between the United States and India in particular. They have researchers working in different disciplines and thus can promote cross-disciplinary international collaboration. As one respondent said, "The university's top administration should put a program in place to facilitate international collaboration." Another noted, "They should establish visiting faculty positions for international scholars." This respondent stated, "The main thing that can be done to further aid collaborations across Indian and US scientists is to create a better exchange program for students and faculty." Another believed that "there should be a way to support visiting faculty from here to there and from there to here. This would be tremendously attractive." Similarly, this respondent stated, "There could be some kind of a program by which graduate students from here could go to an Indian institution for a year or so and graduate students from there could come here for a year or so." In other words, universities and research organizations should expand their roles to build international collaboration rather than just being a facilitator of it.

Some respondents (18 percent) noted the differences in research environments between the two countries. They believed India ought to take a longer view that investments in research in science and technology lay the foundation for its economic growth. Accordingly, they suggested an improvement in Indian infrastructure to alleviate collaboration constraints. As one respondent said, "India is just not at a stage where they can support collaborations. They just do not have the infrastructure to do it. Even when they set something up, there is a lot of graft. . . . What they need is have an honest, accountable, clean, transparent system." Another noted, "They are making strides, but simply they are not there yet in terms of labs and equipment."

Given that the improvement in infrastructure such as updating equipment and instruments, providing trained human resources, and keeping data banks is under government and administration control, some respondents suggested specific courses of action for researchers in India. The general feeling was that Indian researchers residing in the United States are visible within the international scientific community, which is not the case with those residing in India. As one respondent said, "India has many good institutes. But they are doing a poor job of promoting what they are doing. So they need to advertise their research." Similar sentiment was echoed by this respondent: "The way to establish collaboration is for Indian faculty to start attending international conferences." A few respondents emphasized that their peers in India need to change their own outlook on research, which will lead to future collaboration. As one said, "In India, the mindset needs to change to one where the primary goal is to do research that makes a name for them. Once they do that, then there will be more opportunity to collaborate." Another declared, "Indian researchers need to change their attitude from respect for ranks to respect for research." This respondent suggested that India should "encourage researchers [in India] to come out of theoretical mode and work in the applied field." Similarly, another faculty member echoed, "They should be motivated to go out and work in the fields." The general feeling was that "a bunch of fundamental chemists, physicists and mathematicians are hiding in engineering departments."

Finally, a few respondents (14 percent) touched upon practical issues: difficulties in obtaining visas for international travel, problems in security clearance, and limited opportunities to interact with peers in India. There was a general recognition that we are living in a global world where international collaborative research is needed, if not imperative. However, the goal of international research collaboration cannot be achieved without the ability to travel outside one's home country for conferences, workshops, and scientific events. The process of attaining a visa tends to act as a deterrent to wanting collaboration with peers in India. As one respondent said, "First, there is the academic side and then there is logistical side. On the logistical side, getting a US visa is hard. So, something should be done about that." Similar difficulties exist on the Indian side. For instance, Indians holding a US passport need a visa to go to India, which needs to be planned well in advance since, as this respondent noted, "you will not get your passport back on time." Likewise, some security concerns end up having consequences to international research collaborations. As this respondent noted, "There should be trust for collaboration to visit the facilities. However, you cannot enter an [institute's] biotech building without clearance. Security issues need to be sorted out before one can think of collaborating with international scholars." In addition, there should be a venue where international researchers could interact, share

their ideas, voice their concerns, and narrate their success stories. One respondent called such venues “listening sessions,” while another called them “direct engagement sessions.”

6 Discussion

Research collaboration in universities is highly valued in scholarly literature. Most studies measure research collaboration through coauthorship (Mattsson et al. 2008; Corley and Sabharwal 2007; Wagner and Leydesdorff 2005a; Meyer and Bhattacharya 2004). The results of the present study, however, show that collaboration is not limited to coauthorship. Apart from producing joint papers, collaboration between researchers in this study resulted in joint grant proposals and funded projects, traveling for site visits, visiting faculty positions, exchange of students and resources, and developing applications and technology. Furthermore, collaboration ranged from being informal—having discussions with colleagues or delivering a talk—to formal, that is, active engagement in research activities. Various forms of collaborations result in outcomes other than coauthored papers and foster scientific ties among researchers, both nationally and internationally. This study shows that coauthorship is a partial indicator of national and international research collaborations. This study further shows that disciplinary identities and interdisciplinary research do not hinder national and international collaborative efforts as specified in the literature (Parker and Hackett 2012; Hessels and van Lente 2008). The respondents in this study were mostly concerned with pragmatic issues, such as inadequate support for international research collaboration in both countries, the lack of a vibrant research culture in India, and poor research outputs in India.

International collaboration, while documented as an increasingly important outcome of globalization (Wagner and Leydesdorff 2005b; Meyer and Bhattacharya 2004; Glänzel, Schubert, and Czerwon 1999; Gómez, Fernández, and Sebastián 1999), works best when the collaborating units have common research interests, complementary skills, adequate financial and research resources, and a conducive research environment. Several respondents in the study indicated that the research they carry out in the United States is either quite different from that of their Indian counterparts (applied versus basic research) or is resource intensive, which leads them to collaborate increasingly within national borders or with other developed nations. There is some evidence that experimental researchers tend to collaborate more than theoreticians (Smith and Katz 2000). A large majority of respondents in this study belonged to engineering fields and were engaged in applied research; they perceived their peers in India to engage in abstract and theory-oriented research. This was one of the reasons that researchers in this study hesitated to collaborate with researchers in India. In addition, the research environment in India is mired with bureaucratic and administrative inflexibilities, which hinder collaborative efforts.

Scientific research collaboration between nations is often thought of as a formal strategy involving national systems with organized and systematic networks (Wagner and Leydesdorff 2005b; Katz and Hicks 1997; Ziman 1994; Price 1963). However, this study shows that transnational collaborations are self-organized structures promoted by interaction among individuals rather than among individual nations. With

global systems emerging and scientific capacities growing around the world, individuals collaborate because the coauthor/collaborator has special competence, data, equipment, or expertise in a certain methodology (Melin 2000). As such, this study shows that Indians in the United States are more likely to collaborate with scientists in European Union countries and East Asia than with researchers in India. National identity, while an important consideration in cross-border collaboration (Engels and Ruschenburg 2008; Georghiou 1998), is not the only factor that drives collaboration. While researchers of Indian origin in the United States collaborate with those in India, motivations for these collaborations are often limited to social reasons (past friends, colleagues, past collaborations, student-supervisor relationships) rather than goal-oriented reasons, such as gaining access to special equipment, materials, and skills/expertise. The latter often results in greater gains for both parties: increased scientific productivity and outputs (Melin 2000). While national identity might help initiate and maintain existing collaborations, it does not seem to spur goal-oriented collaborations.

Collaborations usually happen when all parties stand to gain from one another (Hwang 2008; Melin 2000). Most respondents in this study recognized the barriers (bureaucracy, red tape, differing research mindsets, poor research quality, etc.) they confront when collaborating with scientists in India and thus had more to offer than gain from such a collaboration. While national identity and love for their home country steered some to continue collaborations with researchers in India, the costs outweighed the benefits. Of those who collaborated with researchers in India, less than one-fifth noted some benefits—usually good-quality students and mutual trust and respect among collaborating units. While this study did not examine the impact of collaboration (only whether collaboration is taking place), the findings support the idea that researchers in the United States collaborate with Indian faculty to gain access to resources (students), but none mentioned gaining visibility and reputation. Successful collaborations thus are a result of individuals from each nation combining their research expertise and resources. These findings go beyond transnationalism theory, which suggests that researchers of Indian origin in the United States will increasingly collaborate with researchers in India. In fact, two-thirds of respondents in this study had collaborations beyond their home country and increasingly with research teams around the world.

Transnationalism theory also purports that “immigrants forge and sustain multi-stranded social relations that link together their societies of origin and settlement” by crossing “geographic, cultural, and political borders” (Lazăr 2011: 70). There seems to be a lack of consensus within the transnational migration literature on the issue of geographic spaces and its impact on collaboration. On this topic, scholarly literature diverges. There is an implicit assumption that, despite the geographic spaces migrants operate in, collaborations flourish. Yet some have indicated no impact of time and space on research collaboration (Bozeman and Gaughan 2011), and a few have suggested a negative impact of distance on international research collaborations (Freshwater, Sherwood, and Drury 2006; Adams et al. 2005; Melin 2000). Several respondents in this study indicated that long-distance collaborations were challenging, if not difficult. While one might argue that technological advances have resolved challenges that researchers face in cross-national collaborations, most respondents in this study stressed the need to meet face-to-face to initiate collaborations. Usually conferences are the best venues for initiation of such collaborations (Thorn and Holm-

Nielsen 2008); however, many respondents in this study noted that participation from Indian scientists and engineers at international meetings was minimal. Lower participation could be a direct result of funds available to Indian researchers for travel to international conferences.

Finally, this study shows that those who stayed in the United States were most likely to collaborate with researchers who have returned to India from the United States. This finding gives credence to social network theory (Thorn and Holm-Nielsen 2008). When scientists move across continents, the social ties they build over time facilitate knowledge spillovers, diffusion, and transfer (Agrawal, Cockburn, and McHale 2006). Returnees build networks or ties with peers and faculty members while in the United States; they carry these networks with them and upon return continue working on projects with linkages they created prior to return. Furthermore, researchers who have returned to India after being trained in the United States have similar professional ethics and work styles, which make it easier to collaborate. Personal chemistry and trust have been documented as important factors in successful international collaborations (Bozeman, Fay, and Slade, 2013). If two people are to successfully collaborate, they have to share similar working styles and get along well.

7 Conclusion

This study contributes to the growing literature on international scientific collaborations. It expands on the literature of transnationalism, which suggests that migrants forge ties with individuals of the same national origin. While this is true to some extent, this study shows that science is truly global and that Indian migrants have collaborations with researchers from around the world. Migrants are thus attracted to the content of work and expertise more than to just a sense of national identity. They do not limit their collaborations with those of the same country of origin; however, Indian migrants are more likely to collaborate with returnees who have been trained in the United States and share a similar professional ethos. This study also indicates that, despite all the technological advances, face-to-face meetings remain an integral part of collaborative efforts. To aid cross-border collaborations, India and the United States should funnel more money into funding joint projects. While funding remains important, it is also essential that Indian counterparts create a conducive environment wherein joint grants can be applied for in a timely fashion without excessive administrative burdens. Furthermore, collaboration continues to be defined by the most quantifiable output: coauthorship. Future studies should examine different dimensions of collaborations and their impact on global science.

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Meghna Sabharwal is associate professor of public affairs at the University of Texas at Dallas. Her research interests focus on public human resources management as it relates to job satisfaction and productivity, workplace diversity, and high-skilled immigration. Her most recent work has been published in *Perspectives on Global Development and Technology*, *Journal of Public Administration Research and Theory*, *Public Personnel Management*, *Public Administration Quarterly*, *Public Management Review*, *Review of Public Personnel Administration*, *Administration and Society*, among others. She has also coauthored *Public Personnel Administration* (5th ed., 2013) and coedited *Public Administration in South Asia: India, Bangladesh, and Pakistan* (2013).

Roli Varma is Carl Hatch Endowed Professor and Regents' Lecturer in the School of Public Administration at the University of New Mexico. Her research focuses on women and minorities in information technology education, Asian immigrants in the science and engineering workforce, return migration of scientists and engineers, and professional ethics. Her research has been supported by the National Science Foundation and the Sloan Foundation. She is the author of *Harbingers of Global Change: India's Techno-Immigrants in the United States* (2006). She served on the Association for Computing Machinery Task Force on Job Migration in 2004–5 and is an invited member of the Social Science Advisory Board of the US National Center of Women in Information Technology.

