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STEM MIGRATION, RESEARCH, AND INNOVATION

Stefano Breschi
Department of Management and Technology, ICRIOS
Università Bocconi, Milan, Italy
stefano.breschi@unibocconi.it

Cornelia Lawson
Alliance Manchester Business School,
University of Manchester, Manchester, United Kingdom
cornelia.lawson@manchester.ac.uk

Francesco Lissoni
GREThA UMR CNRS 5113,
Université de Bordeaux, France
francesco.lissoni@u-bordeaux.fr

Andrea Morrison
Department of Management and Technology, ICRIOS,
Università Bocconi, Milan, Italy
Department of Human Geography and Planning,
Utrecht University, The Netherlands
A.Morrison@uu.nl

Ammon Salter
School of Management
University of Bath, Bath, United Kingdom
a.j.salter@bath.ac.uk

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"Migration has one characteristic that should make it very effective as a diffusion method. The hardships occasioned with [it] will usually discourage all but the most resourceful, energetic, and courageous. Those who have the hardihood to venture in this way hence are likely to have exactly those human qualities which are most essential to innovating and diffusing"

- Warren C. Scoville ("Spread of Techniques: Minority Migrations and the Diffusion of Technology", *Journal of Economic History* 1951: 11/4, p.349)

"... even were it possible to force the professionals to stay at home, it would be a foolish policy. Lack of congenial working conditions, absence of peer professionals to interact with, and resentment at being deprived of the chance to emigrate can lead to a wholly unproductive situation in which one has the body but not the brain. The brain is not a static thing: it can drain away faster sitting in the wrong place than when travelling to Cambridge or Paris!"

- Jagdish Bhagwati (*In Defense of Globalisation*, Oxford University Press: 2007; p.214)

"Le véritable lieu de naissance est celui où l'on a porté pour la première fois un coup d'oeil intelligent sur soi-même: mes premières patries ont été des livres, à un moindre degré, des écoles."

- Marguerite Yourcenar (*Mémoires d'Hadrien*, Plon: 1951)

"We hire from the best schools. All the people who go to those schools [...] we offer jobs to American, non-American, that's who we build these product teams around. And so, because we're in a very competitive business, we don't compromise on that. Wherever we can get those people, that's where we create the jobs."

- Bill Gates (*National Public Radio* interview, March 12, 2008; <https://www.npr.org/transcripts/88154016> - last visit May 2020)

1. INTRODUCTION

This Special Issue attempts to bring new attention to STEM migration, research and innovation. Although the movement of people within and across countries is often the key source of technology transfer and diffusion due to the highly specific and tacit component of technical knowledge, migration has often been placed on the 'back of the shelf' in the innovation literature. Yet, migration speaks to questions of who moves and why, where they go, what they bring when they get there, and what impact they have on their new location and on their old; questions that have profound effects on the rate and direction of technical progress. The papers in this Special Issue hope to cast new light on these issues, spurring a wide range of new research and policy challenges.

2. THE THEMES AND PAPERS IN THE SPECIAL ISSUE

The four citations we have chosen to open this Special Issue with are representative of the themes it investigates. The first one, by Warren Scoville (whose monumental study on 17th century Huguenots' emigration remains a classic; Scoville, 1952a,b), encapsulates two such themes, namely the role of migrants in the diffusion of scientific and technical knowledge and their positive self-selection, which would place them in a unique position to contribute to innovation in their host countries. These are well-known topics to, respectively, economic historians (Cipolla, 1972; Cipolla, 1977; Hilaire-Pérez, 2008) and migration economists (Borjas, 1989; Belot and Hatton, 2012; Parey *et al.*, 2017), but it is only recently that innovation scholars have started investigating them thoroughly, and for different reasons. We will discuss diffusion immediately, leaving self-selection for later.

The current interest in migration as a diffusion channel descends from either theoretical preoccupations or policy concerns, or a combination of both. Theoretically, international migration offers clear-cut settings for studying the role of personal exchanges in the dissemination of scientific and/or technical knowledge,

to be interpreted as proof or measurement of the importance of their tacit component. This is especially true of what Scoville had in mind when speaking of “diffusion by migration” as a “spectacular and violent” process, namely the forced migration of skilled ethnic and religious minorities (Waldinger, 2012; Hornung, 2014; Moser *et al.*, 2014). In today’s scholarly jargon, these represent useful natural experiments, in which an exogenous shock reshuffles the distribution of skilled individuals across frontiers and allows the research to measure the knowledge transfer consequences. Other studies in this spirit are those exploiting any kind of migration shock, were it resulting from the removal or imposition of migration restrictions (as with the collapse of the Soviet Union, see: Borjas and Doran, 2012; Ganguli, 2015; or the quota system introduced in the early 1920s in the US, see: Moser and San, 2019; Campo *et al.* 2020), or from changes in immigration barriers (as with H-1B visa policy changes, see: Kerr and Lincoln, 2010; Doran *et al.*, 2014; Peri *et al.*, 2014). The article by Edoardo Ferrucci in this Special Issue follows in this tradition and finds once again evidence of migrants passing on their knowledge to destination countries via personal contacts (in particular, professional collaborations). Importantly, this study shows that this is true not only in a typical melting-pot country like the US, which is the focus of previous literature, but also for a more culturally homogenous European country, like Germany in the early 1990s.

Policy-wise, the interest in diffusion by migration is motivated by the need to evaluate the less visible or intuitive effects of present-day migration flows. These have incessantly increased since the 1970s, and would be even greater than they are, were it not for the high migration barriers still in place all over the world (Clemens, 2011; for a critique: Borjas, 2015). Despite the weak or contrary evidence, much of the public debate on the effects of migration has concerned its presumed negative effects on wages and the welfare systems in host countries (on wages, see Borjas, 2014 and its review by Card and Peri, 2016; on welfare systems, see Boeri *et al.*, 2002). In contrast, the economic profession has produced some well-established evidence on the positive effects of migration on trade and foreign direct investment (Rauch and Trindade, 2002; Kugler and Rapoport, 2007; Javorcik *et al.*, 2011; Felbermayr and Toubal, 2012; Hernandez, 2014; Li *et al.*, 2019; Parsons and Vézina, 2018). It is reasonable to presume that the flows of goods, services, and capital go hand in hand with those of knowledge. The most immediate way to test this idea consists in borrowing the methodological tools of international economics - such as a focus on bilateral exchanges, specialization indexes and/or gravity models - and adapting them to innovation and diffusion indicators such as patents and patent citations. This strategy is followed by Miguelez and Noumedem Temgoua and by Bahar, Choudhury and Rapoport in this Special Issue. Both find evidence of diffusion effects not only for migrants’ host countries, but also for their countries of origin. In addition, Bahar *et al.* show that such knowledge flows also shape the technological specialisation of host and home countries, which has important policy implication for both emerging and advanced economies.

These latter results bring us to our second quote, which comes from a scholar - Jagdish Bhagwati - who both popularized and discussed the concept of “brain drain”, namely the possibility that high skilled migration would deprive the migrants’ countries of the human capital they need for both innovation and other knowledge-intensive activities (such as healthcare or higher education; Bhagwati, 1976).¹ Despite his usual association to a negative view of high skilled migration, here Bhagwati suggests it to be at the same time inevitable and not necessarily harmful. It is inevitable because preventing it would be inherently wasteful: skills accumulate and escape obsolescence only if their holders can apply them to the right context and, by doing so, learn more. In addition, it may not be harmful if the sending countries find a way to access

¹ On the origin of the “brain drain” concept, see Cervantes and Guellec (2002) and Balmer *et al.* (2009). As it happens, the fortunate expression was not coined in a developing country, but in post-WWII United Kingdom, by local universities and scientific societies complaining for the loss of their best talent to American universities.

their migrants' human and social capital. Starting in the 2000s, economists and other social scientists have investigated how any "brain drain" can compensate the potential "brain gain" (early surveys by Boeri et al., 2012, and Docquier and Rapoport, 2012; see also: Clemens, 2016 and Kone and Özden, 2017).

In particular, migration scholars have considered the extent at which, in developing countries, emigration perspectives provide students and their families with an incentive to invest in education, especially in science and technology. Innovation scholars, instead, have focussed more on what Fackler, Giesing, and Laurentsyeva - in this Special Issue - call "knowledge remittances", namely the migrants' specific contribution to innovation diffusion in their home countries. How much of these remittances pass through international collaborations (Miguelez, 2018) or return migration (Kahn and MacGarvie, 2012; Jonkers and Cruz-Castro, 2013) is still an open question, although Miguelez and Noumedem Temgoua (in accordance with Foley and Kerr, 2013, and Choudhury, 2016) suggest that multinational enterprises (MNEs) may also play an important role (more on MNEs below).

Our third quote, coming as it does from a novel and not a scholarly paper, serves more an evocative purpose, rather than an analytical one. It reminds us of both the importance of international students as migrants and of how migration policies may stand in the way of their frequent wish to elect their host country as home. According to UNESCO (2015) data, the number of students enrolled in a foreign higher education institution in 2005 was less than 3 million; in 2017, it was over 5 million. Most foreign students take a science or technology degree (29% in 2012), especially when it comes to doctoral studies (63%). Hunt (2013) and Hunt and Gauthier-Loiselle (2010) find that, as a result of this orientation, foreign graduates in the US are more likely than native ones to become scientists or inventors, and to appear in the right tail of the productivity distribution (see also: Chellaraj et al., 2006 and 2008). When it comes to doctoral holders, most move to stay abroad. For example, based on a large sample of foreign recipients of a US doctorate in science and engineering, Finn (2014) calculates a return rate—five years after graduation—of less than 10% for India and China to around 40% for Western European countries.

And yet policy-makers in host countries hold at best ambivalent attitudes towards granting long-term or permanent visas to foreign graduates. On the one hand, they put in place or, more often, just announce points-based immigration policies aimed at attracting the best and brightest talents from all over the world (see section 4 below). On the other hand, they harbour a permanent suspicion of higher education as an immigration entry point that may escape their control. As a result, migration policy provisions for students are subject to frequent changes. Two papers in this Special Issue - by Khan and MacGarvie and by Crown, Faggian and Corcoran - explore such changes and show their significant impact on graduates' stay rates and how costly visa restrictions may be in terms of foregone innovation opportunities. In particular, Crown, Faggian and Corcoran study an Australian skilled visa programme and find a positive impact on regional innovation. They show that retaining talented foreign-born students post-graduation can stimulate technological invention and that immigration policies that facilitate the stay of migrants play an important role in this. Khan and MacGarvie show instead how impactful any delay in obtaining permanent residency status can be on the stay rates of Chinese and Indian PhD graduates in the United States, with negative consequences for innovation.

Among the largest employers of migrant students, as well as of the best students worldwide, MNEs stand out, especially in the high-tech sector. Companies such as Microsoft, whose former CEO Bill Gates we quote, are both responsible for making US universities attractive for STEM students from other countries, and for lobbying heavily in order to ease their stay after graduation, so to enter the local labour market (actually, the interview we quote follows a Mr Gates' congressional hearing in which he pleaded jointly for

a joint reform of the educational system and immigration policy of his country). The same MNEs also recruit abroad and often move new hires around the globe, thus further feeding the overall migration flows. Labour economists have mostly focussed on evaluating the effectiveness of various company-sponsored visa systems in selecting the “best and brightest” scientists and engineers, as opposed to exploiting cheap and young graduates (Doran *et al.*, 2014; Sari P. Kerr *et al.*, 2015).

Innovation scholars have chosen instead to study how MNEs organize and take advantage of the knowledge produced or handled by their STEM foreign hires, whether employed at home or in their overseas branches. In this Special Issue, Marino, Mudambi, Perri and Scalera analyse how the migrant inventors working for MNEs help their employers to appropriate the knowledge generated by their affiliates in the migrants’ home countries; while Laursen, Leten, Nguyen and Vancauteran discuss to what extent high skilled migrant employees appear to be more innovative than native ones not so much because they are positively self-selected - as preconized in Scoville’s quote - but because they increase cultural diversity at the firm level. In both papers, management practices play a central role, either by placing migrant inventors at the core of intra-firm knowledge transfer activities or by paying diversity the attention it deserves.

3. NEW THEMES AND FUTURE RESEARCH

3.1 THEMES

While our opening quotes capture the migration and innovation research themes dealt with by the contributions to this Special Issue, they miss some others. Together with ours, such themes form a challenging and far-reaching research agenda.

Diffusion. As per our opening quote, diffusion of innovation has been the key topic of early historical studies on migration and innovation, and it remains central to the field as it speaks to a core theme in modern innovation studies, namely the role of mobility and social contacts in spreading knowledge. Contributions to this Special Issue, studies we cited in our discussion, and other recent research focus on the transfer of knowledge from migrants’ home countries to their hosts. Curiously, this contrasts with historians’ own progress on the topic, which has stressed how diffusion patterns may be more complicated, with migrants being particularly instrumental for diffusing knowledge produced in their host country (whether by natives or other migrants), due to their readiness first to acquire and then to share knowledge via co-ethnic social networks (survey by Lissoni, 2018). This diffusion within the host country as well as to the wider diaspora (“brain circulation”), remains relatively under-explored, especially with regard to knowledge assets that cannot be measured via patents or bibliometric indicators (more on this below).

Diversity. Migration-induced diversity, and its effects on innovation, has arguably received even more attention than diffusion. This is especially true in regional economic geography, where studies have extensively documented the positive association between diversity in cities or regions and local innovation rates (Niebuhr, 2010; Kemeny and Cooke, 2017). As the theory goes, creativity thrives when individuals with different cultural backgrounds meet and mix. Still, it remains less clear, how much of such diverse interaction occurs within the boundaries of the organizations (and possibly of teams therein; Parrotta *et al.*, 2014; Ferrucci and Lissoni, 2019) and how much escapes them, thus generating localized externalities (Hornung, 2019). Formidable identification issues stand in the way of telling these phenomena apart (Kemeny, 2017). Also, that of a cultural difference between two individuals (and hence of diversity in an organization, team, or location) is not a binary concept, but a continuous and subtle one. It calls for characterizations of cultural backgrounds that allow for measurement, but must also escape stereotyping

(as may partially be the case with the much-used Hofstede's categories; Hofstede, 2003; Kirkman et al., 2006). Further, diversity on other dimensions, such as age and gender, intersect with cultural diversity and provides additional difficulties for identification.

Peer-effects. One topic that stands at the cross-road between diffusion and diversity is that of peer-influence that migrants may generate when working with either natives or/and other migrants in the host country. Peer-interaction is a general theme of interest in innovation studies, as it is at the same time the fundamental vehicle for the transfer of tacit knowledge and the essence of teamwork (Jaravel *et al.*, 2018; Dorner *et al.*, 2020). Migrant scientists can improve the performance of the team they join especially in cases where knowledge is difficult to codify or requires extensive recombination (Franzoni et al., 2018). So far, the migration literature has offered two studies on peer-effects both of which rely on quasi-experimental designs based on historical migration shocks (Waldinger, 2012; Borjas and Doran, 2015). Still, there is not much running in the opposite direction, with peer-effect notions applied to ongoing STEM migration flows. The few studies produced so far find a strong tendency for STEM migrants to form homophilic ties with co-ethnic expatriates (Freeman and Huang, 2015; Gompers et al., 2016). This diminishes, instead of increasing diversity, and may also imply that migrants disproportionately source knowledge from co-ethnic communities (Agrawal et al, 2011; Breschi et al., 2017), with negative innovation outcomes (Bengtsson and Hsu, 2015; Almeida et al., 2015). Clearly, more research is necessary to further identify who high skilled migrants interact with, how much they contribute to team-specific knowledge creation, and what the consequences are for innovation. This will cast light on the factors that may affect a better integration and matching between migrant workers and the host countries and organizations.

3.2 CHALLENGES FOR FUTURE RESEARCH

In developing the Special Issue, the editorial team has been acutely aware of the importance of finding new ways to study migration and innovation. As the field stands now, researchers have tended to gravitate to secondary data sources, such as patent and registry data. Indeed, in this Special Issue, seven of the nine papers rely primarily on patent data (see Table 1). The dependence on patent information in the migration-innovation literature is perhaps even more acute than for more mainstream innovation topics. Of course, patent data provide rich information at the level of the technology and the inventor. However, the immigration status of inventors cannot be directly inferred from patent data and one needs to resort to complex analyses of names in order to trace the most likely country of origin. Moreover, patent data poorly measure many other parts of innovation systems. For example, professional services, software and creative industries are infrequent users of patents, and these parts of the economy now account for a considerable share of both economic activity at large and, based on anecdotal evidence, high skilled migration. Therefore, by focusing on patents, there may be a tendency to miss the impact of migration on innovation more generally across all parts of the economic system.

Table 1. Summary of papers in the Special Issue

	Outcome variable	Migration→Innovation mechanism(s)	Outcome data	Migrants	Migration data source	Home/host country effects	Level of analysis	Host countries	Home countries
<i>Babar et al</i>	Innovation	Diffusion	Patents (worldwide share; number increase)	Inventors	Patents	Both	Country pairs	All countries with patenting activity	All countries patenting activity
<i>Crown et al</i>	Innovation	Many at once (self-selection; diversity)	Patents (incl. design); Trademarks	University graduates	Special visa programme (info on beneficiaries)	Host	Local (subnational regions)	Australia	All countries worldwide (by regions)
<i>Fackler et al</i>	Innovation; Diffusion	Diffusion	Patents (number of; citations)	All workers	Official labour stats	Home	Country (macro-regions)	EU and EFTA countries	EU and EFTA countries (by macro-regions)
<i>Ferrucci</i>	Innovation	Diffusion	Patents (number of; indicators)	Inventors	Patents	Host	Technological field; Individuals	Germany	Russia (former USSR)
<i>Kahn and MacGarvie</i>	Return decision	Self-selection	Survey information	University graduates	Survey of doctoral recipients	Host	Individuals	United States	All countries PhD graduates US
<i>Laurssen et al</i>	Innovation	Diversity	Patents (nr of)	Highly skilled workers	Employer-employee database	Host	Firms	Netherlands	All countries worldwide
<i>Marino et al</i>	Diffusion	Diffusion	Patents (citations)	Inventors	Patents	Host	Patent (by MNEs)	United States	All countries patenting activity
<i>Migueluez and Noumedem Temgoua</i>	Innovation	Diffusion	Patents (citations)	Inventors	Patents	Both	Country pairs	All countries with patenting activity	All countries patenting activity

The use of national registry data is a promising line for future research and two of the papers in the Special Issue apply this data very effectively. National data registries provide rich panels of information about individuals and firms. However, they are often limited in their depth of knowledge about individuals' backgrounds before they come to the country and what happens to them after they leave. Moreover, national registry data has significant challenges with the classification of immigrants, often conflating ethnic status with immigration and citizenship status. There is a danger that divisive terms are used in the study of migrants and their descendants and that these terms shape how individuals are identified and therefore treated in the host countries. Many national registries also have incomplete and varying descriptions of the ethnic and migrants groups, with some countries focusing on 'visibility' minorities (as in Canada) and others focus on religious, ethnic or national identities (as in the United Kingdom). Fundamentally, the notion of a person's identity is not something easy to classify for national statistical agencies and for researchers. Identity is itself a fluid concept, as individuals' sense of self changes due to their experience. In this respect, migration is not a single or one-off event, but a continuous process of identity formation and reformation due to personal development and lived experience. As people move, they add layers of experience and their identities become hybrids between different cultures and places. Given this complexity, future research should seek to better understand the personal experience of migration, and how this shapes innovation outcomes. It should also avoid the tendency to see migrants as permanent outsiders with fixed identities, but examine the career and identity pathways of these migrants as they change over time.

Another challenge for future research is to find new ways to track the flow of people across countries. Social media platforms, such as LinkedIn, may provide information about career histories, allowing researchers to map and measure movements, roles and experiences between different countries (for an experiment, see Breschi et al., 2020). This data might help enrich our understanding of brain circulation. However, this data may be only available under restricted terms. It would be useful to have such information available from public sources, freely available to researchers. Scientific publication data, which come increasingly with a unique identifier for their authors, may also provide a tool for tracking movements of scientists, and an insight into how movement shapes the direction of research and their interactions with colleagues (Bohannon, 2017; Orazbayev, 2017).

Future research may also seek to better capture the lived experience of migration using surveys, interviews, and ethnographic accounts of STEM migrants' experience. In the Special Issue process, we received very few submissions using such approaches, which suggests that more research is required to better understand the process through which migrants contribute (or not) to innovation. Although such accounts are present outside economics (a classic reference being Saxenian, 2007), there is lack of integration of these works on-going discussion of migration and innovation. These accounts could give more voice to the migrants themselves, as well as helping to reveal mechanisms of exchange between migrants and their context. This research could also explore how migrants' experience of settlement in the host country is shaped by the attitudes and views of others in their local context, how the openness of these host communities and organizations to these individuals influences the nature of the migrants' contribution as well as the formation of their personal identity. Critically, it is important to account for the recursive effect of migration on the receiving society, and how this society may evolve and change in response to migrants themselves. Research that explores how these changes unfold and led to different patterns of innovation would be highly welcomed.

More generally, the study of innovation and migration would benefit from a structured approach by international coordination to harmonize statistical protocols and data capture to ensure more reliable and valid international comparisons and cross-country studies. The research domain needs greater investment

in integrated datasets, pooling information about immigration systems, economic systems and the S&T system, to help better understand the impact of migration upon both the home and host country. As it currently stands, we have a patch-work of information, from disjointed and incomplete data sources, largely relying on patent and national registry data.

4. WHAT PLACE FOR INNOVATION IN MIGRATION POLICIES?

In the late seventeenth century, both the English crown and the prince elector of Brandenburg welcomed French Protestants escaping religious persecution at home with generous fiscal incentives and other benefits, hoping in this way they will settle down and transfer to locals their expertise in silk manufacturing (Scoville, 1952a,b; Hornung, 2014). A century earlier, centre and northern Italian cities discouraged (even with death sentence) the outward mobility of their talented craftsmen to prevent their secrets would spill over to neighbouring competitors (Belfanti, 2004 and 2006). Still nowadays, albeit in a less dramatic fashion, governments worldwide design policy measures to either attract or retain high-skilled workers (World Bank, 2018; OECD, 2019). These policies differ across countries, reflecting to a large extent their degree of attractiveness. Indeed 75% of high-skilled immigration is concentrated in a handful of destinations, with four Anglo-Saxon countries accounting for two thirds of the total. Emigration comes mainly from the Global South, though few countries are the main contributors in absolute terms (e.g. India, China, or the Philippines) (World Bank, 2018).

However, despite differences, we can observe some common traits and trends. First, all policies tend to be selective, and their degree of selectivity becomes stronger in more attractive places (Facchini and Mayda 2010). Second, over time, most countries have relaxed their admission conditions and offer more generous welcome packages in order to attract skilled workers (OECD, 2019). Third, there is increasingly a convergence between the two most used policy regimes (namely, the employer demand-driven and the point-based supply-driven regime), although there is very little, if any, coordination across countries as far as immigration policy is concerned (World Bank 2018).²

The above trends and traits have important implications on how policies shape the innovation and labour market dynamics in both destination and origin countries. In particular, they can produce different, if not opposite outcomes in these countries. This raises a number of concerns and open questions on how to design and implement high-skilled migration policies. Making no claim of being exhaustive, we tackle here three main issues: 1) the effectiveness of the prevailing policy regimes; 2) the asymmetric impact of selective policies between destination and origin countries; and 3) the national and international coordination of (high-skilled) immigration policies.

First, despite the conventional idea that countries should enter into a global race for attracting the best talent, it is still unclear which policy regime is most effective, and if the net contribution of selective policies is positive after all. Demand-driven policies bring the most tangible benefits by matching employers' needs with migrants' skills, which makes them very attractive for policy makers. However, though very effective in the short-term, they might be missing the long-term goal of raising the skill level of migrants (and the overall working population), for which point-based systems appear to be more effective (Facchini and

² On the one side, demand-driven policies require immigrants to have a job offer in the destination country while on the other side, supplier-driven policies require immigrants to meet certain requirements in terms of education, language proficiency, among others. The US is regarded as the typical example of country using a demand driven approach, followed by several European countries. Canada and Australia have been the main examples of countries adopting a point-based system, which have been followed also by some European countries like UK and Denmark.

Lodigiani, 2014). Though the answer of which system is best will certainly differ between countries, on average it has been argued that government policies should rely more on market mechanisms (World Bank, 2018), which supposedly provide better information than government on labour market needs. However, evidence also points to potentially detrimental effects of demand-driven policies, both for native workers, who can be displaced by *cheaper* migrant colleagues (Doran et al., 2014), and for migrants themselves, who are tied up for too long to their employers and restricted in their mobility (Hunt and Xie, 2019).³ When these policies are combined with a tight cap on the number of visas, a likely outcome is adverse selection, with the best candidates moving to other destinations (Kato and Sparber, 2013) and the remaining ones being randomly selected via lottery (Kerr, 2018). Therefore, some scholars suggest replacing quota restrictions with a fee-based regime as a way to overcome ‘free-riding’ and compensate native workers (World Bank, 2018). More in general, since both approaches have advantages and shortcomings, a tendency towards hybrid systems is emerging, where for example point-based systems give additional points to immigrants sponsored by a potential employer (OECD, 2019). However this might not be a panacea for all countries. Hybrid systems can fix the above limitations, but in order to design, implement and fine-tune such a regime it requires high-quality institutions and a well-equipped public administration, which are features far from easy to find even in high-income economies.

Second, in face to the global competition for talent between receiving countries, sending countries - which fear for detrimental effects - react with policies aiming at reducing the outflows of skilled citizens or the losses attached to them. They have different options at hand, ranging from fiscal incentives for returnees, to programmes aimed at engaging with diasporas abroad, to more radical measures that impede emigration (e.g. quota, emigration bans) (World Bank 2018). The latter option, though difficult to enforce, can be effective if embedded in multilateral or bilateral country agreements or implemented by destination countries that represents a large share of the overall demand (e.g. the US), though it is applied mainly for sectors and skills with high social returns (for example, for health professionals).⁴

However, the first two options (returnees, diaspora) seem to offer higher returns, also in light of the growing evidence showing that they can represent an important source of knowledge for sending countries (Filatotchev et al., 2009; Choudhury 2016; Luo and Popp, 2017). Indeed, several governments have recently designed schemes to either engage with their own diaspora abroad or attract returnees (OECD, 2019). Interestingly to notice, these policies have been implemented by a wide range of countries, including low (e.g. Ghana), middle (e.g. Russia, China, India), as well as high-income ones with high inventor and scientist emigration rates (e.g. Italy, Canada and Portugal) (Åkesson and Eriksson-Baaz, 2015; OECD, 2019).

Although the evidence on the effectiveness of these policy instruments is far from comprehensive (World Bank 2018), some studies point to potential negative effects, for example in terms of lower quality publications for the case of Chinese scientists returning home (Yang and Marini, 2019). More in general there is evidence showing that returnees might be negatively selected (Breschi et al, 2020), in particular when returns to skills are higher in the receiving country (Borjas and Bratsberg, 1996). The above suggests that the distance from the main sources of knowledge can reduce significantly the ability to attract the best

³ For example, it has been discussed whether H1-B visas, a typical employer-based visa widely used by high-tech MNEs in the United States, are used to replace senior native workers, especially software engineers, with younger and often cheaper immigrants. Another important downside of H-1B visas is that they tie to their first employer for a very long time period (see Kerr, 2018).

⁴ For example the U.K. health system limits the recruitment from several developing countries. The World Health Organization Code of Practice promotes practices to reduce the emigration of health workers from low-income countries. The United States, for example, imposed a limit (7 %) to the share of immigrants proceeding from a single country (World Bank, 2018).

and brightest, and make them less able to successfully transfer their knowledge (Kahn and MacGarvie, 2016), which might be amplified if returnees move to an environment with limited resources and collaborations.

All in all, the above considerations beg the question of how to design policies that maximise both returnees' knowledge spillovers and brokering. Though there is no one-fits-all remedy, putting in place mechanisms that make it possible for returnees to maintain closer ties with foreign sources of knowledge, for example allowing temporary instead of permanent migration, would facilitate brokering and potentially reduce negative selection.

Third, in the race for global talent, it seems that countries rely mainly on unilateral policies, with little or no coordination in either multilateral or bilateral frameworks (World Bank, 2018). This differs significantly from other areas, like trade, where international agreements are usually the norm. Some important exceptions are some regional free mobility agreements, like the one among EU and EFTA countries (plus Switzerland). However, even in the EU context, member states tend to act independently as far as international migration is concerned. Few recent initiatives are possibly opening up new opportunities for a more coordinated action among countries, at least in the EU context. The revision of EU-Blue card scheme has been recently put forward, and it should harmonize rules and facilitate intra-EU mobility. Moreover, the recent implementation of the EU directive 2016/801 for students and researchers will increase the minimum post-study stay and facilitate their short/long-term intra-EU mobility (OECD, 2019). However, besides these region-specific cases, agreements between receiving and sending countries are confined only to specific categories of skilled workers (e.g. doctors) or the temporary migration of students.

Finally, policies that select migrants on skills clearly penalizes the entry of the 'low skilled'. However, if high-skill migrants value the presence of a diverse environment, as some literature suggests (Florida, 2005), a tighter immigration policy can have unintended consequences (Doran and Yoon, 2018; Campo et al. 2020). It may also push away high skilled immigrants to more tolerant countries (Kerr, 2018). It is also the case that high skill migrants rarely come unattached, bringing with them larger family units. Most immigration systems retain a strong preference for entry for immediate family members, which means that desired high skill migration may also be associated with 'undesirable' low skill migration. In addition, restrictions directed towards particular nationalities may produce unforeseen complications for STEM migrants. For example, in the UK, the post-Brexit immigration system for EU citizens will be the same as other nationalities, creating a new layer of rules, regulations and costs for potential STEM migrants. As a result, employers, research funders and universities have asked for exceptions or 'carve outs' to exempt STEM migrants from the increasing thicket of rules and restrictions, with only partial success. Therefore, policy makers should carefully consider the interdependence between policies, and their underlying assumptions.

5. CONCLUSION

At every stage of the Special Issue editorial process, we have been acutely aware of the danger that research on migration and innovation, while extremely timely and relevant, may inadvertently reinforce or even seed greater divisiveness with respect to the migration phenomenon at large. In part, this is due to the language of research, which focuses on classifying the migrants, both to highlight their 'otherness' or separation from the immobile or native born, and to classify their skill level and ease of insertion in the labour market. Such an approach can lead to the potential dehumanization of the individuals which are the subject of the

research, failing to capture the rich diversity of their experiences, identity and contributions to their adopted societies. Although STEM migration, as considered in this Special Issue, is typically considered beneficial for the destination countries as well as - at least potentially - for the origin ones, it is not immune from the turn toward nativism and deglobalization in both of them, where political issues of belonging and identity have returned with renewed vigour. Indeed, high skilled migrants are typically seen as 'the good immigrants', in contrast with refugees, asylum seekers and more generally the 'low-skilled' ones. We must avoid value-laden treatments of different types of migrants and stand up to the challenge of developing useful knowledge in this area without ceding the ground to nativist political ideologies. We hope that this Special Issue will help in this sense, by leading - as we meant when conceiving it - to a greater appreciation of how the movement of people between countries shapes patterns of innovation and by spurring further research on this important topic.

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