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# High-Skilled Migration and Agglomeration

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## Abstract

This article reviews recent research regarding high-skilled migration. We adopt a data-driven perspective, bringing together and describing several ongoing research streams that range from the construction of global migration databases, to the legal codification of national policies regarding high-skilled migration, to the analysis of patent data regarding cross-border inventor movements. A common theme throughout this research is the importance of agglomeration economies for explaining high-skilled migration. We highlight some key recent findings and outline major gaps in the literature that we hope will be tackled in the near future.

## 1. INTRODUCTION

A global race for talent is underway, but its outcomes are asymmetric. Individuals with valuable skills have a higher propensity to migrate both domestically and abroad due to the exceptional returns they can earn. They frequently have the option to select from a menu of destinations. Yet not all potential destinations are equally attractive in their professional and social opportunities. Countries differ in their accessibility and the degree to which they welcome foreigners. In addition to government policies, firms and institutions of higher education play crucial roles in the development of skills and the admissions decisions of many countries. Although there is a complex web of actors involved, the central outcome is clear—the flows of high-skilled migrants are very concentrated, both within and across national borders.<sup>1</sup>

Many examples illustrate the prominence of the issues surrounding high-skilled migration. Advocates of high-skilled migration policy reform have adopted the phrase national suicide to describe current policies in the United States. The high-profile H-1B program, described further in Section 5, was one of the few specific policies discussed in recent presidential debates. Demographic pressures in Europe, Japan, and China necessitate building a stronger future workforce by attracting global talent as older populations shrink and public coffers face massive pressure. In the business landscape, high-profile startups like Skype, Uber, and Rocket Internet vault overnight to become globally distributed companies rather than waiting to expand as they mature. They can only achieve such meteoric rises with a global workforce. Many multinational corporations actually operate with a minority of their workers in their headquarters country.

Our review focuses on the agglomeration economies that undergird the asymmetric flows of high-skilled migration, which, in turn, result in further agglomeration that is observed both domestically and internationally. We adopt a data-driven perspective, and Section 2 begins by describing newly available data that are being brought to bear on the phenomenon and that are much needed given the poor information historically available. We argue that the patterns of high-skilled migration, such as the broad flows from a large number of source countries to very few destination countries, are consistent with agglomeration economies. These data further show that processes of migration selection for skills are becoming sharper and increasingly involve high-skilled female migrants. These new patterns, documented in Section 3, complement core areas of past research on migrant networks and the contributions of high-skilled migrants to innovation in destination countries. In these cases, high-skilled migration does not dampen future incentives for migration, as would be the case if overseas opportunities were mostly linked to skilled workers complementing unskilled workers or other fixed factors, but instead further increases the incentives for others.

Section 4 then describes how traditional migration theories are able to explain parts of the observed patterns of high-skilled migration while at the same time missing important dimensions. For example, a significant share of high-skilled migration takes place via the skill-building process fostered by institutions of higher learning. In these cases, initial migration and selection are more about raw talent than formal skills. Foreign students and scholars flock to universities in countries like the United States and the United Kingdom, and the same individuals are later hired by domestic companies upon graduation. Lowell (2015) shows that the United States attracts by far the largest number of international students. In science, technology, engineering, and mathematics (STEM) fields, the United States is close to the top in terms of the percentage of students who are foreign born. These and other factors noted in Section 4 can help agglomeration economies take deep root and build upon themselves in certain locations due to high-skilled migration.

<sup>1</sup>Although the term agglomeration has several connotations, we use it throughout this review to refer to this concentration.

Many countries are launching new policies to attract high-skilled migrants. Examples include the United Kingdom's introduction of a points-based immigration system under Tony Blair's government and its recent programs to attract the brightest and best innovators and entrepreneurs. The Netherlands introduced a new Expatcenter Procedure, which is an entry procedure designed for so-called knowledge migrants. Competing programs pop up regularly—in short, the doors seem to be opening ever wider for high-skilled migrants (with perhaps the partial exception of the United States, where policy moves little). Section 5 analyzes newly available data detailing high-skilled migration policies while providing new insights into the heterogeneity of high-skilled migration flows along several dimensions. We use these data to shed light on how policy influences the rate and direction of migration flows and to describe open areas for further research.

Section 6 focuses on the implications of high-skilled migration for labor markets, social welfare, and inequality, and Section 7 considers important research areas that can help fill major gaps in our current knowledge. Substantial progress has been made on many issues related to labor markets, but much remains to be done. For example, global labor markets for high-skilled individuals are much more integrated than most people realize. Current research, however, fails to adopt a unified approach when exploring the distribution of skill (or human capital) across the globe. Most of the existing analyses are single-dimensional explorations of a country's experience, despite the fact that the impacts of high-skilled migration span international borders. We hope that some ideas presented here catalyze future work.

This review provides an in-depth analysis of available data and introduces several newly available data sources that are open to researchers. In addition to being of interest in their own right, these new data allow a critical appraisal of the existing literature and identify gaps that can now be addressed, illuminating directions in which the next wave of research can go. Moreover, it is important to build upon policy recommendations grounded in research, and countries need to understand the (often small) impacts of high-skilled migration policies on the actual selection of which high-skilled workers come to their countries (e.g., Czaika & Parsons 2017). Without proper attention to the school and work opportunities that high-skilled migrants pursue, the most aggressive policies will likely bear limited fruit for receiving countries. From the perspective of sending countries, research can help shed light on the places where brain drain is a real concern, the places where expatriates and diasporas can offer real advantages, and the factors that can help tilt the balance in the sending country's favor.<sup>2</sup>

## 2. DATA ADVANCES IN HIGH-SKILLED MIGRATION

As is the case in every field of economics, migration research is dependent upon high-quality and publicly available data. Yet the state of migration statistics, especially those pertaining to human capital, skills, education, and labor markets, has been so much maligned that discussions on these matters have become cliché (Özden et al. 2011). The data constraints have long been acknowledged. The father of modern migration research, Ernst Georg Ravenstein (1885), emphasized the importance of high-quality primary data from national sources as he established his so-called laws

<sup>2</sup>This review complements the work of Kerr et al. (2016), but focuses more on data advances that describe migration stocks and flows, the agglomeration aspect of high-skilled migration and the theory behind it, recent data on migration policies, and global implications of high-skilled migration. This review also contains a more extensive set of references to the literature. Kerr et al. (2016) provide a higher-level introduction to patterns of talent flows across countries and focus more on national gatekeepers for high-skilled migration. They also describe more deeply the approaches used to select migrants for admission and compare several Anglo-Saxon economies in this regard.

of human migration. At around the same time, experts at the International Statistical Institute meetings in Vienna in 1891 argued for the standardization and open dissemination of immigrant stock data (Falkner 1895, Santo Tomas et al. 2009). Over the following century, many calls by international organizations and academics have echoed the same pleas, culminating in the United Nations' detailed *Recommendations on Statistics of International Migration* (U. N. 1998). To a large extent, these calls have borne very little fruit.<sup>3</sup>

Migration data remain startlingly poor both in absolute terms and relative to data on other metrics of global interlinkages. It is safe to say that we know more about a piece of clothing crossing an international border or a foreign equity transaction than we do about an average migrant. This weakness is not just a loss for academic research. Effective policy depends upon high-quality data and analysis, and governments currently end up using very coarse data to make decisions with far-reaching implications for their citizens and immigrants. Against this pessimistic backdrop, however, there has been an exceptional surge, over the past decade, of new information and data resources regarding high-skilled migration, which hold the potential to dramatically push forward the boundaries of academic research and policy analysis.

Because the focus of this article is on the skill and education dimensions of international migration, we pay particular attention to data sources that include these dimensions. We can split the noteworthy data sources into two main categories. The first category is made up of the new databases of international migration stocks by bilateral country pairs and disaggregated by skill levels. These are, in essence, large compilations of census and population register data collected from destination countries around the world, and they aim to provide a comparable picture of skill mobility. These databases tend to take two forms. The first wave of projects focuses on destination countries that were members of the Organisation for Economic Co-operation and Development (OECD). The main reasons for this focus are the increased demand from policy makers in these countries and the availability of comparable and high-quality data. These efforts have been spearheaded by the World Bank and the OECD.<sup>4</sup> By focusing on OECD countries, databases can include more detailed information (e.g., finer skill/education categories, occupations, age distributions, etc.).

The second wave of projects focuses on establishing the overall global picture of international human capital movements (e.g., Artuç et al. 2015). This approach acknowledges the inherent differences in recording practices across countries and does its best to harmonize different definitions (e.g., of migrants or education). These studies usually start with OECD-centric data, add available data from non-OECD countries, and implement econometric methods to fill in the gaps where data are otherwise unavailable. The primary goal is to construct a complete mapping of migration patterns by skill/education levels.<sup>5</sup>

These two approaches are comparable to the development of maps over the centuries. Some maps focus on establishing global portraits and include all important details, even if they might be quite inaccurate about the exact shapes of less-explored continents (like Africa) and other geographic elements. Other maps focus on organizing and representing only high-quality details, such as the maps of European countries or well-explored areas.

<sup>3</sup>There are numerous reasons for governments' reluctance or inability to collect and disseminate high-quality and high-frequency migration data. These range from budget constraints to governments' treatment of these data as matters of national security. The discussion of these issues deserves a separate review article.

<sup>4</sup>Important work here has been done by Dumont & Lemaître (2005), Docquier & Marfouk (2006), Beine et al. (2007), Dumont et al. (2007, 2010), Docquier et al. (2009), and Arslan et al. (2014).

<sup>5</sup>Between these extremes lie hybrids like the DIOC-E database of the OECD, which comprises primary data disaggregated by education level from both OECD and non-OECD countries (Dumont et al. 2010).

These bilateral datasets provide the most accurate and up-to-date picture of global human capital mobility. However, by the time the underlying decennial census data have been collected, compiled, harmonized by the national statistical agencies, and then put together into global migration databases by international agencies, they are many years out of date. This is where the second main category of databases and related studies enters the picture. More frequent and/or topical data can be obtained from global or country-level surveys or from national administrative data sources that focus on particular corridors (e.g., from India to the Persian Gulf countries) or occupations. To the best of our knowledge, the only harmonized dataset of bilateral migration flows by skill level is that detailed in Czaika & Parsons (2016) and analyzed in Czaika & Parsons (2017). Examples of occupation-specific databases include those on the mobility of doctors (Clemens & Pettersson 2008, Bhargava et al. 2011), foreign-born scientists (Franzoni et al. 2012), Indian academics (Czaika & Toma 2015), and inventors (Miguelez & Fink 2013).<sup>6</sup> These focused data sources and studies are highly valuable for answering narrower questions and setting the stage for global projects, but one needs to be careful in extending and generalizing their conclusions.

### 3. GLOBAL HIGH-SKILLED MIGRATION PATTERNS

The data advances listed in the previous section provide a far more accurate portrait of high-skilled migration patterns than was previously possible, and we review several of the observed regularities in the following section. In this section, we document features that are critical to high-skilled migration, including migrant selection from origin nations and into destination nations, the shift toward agglomeration of global talent into a few OECD countries from an ever-larger base of origin countries, and the meteoric rise of high-skilled female migration. In an article that can serve as a companion to this review, Kerr et al. (2016) provide complementary patterns and certain statistics that we do not repeat here.

Our data cover the period 1990–2010 and combine the datasets described in detail by Docquier et al. (2009) and Arslan et al. (2014). A migrant is defined as high-skilled if he or she has completed at least one year of tertiary education. The older OECD databases historically comprise individuals aged 15 years and older, whereas those from the World Bank typically capture working ages of 25 years and older. The 2010 OECD data collect detailed information on age distribution that allow better comparison, and we further match these data on the basis of their definition of migration either by country of birth or nationality (Docquier et al. 2009, Arslan et al. 2014). Our primary dataset comprises 29 OECD destinations and 194 origins.<sup>7</sup>

The emigration rates of college-educated individuals are always greater than those of their less educated compatriots across all countries and at every level of development (as measured by per capita incomes), as shown nonparametrically by Dao et al. (2016). There are several reasons for this pattern. First, high-skilled people are more likely to be endowed with skills that are both in demand and globally transferrable. They are able to obtain job offers in advance of emigrating and clearing migration policy hurdles that favor higher levels of human capital. If they are using other

<sup>6</sup>The global migration of inventors and their resulting concentration in a handful of countries are particularly well documented. Examples include the work of Stephan & Levin (2001), Kerr (2008), Stephan (2010), Hunt & Gauthier-Loiselle (2010), Kerr & Lincoln (2010), Agrawal et al. (2011), Ozgen et al. (2011), Stuen et al. (2012), Bosetti et al. (2015), Miguelez & Fink (2013), Parrotta et al. (2014), Breschi et al. (2014, 2015), and Nathan (2015).

<sup>7</sup>The count of 29 destinations is fewer than the total number of OECD countries, as we exclude Chile, Estonia, Israel, Slovenia, and South Korea to afford data harmonization. Our migrant selection analysis includes 144 countries when our migration data are combined with the Barro & Lee (2013) data on the education levels of natives.

migration channels (such as family preferences or lotteries), they know they will find employment or assimilate more easily upon their arrival. In addition, high-skilled migrants generally integrate into the host societies more easily because they are more likely to have better linguistic and cultural as well as professional knowledge of the destination society. Second, high-skilled individuals are more likely to be aware of the opportunities available to them in other countries. They have better access to global information sources, for example through their social and professional networks. Third, high-skilled people can better access financial resources and credit. As a result, they are able to meet the financial costs of migration more easily. The highest-skilled emigration rates are observed from middle-income countries, in which natives are able to surmount migration costs (unlike many residents in poorer countries) while also having incentives to emigrate (unlike many residents of richer countries).

**Figure 1a** plots the share of high-skilled people in the native population against the share of high-skilled people in the emigrant population for 2010, with circle diameter indicating a country's population. A 45° line is drawn for ease of representation, such that all countries that lie above the line exhibit positive selection of emigration from the native population in terms of skills. This positive selection is far more pronounced from poorer origin countries, with the emigration rates of college-educated individuals being approximately 30 times higher than those of less skilled individuals. We also see strong selection in the two most populous countries, China and India. There are only a few countries, like Mexico and Russia, that lie below the 45° line, indicating that their less skilled workers are more likely to migrate. Given its prominence, the economics literature has extensively studied the negative selection from Mexico to the United States (e.g., Chiquiar & Hanson 2005, McKenzie & Rapoport 2010, Moraga 2011), and **Figure 1a** illustrates that this pattern is an exception to the general rule.

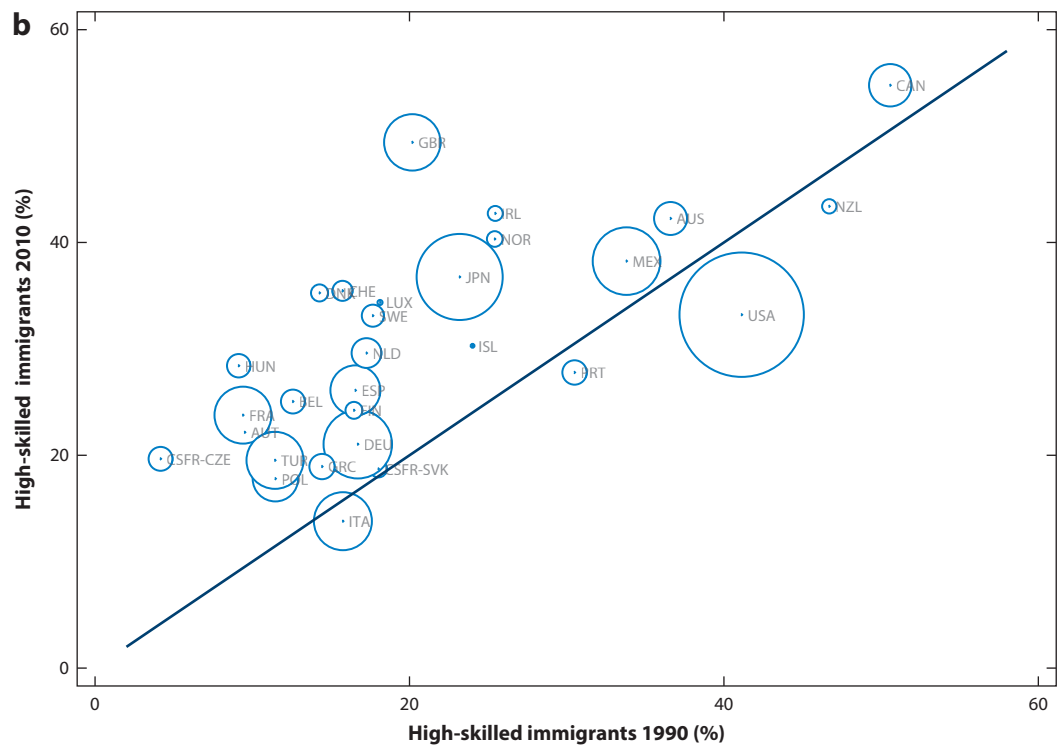
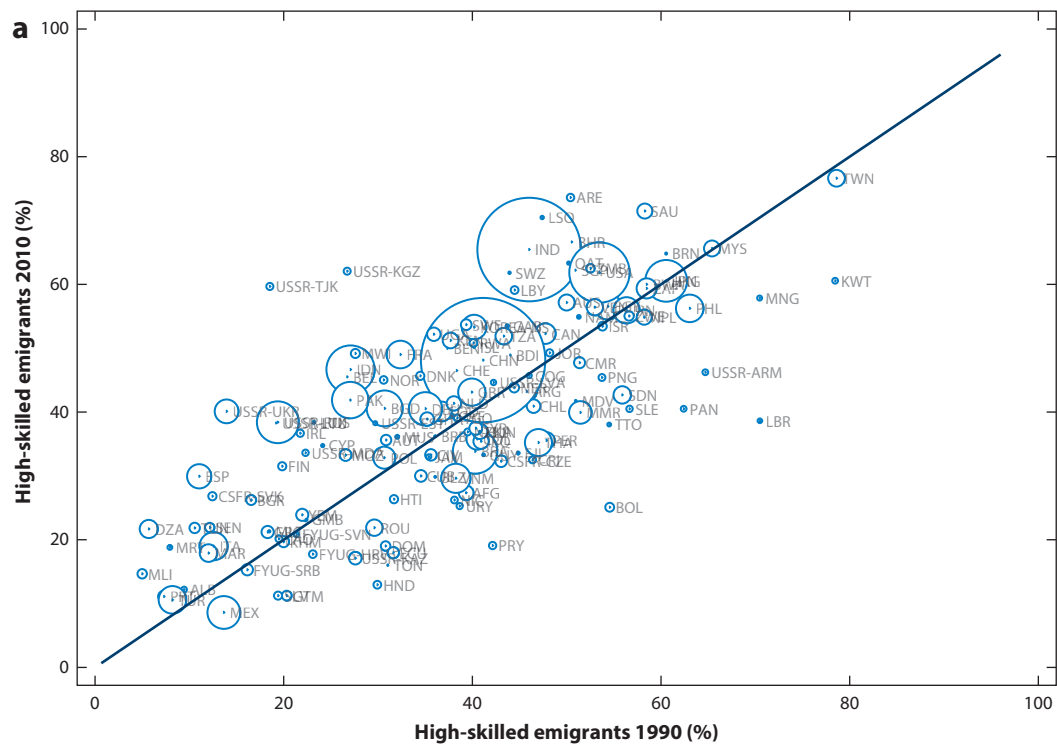
**Figure 1b** analyzes whether incoming immigrants are more or less educated than the resident native population among our OECD sample (i.e., immigrant selection). Many of these high-income destination countries exhibit positive selection, which reflects their policy efforts to attract and screen for high-skilled workers. Moreover, almost all of the negative-selection countries are quite close to the 45° line, indicating that any observed negative selection is quite weak. The most notable exception is the United States, which is the world's most prominent destination for high-skilled migrants, yet admits a migrant population that is on average less skilled than its native population. This is partly due to the fact that US natives are more educated than the native populations of most OECD countries. Interestingly, the four Anglo-Saxon countries that attract the highest proportions of high-skilled migrants—Canada, the United Kingdom, Australia, and New Zealand—implement points-based systems to varying degrees, which we discuss in Section 5. Finally, we note that Mexico also has a noticeable positive immigrant selection.

The patterns observed in **Figures 1a** and **b** are closely linked to the sharp rise in the overall number of high-skilled migrants to OECD countries, which increased by almost 130% from

**Figure 1**

Emigrant and immigrant selection, 2010. Circle diameters indicate each country's population. The 45° lines are shown for reference; all countries that lie above the line exhibit positive selection for high-skilled migration. (a) Emigrant selection from country of origin. The percentage of high-skilled natives is defined as the total population aged 25+ with any tertiary education divided by the total population aged 25+. The percentage of high-skilled emigrants is defined as the total number of tertiary-educated emigrants aged 25+ divided by total emigrants age 25+. Each observation is weighted by the total population at origin. (b) Immigrant selection into destination countries. The percentage of high-skilled immigrants is defined as the total number of tertiary-educated immigrants aged 25+ divided by total immigrants aged 25+. Figure data for high-skilled natives are taken from Barro & Lee (2013); data for high-skilled emigrants are taken from Arslan et al. (2014).





## Figure 2

Changes in emigrant and immigrant selection, 1990–2010 (see **Figure 1**). The 45° lines are shown for reference. (a) Changing emigrant selection to 29 countries of the Organisation for Economic Co-operation and Development (OECD). The percentage of high-skilled emigrants is defined as the total number of tertiary-educated migrants aged 25+ divided by total emigrants aged 25+ in 1990 and in 2010. (b) Changing immigrant selection to the same OECD countries. The percentage of high-skilled immigrants is defined as the total number of tertiary-educated immigrants aged 25+ divided by total immigrants aged 25+ in 1990 and in 2010. Figure data are taken from Docquier et al. (2009) and Arslan et al. (2014).

12 million in 1990 to 28 million in 2010 (Kerr et al. 2016). **Figures 2a** and **b** document changes in emigrant and immigrant selection, respectively, during this period. There does not appear to be a systematic trend in emigrant selection (**Figure 2a**); approximately half of the observations are on either side of the 45° line. By contrast, most OECD destination countries show greater skill selection in 2010 than 1990 (**Figure 2b**). This pattern aligns with observations that the immigration policies of many destination countries are becoming increasingly selective (e.g., de Haas et al. 2016). For example, we see that Canada is consistently selective, whereas the United Kingdom demonstrates the largest increase in selectivity. The United States is again a notable exception, along with Italy, Portugal, and New Zealand, falling somewhat below the 45° line.<sup>8</sup>

As a result of increasing global integration and rising education levels, the number of empty high-skilled migration corridors (i.e., those along which no migrants travel whatsoever) in 2010 totaled just 15% of all potential corridors in our data (631 of the 4,176). This represents a 50% decline in zero-valued cells since 1990. Over the same period, the average high-skilled migration corridor increased by 127% to almost 6,400 individuals. A natural implication of these trends is that high-skilled migrant stocks are becoming more diversified over time, which can yield developmental benefits (Alesina et al. 2016).<sup>9</sup> Herfindahl indices show a lower concentration of origin countries for high-skilled workers than for low-skilled workers. Moreover, since 1990, the high-skilled migrants in OECD countries have hailed from an increasingly wide set of origin countries. By contrast, lower-skilled migrants in OECD countries are increasingly arriving from fewer origin countries.

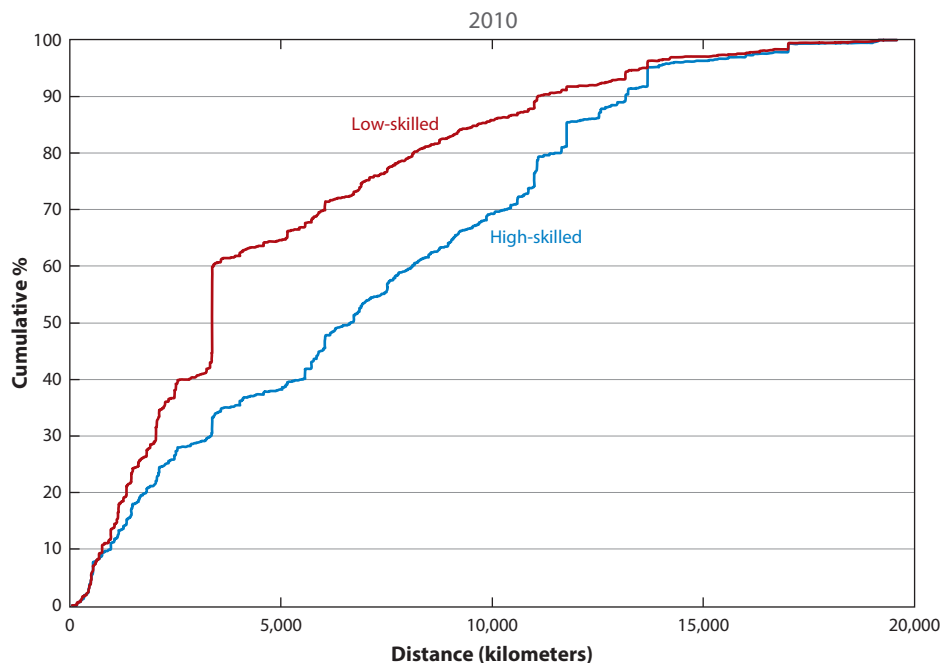
**Figure 3** further demonstrates that high-skilled migrants tend to travel farther to their destination countries than their less skilled compatriots. This graph shows the cumulative distribution of distances traveled by migrants of different skill levels in 2010. We rank each bilateral corridor by the distance between them and tabulate the cumulative share of migration as we add more distant corridors. The figure reveals that the median distance traveled by a high-skilled migrant is 7,000 km, whereas it is below 4,000 km for low-skilled migrants.<sup>10</sup>

Another stark and first-order trend is the significant agglomeration of high-skilled migrants. Artuç et al. (2015) estimate that around two-thirds of all international high-skilled migrants resided in OECD countries in 2000, despite these countries collectively constituting less than one-fifth

<sup>8</sup>The higher selectivity in **Figure 2b** can be reconciled with the limited trend in **Figure 2a** when one observes that very populous countries like China and India lie above the 45° line in **Figure 2a**. It is also interesting to note that the negative selection to emigration from Mexico is becoming more pronounced with time.

<sup>9</sup>Global firms seek to draw talent from around the world, often claiming that they cannot find adequate pools of talent in their home countries. Labor market shortfalls can arise due to factors such as rapidly increasing demand, limited training capacity, and extended length of training. Medical professions are the most prominent examples of these constraints. The recruitment of migrants to fill such gaps can result in far more diverse high-skilled work forces.

<sup>10</sup>By contrast, the differences in step size of the GDP per capita between home and host country are more similar across skill levels.



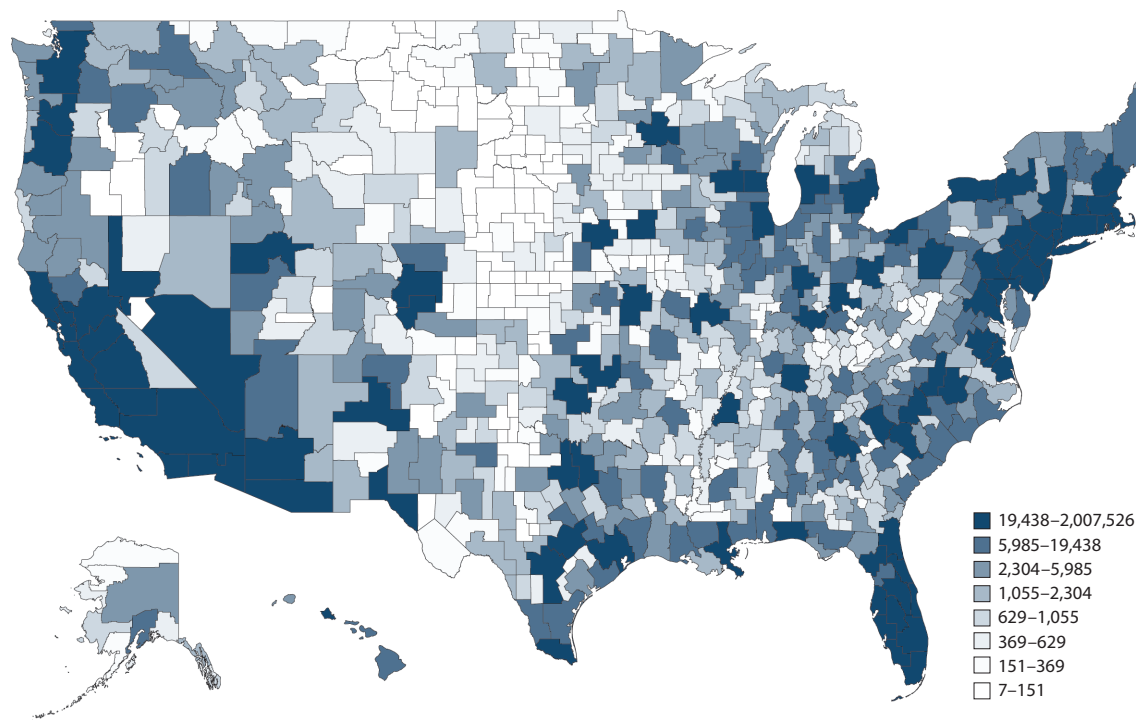
**Figure 3**

Cumulative distribution of migration distance, 2010. The graph plots the relationship between the stock of immigrants to Organisation for Economic Co-operation and Development (OECD) countries and the distance between their destination and origin countries. High-skilled individuals are defined as those with a tertiary-level education and who are aged 25+. Data are taken from Arslan et al. (2014).

of the world's population. Furthermore, the distribution is exceptionally asymmetric even within the OECD. Four Anglo-Saxon countries—the United States, Canada, Australia, and the United Kingdom—host over two-thirds of all high-skilled immigrants in the OECD. This particular concentration has declined somewhat with time but remains exceptionally strong (for an additional analysis of migrant concentrations, see Özden & Parsons 2016).

Agglomeration of talent is a natural phenomenon that also occurs within countries. **Figure 4** plots the stark regional concentrations of high-skilled migrants in the United States in 2010. Significant concentrations of high-skilled migrants occur in Boston, Northern and Southern California, Chicago, New York City, Miami, and Seattle, among other places. Such patterns are reflected globally, with capital cities (e.g., London) and large urban clusters hosting the substantial majority of high-skilled migrants in each country. As in the case of their geographic concentration, high-skilled migrants also agglomerate by occupation or sector. This can reflect the response of migration to domestic shortfalls in native skills or the concentration of migrants in occupations and industries that benefit from agglomeration or diaspora networks. Innovation areas of the United States (such as Silicon Valley, Boston, or Seattle) tend, for example, to show higher levels of immigrant concentration in science and engineering professions compared to other areas (Silicon Valley Compet. Innov. Proj. 2016).

As stark and asymmetric as these high-skilled patterns are, they become even more accentuated at the very highest skill levels (Wasmer et al. 2007, Akcigit et al. 2016). This is true in almost every high-skilled profession, e.g., in academia, entertainment, entrepreneurship, literature, medicine, science, and sports. Migrants have won half of the 56 Fields Medals, awarded every four years for



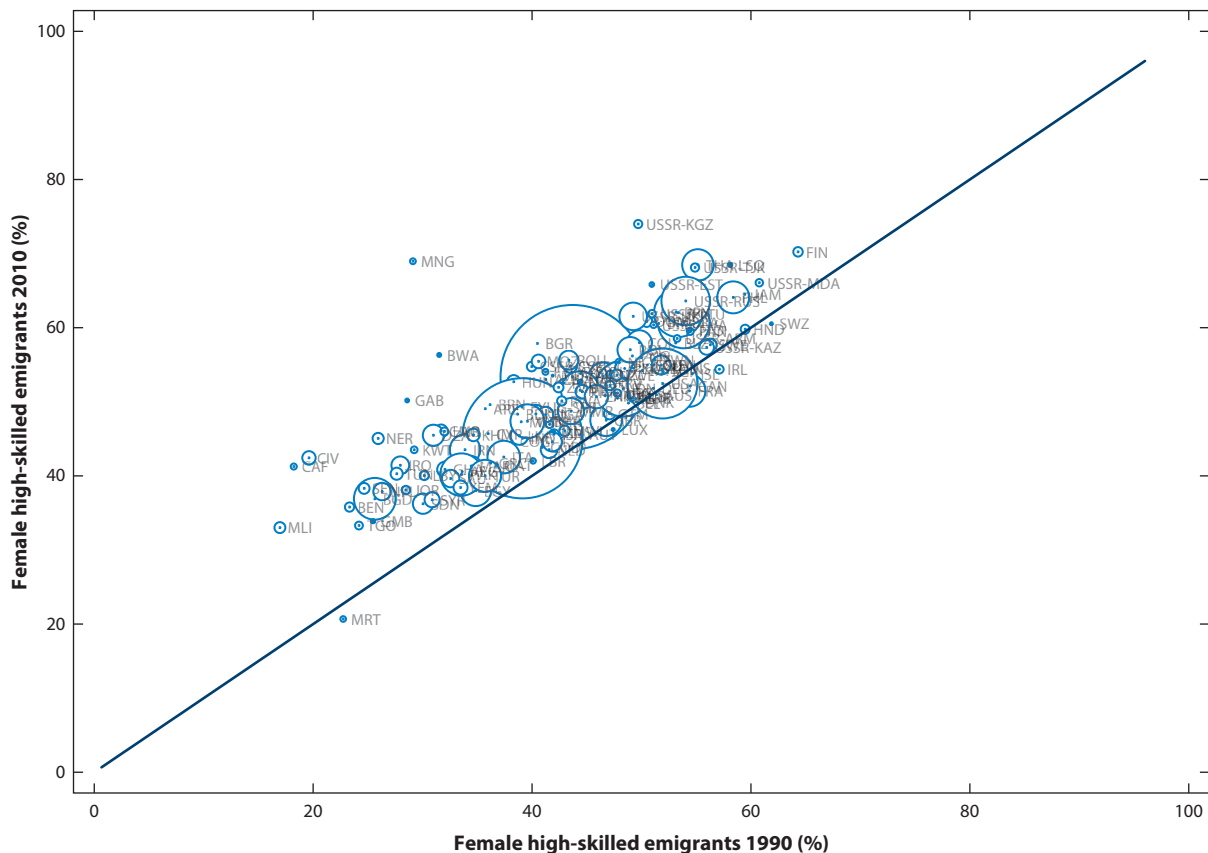
**Figure 4**

Distribution of high-skilled migrants (count) in the United States, 2010. High-skilled migrants are defined as those with at least one year of tertiary education. Data on high-skilled migrants by Public Use Micro Areas are drawn from the 5-year sample of the American Community Survey (Ruggles et al. 2015). These data are subsequently merged into 1,990 Commuting Zones using the crosswalk files and weights developed by Dorn (<http://www.ddorn.net/data.htm>).

outstanding achievements in mathematics, including the most recent award, which went to the first female winner, Iranian-American Maryam Mirzakhani. One-third (15 out of 46) of the winners of the Man Booker prize, a prestigious literary prize awarded to fiction published in the English language, are immigrants (e.g., Salman Rushdie, V.S. Naipaul). Kerr et al. (2016) provide similar statistics for the Nobel Prizes and the John Bates Clark medal, as well as examples from sports ranging from the National Basketball Association in the United States to the English Premier League in the United Kingdom.<sup>11</sup>

Another important but much understudied feature of high-skilled migration is the rapid rise of high-skilled female migration. From 1990 to 2010, the migration of high-skilled females to OECD countries rose by 157%, compared to 106% for males. By 2010, high-skilled female migrants outnumbered high-skilled male migrants. As a proportion of total high-skilled migration, females accounted for a higher percentage across every OECD destination except Spain, although three other Southern European countries, Greece (60%), Portugal (60%), and Italy (65%), exhibited the

<sup>11</sup>In an advocacy piece, Anderson (2013) calculates that more than 40% of Fortune 500 companies were founded by immigrants or their children, with some 18% being founded directly by first-generation immigrants. Broader studies for the United States tend to find evidence for immigrants being more entrepreneurial than natives (e.g., Hunt 2011, Fairlie & Lofstrom 2014, Kerr & Kerr 2016).



**Figure 5**

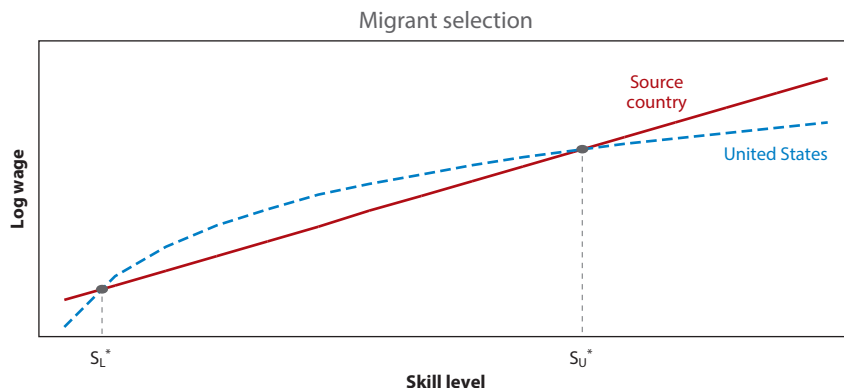
Change in selection on gender in high-skilled emigration to 29 Organisation for Economic Co-operation and Development (OECD) countries, 1990–2010. The percentage of female high-skilled emigrants is defined as the total number of female tertiary-educated emigrants aged 25+ divided by total tertiary-educated emigrants aged 25+ in 1990 and 2010. Each observation is weighted by the total population in the country of origin. Data taken from Docquier et al. (2009) and Arslan et al. (2014).

largest overall proportions. Mirroring this trend in destination countries is the significant feminization of high-skilled emigration from almost all origin countries in the world, as shown in **Figure 5**.

#### 4. DEMAND FACTORS SHAPING HIGH-SKILLED MIGRATION FLOWS

What lies behind these high-skilled migration patterns? As early as the work of Smith (1776), economists have discussed the movement of workers to take advantage of higher wage opportunities. The theoretical framework for studying human-capital flows has its beginnings in 1932, when John Hicks noted that “differences in net economic advantages, chiefly differences in wages, are the main causes of migration” (Hicks 1932).<sup>12</sup> The standard textbook model used to explain the self-selection of immigrants by skill level is an adaptation of the Roy (1951) model. In Borjas’ (1987) version of the Roy model, there is a skill distribution of individuals in both the destination

<sup>12</sup>Sjaastad (1962) and Neal & Uselding (1972) provide examples of early work on human capital and migration decisions.



**Figure 6**

Self-selection of immigrants by skill—intermediate case. Intermediate selection of migrants arises from nonlinear returns to skill in the destination country (the United States) and fixed migration costs across skill groups. Individuals with a skill level between a lower skill bound ( $S_L^*$ ) and a higher skill bound ( $S_U^*$ ) will choose to migrate, whereas those with greater or weaker skill levels will not. Chiquiar & Hanson (2005) discuss a similar model.

and the source countries. Individuals' migration decisions are governed by the relative returns of their skills in both locations, as well as the migration costs they face. Depending on the shapes of the skill–earnings locus and migration costs, positive, negative, and intermediate selection are possible. As one illustration of these models, **Figure 6** shows a simple graphical example, adapted from the work of Chiquiar & Hanson (2005), of intermediate selection arising from nonlinear returns to skill in the destination country (the United States) and fixed migration costs across skill groups. Individuals with a skill level between a lower skill bound ( $S_L^*$ ) and a higher skill bound ( $S_U^*$ ) will choose to migrate, whereas those with greater or weaker skill levels will not.

Grogger & Hanson (2011, 2015) emphasize that immigrant selection and sorting are important features in the high-skilled migration phenomenon. Selection (as described above) refers to how migrants are chosen from the skill distribution of the origin country, and sorting refers to how these migrants choose among potential destination countries. In the simplest case, the relative return to skill across countries (i.e., differences in wage–skill premiums) determines the skill composition of the migrant flows between any pair of countries. Individuals with the highest skill levels tend to migrate to countries with higher earnings variance to receive the greatest wages. This can explain why, for example, the United States and Canada receive a much larger share of high-skilled migrants compared to European countries, where the earnings distributions are more compressed.

How economic growth and changes in migration regimes impact migrant flows depends upon the shape of the skill–earnings locus. With linear skill–earnings profiles and positive selection, for example, overall wage growth in the host country shifts the skill threshold for migration to the left. More people migrate from the source country, and the skill level of the average migrant falls. In contrast, an increase in migration costs (e.g., a more demanding visa system) shifts the skill threshold to the right and thus increases the average skill composition of migrants.

If migration costs are not proportional to earnings but are instead fixed across skill groups (e.g., the costs of a visa or work permit are identical across skill levels), the positive selection of emigrants becomes more likely (Borjas 1991, Chiquiar & Hanson 2005). Indeed, the role of migration costs is crucial for explaining why we observe very different patterns of selection of emigrants from China

and India versus from Puerto Rico to the United States.<sup>13</sup> When migration costs are proportional to earnings, negative selection is more likely, as in the case of migration flows from India to the Persian Gulf States. On the other hand, where migration costs are fixed in nature, we tend to get a strongly positive selection of emigrants, as in the H-1B visa program to the United States.<sup>14</sup>

The basic Roy framework can handle many scenarios and explain many of our observations. We focus on positive hierarchical sorting, where migrants are positively selected from the source-country skill distribution and fall into the upper half of the host-country skill distribution; this is the most empirically relevant scenario, as described in the last section. The conditions for this type of selection require that the host country has higher returns to skill and that the skill demands of the host and the source country are highly correlated. These cases lead to strong talent flows from sending countries. Indeed, due to a wide earnings distribution, comparatively low taxation, and low tax progressivity, the returns to skill are greater in the United States than in most other countries. Akcigit et al. (2016) connect these taxation features of countries to the global migration of very high-quality inventors. The Roy framework also makes clear why demand for South-to-North migration would be substantial from developing economies that have wage curves that sit completely below those in advanced countries.<sup>15</sup>

Although powerful, the textbook Roy model of selection and sorting is insufficient to explain all aspects of high-skilled migration (even before considering admission decisions by countries). For example, the causes of the differences in wage profiles across countries are crucial when explaining persistence. Some differences arise because locations have different levels of financial and physical capital, technology, complementary workers, and institutions. All of these factors impact the quality, productivity, and resulting wages of the jobs present (Moretti 2012). General equilibrium effects of high-skilled migration may narrow the wage differences that prompt the initial movements of talent if they are due to relatively fixed factors. This would be particularly true if wage profile differences originated from workers of different skill levels complementing each other. In fact, this scenario can be the basis for the migration version of the Lucas paradox: Why doesn't human capital flow from rich to poor countries?

At this juncture, agglomeration effects and productivity spillovers become relevant. With agglomeration effects, the presence of high-skilled people in a geographic location—regardless of whether they are natives or immigrants—may increase the incentives for additional high-skilled people to move there. This would be consistent with the patterns observed in the data. Many high-skilled occupations and sectors with high shares of migrants exhibit an agglomeration effect. Each individual's productivity is enhanced by the presence of or collaboration with other skilled workers employed in similar or related occupations and sectors. In fact, in the presence of agglomeration effects, migration of the highly skilled into a geographic area or sector need not lead to a decline in returns to skills or to wages. As a result, this mechanism can be quite self-reinforcing, as embodied in the endogenous growth literature (e.g., Jones 1995). Agglomeration effects make the rewards for higher skills much higher in one country than in others, and they also create differences across locations within the same country. Prominent examples of agglomeration include Silicon Valley,

<sup>13</sup>Migration costs have been the focus of a recent wave of studies (e.g., Beine et al. 2011; Docquier & Rapoport 2012; Grogger & Hanson 2011, 2015).

<sup>14</sup>The migration cost literature also separates out actual moving and assimilation costs versus the cost of obtaining entry into the country in the form of a visa, citizenship, or other means (e.g., Beine et al. 2011).

<sup>15</sup>Recent research studies historical settings where migration was a result of dire economic and social situations. Moser et al. (2014) examine the discharge of German Jewish chemists from Nazi Germany, and Borjas & Doran (2012) examine the fleeing of Russian mathematicians after the collapse of the Soviet Union. These refugee examples are one extreme form of selection, when the economic opportunities in the source country collapse.

Hollywood, and Wall Street, as well as professional sports teams, top academic departments, and research centers.

At the core of the agglomeration process is trade in services provided by high-skilled people. In the Silicon Valley example, high-tech companies compete with each other globally; their market is not limited to Northern California. Thus, there is no inherent limit as to how many firms can physically locate in Silicon Valley. On the contrary, the presence of entrepreneurs, engineers, and scientists leads to employment of others like them as they start new firms or expand existing ones. They share technical knowledge and business information through their social and professional networks, which become more efficient through closer physical proximity. Furthermore, thicker local markets for skilled labor can allow specialization that helps high-tech firms improve their products and compete better globally. High-skilled immigrants allow existing engineers and managers to specialize and become more productive, creating better products for worldwide consumption. Moreover, the agglomeration of activity in a specific geographic location allows a larger-scale presence of complementary specialized inputs and service providers such as legal counsels, marketing executives, and investment bankers.

Another important consideration for migrants is the location of providers of higher education. Much of the theory—whether based on the Roy selection model or agglomeration effects—describes movements of high-skilled individuals, taking their skill levels as predetermined prior to their migration. However, much of the true migration flow is instead first prompted by opportunities for education and skill development in destination countries. It is helpful to consider skill in this context to include both unobserved abilities and formal education because many eventually high-skilled immigrants originally arrive with only their innate intelligence and motivation and with few observable skills and low education levels. These immigrants choose destinations based on the quality of available schools, the possibility of subsequently entering the labor market, and future professional opportunities (see, e.g., Rosenzweig 2006; Kato & Sparber 2013; Grogger & Hanson 2011, 2015). Bound et al. (2015b) show how migrants from China and India can realize a large return by completing a college degree in the United States and remaining there to work afterwards. Many other countries have high shares of foreigners among their student populations, including the United Kingdom (19%), Australia (22%), and Canada (8%).

Additional issues observed in the data arise in return and onward migration (for an analysis of the United States, see Artuç & Özden 2017). From a policy point of view, it is important to know how long skilled migrants remain in a destination country and the characteristics of those who eventually decide to return home or continue on to a third country. The expected length of stay upon entry can impact, for example, the effort that a migrant exerts to assimilate into the host country. The actual length of stay and life stages covered also strongly influence how migrants impact public finances (see, e.g., Storesletten 2000, 2003; Kerr & Kerr 2011; Liebig & Mo 2013; Dustman & Frattini 2014). At an extreme, an adult migrant who works for only a few years in a host country will typically provide more tax revenue than public services consumed. In cases where the migrant's schooling or healthcare expenses are publicly funded in the host country, high-skilled migrants might then represent a net cost to their host country.

Although data for circular migration remain frustratingly limited, the OECD (2008) has made an extensive effort to uniformly compile this information. This report shows that 20–50% of migrants leave within five years of arrival, with some variability by country pair and time period.<sup>16</sup> Broadly, high-skilled migrants appear more likely to leave than low-skilled migrants, but the

<sup>16</sup>The historical patterns agree with these numbers: More than half of the migrants who came to the United States during the mass migration period eventually returned home (Bandiera et al. 2013).

relationship varies and is frequently nonmonotonic in skill levels (see, e.g., Pohl 2006, Dustmann & Weiss 2007, Finn 2007, Aydemir & Robinson 2008, Gundel & Peters 2008, Gibson & McKenzie 2009, Harvey 2009, Bijwaard 2010, Bijwaard & Wahba 2014). At the very highest skill levels, return rates from the United States become substantially lower. Gaule (2014) calculates that less than 10% of foreign-born chemistry faculty in US Ph.D.-granting institutions go back to their home countries, with those from China and India especially unlikely to return. As in our examples above using sports players, the most productive chemists are also the most likely to stay in the United States.

Textbook models tend to consider migration as an individual location choice resulting from maximization of income and other personal objectives. Yet many high-skilled migration decisions have other actors involved—most notably firms that move their workers across national borders (Kerr et al. 2015a). The scale and growth of workforces within multinational firms are often underappreciated and underexplored in the migration literature. Global companies like IBM, General Electric, and Siemens usually employ at least half of their workforces outside of their headquarters country. Although unskilled workers are often drawn from the local labor markets within each country of operation, experienced high-skilled workers and especially senior managers are frequently transferred to different country offices throughout their careers. In addition, many large high-tech companies send recruitment teams to the best engineering schools in India, China, and other emerging economies. Some of the selected individuals, as the model would predict, may then migrate to the United States or Europe within the firm based upon individual decisions and relative wage differences. Observers predict that this type of migration will continue in the foreseeable future because large (in absolute numbers) cohorts of students continue to graduate in China, India, and other countries (Freeman & Huang 2015).

The complete picture is even more complex and multidirectional, with top-notch talent flowing within firms in ways that no standard economic model would predict. Global companies often seek to build their presence in the largest consumer markets, and developing countries provide great potential for rapid growth. Companies send their best employees abroad to enable and lead this corporate development, paying salaries commensurate with or better than what the employee would have earned at home and far in excess of what is typical in the destination country. As an example, Honeywell, a multinational conglomerate with strong roots in aerospace, uses the terminology of high-growth regions instead of emerging markets to describe these overseas assignments to employees because global opportunities account for the majority of the firm's growth. Additional factors, such as tax policies or environmental regulations, also shape the location choices of multinationals and their distributed labor demand. In multinational companies, one or more overseas assignments are common prerequisites for being promoted into the very senior leadership positions. Many global companies, including Rakuten in Japan and Nokia in Finland, also require all employees to speak a common language, usually English (Neeley 2012).

In summary, the classic model of migration decisions needs to be augmented to account for the multidirectional nature of high-skilled migration and the large variations in patterns across countries. The interesting patterns are intuitively linked to the behavior of global firms, institutional and educational differences over countries, and productivity spillovers. This is especially true for superstar talent, for whom global movement and connectivity is almost a necessity for productivity. Further extensions of the basic theory and empirical work to high-skilled migration are a top priority.

## 5. POLICY FACTORS SHAPING HIGH-SKILLED MIGRATION FLOWS

The demand and supply of high-skilled migrants and the resulting flows are shaped at least in part by national (migration, labor market, and education) policies. High-skilled migration

policies are increasingly popular tools implemented by policy makers to attract and select economic migrants. Typically, destination countries adopt one of two broad migration policy regimes (Kerr et al. 2016). The first regime, based on demand-driven policies, requires that incoming migrants must first acquire a job in the destination country. Migrants' almost immediate employment is therefore prioritized, and potential employers and current labor market conditions play a key role in determining who is able to migrate. The second type of regime, based on supply-driven policies, instead requires incoming migrants to be evaluated by a points-based system, with points awarded along numerous dimensions like age, education, professional experience (or earnings), occupation, language proficiency, and so on. Some argue that supply-side policies reflect a more flexible notion of human capital and adopt a longer-term view, and Boeri et al. (2012) argue that immigration policies are only able to effectively attract and fully employ human capital if they are orientated toward longer-term objectives.

In contrast to this extreme depiction, most countries combine elements of both approaches and implement many other policy instruments such as quotas, shortage lists, labor market tests, supplementary points-based tests, postentry rights,<sup>17</sup> policies to protect the employment of natives, financial incentives, etc. These additional elements generally aim to make an immigration destination more attractive to potential migrants while protecting domestic workers against very strong competition. Moreover, in addition to implementing certain policies (the extensive margin), countries also decide upon the stringency with which they enforce existing policies (the intensive margin). Thus, it is also far from clear whether various policy elements act in the same or opposite directions for the same individual. These inherent contradictions make comparing the efficacy of policies across countries and over time quite challenging. As such, Parsons et al. (2014) emphasize the analysis of policy systems, which comprise various policy elements that need to be evaluated in tandem with one another.

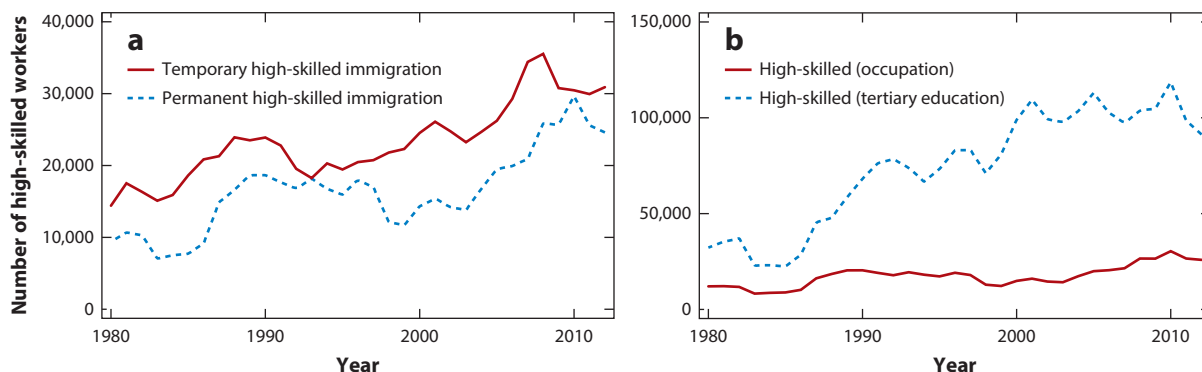
Recording and measuring policies are complex, but testing their effectiveness proves even more difficult for two reasons. First, high-skilled migrants consider a raft of socioeconomic and noneconomic factors when deciding where to move. Papademetriou & Sumption (2013) term these the immigration package, and our measurement of this mix is quite poor. Second, estimations are most useful for policy work when they tightly match the target population, but this requires detailed migrant flow data that are very difficult to assemble (Czaika & Parsons 2016, 2017).

Comparisons of supply and demand policy approaches should account for their differences in terms of their intended time horizons and varying definitions of human capital. **Figure 7a** plots incoming high-skilled migrant flows to Canada between 1980 and 2012, disaggregated by duration of stay.<sup>18</sup> Although these flows follow a similar trend, there are certain meaningful differences that would influence the results of analyses conducted at annual frequency. Next, **Figure 7b** plots migrants of all durations of stay and analyzes definitions of high-skilled migrants by the occupation (ISCO categories 1–3) in contrast with education (tertiary level). These series differ quite wildly given the substantial growth of migration to Canada based upon education and without a recorded occupation upon arrival.

Another important issue is the point in time at which migration actually occurs. It is somewhat natural to think that migrant inflows in a given year imply arrival of migrants across a country's border in that year. However, the timeline may be far from clear because many migrants change

<sup>17</sup>Examples of these rights include provisions for family reunification and spouses' rights to employment and permanent residence.

<sup>18</sup>A migrant in this analysis is deemed high-skilled if he or she is working in an occupation that falls into the first three categories of the International Standard Classification of Occupations (ISCO): (1) managers, senior officials, and legislators; (2) professionals; and (3) technicians and associate professionals.

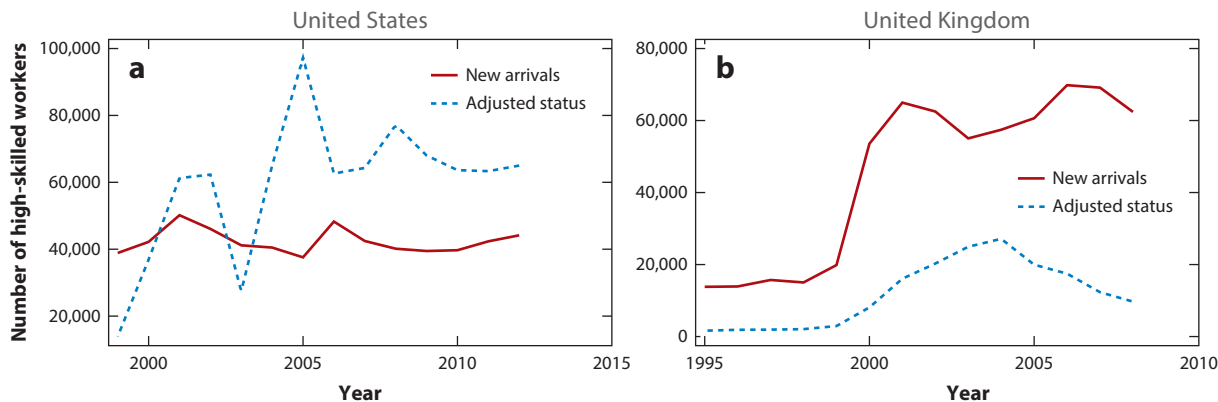


**Figure 7**

Canadian immigration structure, 1980–2012. (a) The graph distinguishes between high-skilled migrants' duration of stay, either temporary or permanent, defining migrants as high-skilled if they are employed in an occupation in the first three categories of the International Standard Classification of Occupations (ISCO): (1) managers, senior officials, and legislators; (2) professionals; and (3) technicians and associate professionals. (b) The graph includes migrants of all durations of stay but distinguishes between high-skilled migrants as defined by their occupation (ISCO categories 1–3) and as defined by attainment of a tertiary education. Data for the figure taken from Citizenship and Immigration Canada (<http://www.cic.gc.ca/english/>).

their legal status while they are in the country without actually moving and are thus interpreted as new arrivals in the administrative records. This distinction is highlighted for the United States in **Figure 8a** by plotting the annual rates of new arrivals and those adjusting their status by obtaining permanent residence as they exit from their visa status. **Figure 8b** similarly considers the data for the United Kingdom. Those from outside of the United Kingdom are recorded as having received work permits, whereas those individuals that transferred to employment status are deemed to have been granted first permission to work. These figures show that high-skilled migrants enter the labor market through very different channels in the two countries. The United States experiences greater numbers of high-skilled migrants obtaining permanent resident status through adjustments after having previously arrived on a temporary or a student visa. By contrast, most high-skilled labor migrants to the United Kingdom arrive with direct work permits from abroad and are subject to greater initial screening.

Given these complications, it is perhaps not surprising that studies evaluating the effectiveness of high-skilled migration policies are sparse (Rinne 2013). Early studies on the topic typically examined single destination countries. In the case of Canada, for example, Green & Green (1995) conclude that changes in the points-based system introduced in 1967 influenced the occupational composition of incoming migrants. Miller (1999) examines the Australian policy system and argues that unemployment rate differentials across migration categories reflect migrants' characteristics as opposed to their entry channel. Cobb-Clark (2003), also in the case of Australia, finds that immigrants facing more stringent entrance criteria fared significantly better in terms of their labor market integration. Antecol et al. (2003), who analyze the immigration policies of Australia, Canada, and the United States, argue that the relatively low average skill level of migrants to the United States is largely driven by the geographic and historic proximity of Mexico rather than differences in immigration policy. In more recent years, the literature has tended to examine the effect of high-skilled migration on particular outcomes by utilizing changes in high-skilled policies as an identification strategy (e.g., Kerr & Lincoln 2010) rather than by testing the efficacy of policy in meeting its stated objectives.



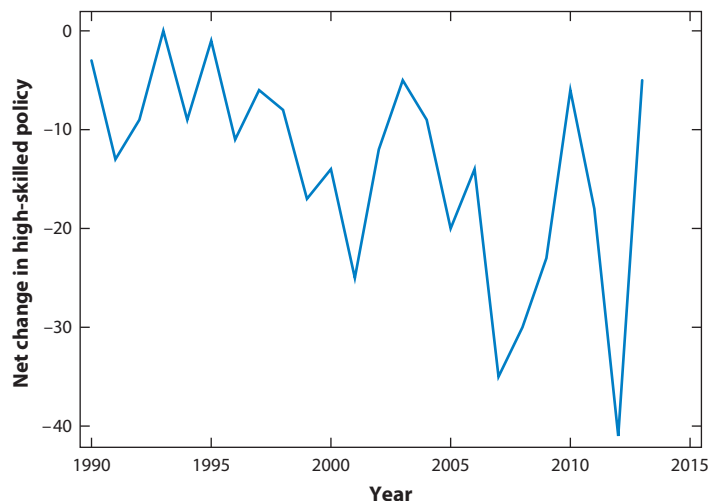
**Figure 8**

Annual rates of new arrivals versus rates of status adjustment (obtaining permanent residence by exiting from visa status) in (a) the United States and (b) the United Kingdom. The differences in when migration flows are actually recorded in the United States and United Kingdom, respectively, are highlighted. Migrants are defined as high-skilled if they are employed in an occupation in the first three categories of the International Standard Classification of Occupations (ISCO): (1) managers, senior officials, and legislators; (2) professionals; and (3) technicians and associate professionals. Data were taken from the United States Department of Homeland Security (<https://www.dhs.gov/office-immigration-statistics>) and the United Kingdom Office of Immigration Statistics (<https://www.gov.uk/government/organisations/uk-visas-and-immigration>).

To facilitate better comparisons across countries and more systematic assessments, large-scale projects seek to build global databases of high-skilled migration policies. The DEMIG POLICY database (de Haas et al. 2016) extends the methodology of Mayda (2010) to codify 6,500 migration policy changes made by some 45 countries during the period 1900–2014. An important feature of this database is the fact that absolute levels of policy criteria are not recorded; only policy changes are included, and the degrees to which they are more restrictive, neutral, or less restrictive are detailed. The degree to which policies have been enacted is unknown. Nevertheless, a number of additional dimensions have been added to flesh out more detail, including the level of legislation, the level of policy change, the areas covered by the policy, the tools used by the policy, and details on the specific target population. The DEMIG POLICY database proves particularly useful for high-skilled migration research because it separately identifies policies aimed specifically at high-skilled migrant flows. **Figure 9** depicts the average net weighted change in policy stance toward high-skilled migrants over the period 1990–2013. All of the net changes are negative, indicating that the policy stance of OECD members has become more relaxed toward high-skilled migration in every year since 1990.

In a companion project, Czaika & Parsons (2016, 2017) construct a dataset of a series of variables for 19 OECD countries, detailing whether 1 of 15 specific policies are in place or otherwise for each year during 2000–2012. This approach allows greater scope for analysis of variations within and between countries, although they do not measure the intensity of enforcement. Czaika & Parsons (2017) find that supply-driven systems prove more effective in increasing the absolute numbers of high-skilled migrants and the skill composition of incoming cohorts.

Also in development are two additional databases that use new approaches: the International Law and Policy Analysis (IMPALA) database (Gest et al. 2014; Beine et al. 2015a,b) and the Immigration Policies in Comparison (IMPIC) database (Bjerre et al. 2014). The construction of IMPALA is guided by legal experts who deconstruct immigration policies at the national level from

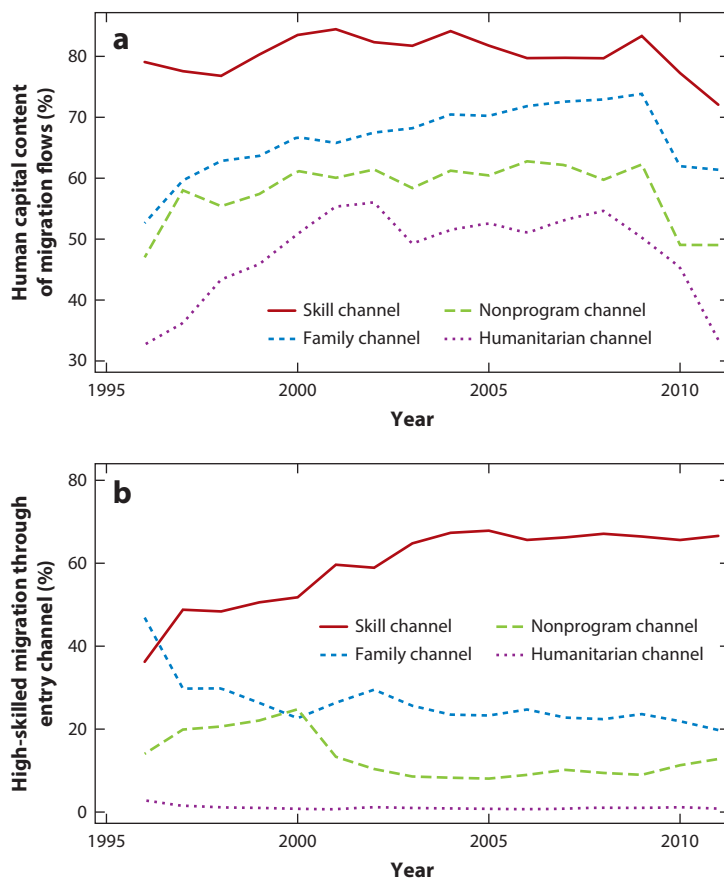


**Figure 9**

Permissiveness of Organisation for Economic Co-operation and Development (OECD) high-skilled migration policies, 1990–2013. The graph shows the average net weighted change in policy stance toward high-skilled migrants over this time period. The fact that all of the net changes are negative indicates that OECD policies toward high-skilled migrants have become more relaxed over time. Data is taken from the DEMIG POLICY database (<https://www.imi.ox.ac.uk/data/demig-data/demig-policy-1>).

legal texts (i.e., de jure rules) into hundreds of binary or categorical variables. Their main units of analysis are the entry paths—family reunification, high-skilled policies, lotteries, asylum, etc. Similar to the work of Czaika & Parsons (2016), these binary variables can be variously aggregated up to form indices that embed dimensions of interest. To date, IMPALA includes nine countries and covers the period 1999–2008. The IMPIC database also draws upon country legal experts to code specific levels of restrictiveness that range from zero to one in each country and year. The project aims to collect data for 33 OECD countries for the period 1980–2010. One particular advantage of these two databases is that the intensive and extensive margins of policies can be evaluated simultaneously, which has the potential to dramatically increase our understanding of the role of migration policies.

As noted above, a crucial and frequently overlooked aspect of the current literature is the fact that a high-skilled worker can arrive through channels quite separate from the simple labor channels emphasized by theory (either exogenously or endogenously). Reliable and detailed administrative data that facilitate analyses of high-skilled workers arriving through noneconomic channels are difficult to access. Australian data, for example, distinguishes four main channels: a skill channel for those that enter Australia for the primary purpose of work, a family channel, a humanitarian channel, and a nonprogram channel that comprises those migrants who had previously resided in Australia without having obtained permanent settlement. **Figure 10a** shows an intuitive ordering in which the proportion of high-skilled migration is highest for the skill channel and lowest for those entering Australia for humanitarian reasons, but the differences are not large. **Figure 10b** shows that at least one-third of high-skilled migrants since the late 1990s have entered Australia through a back door channel other than the skill channel. In a similar spirit, Hunt (2011) shows that high-skilled migrants enter the United States through a variety of visa categories and that these differences are connected to subsequent performance, especially on innovative and entrepreneurial outcomes. There is every reason to suspect this phenomenon is widespread across



**Figure 10**

Human capital arriving through back door channels in Australia. The data detail four main channels of entry: work, family, humanitarian, and nonprogram (largely made up of migrants who previously resided in Australia without having obtained permanent settlement). Migrants are defined as high-skilled if they are employed in an occupation in the first three categories of the International Standard Classification of Occupations (ISCO): (1) managers, senior officials, and legislators; (2) professionals; and (3) technicians and associate professionals. (a) The graph shows how the proportions of high-skilled migrants vary with different immigration channels in Australia. (b) The graph documents what proportions of total high-skilled migrants to Australia arrive through the different immigration channels. At least one-third of high-skilled migrants since the late 1990s have entered Australia through a back door channel other than the skill channel. Data for the figure were taken from the Australian Department of Immigration and Border Protection (<https://www.border.gov.au/>).

all destination countries, and researchers need to look more closely at its implications both for studies of single programs or channels and in aggregate.

Noticeably, there are few effective or extensive bilateral or regional agreements on migration of workers, and it has been frequently noted that there is no World Migration Organization to govern global mobility regimes, as the World Trade Organization does for trade policy. Instead, we have a complex dance of countries taking unilateral actions and some bilateral or regional arrangements emerging along the way. Research needs to move from a narrow focus on one country or channel to a multichannel perspective for a single country or a multicountry perspective in a global setting.

The trade literature, for example, has developed substantially around the Eaton & Kortum (2002) model, which allows for depictions of global Ricardian trade. The European Union offers a live case study that should be closely analyzed in years to come, after it has opened the doors for internal migrant flows and curtailed gatekeeping by individual countries (only to have some doors potentially closed by Brexit).

Coming from the opposite direction of this call for global analysis, and hopefully meeting it in the middle, is a call for greater consideration of the role of institutions such as firms and universities in shaping immigration policies and patterns. This is especially true in countries like the United States, which use demand-driven systems like the H-1B visa program for high-skilled migration. Rather than the migrants submitting applications to enter, the firms sponsor the H-1B visa applicants and make the applications, indicating that a firm-worker match is already in place. This worker could be a professional residing abroad, a foreign student graduating from a US university, a current employee of the firm abroad, or one of many other variants. There is relatively little screening of the visa applications beyond basic requirements for the worker and work conditions, and visas are allocated on a first-come, first-served basis up to an annual cap. A lottery is employed in years when demand outstrips supply within one week, which occurs in robust economic times like 2016. The regulated and capped supply lacks a pricing mechanism, and no limits are placed by occupation, sector, or nationality. Upon arrival in the United States for work, the high-skilled migrant is effectively tied to the sponsoring firm until he or she obtains permanent residency or a temporary visa sponsored by another firm. The firm can potentially sponsor the employee for a green card, a process that takes 6 years (or longer for some nationalities), during which time the employee is even more closely tied to the firm, creating a modern version of indentured servitude in some cases. Kerr et al. (2016) provide greater details and comparisons with points-based approaches.

Given this setting, Kerr et al. (2015a,b) stress that research in the United States and similar demand-driven systems needs to take greater account of the firm. This is especially the case for multinational firms that employ larger numbers of migrants and make global sourcing and production decisions. Adopting a firm-oriented approach can represent a significant departure from models that are built on a conceptual lens of individual actions (e.g., a competitive labor market analysis for measuring employment effects, the Roy model of migration selection). Such models tend to push the firm into the background (e.g., providing a fixed demand curve for workers), whereas the reality is very different. Put starkly, rather than high-skilled migration decisions being based on generating the greatest individual gains, as is implicit in the earlier model, they can be seen as being about the greatest firm-level gains. These may be correlated, but the mapping is far from one-to-one. Moreover, differences in migration policy across countries may impact firm structures and global business competition.

In a policy framework where the economic motivations of firms take center stage, research needs to carefully consider how to adapt the standard techniques and empirical models developed for other labor market analyses. It is very important to understand how visas are used within the sponsoring firms and how the global and local business models of firms can be shaped given the constraints of the policy environment. As an illustration, many H-1B visas are issued to Indian outsourcing companies bringing their employees to the United States to substitute for domestic workers. This was not the original intent of the program, which was to address skill shortages. It is one of many examples where the motivations of policies meet the practicalities of decentralized implementation by profit-maximizing economic agents.<sup>19</sup>

<sup>19</sup> Along these same lines, colleges and universities play a very important role in shaping the future US high-skilled migration pool and labor market through their admissions decisions. The incentives of these institutions can also be different from

Data advances are aiding our understanding of this process in two important ways. First, the development of employer–employee datasets in many countries allows us to look inside the firms, as many of these databases record the nationality or immigration status of the worker. Kerr et al. (2015a,b) consider the Longitudinal Employer–Household Dynamics database for the United States. Beyond providing microdata, this line of research allows us to gain new perspectives that take into account the economic incentives of the firm. Kerr et al. (2015b), for example, quantify the extent to which employers use the visa program to keep their US-based workforces younger, thus taking advantage of lower wage rates, fewer family commitments, and so on. Opponents of the H-1B program have strongly criticized the program based on this feature (Matloff 2003), but it is not feasible to study it using classic labor economics approaches from perspectives that omit firms. Data that facilitate firm perspectives offer substantial promise along the same lines as has been observed in the international trade literature over the past decade, as the role of the firm took center stage. This will be especially true when integrated data begin to afford employee-level records for multinationals in many countries, allowing analysis to move beyond the administrative data of a single country.

Data are also helping to identify the role of firms in the lobbying process for migration policy. Given the importance of high-skilled migrants for their success, it is not surprising that firms attempt to shape the admissions process. Kerr et al. (2014) examine the lobbying efforts of US public firms for high-skilled migration, building upon the interest group work of Facchini et al. (2011) for broader immigration policies. (Public disclosure in the United States now requires firms to publicly release records of all of their lobbying activity and the issues on which they are engaged to the government.) This literature is very thin, especially relative to its importance, yet surprising results emerge. For example, Kerr et al. (2014) document that much of the US lobbying on high-skilled migration is done by firms that regularly lobby on many issues, which only partially overlap with the firms that are most dependent upon the migration policy outcomes. Going forward, we anticipate additional lines of inquiry will refine our understanding of these political-economy aspects of migration policy.

## 6. ECONOMIC IMPLICATIONS OF HIGH-SKILLED MIGRATION FLOWS

The implications of global talent flows are profound, and these flows have the power to influence all aspects of our professional and social lives. Freeman (2013) describes global knowledge as the “ring to rule them all.” This review cannot cover every topic, so we continue in this section by isolating themes connected to our conceptual focus on agglomeration economies and workplace outcomes. We also continue to focus upon areas where new data and methodological advances will unlock our ability to analyze important questions. Hanson et al. (2017) connect talent flows to frontier research in neighboring fields of international economics.

Not surprisingly, the labor market consequences of high-skilled migration for natives in receiving countries are significant themes of recent research (Docquier et al. 2014). These consequences are important for policy makers, and the observed wage and employment dynamics provide direct

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those originally anticipated by policy makers. For example, public institutions with tight or underfunded budgets can find foreign students very attractive due to the higher tuition rates that they pay. Moreover, institutions in remote and declining areas of the country may become very reliant on overseas students seeking to enter the United States for education and employment. Policy makers rarely anticipate all of these unintended approaches and gamesmanship practices when setting up policy structures.

evidence of the strength of agglomeration economies. This line of work has also been tightly connected with measuring the patenting, innovation, and entrepreneurial outcomes of migrants given the higher concentration of these inflows in STEM fields.<sup>20</sup> Indeed, many policy arguments have at their heart questions about whether high-skilled migrants generate or take away jobs and whether or not they expand technology frontiers to push growth.

Kerr (2017) describes the quantity and quality of US high-skilled immigration and reviews the nuanced results in the literature on this subject. In short, studies that look at variations across cities and regions tend to find results very consistent with agglomeration economies, quantifying the fact that high-skilled migrants boost innovation and productivity outcomes. These studies also rarely find adverse wage and employment consequences, and longer time horizons tend to show greater gains (see, e.g., Hunt & Gauthier-Loiselle 2010, Kerr & Lincoln 2010, Lofstrom & Hayes 2011, Stuenkel et al. 2012, Moser et al. 2014, Kerr et al. 2015b, Peri et al. 2015, Ghosh et al. 2016). This line of research has focused mostly on the United States, which *ceteris paribus* gives the most appropriate test of the agglomeration hypothesis given its dominant position as a destination country for high-skilled migration inflows (as noted in Section 3) and its large size. However, positive net impacts of national diversity on innovation are observed in several European countries (see, e.g., Ozgen et al. 2011; Bosetti et al. 2015; Parrotta et al. 2014; Breschi et al. 2014, 2015; Nathan 2015). Further research has confirmed the productivity differences across places for the same high-skilled individuals using rigorous methods (e.g., Clemens 2013, Kahn & MacGarvie 2016).

There are, however, some disagreements on the overall positive effects of high-skilled immigration on native workers. First, several studies with an occupational focus, especially for computer scientists and mathematicians, find displacement effects large enough that high-skilled migrants yield zero net benefit (see, e.g., Matloff 2003, Hira 2010, Borjas & Doran 2012, Bound et al. 2015a). There is also evidence that displacement may occur among students (see, e.g., Borjas 2005, 2006; Lowell & Salzman 2007; Orrenius & Zavadny 2015). Academic settings often have restrictions that prevent agglomeration economies, such as the fixed size of academic mathematics departments described by Borjas & Doran (2012) or caps on the numbers of majors in a college department. Doran et al. (2014) further provide recent evidence that, in the case of H-1B visa lotteries, the marginal visa may not provide benefits that other studies anticipate.

New data will further this work along two avenues of enquiry. First, following Peri & Sparber (2011), a significant theme of recent research is how field and occupation selection of high-skilled migrants can complement native workers. Data on occupations, especially at the firm level, can provide insights into the degree to which immigrants specialize in particular occupations (e.g., engineering) that port well globally and then complement natives focusing on other occupations (e.g., law, marketing) that require more local context and familiarity. Kerr et al. (2016) describe the deep challenges that emerge when interpreting this work, but a first-order effort needs to focus on building our fact base. Second, the linking of employment records to patents and similar innovation datasets offers untapped capabilities to study where agglomeration economies exist and how they function (e.g., citations among inventors, recombinations of technologies).

Turning our attention to origin countries, we find that research evidence is accumulating. Much of the early work in this literature centers on the brain drain hypothesis, in which the migration of talented individuals to high-income countries strongly disadvantages the source (usually lower-income) country due to loss of tax dollars, complementary skills, business leaders, role models, providers of public services, and so forth (see Docquier & Rapoport 2012 for an

<sup>20</sup>Carlino & Kerr (2015) review the fundamental connections between agglomeration economies and innovation.

extensive review). There are certainly cases of extreme brain drain; for example, some African countries suffer from a severe lack of medical doctors. The overall welfare calculation becomes more complex in many settings, however, when we consider ways that diasporas can generate gains for their home countries. For example, globally connected migrants can aid economic and noneconomic exchanges that include trade and foreign direct investment (FDI), technology and knowledge, and cultural norms and political views (e.g., Parsons & Winters 2015).

Several studies find that high-skilled migrants to the United States provide technological and business benefits to their countries of origin. A survey of immigrant scientists and engineers in Silicon Valley undertaken by Saxenian et al. (2002) is quite well-known and provocative in this regard. Although such results must be treated with heavy caution given the highly selected nature and narrow focus of the survey sample, this study finds that about half of high-skilled migrants engage in business exchanges with their home countries annually or with even greater frequency. The survey further suggests that more than 80% of high-skilled migrants share technical information. Since the publication of the Saxenian et al. (2002) study, and in part because of it, the literature has increasingly focused on the brain gain possibilities from high-skilled migration for sending countries.<sup>21</sup>

Subsequent academic work has sought to assemble data for more rigorous quantification. One method uses patent data and inventor citations to measure heightened knowledge flows across countries, where migration to the United States advances technology development abroad, similar to results found by the technology transfer literature (e.g., Keller 2004). This work emphasizes the special access that high-skilled migrants can provide to very recent innovations that boost productivity in the sending countries (Kerr 2008), and Kerr (2013) shows that the accumulated transfers are significant enough to influence the exports of the sending countries of high-skilled migrants. Agrawal et al. (2011) find that knowledge diffusion from the Indian diaspora in the United States aids the development of major advances in India more than domestic inventors working in India itself, but the opposite is true for the development of incremental inventions. There is substantial heterogeneity in the strength of these connections and the types of transfers facilitated (Kerr 2008, Oettl & Agrawal 2008).

Studies also connect migrants to their home countries through formal business channels like FDI (e.g., Kugler & Rapoport 2007, 2011; Javorcik et al. 2011; Kim & Park 2013); Docquier & Lodigiani (2010) specifically focus on the relationship between skills and business networks. Foley & Kerr (2013) examine firm-level data from the US Bureau of Economic Analysis connected to ethnic patenting data. Their work emphasizes the fact that high-skilled migrants can enable their US employers to conduct research and development-based work abroad and navigate overseas environments without the aid of joint venture partners.<sup>22</sup> Recent work further emphasizes the role of global collaborative teams in innovation (e.g., Miguelez 2014, Branstetter et al. 2015, Kerr & Kerr 2017). This research strand has a promising future given the increasing presence of global inventor teams, which Kerr & Kerr (2017) estimate has risen from 1% of US public company patents in 1982 to 6% in 2004, and given the impressive amount of information that patent records contain and the developing databases for innovations worldwide.

One area that requires close attention is the role of high-skilled migrants in the overseas outsourcing of work. High-skilled Indian migrants are thought to play an important role in India's

<sup>21</sup>Docquier & Rapoport (2012) provide an extended review of the brain drain and brain gain literatures, as well as related theory and comprehensive empirics.

<sup>22</sup>Research has also considered migration and trade (e.g., Rauch 2001, Rauch & Trindade 2002), with the work of Hatziogeorgiou & Lodefalk (2011) being an example of firm-level analysis. The specific relationship of high-skilled migration to trade is less developed.

outsourcing industry, and the phenomenon is likely to apply much more broadly. Hira (2010) decries how Indian firms use the US H-1B program as a vehicle for outsourcing, which, as we noted above, is not the program's intent but is allowed by the program's legal structure. In 2013, for example, the top three applicants for H-1B visas were Indian outsourcing firms, with Infosys (ranked first) applying for three times more visas than Microsoft (sixth). This is in line with earlier work that notes (usually from a more positive perspective) how diasporas can provide information about economic opportunities to their home countries and serve as reputational intermediaries. Even in online labor-sourcing platforms, Ghani et al. (2014) find evidence that US-based ethnic Indians are more likely to send work to India when outsourcing tasks. However, overall, little is known about this phenomenon, and the theory of trade in tasks is quite nuanced (Grossman & Rossi-Hansberg 2008). Given the ongoing polarization of the labor markets in the United States and other advanced economies, this is a very important gap in the literature.

A growing body of research quantifies how high-skilled migrants continue to interact with their home countries after moving to advanced economies. This is only one aspect of the brain drain versus brain gain debate (e.g., Agrawal et al. 2011, Weinberg 2011, Docquier & Rapoport 2012), and each country and circumstance is ultimately unique. Two other complementary research gaps are worth stressing. First, the circular flow of talent over short and long durations has increasingly been emphasized as brain circulation (e.g., Saxenian 2006, Nanda & Khanna 2010, Hovhannisyan & Keller 2015). Reflecting the data challenges mentioned above concerning the varieties of migration pathways into countries and their associated durations of stay, the literature has very little to say about the respective economic impacts of short-term and transit migration compared to longer and permanent stays. Second, cost-benefit analyses should consider where migrating individuals are trained, who funds the training, and what other opportunities exist (e.g., Bhagwati 1976, Beine et al. 2007, Özden & Phillips 2015). In other words, the counterfactual of high-skilled migration is difficult to establish. It may be that "high-skilled" only overlaps with "migrant" in specific settings.

These discussions naturally lead to a key objective that research should address over the next decade, namely, to identify how high-skilled migration impacts inequality within and across countries. In our discussion of key policy considerations and data development above, we reflect on the simultaneous need for both a more global/macro data perspective that embodies many countries and a more microdata perspective on certain understudied but pivotal actors. The same holds true for the inequality literature. First, we need to begin the effort to determine how high-skilled migration impacts global inequality, going beyond the labor market impacts in receiving economies and the role of brain drain/gain in sending economies. The impacts on origin, sending, and third countries can be profound when we take into account agglomeration effects, the global competition for talent, and related spillovers. For example, the migration of talent to the United States from India is likely to have a nontrivial role in the competition among multinational firms in the electronics industry, which may then impact Japan through product market competition and China through production contracts. Many of Apple's and Google's high-skilled workers are migrants, and thus the travails of Nokia in Finland may be partly attributable to the special clustering in Silicon Valley that high-skilled migration facilitates.

Second, to understand the impact of high-skilled migration on inequality, we need to understand the real distribution of returns. This task is quite complex and requires extensive microdata work. One consideration is the location of production and other inputs (e.g., finance, marketing) that surround the work of high-skilled migrants, who are often drawn from far-flung locations. Furthermore, even within one city, our economic models point to a focus on real income levels that are net of prices. The standard spatial equilibrium models from urban economics would suggest that landlords and property owners in the core clusters would reap enormous benefits from

high-skilled migration (Glaeser 2008), and the skyrocketing rental rates and property prices in Silicon Valley, London, and similar places suggest this holds true. Many highly paid individuals in these clusters say they could never afford a home! Saiz (2007) connects immigration to rising US rents, and this effect has been observed in other settings, as well. This may indicate that the battery of studies that have found no labor market displacement due to migration have missed important declines in real wages once prices are considered. Accounting for the role of city amenities, property prices, and so forth is complex but necessary. In the end, agglomeration economies revolve around trade-offs, as the escalating demand for the productivity benefits of being located in a hot spot are weighed against the escalating costs. We anticipate that the research going forward will be better able to capture these features and enhance our overall understanding.

## 7. LOOKING FORWARD

In some respects, research into high-skilled migration has seen a lot to be proud of over the past decade, including the emergence of new datasets, rapidly increasing visibility in leading journals, and more young researchers entering the field. Part of the purpose of this review has been to bring together these various streams of effort and celebrate the progress made. We have a significantly greater number and variety of data sources than ever before, and new sources are in the pipeline. Research on high-skilled migration has also begun to develop its own conceptual voice, distinguishing itself from traditional immigration analyses. This, too, is very promising, as the welfare and policy implications of high-skilled migration, ranging from the role of sponsoring firms to agglomeration economies, are quite different from those of low-skilled migration. However, one cannot help but feel that the progress made in other areas of international economics, such as international trade or finance, has been even greater over the past decade. We hope that this field is on the cusp of a similarly transformative decade.

We close this review by continuing our strong emphasis on data and describing productive areas for data construction that have not already been mentioned. First, future research needs to be directed toward better understanding of the contribution of high-skilled immigration to economic growth and development in both origin and destination countries, especially as migrants act as both creators and transmitters of knowledge. As such, we need to match high-skilled migration data with productivity data at the firm and sector levels. Many countries collect data on work visas, entry permits, permanent residency, and citizenships that are awarded to high-skilled migrants, but these data are rarely merged together with the employer–employee datasets or labor force surveys that underlie economic research for productivity outcomes. Often, the reason for this gap in current analyses is simply that different authorities maintain the databases, and researchers have no way to bring the elements together. This is partly due to legitimate privacy and data security concerns, but we believe it is possible to overcome these barriers, for example, by utilizing the government research data centers that are increasingly available in many countries or by using data matching techniques (Özden & Phillips 2015). Removing such obstacles to data access would aid research on how globally mobile talent pushes the technological frontier forward and where spillovers to domestic workers are most effective. Without detailed information on immigration visas and pathways and the ability to match this information to labor market and productivity data, our policy recommendations will remain incomplete.

Second, we need to improve upon how we measure skills and migration; our current measurement methods rely too much on data recorded on the basis of education and place of birth. We know university degrees obtained in different locations do not indicate the same quality or type of human capital, yet we treat them as equivalent in our empirical analysis. A related question is, how can we better measure the mobility of raw human capital through, first, enrollment in schools,

then jobs, and then careers as celebrated scientists or CEOs? This seems particularly relevant for settings such as Europe, where high-skilled individuals frequently live in multiple countries for study and work over their careers, with their human capital evolving at each stage. The (partially endogenous) path of these career trajectories has further implications for borders, public finances, and the ways in which domestic and multinational firms operate. Researchers can get a handle on part of these trajectories by accessing data from the personnel records of multinational corporations (e.g., Choudhury 2016), with integrated datasets being the long-term goal. The development of electronic visas is particularly promising for future data assembly efforts. We also need to build better data on the families of high-skilled migrants, about whom we know very little, to study their outcomes and impacts on others (e.g., spillovers among children within schools).

The above two paragraphs are mostly cast in terms of developing administrative datasets, which we believe is critical. Paralleling this development, of course, is the enormous rise of potential sources of information through online platforms like Facebook and LinkedIn. This potential includes the obvious (e.g., networks, occupation and professional titles, skills) and the more subtle (e.g., the Internet Protocol addresses of host computers can be linked to latitude–longitude coordinates to provide unprecedented detail on location). It is quite fortuitous that high-skilled individuals are major users of these digital platforms. Public availability of patent data is one reason why this part of the high-skilled migration literature is much further developed than equally important spheres of work. We do not know where these other roads will lead, but we are eager to find out!

Global integration is generating ever-greater returns for matching the right talent with the right job or opportunity, with country borders seemingly being relegated to second-order in importance—except that these borders are far from negligible in importance! Intricate national migration policies, and the gatekeepers that these policies establish, still hold sway over high-skilled migration patterns. Moreover, many points of resistance emerge due to knee-jerk political reactions alongside well-placed concerns about the implications for domestic workers. Economists should be cautious about over-reliance on tidy models, as political realities and messy business deals play powerful and complex roles that we are only starting to understand. The most successful individuals, companies, and countries will be those who discern how best to navigate the current web of constraints and how to untangle its knots to discover a better potential as we move forward.

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## Errata

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