ISSUES IN HIGH-SKILLED INTERNATIONAL MIGRATION

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Abstract

Highly-skilled migrants are becoming a more important part of the world economy and of policy debates in a diverse set of countries. The proliferation of skills around the world, increases in world trade, the growth of R&D, and the general increase in the labor market demand for diverse sets of skills, have all contributed to the emergence of high-skilled migration as a major factor in the economies of most countries. High-skilled migration is often discussed in narrow terms of "brain drain/brain gain", when both the pattern of migration and its effects appear to be much more complex. However, our understanding of the effects of high skilled migration is much less than for international migration in general, and is based upon much less research and data. This paper reviews the possible effects of high skilled international migration, and the major research and policy questions that need answering.

INTRODUCTION

Migration across national borders provokes many spirited political and policy debates. Although these debates are often most contentious when they deal with lower-skilled migrants, high-skilled migration also raises strong emotions. If nothing else, immigration changes the status quo. If lower-skilled migrants are sometimes said to take jobs that natives do not want, high-skilled migrants are employed in the types of jobs that many would prefer go to natives. At the same time, government in both less-developed and many developed countries worry about losing their more highly educated workers. As high-skilled migration appears to become more important to the world economy, it becomes all the more important to understand its likely effects. Unfortunately, these effects have not been well studied or measured and are likely to be more complex than acknowledged in most policy discussions.

This paper provides an overview of the major research and policy issues in

the international migration of highly skilled individuals and their families. Knowledge and understanding of this migration's effects are limited not only by available data (as is the case in much immigration research), but also by unanswered questions in labor market theory and economic growth theory: How fungible are skills among those with specialized knowledge? Does presence in an economy of highly skilled workers affect investment and R&D decisions by firms (increasing demand over time for high-skilled workers)? Do more scientists lead to more knowledge? This paper does not answer these questions, but deals with how these and other questions affect our understanding of high-skilled migration.

As the world's largest economy, as the largest educator of foreign students, and as a traditional nation of immigration, the United States is an important nexus for the international movement of high-skilled workers. As such, this paper uses U.S. data on high-skilled migration to and from the United States to provide some insights into the magnitude and direction of the possible effects of high-skilled migration.

While this paper often focuses on economic and knowledge creation effects for individual countries and the global economy, it is also important to recognize that this should not be the only component of policy making on immigration policy. Freedom of movement is valued as a human right, and is recognized as such in the Universal Declaration of Human Rights, albeit in a limited form. Aside from the maximization of human liberty, it seems likely that migrants themselves incur greater economic benefits and costs of high-skilled migration – theory would suggest that at least the expected value of individual net benefits is positive for those who choose to migrate, although these benefits and costs may also include substantial non-economic factors. On the other hand, countries may seek to limit immigration for cultural reasons, or prefer for humanitarian reasons to favor immigration of family members of previous migrants.

NATIONAL AND GLOBAL CONSEQUENCES OF HIGH-SKILLED MIGRATION

Table 1 outlines one attempt to lay out likely or possible economic effects of high-skilled international migration. In addition to the normal "brain drain" effects, any accounting needs to include possible positive effects for sending countries and negative effects for sending countries. Also neglected in the simple "brain drain" paradigm are global effects on the growth of technology and knowledge that cannot be easily assigned to individual polities.

Table 1. Possible global and national effects of high-skilled international migration

Sending Countries: Possible Negatives	**Receiving Countries:** **Possible Negatives**
• "Brain drain": lost productive capacity due to at least temporary absence of higher skilled workers and students · Less support for public funds for higher education	• Decreased incentive of natives to seek higher skills • May crowd out native students from best schools • Language and cultural barriers between native and immigrant high-skilled workers • Technology transfers to possibly hostile countries
Sending Countries: Possible Positives	**Receiving Countries:** **Possible Positives**
• Increased incentive for natives to seek higher skills • Possibility of exporting skills reduces risk/raises expected return of personal education investments • May increase domestic economic return to skills • Knowledge flows and collaboration • Increased ties to foreign research institutions • Export opportunities for technology • Return of natives with foreign education and human capital • Remittances and other support from diaspora networks	• Increased R&D and economic activity due to availability of additional high-skilled workers • Knowledge flows and collaboration • Increased ties to foreign research institutions • Export opportunities for technology • Increased enrolment in graduate programs/keeping smaller programs alive

Possible Global Effects

- Better international flow of knowledge
- Better job matches
- Greater employment options for workers/researchers
- Greater ability of employers to find rare/unique skill sets
- Formation of international research/technology clusters (Silicon Valley, CERN)
- International competition for scarce human capital may have net positive effect on incentives for individual human capital investments

The categories, "receiving" and "sending" are not meant be synonymous with "developed" and "less developed". Many developed countries, such as the United Kingdom, have expressed concerns about retaining their researchers, and many less-developed countries do attract foreign talent in areas where they are able to offer opportunities to study or use unique geological and biological natural resources. Indeed, many countries may be both net receivers and net senders in different skill areas.

Few of the possible effects discussed in this paper are well established empirically, although some "indicator" data do exist. Thus, this represents for research agenda.

Negative Effects for Sending Countries

A loss of productive capacity due to the, at least temporary, loss of highly skilled workers and students is the most discussed negative effect of migration on sending countries. This "brain drain" has been an issue not just for countries, but for any area whose educated natives migrate – in the United States, rural states often worry about the products of their state universities moving to other parts of the United States where their skills are in greater demand. In addition to the direct effect on the availability of high-skilled labor, another consequence of highly educated workers leaving a country may be a reduction in political support for funding for higher education.

Table 2. Share of US foreign-born with foreign degrees

	% with highest degree from foreign school	% with any foreign degree	% with foreign secondary school
Bachelor's degree	49.1	51.1	67.4
Master's degree	24.1	57.2	76.4
Professional degree	60.0	69.3	74.3
PhD	31.2	73.3	86.7
All degree levels	40.2	54.7	71.0

Source: NSF/SRS 1993 National Survey of College Graduates.

College educated migrants to the United States do have a significant proportion of their formal education from outside the United States. As shown in Table 2, about 55% of the college-educated foreign-born in 1993 had at least one post-secondary degree from an institution outside the United States, and 40% had their highest degree (or most recent if at the same degree level) from a foreign institution. Even at the highest education level, nearly one-third of the foreign-born with doctorates who were resident in the United States received their doctorates from foreign institutions. Although many immigrants to the United States arrive as children, 71% of the college-educated foreign-born graduated from a foreign secondary school, with their pre-university education funded outside the United States.

Many countries are concerned with the return rates of their nationals who go to other countries for graduate training. Finn (1999) shows that slightly over half (53%) of 1992-93 recipients of science and engineering doctorates from US schools were working in the United States in 1997.

Positive Effects for Sending Countries

Less often discussed are the positive effects that may exist for countries whose highly skilled natives and citizens move across borders. In part, this is because of measurement difficulties. Although data on international migration is often poor, counts of initial migrations of people are easier to obtain than data on return migration or return knowledge flows. Nevertheless, there are several indicators that such benefits might exist. While there is talk of "brain drain," others have talked of "brain gain" or "brain circulation" to describe these complex effects.

Incentives for Human Capital Investment

The most difficult to measure – but theoretically likely benefit – may be an increase in the incentive for natives to invest in their own human capital. This can occur in theory through four mechanisms: i) an increase in the domestic return to skills due to the relative scarcity created by the "brain drain"; ii) an increase in the expected value of an individual's human capital investment if they have migration as an option; iii) a reduction in the risk associated with the return on individual human capital investment if migration serves as a labor market stabilizer; and iv) increased domestic demand for high-skilled labor due to global interactions. Although many of these hypothesized effects clearly are interrelated, this chapter does not attempt to theorize beyond partial equilibrium effects.

The first effect is the improvement of labor market conditions for highly skilled workers when their domestic supply is reduced by emigration to other national labor markets. Wages and unemployment for high-skilled workers in less-developed countries (with less developed financial markets and entrepreneurial infrastructure) may be particularly sensitive to "over-supply." While other channels through which migration leads to increased supply, may offset this, it is still an immediate effect.

The second effect results from uncertainties that individuals might have about their likely migration behavior. To show this in a simple algebraic form, the expected value of an individual's human capital can be expressed as:

$$E(H)= Pm\ E_f(H) + (1 - P_m)\ E_d(H)$$

where P_m is the subjective individual probability of migration, E_f is the expected value of human capital H in the best foreign labor market, and E_d is the expected value of the same human capital in the domestic labor market.

When the expected foreign value of human capital is much greater than the domestic value, even a small non-zero expectation of migration may have an important effect on the expected value of a human capital investment decision.

The third effect depends whether the amount of emigration of high-skilled labor from a country relates to current labor market conditions. If a downturn in demand for high-skilled labor in a country results in more high-skilled workers leaving, that might tend to reduce fluctuations in employment and salaries, reducing "risk" associated with the human capital investment. The considerable investments required for an individual to acquire higher skills might seem less worthwhile if the labor market demand for those skills is volatile. To the extent that high-skilled also means specialized skills, additional training may make individuals more, rather than less, sensitive to economic fluctuations. An example from the United States may be

aerospace engineers, who have faced greater employment volatility than those in other occupations. To some extent, this role of a labor market stabilizer may be offset by any instability caused by return migration driven by changes in conditions in the receiving countries.

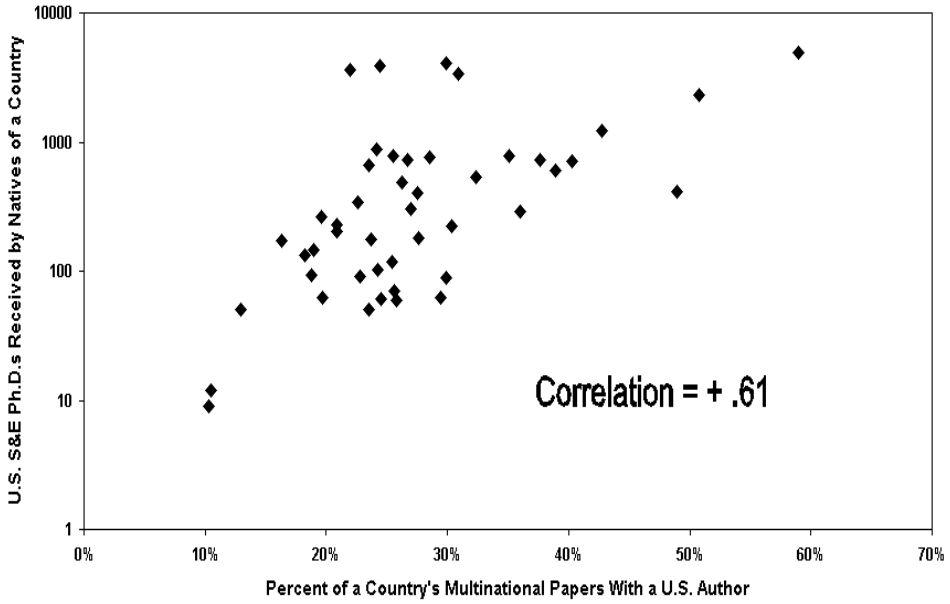
The fourth effect, an increase in domestic demand for high-skilled labor depends upon other effects discussed in this paper—the various ways that the connections formed through international migration may lead to increases in commercial activity and technology use.

Knowledge Flows and Collaborations

International migrants (other than refugees) seldom break all ties with their country of origin. There is reason to believe that high-skilled migrants who have extensive education and, often, work experience in their country of origin maintain contacts with former colleague and education institutions. This may provide a benefit for sending nations by facilitating the formation of international networks of contact and knowledge exchange – both with expatriate natives and with contacts nurtured by returning expatriates while abroad. Some evidence for this is seen in Figure 1, which shows a positive correlation $r = .61$ between the log of the number of US doctorates received by natives of a country and percentage of that country's internationally co-authored articles with individuals at U.S. institutions.

The fact that contact in graduate school may lead to research collaboration across borders is not an unexpected effect. The same effect is likely to be created by the international movements of people employed by industries. Movement of workers between firms has long been recognized as a powerful source of knowledge transfer – both of technology and of more subtle things such as business practices and networks of contacts – and this is likely to occur even when the firms are across national borders.

Figure 1. Scatter plot of percentage of 1991-95 multinational papers with a US author vs. number of 1986-1990 US science and engineering PhDs received by natives of a country.



Return of Natives with Foreign Education and Human Capital

An important way for a sending country to benefit from knowledge flows is for its natives to return after spending a period of time outside their country of origin. Despite wage differentials and other differences in opportunities, return migrations are common even between developed and less-developed countries. To a great extent, this is unsurprising and reflects the importance of cultural and family ties to migrants. Another factor which encourages return migration is the temporary nature of the work permits that many countries use as their primary method of allowing employers to recruit non-citizens. For example, in the United States, the most common high-skilled work visa (known as a H-1b) is for three years, with a single three-year renewal allowed, and is not formally part of any path to a permanent visa.

Finn (1999) shows that around half of foreign students with temporary visas who receive US science and engineering doctorates are still working in the United States five years later, this implies that the other half leave the United States with training received at a US university and perhaps a post-doc or other post-

graduate work experience. As shown in Table 3, Finn found that "stay" rates varied by field of degree, ranging from 32% in the social sciences to 61% in the physical sciences and mathematics.

Table 3. 1992-93 temporary visa US PhD recipients remaining in the United States, 1994-97

(Percentages)

	1994	1995	1996	1997
All S&E PhD recipients	48	51	52	53
Physical sciences and mathematics	55	59	60	61
Life sciences	48	51	53	54
Social sciences	29	31	32	32
Engineering	49	53	53	54

Source: Finn (1999).

Also noteworthy is that the stay rates shown in Table 3 hold steady or increase somewhat with time since degree. However, another data source, the NSF's Survey of Doctorate Recipients (SDR), suggests that even those who do stay in the United States leave after a period of time. This seeming contradiction may be reconciled through a complex pattern of migration – while some individuals who earned a US doctorate leave each year, others return.

In 1995, a special effort was made in collecting data for the SDR to discover whether survey non-respondents resided outside the United States. Since it is quite possible that other non-respondents whose location was never discovered, also resided outside the United States, this should be considered a lower-bound estimate. Table 4 presents these estimates for foreign-born individuals in the SDR (which covers those with doctorates from US schools who were either a US citizen, a US permanent resident, or had plans to stay in the United States at the time of their degree). Thus, the SDR included only those foreign-born PhD recipients with particularly strong ties to the United States. Among this group, about one-fifth of those who graduated in the last three decades were identified as residing abroad; in the case of graduates from the last ten years, over 4% had moved from the United States in the previous two years.

In addition to knowledge transfers, the return of natives to a sending country also brings a gain of human capital that may not have been developed had the migrants stayed in their home countries. There are several reasons for this.

Differences in the availability or quality of particular areas of university instruction may have been a reason for the original cross-border movement. Knowledge of unique technologies may also be gained in formal employment. In addition, foreign employers and educational institutions often finance both formal education and job-related training to a considerable extent.

Table 4. Lower-bound estimates of foreign-born with US science and engineering PhDs working outside the United States in 1995

(US citizens, permanent residents or those who expressed definite plans to stay at time of degree)

Decade of PhD	Percent residing outside the U.S. in 1995	Percent in 1995 who had left the U.S. since 1993
1945-54	6.1	0.6
1955-64	13.7	0.8
1965-74	22.7	1.3
1975-84	22.2	2.3
1985-94	19.4	4.1

Source: NSF/SRS 1993, 1995 Survey of Doctorate Recipients.

Support from Diaspora Networks

Many immigrations studies have analyzed effects of having large populations of natives outside of a country's border (See Saxenian, this Symposium). These include both the creation of new export opportunities for their home countries and the value of remittances to relatives and institutions in their home countries. It seems plausible that high-skilled migrants create of opportunities, albeit sometimes in different ways.

Less-skilled migrants often form part of the retail and wholesale infrastructure in their new countries. High-skilled migrants may be less likely to become retail or wholesale managers, but more likely to be involved in the purchase or selection of technology products and services. For example, there is significant anecdotal evidence that Indian migrants have played a key role in the business partnerships and relationships between US and Indian technology firms.

Remittances from high-skilled migrants may also be only a variation of the phenomenon discussed in the general immigration literature. High-skilled migrants are smaller in number, but often earn higher incomes. In addition to gifts to relatives, high-skilled migrants may serve a significant financial and other role as

alumni of education institutions in their home countries.

NEGATIVE EFFECTS FOR RECEIVING COUNTRIES

Many participants in discussions of immigration policy have been surprised in recent years to find that high-skilled international migration is no less politically controversial within receiving countries than is immigration in general. There is much literature in economics seeking effects of lower-skilled immigrants on opportunities for lower-skilled natives. However, little research has been conducted on the effects of higher-skilled migration. Nevertheless, several effects can be hypothesized.

Decreased Incentive for Natives to Seek Higher Skills

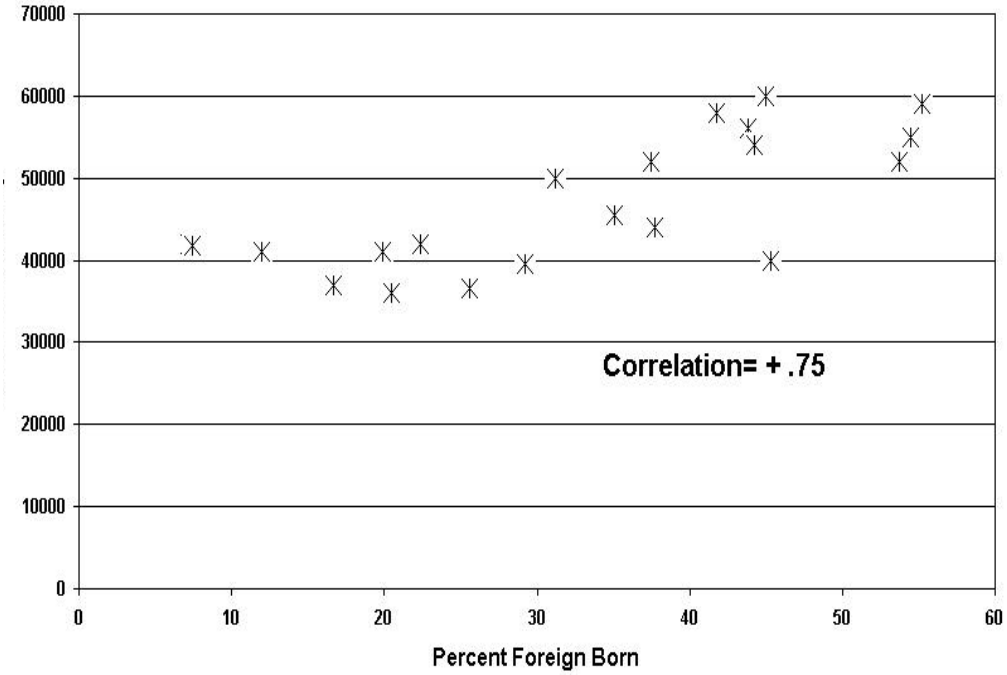
If high-skilled migrants are substitutes for natives in the domestic labor market, then a normal static supply and demand analysis would suggest a reduction in the wages associated with higher-skilled occupations. This in turn leads to a decreased incentive by natives to make human capital investments.

There are a number of theoretical factors that may moderate any such effect on native human capital investment patterns. First, the same analyses that assume lower-skilled migrants to be substitutes for both lower-skilled natives and for capital also assume that high-skilled migrants are complements to both lower-skilled workers and to capital. Thus, high-skilled migrants might do more to create new capital investment and utilization of a perhaps underused segment of the labor force. This is to say that, to some extent, higher-skilled workers may produce economic changes that increase the demand for their services, and thus mitigate the effect of increased supply upon compensation.

Although there have been no detailed econometric studies, basic statistics suggest that high-skilled migration is most prevalent in fields presenting relatively good employment opportunities. This may be for many different reasons. Workers may be less willing to undertake the costs of migration unless the opportunities are great. Employers may not want to pay the often-considerable legal costs associated with obtaining work visas unless they face a tight domestic labor market. In addition, influx of diverse human capital brought by migrants may contribute to creating opportunities in a field.

Figures 2 and 3 compare the proportion of US science and engineering PhD holders who are foreign born in a list of major S&E fields of degree to measures of labor market conditions for recent PhD recipients in those fields.

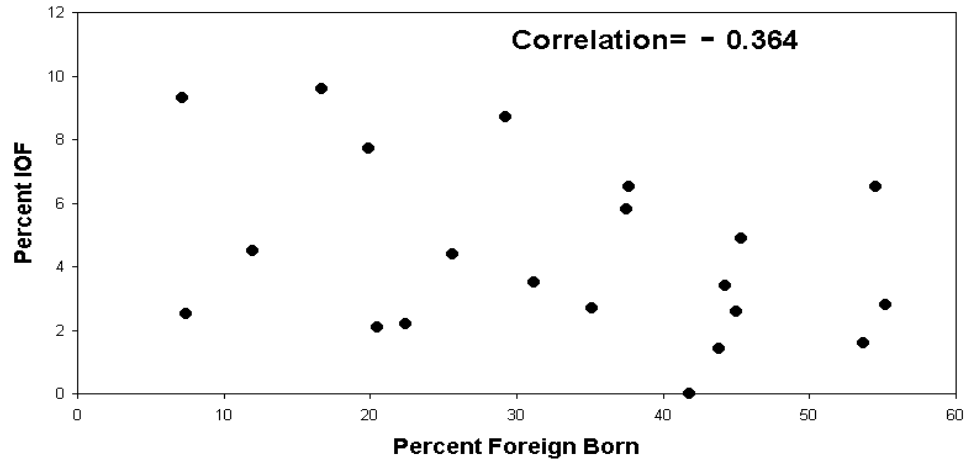
Figure 2. 1988-92 science and engineering PhDs comparison of percentage foreign-born to median native salary for selected fields



In general, the higher the proportion of foreign-born, the higher the salary. This is not driven just by the high proportion of foreign-born among US PhDs in engineering, since even in many broad fields higher foreign-born representation is associated with higher salaries: In the social sciences, economists are paid more than sociologists. In the life sciences, biological scientists are paid more than agricultural scientists. In the physical sciences, physicists are paid more than geologists. In each case, the lower-paid field had fewer foreign-born PhD holders. In Figure 2, the correlation between median salary and percentage of foreign-born is a strong positive .75.

Figure 3. 1988-92 science and engineering PhDs in 1993

Comparison of percentage foreign-born to percentage involuntarily out-of-field for selected fields of degree



The same pattern holds when comparing the percentage of a recent PhD cohort that is foreign born with a measure of labor market distress. For high-skilled workers, the unemployment rate can be a poor measure of labor market conditions in a field, since high-skilled workers are usually highly employable in some capacity. A statistic generated from the NSF SESTAT data file, the percentage involuntarily working outside their field of degree, often provides a more sensitive indicator of labor market conditions. Figure 3 shows the involuntary out-of-field rate for recent PhDs to be inversely related (r = .364) with the percentage of foreign born.

Crowding Out of Natives from Advanced Education

Another, often discussed but little studied, possible effect of high-skilled migration on receiving countries is a "crowding out" of natives from graduate programs and other sources of advanced training. To some extent, this argument is simple to understand: if a given university has a limited number of openings for graduate students, then a migrant student would prevent a native from taking that slot.

The number of graduate departments that have some flexibility in the number of students they admit may offset this argument, at least in terms of aggregate positions in graduate programs. Beyond the top tier of institutions, some graduate programs would prefer to admit more high-quality graduate students to help faculty with both teaching and research. This is particularly true for graduate

programs that may have trouble justifying their existence in terms of total graduate enrolment.

One attempt to look at the issue of displacement can be made using the National Science Foundation's Survey of Graduate Students and Postdocs (GSS). This is an annual survey of graduate departments of science and engineering to tabulate their enrolment. Using GSS records from 1982-1995, it is possible to create pooled longitudinal file with academic departments as the unit of observation. From this file, it is possible to make empirical estimates of the observed effect of changes in foreign student enrolment on the enrolment of various ethnic categories of US citizen and permanent resident enrolment. An increase in enrolment of 1.0 foreign student was associated with a increase enrolment of 1/3 (0.33) of a white US student, of an additional 0.02 US under-represented minority students, and a decrease of 0.07 US Asian students. With the exception of the odd, if small, decrease for US Asians, increases in the enrolment of one group was associated with increases in the enrolment of all groups – a result inconsistent with displacement.

Other Negative Effects

Two other possible negative effects of high-skilled migration for receiving nations are included here for the sake of thoroughness, although even less analysis has been done on these topics than in other areas.

Some critics of high-skilled migration have raised concerns about cultural differences between natives and migrants as a barrier to native participation in technology. This criticism can range from concerns about the ability of native students to understand the accents of foreign-born teachers, to workplace discrimination against natives who are not part of the same ethnic group as their boss. Although this concern is difficult to evaluate, it would be a mistake to assume that this is not an important part of the political response in many countries to high-skilled migration.

Technology transfer to potentially hostile countries is another issue which is difficult to analyze. In terms of a general transfer of knowledge that is useful to both civilian and military industries, this almost certainly occurs. In the more specific sense of espionage to obtain classified information on military technologies, it may be a murkier picture. In the context of the United States, major public espionage cases have sometimes involved ethnic affinity, but in other cases have involved natives apparently motivated by money, power or ideology.

POSITIVE EFFECTS FOR RECEIVING COUNTRIES

Many of the positive effects of high-skilled migration for receiving countries have been discussed in the discussion of positive effects for sending countries – gains related to increases in international collaboration and technology transfers, with the same implications for increasing domestic productivity and developing global markets.

Increased Economic Activity and R&D

Even in a model of high-skilled migration where there is no "brain circulation", receiving nations are the recipients of a brain gain. They experience an exogenous increase in their stock of human capital, often including scarce or unique sets of skills that are needed to overcome bottlenecks in production or research.

In the United States, high-skilled foreign-born workers make up a large part of the total science and engineering labor force (Table 6): one-quarter of S&E doctorate holders; one-fifth of those holding any level of degree in engineering, computer science, chemistry, or physics; around half of PhD holders in computer science, electrical engineering, industrial and civil engineering.

These estimates, and others shown in Table 6 from the NSF SESTAT data file, are underestimates of the total proportion of foreign-born scientists in the United States. Because of the practical difficulties involved in tracking high-skilled migrants, SESTAT data on the US S&E labor force exclude individuals whose science and engineering degrees were obtained from foreign educational institutions unless they were in the United States as of the decennial census of 1990. This would exclude, for example, the majority of individuals entering the United States with the high-skilled H-1b temporary visa. The US Immigration and Naturalization Service reports that 60% of H-1b visa recipients are holders of foreign degrees.

Knowledge Flows and Collaboration

As shown in Figure 1 and discussed earlier, there are strong reasons to believe that international migration leads to increased international collaboration and transmission of knowledge. With reference to the United States, the increased connection to the rest of the world has always been a benefit of having large numbers of foreign students and large numbers of high-skilled immigrants.

This factor may become even more important as the rest of the world continues to expand it's R&D capacity – as of 1997, the United States' R&D spending was down to 43% of the OECD total.

Increased Enrolment in Graduate Programs

This is the other side of concerns about displacement of natives in graduate programs. In the context of the United States, the availability of foreign students may allow many graduate departments to expand or maintain graduate programs. In other cases, foreign students may allow more elite programs to maintain very high standards by allowing them to choose among the best of both foreign and native applicants. To the extent that the benefits of a graduate program accrue to graduate students, this might not be an important benefit, or might even be viewed as a cost if graduate education is partially subsidized. However, graduate programs are also important sources of new research and knowledge. This may provide a benefit to receiving countries even if foreign students were to leave immediately after graduation and form no part of later knowledge networks.

GLOBAL EFFECTS

In addition to any benefits or costs that might be viewed as accruing to particular countries sending or receiving high-skilled migrants, there are possible global effects that cannot be assigned to individual countries. These are essentially all the effects that could result in greater efficiency in the production of knowledge, and in the production of goods and services. Even if one rejects the idea that one country benefits from wealth and knowledge creation in another, this greater efficient would result in greater global sum of GDP, however distributed.

A better international flow of knowledge increases the efficiency of new knowledge production everywhere. It leads to better solutions to particular problems and a reduction of duplication in R&D.

An international job market has important implications for the quality of job matches for both workers and employers. In a world where increased specialization leads to increased employer dependence on scarce or unique skill sets, it becomes clear why employers find it increasingly efficient to search across borders. At the same time, greater employment options resulting from a global labor market may allow workers to find the work most interesting to them.

There may also be a global benefit from the formation of international research and technology centers. Researchers on innovation have long noted the apparent benefits of geographic clustering of particular research activities. To a great extent, this specialized clustering required high-skilled international migration for staffing.

For all of these reasons, high-skilled international migration is likely to have, at the global level, a positive effect on the incentives for human capital investment. It increases the opportunities for high-skilled workers, both by providing the option of job search across borders and by encouraging the growth of new knowledge.

CONCLUSION

This paper has outlined major research and policy issues related to high-skilled international migration. Simple models of "brain drain" and "brain gain" do not fully capture either the complex movement of people and knowledge across borders, or the effects of this movement on knowledge creation and investments in both physical and human capital. Both sending and receiving countries have to be concerned with the potential positive and negative effects of high-skilled migration, and much research needs to be done to better understand these effects. Although this does not explore policy options, it seems likely that the magnitude of various positive and negative effects are likely to be significantly affected by aspects of a country's immigration, education and technology policies. As with trade, some countries may find it desirable to compensate domestic "losers" from high-skilled migration as a way of gaining support for more open policies.

Globally, the net effect of high-skilled migration seems likely to be positive for both knowledge creation and economic growth and should result in both more efficient use of high-skilled labor and increased knowledge flows. However, even this assumption needs to be qualified, as little is known about the net global effects of high-skilled migration on human capital investment.

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