REVIEW SUMMARY

ECONOMICS

Brain drain or brain gain? Effects of high-skilled international emigration on origin countries

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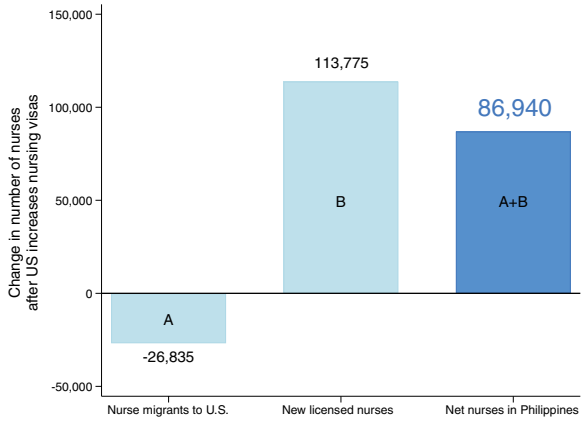
BACKGROUND: Emigration rates are in the range of 10 to 50% for highly skilled individuals such as top academics, inventors, scientists, engineers, and medical professionals from many lower-income and smaller countries. There have long been concerns that this "brain drain" harms origin economies. However, high-skilled migration can also enhance human capital at home through "brain gain" effects on incentives to invest in education, remittances, and return migration. Additionally, it can have other beneficial impacts on well-being in the origin country through trade and business development, innovation, and transmitting knowledge and positive norms from the destination.

ADVANCES: Much of the debate around brain drain and gain has relied on theoretical arguments, anecdotes, and noncausal empirical associations. Recent research has used modern experimental and nonexperimental methods to establish causal evidence on these different channels.

We now have empirical validation of the theoretical argument that new high-skilled migration opportunities can increase, rather than decrease, the overall stock of educated workers in a country. Exogenous changes in US immigration policies resulted in more Filipinos training as nurses and more Indians acquiring computer science skills than the people emigrating, raising the total number with these skills at home (see summary figure). Human capital at the origin also increases through remittances funding education and from migrants returning with education and work experience acquired abroad. Whether the net effect is a brain drain or gain will depend on fundamental factors such as how quickly universities and training institutes can adjust to produce the skilled workers demanded abroad given the regulatory environment for higher education, or the conditions governing investments at home.

Other impacts on home economies vary with the time frame, type of skill migrating, and country context. There can be short-term negative consequences on firms and scientific innovation in origin countries when skilled workers depart, but over time these emigrants build trade and FDI networks and act as conduits for knowledge transfer. This can spur the creation of new industries, as has occurred in the IT sector in several countries. Migrants also tend to transfer political attitudes and social norms of their destination countries, which can boost support for democracy, improve population health, and enhance female decision-making power at home when migrants go to more liberal and democratic destinations.

The largest welfare impacts are on the high-skilled emigrants themselves, who often more than double their incomes by migrating. Migration also produces much broader positive impacts on origin communities. Benefits accrue not only to other household members left behind by the migrant, but also to entire regions through the investment, trade, entrepreneurship, and innovation channels described above. Despite fears of medical brain drain, there is an absence of causal evidence for negative impacts, and population health at home can also improve with emigration as a result of improved norms, remittances, knowledge transfers, and return migration of skilled health professionals.



"Brain drain" of Filipino nurses leading to brain gain. The US expanded the number of visas available for foreign nurses between 2000 and 2006 and the number of nursing graduates in the Philippines rose substantially in response. Bar (**A**) shows the outflow of Filipino nurses to the US between 2000 and 2006. Bar (**B**) shows the number of newly licensed Filipino nurses between 2000 and 2006. Bar (A) + (B) show the net gain ("brain gain") of nurses in the Philippines during this period.

OUTLOOK: Rising education levels worldwide, international competition for talent, and a preference for high-skilled migrants in many destination-country migration policies are all likely to ensure that the flow of high-skilled migrants from poor to rich countries will continue to grow. Recent literature should provide some reassurance to those concerned about "brain drain" as it demonstrates many potential ways origin countries gain from the outflow.

However, the evidence base remains limited, and there are many opportunities for new causal research. Most research looks at the impact of all types of skilled migration combined, or pools together educated and less-educated migrants, whereas net impacts may vary depending on the type of skill departing. Much of the literature focuses on impacts in a few large middle-income countries such as India, the Philippines, and Mexico, but outcomes may differ in more fragile and poorer countries that have fewer opportunities for skill acquisition and productive home investments. Despite these differences, for small, poor origin countries, the existing body of research can help clarify policies that may enable these countries to experience more of the benefits from skilled migration rather than the costs. The biggest research gaps, however, lie in understanding effective policy responses in sending regions. Comprehensive policy analysis requires a consideration of the full range of direct and indirect "general equilibrium effects" of emigration on all relevant labor markets, and any external benefits accruing to population health and well-being through new innovations and business creation. □

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Brain drain or brain gain? Effects of high-skilled international emigration on origin countries

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How does emigration of highly educated citizens of low-income countries to high-income countries affect the economies of the origin countries? The direct effect is "brain drain"—a decrease in the country's human capital stock. However, there may also be indirect "brain gain" effects. This review summarizes evidence that uses causal inference methods to reveal mechanisms that may lead to brain drain, gain, or circulation. Collectively, the weight of the evidence suggests that migration opportunities often increase human capital stock in origin countries and produce downstream beneficial effects through remittances; foreign direct investment and trade linkages; transfers of knowledge, technology and norms; and return migration. We discuss conditions under which benefits from skilled migration may outweigh costs and also describe potential research paths to inform policy.

Introduction

One-third of doctors trained in Ghana have emigrated (*1*) and its nurses were leaving the country at the rate of 500 per month in 2022 (*2*). An astounding 91% of Ethiopian-born PhD holders (*3*) and 62% of the country-wide top 100 scorers on the entrance exams for the Indian Institutes of Technology (IIT) are abroad (*4*), as are two-thirds of software engineering graduates from top Canadian universities (*5*). Across Sub-Saharan Africa, the Caribbean, and the Pacific, people with tertiary education are 30 times more likely to emigrate than those who are less educated (*6*). Notably, 18% of all individuals from low-income countries with bachelor's degrees are living in OECD countries (*7*).

Skilled individuals, such as those highlighted above, tend to outmigrate from poorer and smaller countries at a higher rate, in pursuit of educational and career goals. Conflicts or natural disasters tend to accelerate that process. Top academic achievers from five countries earned an average of 35,000 to 79,000 USD per year more after migrating, equivalent to a 53 to 600% increase (*8*).

Figure 1 shows that high-skilled emigration rates can vary substantially by country and skill categories. A natural concern is that such high rates represent a substantial loss of human capital in sending countries—colloquially referred to as "brain drain." Public health officials fear that it can create health care worker shortages in poor countries, leading the World Health Organization (WHO) to list 55 countries where health worker recruitment should be subject to additional safeguards (*9*). Sociologists have characterized these flows as a form of exploitation, as well as a cause of underdevelopment (*10*). Political scientists lament the exit of individuals who could have led political change at home (*11*), while economists worry about fiscal and other externalities of losing skilled human capital (*12*, *13*).

However, simply observing out-migration does not necessarily imply a net loss in human capital in origin countries, as migration opportunities can also create new human capital. Estimating the overall impact of high-skilled emigration on origin-country outcomes is challenging because it requires taking into account both the indirect and direct effects of the absence of a migrant. For example, simply observing high migration rates of doctors from poor countries with limited health care does not mean that emigration has worsened health outcomes. Causation could run in the other direction with poor health conditions motivating people to leave, or both emigration and limited health could reflect third factors such as political instability. We need to know the "counterfactual" of what would have happened without emigration.

Although brain drain has been the subject of considerable research over decades in many disciplines, recent research has made advances toward estimating these causal effects of skilled emigration through the use of modern empirical methods [see Box 1 (*14*–*18*)]. We review this evidence here and focus on results which we deem credible, though some are still in working paper form. We begin with a conceptual framework to outline the possible mechanisms through which high-skilled emigration could affect the origin economy.

Conceptual framework

An immediate effect of the emigration of a skilled worker is that her human capital is no longer available in the sending country after she moves abroad. This "brain drain" is the primary concern with a skilled migrant's exit. However, careful economic reasoning reveals other indirect channels through which this initial trip can affect human capital in the sending economy, such that new migration opportunities can, on net, either increase or decrease the aggregate human capital stock of the developing country that migrants leave behind. We summarize these direct and indirect channels in Fig. 2.

First, the appearance of the migration opportunity may itself have induced that emigrant to invest in acquiring skills that have high returns in the destination labor market; human capital that she might otherwise not possess had that opportunity never existed. If Canada provides visas to trained Filipino nurses, then more young Filipinos may now enroll in nursing school. Unless every graduate of those nursing programs receives a Canadian visa and exits, the Philippines may end up with more nurses at home than they otherwise would, absent that migration opportunity. This effect represents the narrow version of "brain gain"; however, we also use this term more broadly to describe beneficial effects of emigration on the origin country through other channels highlighted in this section.

Second, migrants typically earn higher incomes abroad, some of which is remitted to the sending country. Remittance recipients may use some fraction of that windfall to invest in education and skills. The box labeled "remittances" in Fig. 2 can thus increase the aggregate stock of human capital in the sending country. We examine empirical research on the net effects on human capital in Section 3.

Third, many developing country citizens migrate abroad specifically to attend universities and acquire training not available locally, which directly increases the number of educated individuals born in the origin country. Many of them then return home with this education. Some popular global migration corridors involve richer countries in the Middle East and East Asia offering temporary work opportunities to citizens of the Global South, on short-term renewable contracts. These contracts do not offer a path to citizenship. Many of those migrants, therefore, return to their country of birth after the contract expires, bringing back the work experience and skills acquired abroad. A diaspora of skilled migrants abroad, as well as the return of those with experience abroad, can help spread specialized frontier knowledge

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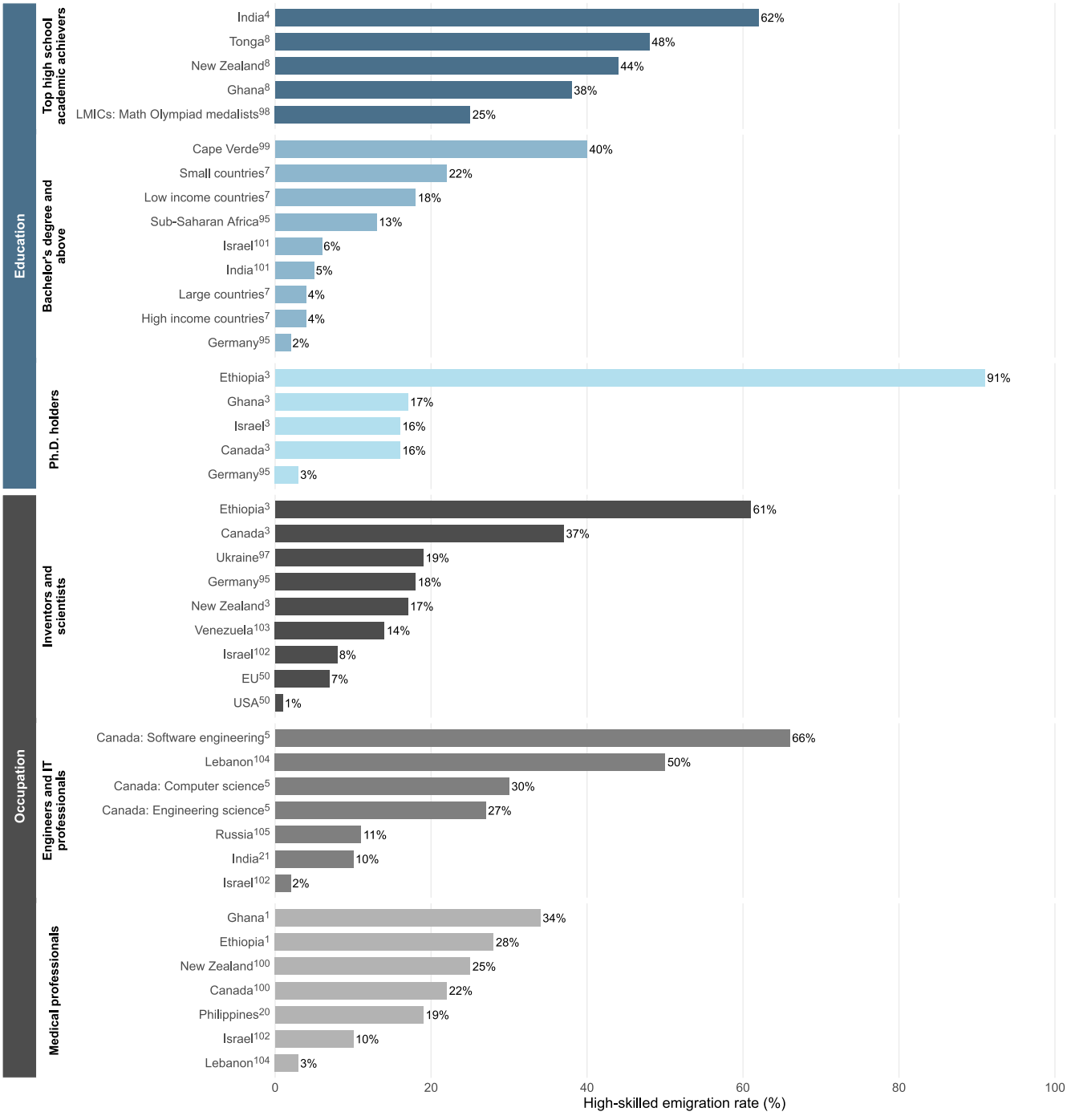

Fig. 1. Estimates of high-skilled emigration rates (percentage of the skilled population living overseas) across skill types and countries. Refer to (*93*) for a description of the data sources and destination countries (mostly OECD countries). Vertical axis labels indicate the source country. Reference numbers in superscript (*1*, *3*, *4*, *5*, *7*, *8*, *20*, *21*, *50*, *94*, *95*–*103*).

from rich countries, all of which can increase innovation and entrepreneurship and even change social norms and political behaviors at home. There could also be negative externalities if the departure of scientists reduces local innovation, medical worker exit undermines health, or the departure of educated elites reduces political accountability. Empirical research on these channels is discussed in Section 4.

The factors discussed above can either increase or decrease the human capital stock in a migrant-sending developing country when a new migration opportunity arises for skilled workers. The relative importance of these different channels will determine the net effect on income, consumption, and health in the origin country, and we review these effects in Section 5. The relevance of any such factor may be a function of the type of migration opportunity, the specifics of destination country migration policies, and the characteristics of the home country's labor market and education system.

Whether migration directly results in a large loss of human capital depends crucially on whether destination countries demand high- or low-skilled workers (*19*). Given the excess supply of workers

Box 1. Identifying causal impacts of high-skilled migration

Recent research has employed a variety of methods that enable researchers to obtain causal estimates of the effects of high-skilled migration:

1. Random assignment (RA): RA randomly allocates individuals into treatment and control groups, e.g., in a randomized controlled trial. This allows estimating causal effects by simply comparing average outcomes in the treatment and control groups (e.g., *14*). Care must be taken to rule out or measure indirect impacts on untreated individuals.

2. Difference-in-differences (DID): This quasiexperimental method compares two groups of individuals, one treated and one untreated, before and after a policy change. DID assumes that in the absence of the policy treatment, outcomes for the two groups would evolve similarly over time ["parallel trends" (*15*)]. Violations of this "parallel trends" assumption represent the most substantial challenge to this approach.

3. Regression discontinuity (RD): Another quasiexperimental method, RD, is used in settings where a cutoff point along some dimension determines who receives a treatment and who does not. If people just below the cutoff are similar to those above except for the treatment, comparing these groups provides an estimate of the treatment effect (e.g., *16*). The validity of the approach is compromised when additional changes occur at the cutoff, or when individuals "game" the threshold (*17*).

4. Shift share instrumental variables (SSIV): SSIV is a quasiexperimental method that uses historical variation in conditions across regions ("shares")—e.g., which is the dominant industry—in combination with arguably exogenous shocks ("shifts") that affect different regions differentially due to these variations in conditions (e.g., *18*). The most notable challenge of this approach is possible effects of shocks on outcomes that operate through mechanisms other than the one of interest.

in some skill categories in labor-abundant, migrant-sending nations, demand for agricultural or home-care workers does not necessarily pose "brain drain" concerns. And even if the foreign work opportunities are in medicine, IT, or engineering, the net effect on domestic human capital will depend on how quickly training institutes in the source country can produce new graduates. That supply elasticity is itself a function of government policy, such as regulation in higher education.

Another critical factor for policymaking is the domestic labor market's capacity to absorb the newly skilled workers. As a simple example, if emigrants acquire English or French language skills to be more productive in destination labor markets, those language skills can probably be productively used at home even if the visa never comes through, or reused when migrants return home. Other language skills may be less portable.

The importance of the remittance channel will depend on how remittance funds are spent at home. If recipients invest those funds in skill acquisition or entrepreneurial ventures, emigration is more likely to lead to a "brain gain". If remittance funds are mostly consumed or invested in real estate, we may not see as much gain in human capital, but it may improve welfare in other ways. The source country is more likely to benefit in the long run if returning migrants and their families combine their new ideas, innovations, and capital to create novel enterprises at home. This, in turn, crucially depends on the investment climate, political stability, and investor protections at home. Finally, the propensity of skilled workers and elites to depart will depend on how well their physical and intellectual property is protected at home; e.g., scientists tend to leave when the returns to innovation are low in the home market.

In summary, to understand the net effect of new migration opportunities on the human capital stock in source countries for any given context (source-destination pair) and sector, we need to review the empirical evidence on all channels by which home-country skill acquisition and retention may be affected, as well as the underlying factors that determine the importance of each channel. We begin in Section 3 by discussing the effects of high-skilled migration on the human capital stock.

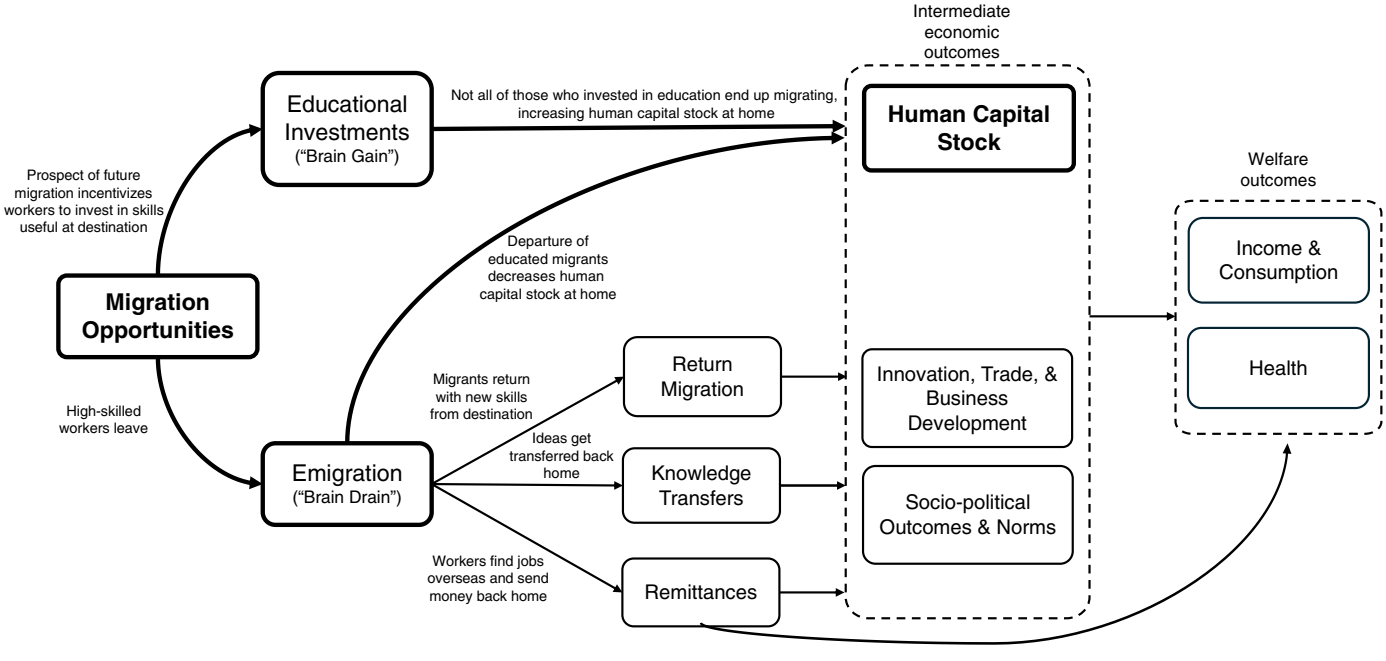

Fig. 2. Conceptual framework. Effects of high-skilled emigration on origin economy.

Effects on the human capital stock

Some recent papers in economics use causal identification methods that exploit policy changes and plausibly exogenous shocks (see Box 1) to provide compelling evidence for the "brain gain" channel, whereby a new migration opportunity increases the stock of educated workers in the origin economy. For example, a DID analysis shows that a sudden exogenous change in US visa availability for Filipino nurses increased not only the number of tertiary-educated nurses in the Philippines, but also the overall stock of tertiary-educated labor (*20*). For each new nurse that moved abroad, nine new nurses were licensed in the Philippines. Similarly, when the H-1B visa cap was relaxed in the US—increasing Indian IT workers' likelihood of migrating there—Indian students and workers acquired computer science skills at higher rates (*21*). A migration-induced increase in the earnings of Indians in the US by 10% raised IT employment in India by 5.8%. Figure 3 illustrates how enrollment in nursing in the Philippines closely tracked the expansion and contraction in visa availability. As these papers carefully and rigorously establish, it would be difficult to explain away the evident close correlations between enrollment fluctuations and the sudden changes in the visa caps using some other omitted factor.

Substantial brain gain can only occur if the origin country has adequate training infrastructure. In the Philippines, US visa opportunities caused the supply of nursing programs, especially at existing private institutions, to expand to accommodate increased demand (*20*). Enrollment increased more in places with a larger supply of private institutions without preexisting nursing programs.

Migration opportunities may also change the skill composition of the labor force at home. One potential concern is that not all of those induced to invest in skills because of migration will find jobs that use these skills at home if they do not migrate, and that even some of those who do migrate end up underutilizing their skills abroad. Qualitative work has documented occurrences of this skills mismatch (*22*, *23*), but currently, causal studies that compare these labor market outcomes with a counterfactual of what these same individuals would do were migration not an option do not seem to exist. So, in the case of the Philippines, although some individuals who trained as nurses because of the possibility of migration may be observed working in call centers at home or as domestic helpers abroad, it is unclear whether they would have ended up in more remunerative occupations without this migration possibility. In theory, there could be shortages if, say, doctors chase migration opportunities and pursue geriatric or surgical specializations when there is a greater need for tropical medicine or pediatrics at home. Measuring whether migration causes such mismatches in a variety of settings should be a subject of future research. Migrant remittances may increase educational investments in the long run (*16*, *24*–*29*). This could prompt a virtuous cycle leading to more high-skilled migration in the future, which in turn raises incomes and education levels (*30*).

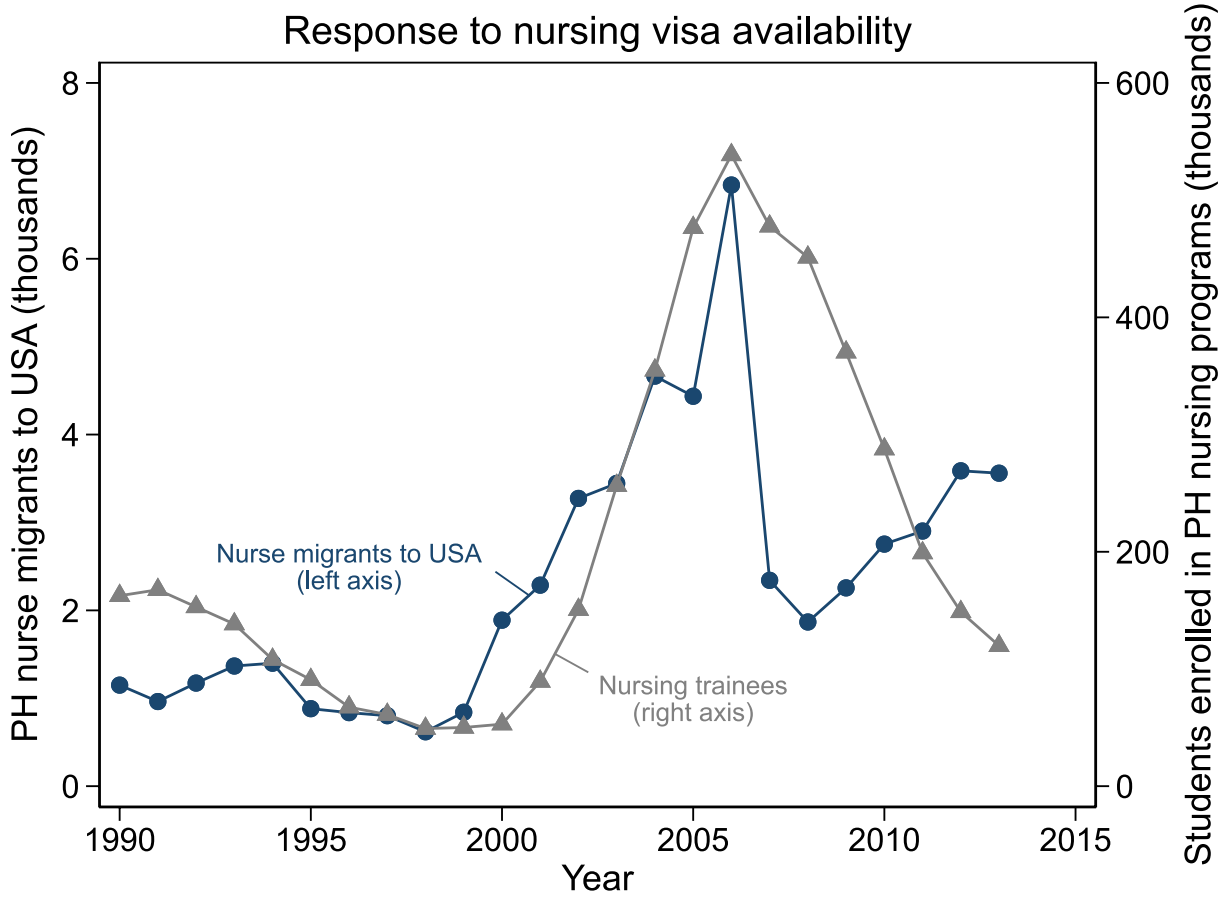

Fig. 3. Enrollment response to migration prospects. Results reproduced from a study on Filipino nurses migrating to the US [adapted from (*20*)]. It shows the total number of nurse migrants to the US (blue line, left axis) based on data from the Commission for Filipinos Overseas, and postsecondary nursing program enrollment in the Philippines (gray line, right axis) from the Philippine Commission on Higher Education.

Finally, many migrate for the explicit purpose of acquiring skills. Globally, the number of international students rose from about 2 million in 2000 to 6.4 million in 2021 (*31*). Much of the growth in the number of students was from large countries like China and India (*32*), but for many smaller countries, a large fraction may be educated abroad. For instance, 100% of educated emigrants from Tonga and Micronesia had received their bachelor's education abroad as there were limited opportunities at home (*8*). Returnees may bring back academic knowledge, as evidenced by returning Fulbright Fellows (*33*), but may be less likely to find employment if they lack local work experience (*34*).

Effects on innovation, entrepreneurship, and norms

Business development, FDI, trade, and entrepreneurship

Skilled emigrants can benefit others in their origin country by creating and growing businesses at home. These businesses provide jobs and new goods and services valued by consumers, and influence the productivity of other firms through supply chains and knowledge spillovers. A diaspora of migrants abroad, and return migrants, contribute by financing capital, sharing ideas and knowledge, or through trade linkages. One study uses a shift-share IV design on historical data to show that US counties with larger migrant networks send more foreign direct investment (FDI) to the migrants' origin country (*35*). Cross-country analysis suggests that FDI has a strong association with the stock of tertiary-educated migrants (*36*). A difference-in-differences (DID) analysis using a 1990 US immigration reform that changed the number of high-skilled scientists and engineers from some origin countries but not others shows that a 10% increase in the migrant ethnic network increases manufacturing output in the sending country by 3% (*37*).

Migrants also facilitate connections between exporters and importers across borders. This enables firms to access new markets abroad while offering consumers a wider array of lower-cost products. Natural experiments derived from Vietnamese refugee resettlement in the US (*38*) and Japanese ethnic networks formed during World War II imprisonments (*39*) provide convincing causal evidence on the links between migration and trade. Exports increase in both the host and sending countries, and having a more skilled diaspora is associated with larger trade impacts (*40*). Skilled migrants generate even further productivity benefits: Immigrant IT sector workers who returned home to India after their US H-1B work visas expired spurred the subsequent offshoring of IT production from the US to India (*21*).

The effect of migration on business development should vary with the type of migrant, the time frame for adjustment, and on economic conditions at the origin. Skilled human capital departing from small countries with limited domestic markets or fleeing conflict, recession, or political repression are less likely to invest in firms at home. In these cases, the direct loss of skilled labor may be the dominant effect. For example, evidence from a shift-share IV design shows a one standard deviation increase in the emigration rate of young, skilled migrants after a recession reduced new firm creation by 4.8% in Italy (*18*).

The effects of emigration may be negative in the short run, before economies have time to adjust. A staggered DID analysis based on variation across countries-of-origin and industries in the timing of when workers could enter the European labor market finds that as tertiary-educated workers emigrated from Eastern European countries which were new members of the European Union (EU), labor costs increased by 7% and productivity fell by 6% in home markets. However, these negative effects dissipate over time as firms adjust (*41*).

Migration of academics, scientists, and medical professionals is less likely to affect business development than the migration of entrepreneurs and inventors. A survey of academic high achievers from Ghana, New Zealand, Tonga, Micronesia, and Papua New Guinea reveals that it is extremely uncommon for this group to help firms make trade deals, facilitate knowledge transfers to businesses, or provide the capital needed to start new businesses, regardless of the individual's migration status (*8*). These types of migrants, therefore, do not have a large effect on business development. By contrast, migrant information technology (IT) workers from India, China, Israel, and Taiwan provided venture capital, knowledge, and network connections to help spur the creation and growth of the IT industry at home (*42*). Skilled migrants returning home can also improve corporate governance. Leveraging the staggered rollout of return migration incentives over time across different Chinese provinces, one study found that return migration increased the valuation and productivity of the Chinese firms whose corporate boards return migrants joined (*43*).

Innovation and scientific development: Some skilled workers are inventors who generate external benefits to the broader economy (*44*). Technological innovation spurs positive local economic spillovers, especially when inventors develop general purpose technologies that have a range of applications across industries and sectors. Furthermore, skilled migrants and returnees may import ideas, insights, and practices from abroad, and enhance the technical knowledge base at home. This diffusion of knowledge through migrant networks has been shown to increase patenting activity (*37*, *45*, *46*) and the productivity of academic research (*33*, *47*, *48*), and to transfer productive business knowledge and practices (*43*) back to migrant origin areas. Such knowledge transfers do not necessarily require return migration as they may occur remotely through networks (*49*).

These papers mentioned in the previous paragraph leverage policy variation to establish causality. For instance, for every 1% increase in emigrants from European countries due to changes in European mobility laws, patent applications in these origin countries rise by 0.64% in the subsequent two years (*46*). When Chinese provinces attract returnees by providing incentives, resident companies that hire directors with foreign experience improve management practices and enjoy higher valuation and profits (*43*). Employees of a large Fortune 500 company in India who were assigned by their human resources department to returnee managers (in a manner uncorrelated with their baseline characteristics) filed more US patents (*45*).

Conversely, losing potential innovators through brain drain can inhibit economic growth and innovation in sending countries (*18*, *50*). Openness to migration can therefore create tradeoffs: potentially fewer innovators at home but greater access to global knowledge that drives local innovation (*51*). These tensions underscore the delicate balance needed when promoting innovator emigration to maximize local innovation. Firm responses to changes in human capital further complicate optimal policy. Firms may respond to "brain gain" by investing in skilled labor–augmenting advanced technologies, or by disinvesting from labor-substituting technologies. An increase in the supply of workers dissuaded Italian firms from investing in productivity-enhancing technologies, as firms substituted away from capital toward the more abundant labor (*52*). Conversely, repatriation of migrants from South Africa back to Malawi catalyzed structural change as their capital financed new investments in nonfarm physical and human capital, and rural workers shifted from farming to nonfarm work (*53*).

Finally, emigration and return migration affect science and academic research in home countries through knowledge transfers. For instance, the Fulbright Fellowship program requires fellows to return to their home countries and these returnees are more influential in their home countries, being cited 90% more than a control group (*33*). A study of top high school academic achievers from Pacific countries shows that although return migrants have no greater direct research impact than similar nonmigrants, they are the main source of research knowledge transfers across borders (*47*). Return migration of a US-trained African scientist increases their nonmigrant scientist colleagues' publication output by 12% through improved knowledge access and connections (*48*).

Compared with nonmigrants, migrants may also engage in more collaborations with cross-border research teams. A DID analysis shows that internationally mobile Chinese scholars had 7.3% more collaborators than their nonmobile counterparts (*54*). By contrast, other DID estimates show that cross-border collaborations in new-EU countries actually fell as researchers with international linkages moved from these countries to other EU countries due to the EU enlargement (*55*). Thus, scientist migration has the potential to either increase or decrease cross-border collaborations.

Political and social norms and outcomes: If skilled emigration leads to an exit of "agents of change" who would otherwise voice concerns, participate in politics, or hold leadership accountable, it can undermine domestic political accountability (*11*). However, it is also possible for skilled emigration to enhance democracy if the diaspora uses their resources and connections to promote better political norms and accountability, or if return migrants exposed to democratic values abroad transmit those values locally upon their return (*56*). A cross-country study finds that sending international college students to study in high-quality democracies is associated with subsequent improvements in the quality of democracy in origin countries (*57*). Relatedly, areas of Cape Verde with more emigrants—particularly educated emigrants to the United States—displayed greater demand for better public services (*58*). Other nonexperimental evidence also points to positive effects of emigration on the quality of political institutions, through both supply and demand channels (*59*–*63*).

Returning migrants or the diaspora might also transmit positive social norms regarding marriage, fertility, and gender. A randomized intervention to improve the integration of Cape Verdean immigrants in Portugal had a spillover effect on their closest contacts in Cape Verde, who increased support for gender equity in household decision-making by 4 to 6%, and electoral participation by 12%, relative to the contacts of migrants not offered the intervention (*64*). There were large improvements in female decision-making power within families of Bangladeshis who won a visa lottery to work in Malaysia, relative to those whose lottery entry was unsuccessful (*65*). Lottery winners' wives were 148% more likely to be identified as the household head, and there was a 75% increase in females holding exclusive decision-making authority in those families. Conversely, migrants returning to Jordan from more conservative Arab countries return with more conservative gender norms (*66*).

Changes in gender norms can produce downstream benefits to child health and development. Lottery winners exhibited delayed marriage and childbirth in the Bangladesh study. Exposure to more liberalized reproductive health policies abroad results in lower fertility rates in origin areas, documented using a shift-share instrumental variables (IV) research design (*67*). Other studies also show that migrants adopt and transmit fertility norms from destination to origin countries (*68*, *69*).

Impacts of high-skilled emigration on origin country welfare

We care about human capital, entrepreneurship, innovation, and norms because they all contribute to the well-being and prosperity of origin countries. We therefore now turn to evidence on the effects of emigration on income, consumption, and health. Very few studies have managed to isolate the effects of high-skilled migration, so this section reviews some literature on the welfare impacts of low-skilled migration as well.

Income and consumption: When economic migrants gain access to labor markets in richer countries, their incomes increase substantially (*70*). Random assignment of international migration opportunities not only yields significant income gains for migrants but also improves the well-being of their families remaining behind (*65*, *71*, *72*). Migrants are able to raise their incomes considerably—gains that are many times larger than the estimated impacts of trade liberalization or capital mobility or in situ development programs (*73*, *74*). The benefits accruing to household members remaining in the origin have been documented extensively using credible causal identification methods (*16*, *25*–*27*, *65*, *72*, *75*–*82*).

Migration has even broader impacts on entire sending economies through the human capital, entrepreneurship, innovation, and business growth channels described above, all of which can create new employment opportunities for citizens remaining behind.

Two papers estimate area-wide impacts on migrant-sending areas of the Philippines. The first uses a DID framework to analyze how removing Filipina women's ability to work in Japan as entertainers—a relatively lucrative occupation—affects area-wide economic outcomes (*83*). Moving from a province that was less dependent on these employment opportunities (at the 25th percentile) to a more dependent (75th percentile) province reduces mean household income by 0.5% and raises the rate of child labor by 2.8%. The second study uses exchange rate shocks in Filipino migrants' overseas destinations, which changes remittances, on development outcomes in their origin provinces (*30*). Improved migrant income prospects make future migrants better-educated and more likely to work in high-skilled jobs. This is likely due to both reduced financial constraints (education funded by remittances) as well as changes in the perceived returns to education (since working internationally now pays better). A one standard deviation shock increases domestic income per capita by 1349 Philippine pesos, and expenditure per capita by 1,224 Philippine pesos (real 2010 pesos, 0.12 standard deviation in each case) in Filipino-origin provinces. This is likely due to both investments of remittances in small enterprises and in education. The remittance shock creates a virtuous cycle in which improved migrant income opportunities promote investment in education, which then leads to future migration in higher-skill, higher-wage occupations.

Even low-skilled migration of Malawians to South Africa benefited origin-area education and development in the long run (*29*, *53*). Mexican migrant exposure to Great Recession shocks in the US led to short-run declines in educational investment in origin areas (*84*). Estimates from microdata from 11 major destination countries suggest that more-educated migrants remit more to their origin countries (*85*). These results suggest that any positive effects of remittances on development outcomes in home countries found using data on low-skilled and high-skilled migrants may be magnified when focusing on high-skilled migrants alone.

Health: Emigration could undermine population health in origin countries if needed health care workers depart. However, we have already seen that migration opportunities can lead to a "brain gain" in health care on net. (*20*). Indeed, across 53 African countries, larger emigration rates of physicians and nurses do not lead to substantial reductions in the number of physicians and nurses in the home country, as revealed in an IV analysis (*86*). The same study also cannot find evidence that physician and nurse emigration worsen population health in terms of infant mortality or disease prevalence. Instead, undesirable living and working conditions for health care workers in underserved, remote areas may be the limiting factor for population health. Indeed, when the government of Nigeria randomly assigned new doctors to rural communities, the easing of the shortage of doctors led to substantial infant mortality reductions (*87*). The fact that the intervention precisely eliminated the rural-urban gap in infant mortality suggests that the binding constraint for health outcomes in rural areas is not emigration, but within-country factors that keep highly qualified medical staff away from these communities. Restricting emigration is therefore unlikely to be the appropriate intervention; government policies that incentivize work in rural areas may be more promising.

In addition, remittances from migrants might actually pay for better access to health care, improving population health. Health care spending in Mexican communities responds very strongly to remittances, with

a 6% marginal propensity to spend on health care out of remittance income (*88*). Another study finds that a 1 percentage point increase in households with return migrants led to a 13% decrease in the share of households without access to health care in Mexico, using variation in interior immigration enforcement policies across US states as shift-share instruments for return migration from the US to Mexico (*89*).

There may also be positive knowledge and norms spillovers from destinations to origins in the health care sector, as in other knowledge sectors. Migration from Mexico to the US increased birth weights and reduced infant mortality in origin households, partly due to improved medical knowledge (*90*). Migration-induced changes in social norms around reproductive health in the Philippines led to reduced origin-community fertility and lower infant mortality in a shift-share IV design (*67*).

In summary, although it is theoretically possible for emigration to worsen population health, the empirical evidence does not suggest strong negative effects and in some cases points toward migration improving health care at the origin. The evidence base we cite includes both high- and low-skilled migrants, but whether high or low-skilled migration contributes more to health improvements is an open question. Effects on ability to pay for health care and on improvement in health knowledge may well be greater for households that start out poorer and less educated at the origin. On the other hand, remittances that affect the ability to pay for health care at the origin may be larger amongst higher-skilled migrant categories. High-skilled migration may also facilitate technological innovations and diffusion in the health sector, but there is no rigorous research on these topics.

Conclusions

Given the importance of human capital for a country's growth and development, it is natural to react to the large high-skilled emigration rates from developing countries highlighted in Fig. 1 with concerns about "brain drain", exploitation, and the prospect of economic stagnation in poorer countries. But carefully thinking through economic theory and examining modern empirical evidence on the full range of direct and indirect effects of emigration makes clear the possibility that migration opportunities can increase human capital in origin economies and improve the well-being of the population on net.

Our review has focused on research that provides causal evidence on these channels, much of it produced by applied microeconomics. The weight of the evidence establishes that "brain gain" and "brain circulation" are not just theoretical possibilities, but also empirically relevant (e.g., *15*, *20*, *21*, *91*). Certain conditions can help facilitate brain gain. Substantial wage benefits from migration in a skilled field, combined with uncertainty in the migration outcome, may induce students to invest in skills at home. At the same time, the home country's education sector should be able to cater to this increase in demand for skills and effectively absorb workers who could not migrate or return from abroad. Strong diaspora, trade links, and return migration can further facilitate the flow of ideas and technology back home whereas existing credit constraints in investments for human capital and businesses may imply there are high returns to remittance-driven investments, leading to substantial gains in origin countries. Although this new literature may help offset some of the concerns about "brain drain," the paucity of data on many skilled migration flows, coupled with the challenge of credibly identifying causal effects, still means more evidence is needed on the mechanisms.

We see five important directions for future empirical work and for policy. First, much of the literature has examined impacts on large, middle-income countries, where emigration is driven by more lucrative economic opportunities for skilled workers abroad. More work is needed regarding more fragile and poor countries in which people left behind have limited opportunities to invest in skill acquisition and where domestic conditions discourage remittances and knowledge transfers from getting converted into actual investments. Second, the impacts of high-skilled emigration are likely to vary substantially depending on the type of skill: an inventor, a doctor, a computer scientist, or a humanities professor leaving will not have the same effects on the home country. However, a considerable amount of work typically lumps all migrants together or disaggregates by tertiary education. Third, most of the existing literature focuses on average effects, but there may be important distributional effects and heterogeneity across sub-groups.

Fourth, more research is needed on the full range of direct and indirect "general equilibrium" effects of emigration, which is necessary for accurate policy analysis. For example, the fact that migration opportunities for Filipino nurses or Indian IT workers produce more nurses and IT workers in the home countries is an interesting observation that addresses the proximate brain drain concerns but by itself it doesn't answer the deeper, more relevant question of whether a larger number of nurses and IT workers are welfare-improving for the home economy. It is possible that chasing a US visa distorts young people's decisions away from investing in skills (e.g., finance, law, medicine, or civil engineering) that are more needed in the origin economies, and instead produces a glut of nurses and IT professionals. Comprehensive policy analysis is only possible with serious consideration of the effects of these human capital investment choices on all labor markets, on population well-being, and even on the potential creation of new products and markets through innovations (*21*).

A fifth and final limitation of the literature is its emphasis on documenting origin-country responses to migration shocks, as opposed to identifying effective policies with the potential to enhance the benefits and reduce the costs of high-skilled emigration. This is where there is a need for more active policy efforts and for testing these policies. Policymakers should not aim to restrict emigration but rather enact policies that enhance its benefits and reduce its costs. Fostering a flexible and partly private system of tertiary education that can expand the supply of skills in response to demand from abroad has been key to the "brain gain" seen in the Philippines and India and is something other countries could learn from. There are innovative new models of financing such efforts such as proposals for public-private "global skill partnerships" (*92*) with pilot projects underway; however, scaling and rigorous evaluations of their impacts are still needed. Diaspora-engagement policies may enhance the knowledge and benefits flowing from those who are abroad, while removing barriers to return migration and circulation may help bring back skills acquired abroad. In addition to origin-country policies, better immigrant integration policies at destinations can also change the nature and scale of "brain gain." It is particularly important to trial and research such policies in smaller countries and more fragile states, where high-skilled emigration rates can be the highest.

REFERENCES AND NOTES

1. E. Adovor, M. Czaika, F. Docquier, Y. Moullan, Medical brain drain: How many, where and why? *Journal of Health Economics*, **76**, 102409 (2021). doi: 10.1016/j.jhealeco.2020.102409; pmid: 33465558
2. J. Nyabor, "Why are Ghana's nurses emigrating in droves?" (2023); https://www.theafricareport.com/303027/why-are-ghanas-nurses-emigrating-in-droves/.
3. F. Docquier, H. Rapoport, in *Brain Drain and Brain Gain: The Global Competition to Attract High-Skilled Migrants*. T. Boeri, H. Brücker, F. Docquier, H. Rapoport, Eds. (Oxford Academic, 2012); pp. 213–232.
4. P. Choudhury, I. Ganguli, P. Gaulé, Top talent, elite colleges, and migration: Evidence from the Indian Institutes of Technology. *Journal of Development Economics*, **164**, 103120 (2023). doi: 10.1016/j.jdeveco.2023.103120
5. Z. Spicer, N. Olmstead, N. Goodman, "Reversing the brain drain: Where is Canadian STEM talent going?" (Brock University Technical Report, 2018).
6. World Bank, "Migrants, refugees, and societies" (World Bank Technical Report, 2023).
7. N. Cha'Ngom, C. Deuster, F. Docquier, J. Machado, "Selective migration and economic development: A generalized approach" (IZA working paper, 2023)
8. J. Gibson, D. McKenzie, The economic consequences of brain drain of the best and brightest: Microeconomic evidence from five countries. *Econ. J.* **122**, 339–375 (2012). doi: 10.1111/j.1468-0297.2012.02498.x

9. World Health Organization (WHO), "WHO renews alert on safeguards for health worker recruitment" (WHO, 2023); https://www.who.int/news/item/14-03-2023-who-renews-alert-on-safeguards-for-health-worker-recruitment#:~:text=The%20World%20Health%20Organization%20(WHO,coverage%20(UHC)%20by%202030.
10. A. Portes, International migration and national development: From orthodox equilibrium to transnationalism. *Sociol. Dev.* **2**, 73–92 (2016). doi: 10.1525/sod.2016.2.2.73
11. A. O. Hirschman, *Exit, Voice, and Loyalty: Responses to Decline in Firms, Organizations, and States*. (Harvard Univ. Press, 1970).
12. H. B. Grubel, A. D. Scott, The international flow of human capital. *The American Economic Review* **56**, 268–274, 1966.doi: 10.1525/sod.2016.2.2.73
13. J. Bhagwati, K. Hamada, The brain drain, international integration of markets for professionals and unemployment: A theoretical analysis. *Journal of Development Economics*, **1**, 19–42, 1974. doi: 10.1111/ecoj.12306
14. M. A. Clemens, "The effect of international migration on productivity: Evidence from randomized allocation of U.S. visas to software workers at an Indian firm" (Center for Global Development Technical Report, 2012).
15. S. A. Shrestha, No man left behind: Effects of emigration prospects on educational and labour outcomes of non-migrants. *Econ. J.* **127**, 495–521 (2017). doi: 10.1111/ecoj.12306
16. M. A. Clemens, E. R. Tiongson, Split decisions: Household finance when a policy discontinuity allocates overseas work. *The Review of Economics and Statistics* **99**, 531–543, 2017. doi: 10.1162/REST_a_00657
17. H. J. Kleven, Bunching. *Annual Review of Economics* **8**, 435–464 2016. doi: 10.1146/annurev-economics-080315-015234
18. M. Anelli, G. Basso, G. Ippedico, G. Peri, Emigration and entrepreneurial drain. *American Economic Journal: Applied Economics* **15**, 218–252 2023. doi: 10.1257/app.20210194
19. D. McKenzie, H. Rapoport, Can migration reduce educational attainment? Evidence from Mexico. *Journal of Population Economics* **24**, 1331–1358 2011. doi: 10.1007/s00148-010-0316-x
20. P. Abarcar, C. Theoharides, Medical worker migration and origin-country human capital: Evidence from U.S. visa policy. *The Review of Economics and Statistics* **106**, 20–35, 2024. doi: 10.1162/rest_a_01131.
21. G. Khanna, N. Morales, "The IT boom and jrn unintended consequences of chasing the American Dream" (Center for Global Development Working Paper, 2024).
22. Y. Y. Ortiga, Learning to Fill the Labor Niche: Filipino nursing graduates and the risk of the migration trap. *RSF: The Russell Sage Foundation Journal of the Social Sciences* **4**, 172–187, 2018. doi: 10.7758/rsf.2018.4.1.10.
23. Y. Y. Ortiga, *Emigration, Employability and Higher Education in the Philippines* (Routledge, ed. 1, 2018).
24. P. Agte, A. Bernhardt, E. Field, R. Pande, N. Rigol, "Investing in the next generation: The long-run impacts of a liquidity shock" (NBER Working Paper 29816, 2022).
25. D. Yang, International migration, remittances and household investment: Evidence from Philippine migrants' exchange rate shocks. *The Economic Journal*, **118**, 591–630 2008. doi: 10.1111/j.1468-0297.2008.02134.x.
26. J. Gibson, D. McKenzie, S. Stillman, The impacts of international migration on remaining household members: Omnibus results from a migration lottery program. *The Review of Economics and Statistics,* **93**, 1297–1318, 2011. doi: 10.1162/REST_a_00129.
27. J. Gibson, D. McKenzie, H. Rohorua, Development impacts of seasonal and temporary migration: A review of evidence from the Pacific and Southeast Asia. *Asia Pac. Policy Stud.* **1**, 18–32 (2014). doi: 10.1002/app5.12
28. C. Theoharides, Manila to Malaysia, Quezon to Qatar: International migration and its effects on origin-country human capital. *Journal of Human Resources* **60**, 1548–8004 (2025). doi: 10.3368/jhr.53.4.0216.7714R1.
29. T. Dinkelman, M. Mariotti, The long-run effects of labor migration on human capital formation in communities of origin. *American Economic Journal: Applied Economics*, *Rev. Econ. Stud.* **8**, 1–35 (2019). doi: 10.1257/app.20150405.
30. G. Khanna, E. Murathanoglu, C. Theoharides, D. Yang, "Abundance from abroad: Migrant income and long-run economic development" (NBER Working Paper 29862 2022).
31. UNSECO, "Welcome to the UIS Data Browser" (UNESCO, 2025); https://data.uis.unesco.org.
32. G. Khanna, K. Shih, A. Weinberger, M. Xu, M. Yu, Trade liberalization and Chinese students in U.S. higher education. *Rev. Econ. Stat.* **2023**, 1–46 (2023). doi: 10.1162/rest_a_01378
33. S. Kahn, M. MacGarvie, Do return requirements increase international knowledge diffusion? Evidence from the Fulbright program. *Res. Policy* **45**, 1304–1322 (2016). doi: 10.1016/j.respol.2016.02.002
34. M. Chen, The value of U.S. college education in global labor markets: Experimental evidence from China. *Manage. Sci.* **70**, 1276–1300 (2024). doi: 10.1287/mnsc.2023.4745
35. K. Buchardi, T. Chaney, A. Tarek, Hassan. Migrants, ancestors, and foreign in- vestments. *Rev. Econ. Stud.* **86**, 1448–1486 (2019). doi: 10.1093/restud/rdy044
36. B. S. Javorcik, Ç. Özden, M. Spatareanu, C. Neagu, Migrant networks and foreign direct investment. *J. Dev. Econ.* **94**, 231–241 (2011). doi: 10.1016/j.jdeveco.2010.01.012
37. W. R. Kerr, Ethnic scientific communities and international technology diffusion. *Rev. Econ. Stat.* **90**, 518–537 (2008).
38. C. Parsons, P.-L. Vézina, Migrant networks and trade: The Vietnamese Boat People as a natural experiment. *Econ. J.* **128**, F210–F234 (2018). doi: 10.1111/ecoj.12457
39. L. Cohen, U. G. Gurun, C. Malloy, Resident networks and corporate connections: Evidence from World War II internment camps. *J. Finance* **72**, 207–248 (2017). doi: 10.1111/jofi.12407
40. D. Bahar, H. Rapoport, Migration, knowledge diffusion and the comparative advantage of nations. *Econ. J.* **128**, F273–F305 (2018). doi: 10.1111/ecoj.12450
41. Y. Giesing, N. Laurentsyeva, "Firms left behind: Emigration and firm productivity" (CESifo Working Paper, 2017).
42. A. L. Saxenian. *The New Argonauts: Regional advantage in a Global Economy*. (Harvard Univ. Press, 2007).
43. M. Giannetti, G. Liao, X. Yu, The brain gain of corporate boards: Evidence from China. *The Journal of Finance*, **70**, 1629–1682 (2015).
44. C. Jones, R & D-based models of economic growth. *J. Polit. Econ.* **103**, 759–784 (1995). doi: 10.1086/262002
45. P. Choudhury, Return migration and geography of innovation in MNEs: A natural experiment of knowledge production by local workers reporting to return migrants. *J. Econ. Geogr.* **16**, 585–610 (2016). doi: 10.1093/jeg/lbv025
46. T. A. Fackler, Y. Giesing, N. Laurentsyeva, Knowledge remittances: Does emigration foster innovation? *Res. Policy* **49**, 103863 (2020). doi: 10.1016/j.respol.2019.103863
47. J. Gibson, D. McKenzie, Scientific mobility and knowledge networks in high emigration countries: Evidence from the Pacific. *Res. Policy* **43**, 1486–1495 (2014). doi: 10.1016/j.respol.2014.04.005
48. C. V. Fry, Bridging the gap: Evidence from the return migration of African scientists. *Organ. Sci.* **34**, 404–432 (2023). doi: 10.1287/orsc.2022.1580
49. D. M. Coluccia, G. Dossi, "Return innovation: The knowledge spillovers of the British migration to the US, 1870-1940" (Centre for Economic Performance Working Paper, 2023).
50. M. Prato, The global race for talent: Brain drain, knowledge transfer, and growth. *Q. J. Econ.* **140**, 165–238 (2025). doi: 10.1093/qje/qjae040
51. A. Agrawal, D. Kapur, J. McHale, A. Oettl, Brain drain or brain bank? The impact of skilled emigration on poor-country innovation. *J. Urban Econ.* **69**, 43–55 (2011). doi: 10.1016/j.jue.2010.06.003
52. D. M. Coluccia, L. Spadavecchia, "Emigration restrictions and economic development: Evidence from the Italian mass migration to the United States" (CESifo Working Paper, 2024).
53. T. Dinkelman, G. Kumchulesi, M. Mariotti, "Labor migration, capital accumulation, and the structure of rural labor markets" (NBER Working Paper 32144, 2024).
54. J. Gu, X. Pan, S. Zhang, J. Chen, International mobility matters: Research collaboration and scientific productivity. *J. Informetrics* **18**, 101522 (2024). doi: 10.1016/j.joi.2024.101522
55. A. Omar, Doria Arrieta, Fabio Pammolli, and Alexander M. Petersen. Quantifying the negative impact of brain drain on the integration of European science. *Sci. Adv.* **3**, e1602232 (2017). doi: 10.1126/sciadv.1602232
56. P. Levitt, Social remittances: Migration driven local-level forms of cultural diffusion. *Int. Migr. Rev.* **32**, 926–948 (1998). doi: 10.1177/019791839803200404; pmid: 12294302
57. A. Spilimbergo, Democracy and foreign education. *Am. Econ. Rev.* **99**, 528–543 (2009). doi: 10.1257/aer.99.1.528
58. C. Batista, P. C. Vicente, Do migrants improve governance at home? Evidence from a voting experiment. *The World Bank Economic Review* **25**, 77–104 (2011). doi: 10.1093/wber/lhr009.
59. L. Chauvet, M. Mercier, Do return migrants transfer political norms to their origin country? Evidence from Mali. *Journal of Comparative Economics* **42**, 630–651 (2014). doi: 10.1016/j.jce.2014.01.001.
60. F. Docquier, E. Lodigiani, H. Rapoport, M. Schiff, Emigration and democracy. *J. Dev. Econ.* **120**, 209–223 (2016). doi: 10.1016/j.jdeveco.2015.12.001
61. M. Mercier, The return of the prodigy son: Do return migrants make better leaders? *J. Dev. Econ.* **122**, 76–91 (2016). doi: 10.1016/j.jdeveco.2016.04.005
62. T. Barsbai, H. Rapoport, A. Steinmayr, C. Trebesch, The effect of labor migration on the diffusion of democracy: Evidence from a former Soviet Republic. *Am. Econ. J. Appl. Econ.* **9**, 36–69 (2017). doi: 10.1257/app.20150517
63. C. Batista, J. Seither, P. C. Vicente, Do migrant social networks shape political attitudes and behavior at home? *World Dev.* **117**, 328–343 (2019). doi: 10.1016/j.worlddev.2019.01.019
64. C. Batista, L. Bohnet, J. Gazeaud, J. Seither, "Integrating immigrants as a tool for broad development" (NOVAFRICA Working Paper wp2205, 2024).
65. A. M. Mobarak, I. Sharif, M. Shrestha, Returns to international migration: Evidence from a Bangladesh-Malaysia visa lottery. *Am. Econ. J. Appl. Econ.* **15**, 353–388 (2023). doi: 10.1257/app.20220258
66. M. Tuccio, J. Wahba, Return migration and the transfer of gender norms: Evidence from the Middle East. *J. Comp. Econ.* **46**, 1006–1029 (2018). doi: 10.1016/j.jce.2018.07.015
67. S. Godlonton, C. Theoharides, "Diffusion of reproductive health behavior through international migration: Effects on origin-country fertility", presented at Amherst College, Amherst, MA, November 15, 2024.
68. M. Beine, F. Docquier, M. Schiff, International migration, transfer of norms and home country fertility. *Can. J. Econ.* **46**, 1406–1430 (2013). doi: 10.1111/caje.12062

69. S. Bertoli, F. Marchetta, Bringing it all back home Return migration and fertility choices. *World Dev.* **65**, 27–40 (2015). doi: 10.1016/j.worlddev.2013.08.006
70. M. Clemens, C. Montenegro, L. Pritchett, The Place Premium: Bounding the price equivalent of migration barriers. *Rev. Econ. Stat.* **101**, 201–213 (2019). doi: 10.1162/rest_a_00776
71. N. Gaikwad, K. Hanson, A. Toth, Bridging the Gulf: How migration fosters tolerance, cosmopolitanism, and support for globalization. *Am. J. Pol. Sci.* **2024**, 1–18 (2024). doi: 10.1111/ajps.12893
72. J. Gibson, D. McKenzie, H. Rohorua, S. Stillman, The long-term impacts of international migration: Evidence from a lottery. *World Bank Economic Review* **32**, 127– 147 (2018). doi: 10.1093/wber/lhx003
73. M. A. Clemens, Economics and emigration: Trillion-dollar bills on the sidewalk. *J. Econ. Perspect.* **25**, 83–106 (2011). doi: 10.1257/jep.25.3.83
74. L. Pritchett, F. Hani, *The Economics of International Wage Differentials and Migration* (Oxford Research Encyclopedia of Economics and Finance, 2020).
75. L. Bossavie, J.-S. Gorlach, C. Ozden, H. Wang, "Temporary migration for long-term investment" (World Bank Group Working Paper 9740, 2021).
76. A. Cuadros-Menaca, A. Gaduh, Remittances, child labor, and schooling: Evidence from Colombia. *Econ. Dev. Cult. Change* **68**, 1257–1293 (2020). doi: 10.1086/702790
77. C. Dustmann, O. Kirchkamp, The optimal migration duration and activity choice after re-migration. *J. Dev. Econ.* **67**, 351–372 (2002). doi: 10.1016/S0304-3878(01)00193-6
78. J. Gibson, D. McKenzie, S. Stillman, How important is selection? Experimental vs. non- experimental measures of the income gains from migration. *J. Eur. Econ. Assoc.* **8**, 913–945 (2010). doi: 10.1111/j.1542-4774.2010.tb00544.x
79. A. Gröger, Easy come, easy go? Economic shocks, labor migration and the family left behind. *J. Int. Econ.* **128**, 103409 (2019). doi: 10.1016/j.jinteco.2020.103409
80. M. A. Hilmy, "Remittances, Economic Development, and Education Investment" (Univ. of New South Wales, Working Paper, (2022).
81. M. Mendola, Rural out-migration and economic development at origin: A review of the evidence. *J. Int. Dev.* **24**, 102–122 (2013). doi: 10.1002/jid.1684
82. D. Yang, C. A. Martinez, in *International Migration, Remittances, and the Brain Drain* (World Bank and Palgrave Macmillan, 2006) Ç. Özden, M. Schiffpp, Eds. pp. 81–122.
83. C. Theoharides, The unintended consequences of migration policy on origin-country labor market decisions. *J. Dev. Econ.* **142**, 102271 (2020). doi: 10.1016/j.jdeveco.2018.07.012
84. M. E. Caballero, B. C. Cadena, B. K. Kovak, The international transmission of local economic shocks through migrant networks. *J. Int. Econ.* **145**, 103832 (2023). doi: 10.1016/j.jinteco.2023.103832; pmid: 39130728
85. A. Bollard, D. McKenzie, M. Morten, H. Rapoport, Remittances and the brain drain revisited: The microdata show that more educated migrants remit more. *World Bank Econ. Rev.* **25**, 132–156 (2011). doi: 10.1093/wber/lhr013
86. M. A. Clemens, "Do visas kill? Health effects of African health professional emigration" (Center for Global Development Working Paper, 2007).
87. E. N. Okeke, When a doctor falls from the sky: The impact of easing doctor supply constraints on mortality. *Am. Econ. Rev.* **113**, 585–627 (2023). doi: 10.1257/aer.20210701
88. C. Amuedo-Dorantes, S. Pozo, New evidence on the role of remittances on healthcare expenditures by Mexican households. *Rev. Econ. Househ.* **9**, 69–98 (2011). doi: 10.1007/s11150-009-9080-7
89. J. R. Bucheli, M. Fontenla, The impact of return migration on economic development. *Rev. Econ. Stat.* **107**, 1–15 (2025). doi: 10.1162/rest_a_01273
90. N. Hildebrandt, D. J. McKenzie, G. Esquivel, E. Schargrodsky, The effects of migration on child health in Mexico. *Economia* **6**, 257–289 (2005).
91. S. Chand, M. A. Clemens, Human capital investment under exit options: Evidence from a natural quasi-experiment. *J. Dev. Econ.* **163**, 103112 (2023). doi: 10.1016/j.jdeveco.2023.103112
92. M. A. Clemens, Global Skill Partnerships: a proposal for technical training in a mobile world. IZA Journal of Labor Policy. **4**, 681–730 2015. doi: 10.1186/s40173-014-0028-z
93. D. Han, Brain Drain or Brain Gain? Effects of High-Skilled International Emigration on Origin Countries, OSF (2025); https://doi.org/10.17605/OSF.IO/EWH3S.
94. F. Docquier, H. Rapoport, Globalization, brain drain, and development. *J. Econ. Lit.* **50**, 681–730 (2012). doi: 10.1257/jel.50.3.681
95. G. de Rassenfosse, T. Murovana, W.-H. Uhlbach, The effects of war on Ukrainian research. *Humanities and Social Sciences Communications* **10**, 856 (2023). doi: 10.1057/s41599-023-02346-x
96. R. Agarwal, I. Ganguli, P. Gaulé, G. Smith, Why U.S. immigration matters for the global advancement of science. *Research Policy* **52**, 104659 (2023). doi: 10.1016/j.respol.2022.104659
97. C. Batista, A. Lacuesta, P. C. Vicente, Testing the brain gain hypothesis: Micro evidence from Cape Verde. *Journal of Development Economics* **97**, 32–45 (2012); doi: 10.1016/j.jdeveco.2011.01.005
98. A. Bhargava, F. Docquier, Y. Moullan, Modeling the effects of physician emigration on human development. *Economics & Human Biology* **9**, 172–183, (2011). doi: 10.1016/j.ehb.2010.12.004; pmid: 21288783
99. H. Brücker, S. Capuano, A. Marfouk, "Education, gender and international migration: Insights from a panel-dataset 1980-2010" (IAB Working Paper, 2013).
100. E. Gould, O. Moav, Israel's brain drain. *Israel Economic Review* **5**, 1–22 (2007).
101. J. Requena, C. Caputo, Loss of talent in Venezuela: Migration of its researchers. *Interciencia* **41**, 444–453 (2016).
102. D. Saoud, "Lebanon's brain drain: Doctors, nurses, engineers leaving amid crisis" (UPI, 2020); https://www.upi.com/Top_News/World-News/2020/12/22/ Lebanons-brain-drain-Doctors-nurses-engineers-leaving-amid-crisis/ 9091608581590/
103. J. Wachs, Digital traces of brain drain: Developers during the Russian invasion of Ukraine. *EPJ Data Science* **12**, 14 (2023). doi: 10.1140/epjds/s13688-023-00389-3

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