CHAPTER 3

Global science, global talent in the wake of nationalism and populism

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US President Donald Trump is part of a chilling parade of politicians […] who have risen to prominence in the past decade by fuelling anti-immigrant sentiment. But […] we should be grateful for what global talent has done for our economy. Since 1900, immigrants have made up one-third of US recipients of Nobel prizes in chemistry, physics, medicine and economics. Immigrants account for more than one-quarter of the approximately 110,000 patents filed in the United States each year. There are more than 1 million foreign students in US universities, representing about 5% of enrollees and providing an estimated US$39 billion annual stimulus to the economy. William R. Kerr (2018a)

Globalization is a key feature of the 21st century. The global playfield did not come naturally to Western universities, many of which were created in the 19th century and had a clear national or regional orientation. Today, the best universities — as in best-ranked universities — are also the most connected and the most international. Globalization brought along deep societal changes; today we experience a backlash which asks for tighter control of immigration and for economic protectionism. In many countries there is now a majority opinion that immigration and trade openness must be aligned with national needs. This can threaten world-class universities who run on the engine of openness. To these universities, the willingness of a country to attract foreign talent is fundamental to sustaining the quality of its national science and engineering workforces.

In this paper we first try to map the extent of the global academic talent, then we analyse recent forms and features of academic internationalization, and finally we discuss the challenges of attracting global talent today.

KEY DATA ON HIGHER EDUCATION DEMOGRAPHICS

ELIGIBILITY FOR TERTIARY EDUCATION How many young people are there available to universities? In 2015, there were 715 million people aged 18-23 globally — data in this chapter are from National Science Board (2018) or OECD (2018) — a number that will reach 800 million by 2040. Three quarters of this growth will be attributable to just nine African countries, plus Pakistan. However, our planet is aging, and the college-age population will represent just 8.2% of the total population in 2050, a three percentage point decrease from today.

STUDENT ENROLMENTS How many students will there be in the future? While predictions are always shaky, Fig. 1 presents a projection based on UNESCO numbers (Calderon, 2018). Today there are about 200 million tertiary students; there will be three times more in 25 years. However, the regions that historically dominated the student world, North America and Europe (i.e. the West), will see a mighty loss of influence. At the beginning of this century, the West still had about a quarter of total students. This number might decline to about 7.5% by 2040; the small rise of enrolments will be mostly attributable to immigration. Note also the later take off of Africa (after 2030).

Figure 1– Projected student enrolments, total number and for selected regions. Source: Calderon (2018).

(millions of students)	2016	2030	2040
Total	215	377	594
East Asia	71	149	258
South Asia	42	91	160
North America and Western Europe	37.5	41	44
Sub-Saharan Africa	7.4	8.8	22

STEM (S&E) STUDENTS AND PHDS (National Science Board, 2018) In 2014, more than 7.5 million first university degrees were awarded in S&E worldwide. Students in India or China earned about half of those degrees, those in the European Union earned about 12%, and those in the United States earned about 10%. China and India are expected to produce 60% of young STEM-degree holders by 2030. At the doctoral level, Western research universities deliver still about half of 230,000 S&E doctoral degrees that were awarded worldwide in 2014: 73,000 degrees earned in the EU, 40,000 in the United States, 34,000 in China, 19,000 in Russia and 13,000 in India.

TOTAL NUMBERS OF MIGRANTS The proportion of migrants, 3.4% of world population in 2017 (258 million) has surprisingly changed little over the last 100 years (Pison, 2019). There were about 35 million migrants with tertiary education in the OECD in 2010/11 (OECD-UNDESA, 2013). In most countries, the emigration rates of college-educated individuals are greater than those of their less educated compatriots; Mexico and Russia are notable exceptions. One in every nine persons in Africa with a tertiary degree lived in the OECD in 2010/2011; and migrants from India, China and the Philippines accounted for one-fifth of all tertiary educated migrants in the OECD area. This implies that intra-OECD migration is (still) very high. Noteworthy: since the beginning of the century, high-skilled female migrants outnumber high-skilled male migrants (Arslan *et al.*, 2014)

INTERNATIONAL STUDENTS Overall the volume of student mobility is at an all-time high. There were 5 million international students in 2016, up from 2.1 m. in 2001 (and 1.3 m. in 1990). More internationally mobile students go to the US than to any other country (National Science Board, 2018), 19% of internationally mobile students worldwide. Other top destinations include the United Kingdom (10%), Australia (6%), France (5%), Russia (5%) and Germany (5%); these six countries host together about half of all internationally mobile students. In absolute numbers, the United States remains the top destination with about 1 million students, but its share is declining (25% in 2000, 19% in 2014 [OECD, 2017]). Of these one million students, Chinese and Indian students accounted for half. In most OECD countries, international students make up a significant part of doctorates (37% in the US; and 52% in Switzerland), reflecting the international attractiveness of research universities.

INTERNATIONAL STUDENT SITUATION IN SWITZERLAND (OFS, 2017) International students make up 19% of the student population when all types of higher education institutions are considered, and they constitute 22% of all master students and 52% of all PhDs. We are also happy to report that international students in Switzerland are on average 31 years old, and that 17.8% of them have kids. One quarter of these students came from a non-European country, one fifth does not speak a Swiss national language, and two thirds of international students are concentrated in just two areas, the Zurich or the Leman area.

INTERNATIONAL STUDENTS AT EPFL (Table 2) Over the last 20 years EPFL has become an internationally recognized polytechnic university, well placed in all international rankings, attractive to international faculty, and very attractive in terms of student fees (EPFL charges all students the same fees, about €1,000 per year). The "internationality" of EPFL is higher than the national average, Swiss students are a minority at all levels of study, and the share of international students has increased sharply in a short time.

At bachelor and master levels we recruit "glocal" students, i.e. international students from nearby France; the PhD level is truly international. EPFL views internationality as a measure of success.

Figure 2– Students at EPFL, segmented according to their previous diploma.

	Bachelor			Master			PhD		
Previous diploma	2005	2010	2018	2005	2010	2018	2005	2010	2018
Switzerland	72%	64%	49%	68%	55%	40%	35%	35%	32%
France	13%	25%	38%	12%	16%	33%	12%	7%	8%
Rest of Europe	8%	7%	8%	9%	14%	14%	32%	38%	39%
Asia	2%	1%	1%	4%	9%	7%	11%	13%	15%
Others	5%	3%	4%	7%	6%	5%	9%	8%	6%

OUTLOOK OF HIGH SKILLED MOBILITY In the end, host countries may end up with high concentrations of high-skilled immigrants (Stephan *et al.*, 2013); for example, immigrants account for some 57% of scientists residing in Switzerland, and 38% in the United States. Strong reliance on foreign talent is therefore not a sign of scientific weakness, on the contrary. In comparison, in India, Italy and Brazil less than 4% of the doctoral or postdoctoral-trained workforce is foreign-born.

INTERNATIONAL STUDENTS IN THE 21ST CENTURY

Over the past 40 years internationalization of higher education has taken several forms and accents. For a long time, internationalization was primarily focused on development, cooperation and aid. Then, particularly in Europe, the focus shifted from aid to exchange of students and curriculum development. We analyse here the developments since 2000, following closely the "three waves" segmentation proposed by (Choudaha, 2017). The underlying drivers and characteristics of these three waves suggest that academic institutions will be under increasing financial and competitive pressure to attract and retain international students.

Wave I

Wave I (1990s-2005) was shaped by the increasing demand for talented students in STEM fields, pushed by demand in biotechnology and information and communication technology; Europe was building the European Higher

Education Area, an initiative to create some coherence in higher education and to foster student mobility within Europe. Also, the terrorist attacks of 2001 made it harder for many students to enrol in American research universities. Towards the end of Wave I, five of the top 10 destination countries were in Europe (the UK, France, Italy, Austria and Switzerland). China became an important source country, with many Chinese students moving to Japan or South Korea. International students in this wave were more likely to be academically prepared in science, choosing the best universities but dependent on financial aid and scholarship from the hosting institutions (Choudaha, 2017).

ERASMUS A continuing success story from this era is the ERASMUS Program (De Wit, 2013), initiated by the European Commission in 1987. To date about nine million students in Europe have profited from this mobility program. Its budget will even double for the next funding period (FP9), to €30 billion, and it aims to internationalize about 12 million students (and apprentices) (European Commission, 2019).

Wave II

Wave II (2006–2013) Wave II was shaped by the global financial recession which triggered financial motivations for recruiting international students, as they were severe budget cuts in the higher education sector in many countries around the world. The narrative of Wave I of "attracting global talent" changed to "recruiting international students" in Wave II (Choudaha, 2017). Interest in recruiting foreign students grew as their tuition fees were often higher than for national students. In the US in particular, there was a dramatic growth of self-funded Chinese students and of government-funded Saudi students. Most students in this wave concentrated in business studies, especially at the undergraduate level.

In the UK predominantly, but also in continental Europe (Denmark, Sweden, The Netherlands), moves occurred or were planned for higher fees for international students from outside the EU. And, "against all expectations" (De Wit, 2013), it has been surprising to see that this did not result in a decrease of international students but in a substantial increase, following the principle "what you have to pay much for must be of good value" (De Wit, 2013), making the United Kingdom the number 2 and Australia the number 5 countries in receiving international students.

TEACHING IN ENGLISH In Europe there was about a ten-fold increase in masters programs taught in English (8,100 in 2014, up from 725 in 2001, [Benson & Griffith, 2018]), reflecting the will to serve international students. And if our experience at EPFL helps, teaching in English not only serves to attract students, but also helps local students to get out into the world.

Wave III

Wave III is being shaped by a combination of three major events (again we follow Choudaha [2017]). First, the economic slowdown in China is decelerating the growth of Chinese students going abroad. The second major event is Brexit and the third is the election of Donald Trump. The US and the UK are both top destination countries for international students and both events have strong anti-immigration tones.

In parallel, many countries detect skills gaps (due to aging of the population) prompting policies that align migration programs with the economic needs of the country, in part through international students. Retaining talent in line with the needs of the country is a dominant policy of wave III.

FOREIGN ENROLMENT FALLS IN THE US (Nature Careers, 2019). A first consequence, and a first in recent history, is the small decrease in the number of international students enrolling in US graduate programs. The US Council of Graduate Schools (CGS) reports that a first decrease of application from prospective international graduate students occurred in autumn 2017 (3.7% decrease), followed one year later by another 4% decrease. Somewhat unsurprisingly, substantial declines were noted for Iran, the Middle East, Europe (-13%) and India.

CHINESE ENROLMENT IN THE UK INCREASES Illustrating the race to attract students, while the enrolment of Chinese students is stalling in the US, the UK signals a huge increase of Chinese international students (Weale, 2019). Ten years ago, 45,000 Chinese students were enrolled in UK universities; today there are 130,000, and rising. Manchester University for instance has about 5,000 Chinese students for a total of 40,000. Is there thus a bright side to Brexit, meaning a competitive edge for the UK in recruiting non-EU students?

THE GROWTH OF GLOCAL STUDENTS: another consequence of a disturbed international environment is the rise of glocal students, students that aspire to gain a global experience, but at local cost (Choudaha, 2017). In the OECD, 850,000 mobile foreign students (i.e. about one out of five) come from a bordering country. Regional migrations are paramount in Asia. About one third of the 1 million mobile students in East Asia moved within the region (OECD, 2018). EPFL experienced a fantastic rise in international students from neighboring France (see Table 2).

TRANSNATIONAL EDUCATION Cross-border delivery of education (offshore education) is another trend of Wave III. The underlying assumption is "if they do not come to us, why don't we go to them". The largest exporters of branch campuses (C-BERT, 2017) were the United States (109 branch campuses), the United Kingdom (45), France (31), Russia (22) and Australia (21). The largest importers of branch campuses were China (38 branch campuses) and the Gulf states (77).

INTERNATIONAL SCIENTISTS SUSPECTED AS SPIES Raising economic tensions between countries may create a climate of suspicion directly affecting foreign scientists. The most publicized examples (e.g. Facher, 2018) are from Chinese scientists working in the US or Europe; this should not imply that Chinese scientists are particularly prone to academic espionage. Liu Ruopeng, a Chinese researcher working at Duke University who was accused of stealing information used to develop a so-called "invisibility cloak" on behalf of the Chinese government between 2006 and 2009, by running a "shadow lab" in his home country while conducting government-funded research in the US. Or Chinese student Huang Xianjun, a PhD Student in Graphene material science at the University of Manchester, one of the estimated 2500 scientists chosen by the Chinese military to study abroad under the program doing "Picking flowers in foreign lands to make honey in China". And three researchers have been ousted from MD Anderson Cancer Center (Ackerman, 2019) because NIH discovered they disclosed information about confidential grants to people with ties to foreign governments during the peer-review process. The global science enterprise, built on trust and exchange, appears to be totally unprepared for this.

TODAY/CONSEQUENCES

Immigration and Universities

IMMIGRATION AND NATIONAL PRIORITIES Countries select many of their immigrants in accordance with clearly articulated economic criteria to maintain public confidence in the governance of migration. Selection systems of immigrants, including students and academics that respond to a country's labour-market needs become the gold standard. For universities the challenge is to accept the link to local labour-market needs without losing the mission of educating the students "of tomorrow and not just of today".

One might question why high-skilled migration should ever be restricted (Pekkala *et al.*, 2017). The primary economic arguments centre on possible adverse wage and employment effects on skilled native workers (Pekkala *et al.*, 2016). As universities both host high-skilled immigrants AND are educating skilled native workers, they are at the heart of the discussion.

THE UNIVERSITY IMMIGRATION PATHWAY (We follow Kerr [2018b] for the argumentation). Many "skilled immigrants" arrive with only "raw talent and ambition" with the aim of improving their life through formal schooling. Universities and colleges are important gatekeepers through their selection of individuals, as student visas and student circulation are often unlimited, as exemplified by the F1 (student) or J1 (exchange visitor)

visas in the US. About 700,000 such visas were delivered in 2015 alone. Such visas do not offer long-term employment, but graduates often get hired by local firms: nearly half of the new H-1B working visas in 2014 went to applicants already in the country, notably from these school-to-work transitions. In addition, temporary work visas are extended for STEM students, to 36 months after graduation by the Obama administration (with subsequent restrictions by the later administration). The university pathway has also become more important as PhD students more frequently enter the private sector (Langin, 2019); in the US in 2017, private sector employment of PhDs (42%) was now nearly on par with educational institutions (43%).

LONG-TERM STAY RATES In this new framework, the competitive economic advantage in attracting foreign students is fully realized only when these individuals stay to work after graduation. Stay rates are generally high; for PhD recipients they were (in 2015) 70% both at the 5- and 10-year stay rates in the US. The percentage of new STEM doctorates from China and India — the two top countries of origin — with definite plans to stay in the US has declined over the past decade to about 50%, as these nationals either feel unwelcome or their country of origin has built their own innovation capacity. In Switzerland (OFS, 2017), about one third of foreign graduates have left the country one year after graduation. Most move back to their country of origin (mostly France and Germany); then about one quarter of the returnees, while leaving abroad, will work in Switzerland as *frontaliers*. The total "keep rate" of Switzerland regarding foreign graduates is therefore about 75%, an excellent score; the score is less stellar for extra-European graduates (Waltersperger & Donzé, 2019).

LIMITING FOREIGN STUDENTS For the time being, Swiss universities — among many European universities — do not charge full cost to foreign students, and therefore discussions flare up regularly to submit international students to quotas. The possibility of limiting the number of foreign students at EPFL or ETH Zurich was effected into law in 2016. If these universities want to restrict access of foreign students, they have to demonstrate that the influx of foreign students (EU or non-EU) would exceed their "capacity". Except for the medical curriculum at ETH Zurich, no restrictions have been effected so far. On the contrary, at EPFL international students are seen as a sign of attractivity and, rather than establishing quotas, EPFL intends to invest in teaching, hire more professors and build more on-line modules. EPFL applies a selection (but not a quota) on French students who need a final note of 16/20 and a *mention très bien* on their baccalaureate to apply to EPFL.

RE-EVALUATING BRAIN DRAIN Emigration increases with development, because the proportion of college graduates in the native population increases and it is precisely this group that has highest propensity to emigrate abroad (Dao *et al.*, 2018). The number of tertiary-educated African migrants

in OECD increased dramatically by 80% between 2000 and 2010, but the emigration rate went down. This is explained by the almost doubling of the population with tertiary education in Africa for the period. Skilled migration does not necessarily lead to a brain drain. The positive effects of skilled migration can come in the form of remittances and knowledge exchange through professional networks. In science, an effective "ethnic" network is at work, with the potential of delivering knowledge spillovers to origin countries (Tejada & Bolay, 2015). According to the World Bank, officially recorded remittances to developing countries amounted to US$414 billion in 2013. This is about three times greater than official development assistance! Medical Brain Drain however is the most problematic aspect of brain drain and is unsolved.

FULLY CAPITALIZE ON OUR OWN CITIZENS Attracting the best students is not incompatible with building a strong national "STEM workforce"; as the National Science Board (2018) puts it: "Governments and businesses should expand their investments in community and technical colleges, which continue to provide individuals with on-ramps into skilled technical careers, as well as opportunities for skill renewal and development for workers at all education levels throughout their careers." Switzerland is lucky to have a dual system of high-quality research universities and professional apprenticeships. This differentiated R&D system, with solid national or local roots for skill development creates a "vertically integrated innovation system", which leaves room for research universities to concentrate on attracting global talent and playing the global competition.

Global Talent

THE RACE TO ATTRACT TALENTS IS LIKELY TO GET TOUGHER IN THE FUTURE Global demographics, regional developments, changing student enrolments described above make it likely that there will be, in the coming years, increased competition for global talent.

In times of growing protectionism, some governments are paradoxically active in promoting mobility. Internationalization is seen as a means to increase soft power, to infrastructure capacity-building, to drive up research and teaching standards, or to solve workforce weaknesses with an aging population. An illustration is China's activities in Africa (Benson *et al.*, 2017), with 70,000 scholarships over 8 years, 40,000 training opportunities in Chinese companies, the establishment of 46 Confucius institutes over 30 countries in Africa. Canada aims for 450,000 international students by 2022 (312,000 in 2017), with a point system that advantages applicants for residency for those whose degrees were obtained in the country; Germany aimed at 350,000 students by 2020, the target was already reached in 2017, with an 18 month-time span to find employment after graduation to retain the students. China aims

at 500,000 international students by 2020 (442,000 in 2016), with internships and smoother pathways to residency permits. Japan wants to boost its international student force to 300,000 by 2020, from 180,000 in 2017 with targeted recruitment, subsidized company internships, job search assistance and streamlined visas. (All examples are from [Ilieva *et al.*, 2017]).

EXCELLENCE ATTRACTS EXCELLENCE In the end, the true engine of international mobility of students is quality of teaching and excellence of research. Global university rankings are the iconic manifestation of trying to measure excellence in a truly global way. Some countries could rest on "Ivy Leagues", some others created excellence initiatives to help shape world class universities. China's strategy (C-9, the Chinese "Ivy league") (OECD, 2017) was to dedicate important resources (C-9 = 10% of whole budget) to a few universities, and has now six universities in the top 200 Times Higher Education ranking (up from two in 2011). Russia and India are also moving up the ranks. Undoubtedly students — or their sponsors — are consulting these rankings.

There are other ways to check for excellence. In the coming decades, Europe, and probably North America, will no longer be able to attract new students massively. But we must play on quality. In research, we'd move away from quantity, i.e. publication numbers, and concentrate on quality, i.e. top-cited publications. Here Switzerland is ranked first, followed by The Netherlands, Denmark, US and Great Britain. By analogy we'd deploy the best graduate programs. Our funding systems, our international connections should be designed to be able to maintain scientific quality, which in the end is what attracts the brightest students.

World class universities can become similar through the unifying pressure from key performance indicators of the global rankings, or they can converge quietly (by use of English, and converging PhD training with doctoral schools). Or the transformation can be more profound, by creating a truly global science through open science (Henry & Vetterli, 2018) and open enrolment, living by "association by the best and participation by all" (Beddington, 2019).

Let our slogan be: #youarewelcomehere!

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