Project Working Paper 6

Universities and Industrial Policies: National Treatment, Reciprocity and Globalization

Eion Lys [1]

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Overview: The National Roles and Global Footprint of Universities [2]

The host country roles and responsibilities of universities, though almost always extensive and long-standing, are sometimes unclear. Many universities chartered in the 20th and 21st centuries were created to include explicit roles as engines of national economic and social development. In these cases, time lags and academic subject matter complexities (between education and research and their eventual impacts) can obscure the expected and realized contributions of universities, and university graduates, to national interests.

In older institutions, such as many in the UK and the US, historic traditions of academic freedom and operational independence additionally cloud linkages. There is a chronic tension, sometimes acute but often dormant, between university autonomy and government direction. Public universities in the US struggle with this tension explicitly, as state legislatures often aim to exercise control over state-chartered institutions, even with university faculty being able to set their own research and teaching agendas. This explicit tension is the tip of the iceberg, however, as many different channels exist for aligning the activities of universities with country-level interests, including national industrial policies. These channels include direct and indirect student financial assistance, teaching and research grants, capital investments, government support for new (and often targeted) programs and institutions, and IP and technology transfer rules and programs.

Education, and academic research exchange and collaboration, have been leading cross-border activities for centuries, arguably at least since at least the Scientific Revolution in the 1500s. The surge in economic globalization in recent decades has accelerated this situation. This evolution poses new, or at least newly apparent, challenges in reconciling the international activities of universities (and individual faculty and students) with their national roles and responsibilities.

Before turning to some of the particulars of these challenges, it is worthwhile to review a few summary metrics about the size and importance of higher education globally. These data help with understanding

[1] Information about the Global Innovation and National Interests Project is available at https://www.brginstitute.org/project-description. The author appreciates the comments and suggestions from members of the project working group, which have been incorporated into this working paper. Opinions expressed are those of the author and not of the project or BRG Institute, and may evolve with ongoing research.

[2] Higher education institutions, or HEIs, include all tertiary entities, from vocational and trade schools, to primarily undergraduate and regional colleges, to globally-oriented research universities. For topical brevity and clarity, this discussion will focus on research-intensive universities, while noting much of the surrounding data, and many of the questions and challenging current issues can also apply to other kinds of HEIs.

the large-scale societal and economic impact of, and connections between, tertiary institutions both nationally and globally.

1. **Total tertiary spending**, in the US (about three percent of US GDP): "In 2017–18, degree-granting postsecondary institutions in the United States spent $604 billion (in current dollars). Total expenses were $385 billion at public institutions, $207 billion at private nonprofit institutions [...]"[3]
2. **Economic significance**, in Germany: "Baden-Württemberg's nine public universities multiply initial state funding by a factor higher than two in regional impact. They account for an annual aggregate economic impact of €3.7 billion in value-added, 63,000 jobs, and €350 million in tax revenues."[4]
3. **Global tertiary enrollment growth**, as of 2017: "there are around 200 million higher education students in the world, up from 89 million in 1998."[5]
4. **Broader economic impact of graduates**, from the Brookings Institution, as of 2016: "MIT reports that 25 percent of its alumni start their own companies, and the firms currently active have total revenue of $1.9 trillion—more than the GDP of India."[6]
5. **Non-graduate majority populations**, as of 2019, the average tertiary education attainment rate (comprising national population between 25 and 64 years old who have attended or completed a tertiary institution, not only those who graduated) among OECD member countries was 38 percent. That is, an average of 62 percent of adults in OECD nations have not attended or completed a college or university training, certificate, or degree program.[7]

In more qualitative terms, universities serve at least three vital national functions. First, they act as major players in the technology hub regions of R&D-intensive countries, and are located at the center of some of the most valuable and strategic know-how of an innovation economy. Any innovation-heavy metro region – Shenzhen, Seoul, London, Zurich, Boston, Silicon Valley – has an abundance of HEIs within commuting distance.

Second, universities are the means for a country to generate its future technical and managerial workforce. There are no emerging technologies without university-educated thinkers, inventors, engineers, and operators. Third, relating points one and two, universities are international magnets for their countries, attracting high-skilled (and future high-skilled) talent from around the world – workers who often stay in the host country after their initial visa term to start and run innovative companies.

It is possible to suggest three broad, industrial policy connected categories of change to universities in the last several decades. First, as student counts have increased, so have complexities and costs. A global university in 2020 will have more capital and managerial line items to pay for than it did in 1980.

[3] National Center for Education Statistics (NCES). https://nces.ed.gov/fastfacts/display.asp?id=75
[4] Glückler, J., et al. https://link.springer.com/chapter/10.1007/978-3-319-75593-9_15
[5] World Bank. https://www.worldbank.org/en/topic/tertiaryeducation
[6] Andes, S. https://www.brookings.edu/blog/metropolitan-revolution/2016/10/20/for-higher-education-firepower-cities-should-check-their-own-backyards/
[7] OECD. https://data.oecd.org/eduatt/adult-education-level.htm#indicator-chart

Institutions meet these obligations in various ways – tuition, government revenues, and domestic and foreign private support.

Second, while global universities remain largely on-campus operations, information exchange is much easier than in the past. Collaborations, even before COVID, could take place via virtual means, and online courses, though still not central to research universities, have steadily grown in size and subject matter breadth at many institutions.

Third, China has emerged as an educational, R&D, and innovation superpower. Prior to further exploration of Chinese policies, programs, and universities, it is important to note this paper's discussion of recent events and trends in and relating to China is based on the information available in English-language sources. Such literature can often contain a Western bias, either explicitly or subtly. While this paper fully attempts fair treatment, existing readings can present a unique challenge when attempting thoughtful coverage of China. Analyses presented herein should be considered as much a reflection on available documentation, and as an invitation to further discussion, as definitive conclusions or suggestions for paths forward. There is a need for additional viewpoints, interpretations, and academic and policy work in this area. [8]

The above noted, China's rapid ascent appears to have happened in large part due to the rise of universities and resulting knowledge clusters. *World Education News + Reviews* summarizes, "It's now the world's largest education system after the number of tertiary students surged sixfold from just 7.4 million in 2000 to nearly 45 million in 2018, while the country's tertiary gross enrollment rate (GER) spiked from 7.6 percent to 50 percent" (para. 3).[9] Many scholars and analysts, Diamond and Schell included, have highlighted the changes to global university teaching, research, and programming from this growth.[10]

The Chinese government has created ambitious and large-scale initiatives that both develop its own universities, and connect them (and other entities in the country) to foreign institutions. The overseas linkages include financial support, program creation, and in-person and virtual collaborations and exchanges. Programs including the Double First Class Universities Plan, Thousand Talents, Made in China 2025, and Confucius Institutes, and general academic sector growth (domestically and with outbound overseas students and researchers) have entered global dynamics of university relations with states, and of national treatment and reciprocity.

China's academic sector, as an element of national development, has changed what had been an international order pioneered and dominated by liberal democracies, in which higher education institutions were either organizationally disconnected from their host countries, or, with stronger state connections but still abiding by principles of academic freedom. Whereas the second half of the 20th century saw a US-centric model with regional concentrations in East Asia and Europe, largely playing by

[8] The author thanks members of the project working group for their comments on this subject.
[9] Gu, M., et al. https://wenr.wes.org/2019/12/education-in-china-3
[10] Diamond, L., Schell, O., et al. https://www.hoover.org/research/chinas-influence-american-interests-promoting-constructive-vigilance

similar academic and national-level rules, China, as a more centralized, one-party state can operate differently in academic and research areas than other leading R&D-intensive countries.

In sum, universities have been, and are increasingly, important in international exchange and collaborations as well as to the ability of a nation to realize national goals. It has generally been possible, to the benefit of both universities and the missions they serve, to ignore or downplay tensions between autonomy and realized national interests. That may no longer be the case, however, and it is important to explore whether, to the benefit of both nations and the international order, it is time to consider new shared rules and approaches.

The Implications of Varied Structures of University-Nation Relations

Although university-state engagements span a wide range of characteristics, three models describe and encompass most of the variations in leading R&D states around the world:

1. **Decentralized Model** (Anglo-American): Universities and other HEIs are independent (non-state) entities, or organized via regional states or provinces. Industrial policy connections and relationships with industry are often obscure or carried out at the institutional level, for example, US laws on tax waivers for graduate students and on ownership of grant-funded intellectual property. There is a high degree of foreign engagement, through visiting students, researchers, and collaborations. Example countries include the US, the UK, Canada, Australia, and New Zealand.

2. **Hybrid Model** (Continental European): HEIs are partially separate from the state, but have strong national connections by means including organization models (e.g. the Swiss University Conference) and heavily subsidized tuition. Universities tend to focus more on educational programs than in decentralized nations, as research is concentrated in quasi state-run entities such as Fraunhofer in Germany and CNRS in France. These entities, however, tightly link universities and industry, through student internships and sponsored degree programs. There are generally fewer foreign collaborations than in the Anglo-American model. Example nations include France, Germany, the Nordic countries, and Israel.

3. **Centralized Model** (East Asia): Universities are often, either by charter or heavily in practice, state entities. Strong formal and "off-the-org-chart" collaboration exists between HEIs, companies and industrial sectors, and the national government. There are relatively low numbers of foreign students and researchers. Academic freedom still normally prevails, however recent changes to institution charters in China, to be discussed, may be an exception. National government initiatives can prioritize universities and programs, such as China's Double First Class Universities Plan to designate select institutions as world-class and heavily increase their funding.

For each of the three models, and variants within them, two central questions emerge. First, how can universities and their nations reconcile accelerating globalization and host country benefits for mutual

benefit? Second, how should universities and nations respond to the diversity of university forms and university-state relationships around the world, in the context of national treatment, reciprocity, and academic freedom and openness? **The implication is that current approaches of university cross-border engagements need updating for global stability and welfare, continued national development and adjustment, and university institutional effectiveness.**

The challenge of new approaches is explored below through a set of topical considerations: university missions and international reciprocity, COVID-19 revenue shortfalls, global talent development, and academic-corporate partnerships. Existing international collaboration guidance, and inter-institutional organizations and alliances are also discussed as context and channels for country-level and international negotiations and policymaking. While the treatment below raises questions about the linkages among research universities, national industrial policy, and country-level economic and national security there is no attempt to conclusively offer solutions. Such policy- and rule-making, and procedural implementation, should start to take place in small-tent and big-tent dialogues and forums, as discussed and suggested in the final section of the paper.

Tertiary Education Metrics: Comparisons Among R&D Intensive Nations

There are several measures on international higher education that should be reviewed for a quantitative overview of the forces surrounding industrial policy, national treatment and reciprocity considerations. First, there is a large spread among developed nations in the percentage of **public spending on tertiary education** (as opposed to tuition and other private income streams). This figure ranges from 25 percent, 32 percent, and 35 percent in the UK, Japan and the US, respectively, to over 90 percent in Austria, Finland, and Norway.[11] The distribution is shown in Figure 1. The funding allocations from direct public sources are generally higher in hybrid model countries than both decentralized and centralized model countries, as of the latest OECD data, from 2015.

The above data suggest hybrid countries could have greater insulation than the other country models both from market shocks such as COVID-19, and potentially from foreign attempts to recruit students and recent graduates with financial incentives. However, it is important to also consider the variety of revenue mechanisms between nations, and their trends over time, and to note that university autonomy and national roles are more complex than a matter of funding inputs.

As one such variable, tuition at public universities indicates part of the degree to which a **country's higher education system depends on student market forces for fiscal stability**. Countries with higher tuition could have greater exposure to shocks such as COVID-19, and greater susceptibility to sharp practice from foreign entities by way of financial incentives form students and recent graduates. However, countries with lower tuition levels could also be impacted by a "get what you pay for" mindset, whereby students and faculty have less systemic motivation to efficiently complete degrees or research projects, or launch new programs or centers.

[11] OECD. https://data.oecd.org/eduresource/spending-on-tertiary-education.htm

Figure 2 presents tuition data, indicating higher tuition fees in decentralized countries, somewhat lower fee levels in centralized nations, and negligible tuition in hybrid nations, in a similar pattern to overall public versus private funding of universities as a whole.[12] The values do not account, however, for tuition discounting and other student financial support practices, which can be an important policy and mechanism for university access across different student and family income and asset levels.

The percentage of **GDP represented by R&D funding performed specifically in the higher education sector** presents another national fiscal input metric. Hybrid model countries tend to have higher ratios here, such as Sweden at 0.85% and Denmark at 0.99%, with decentralized and centralized model countries tending towards figures such as 0.33% for the US and 0.16% for China, all as of 2018.[13] Figure 3 presents the data from additional countries. As with public spending, research expenditures in higher education vary by country and do not appear to indicate centralization versus decentralization. It is important to note, however, that all developed countries have substantial funding for industry R&D. A policy lesson could be that as long as industry R&D remains strong (to develop and improve complex products and services), levels of R&D funding in higher education could be adjusted based on national needs. As one simplified example, government programs could support either new labs at universities, or fund students working at labs in company settings.

The number of **foreign inbound tertiary students** relative to the total tertiary student count suggests a nation's openness to immigrant talent. It also could point to a national university sector's potential dependence on international student tuition and accompanying income, and possible greater exposure to the risk of sharp practice by foreign actors with closer connections to government or military entities than they declare. Figure 4 shows comparative data from UNESCO.[14] With some exceptions, such as the US having relatively fewer international students, and Singapore relatively more, the more centralized the country's model, the lower the proportion of foreign students. Likewise, decentralized countries have higher relative numbers of international students, and therefore draw more immigrant talent and depend to a greater extent on international tuition revenues. There are trade-offs either way: between the possible loss of value capture from a more international student body and the potential lack of value generation from fewer foreign students and their resulting contribution to national innovation and know-how.

The ratio of **outbound international students** to total in-country students can suggest global engagement from the sending nation, as well as whether any country appears particularly able to capture academic know-how and potential commercial value abroad. Figure 5 presents UNESCO data of outbound students as a percentage of the country's domestic students.[15] There is some correlation between centralized and hybrid countries having more outbound students than decentralized nations, however, smaller countries also have more students studying overseas. The percentage figures hide a related data point, which is that China has by far the largest number of outbound international tertiary

[12] OCED. https://doi.org/10.1787/888934164921
[13] UNESCO. http://data.uis.unesco.org/index.aspx?queryid=74
[14] UNESCO. http://data.uis.unesco.org/index.aspx?queryid=3830
[15] UNESCO. http://data.uis.unesco.org/Index.aspx?DataSetCode=SCN_DS&lang=en#

students – almost one million as of 2018, more than twice as many as the counts from Germany, South Korea, the US, France, Canada, the UK, and Japan combined. This suggests Chinese investment in overseas knowledge development for eventual value capture at home, which is a model other countries should review and consider.

Authorship and citation counts, while not exclusive to authors at higher education institutions, give an impression of university connections to international science by country, and of higher education outputs. *Nature Index* tracks authorship by country, and as of the 2019 *Index*, the US and China dominated in scientific article publication, followed, in distant next places, Germany, the UK, and Japan.[16] Figure 6 presents this dataset. The country model does not appear as relevant as country size – the larger the nation, the more universities and other knowledge-generating entities, and as such, the greater the published scholarly outputs. A potential policy approach is for countries to ensure they retain access to existing international knowledge generation, rather than trying to duplicate it. In the same way that domestic university systems avoid duplications of programs, so could alliances of countries explore possible ways to avoid costly redundant research programs in non-strategic areas.

Citation counts further indicate the quality of a nation's research university connections to global science production. *Scimago Journal and Country Rank* weighs these counts by country. In the rankings of citations from 1996 to 2019, hybrid model countries appear to have the highest citations per paper, led by Switzerland, the Netherlands, Denmark, and Norway, followed by decentralized nations, and with centralized model countries tending to have between five and fifteen fewer citations per paper than hybrid and decentralized model nations.[17] Figure 7 shows the data for R&D intensive nations. This suggests a potential drawback of the centralized university model – fewer connections to international research, and less recognition from global research networks.

In addition, there does not appear to be a penalty for the hybrid versus the decentralized model, which could mean decentralized countries, in this metric, could increase university-nation alignment without necessarily reducing citation counts. However, other related statistics should be explored in this area, including changes over time. One such measure is the Highly Cited Researchers ranking from Web of Science. The 2019 edition notes that China has surpassed the UK in second place globally, behind the United States.[18]

Reuters provides a ranking of leading **innovative universities** around the world. The methodology covers factors including patent volume and success, industry citations of academic literature, and total article production. The US dominates the list, with 46 out of 100 institutions, followed by Germany and France with nine and eight ranking universities, and then by Japan and South Korea, with six each.[19] Figure 8 displays the results. Except for the US and China, countries of similar overall R&D funding and activity seem to have comparable numbers of top tier institutions, irrespective of country model. It seems

[16] Nature Index. https://www.natureindex.com/annual-tables/2020/country/all
[17] Scimago Journal and Country Rank. https://www.scimagojr.com/countryrank.php
[18] Pendlebury, D. https://clarivate.com/webofsciencegroup/article/highly-cited-researchers-2019-strong-evidence-of-mainland-chinas-rise-to-the-highest-levels-of-research/
[19] Ewalt, D. https://www.reuters.com/innovative-universities-2019

countries could, at least somewhat, alter their centralized-decentralized orientation position without necessarily impacting this aggregate measure.

An annual ranking of the "**most international universities**" is published by *Times Higher Education*, based on counts of international students and staff, co-authorships, and reputation. The 2020 edition includes 170 institutions, of which 57 are in the US, with China, Japan, and the UK placing with 13, 12, and 11 universities, respectively.[20] Figure 9 presents the rankings. As with the "most innovative" index, while the US has a commanding share of the top hundred universities, other countries mostly align with total R&D activity and intensity, again suggesting national-level reforms on a centralized-decentralized axis might not affect this metric at large.

UNESCO publishes data on **university R&D by funding source**. Comparing the growth patterns of business-funded and government-funded research in the 2010s reveals a few trends. First, business funding of university research only totals a median eight percent of the government funding amount in twenty sampled R&D intensive countries. However, private funding grew by a median of 19 percent between 2013 or 2014 and 2017 or 2018, compared with 10 percent growth in government support. The largest relative rise in business funding over that from government occurred in decentralized countries (22 percent and six percent), and the smallest gap (even if the largest total increase in both categories) developed in centralized model nations (27 percent to 22 percent). Universities in hybrid nations had median growth rates of 16 percent from business and 11 percent from government sources. China is a notable outlier, with government funding increasing 87 percent versus 33 percent from industry.[21] Figures 10 and 11 display the data.

These results suggest decentralized country models are relying more heavily on industry-sponsored R&D, centralized countries are increasing their spending in business and government funded categories, and hybrid model nations are not keeping pace with other models in either funding source. Industry-university collaborations will be discussed in more detail later, however this is a subject meriting additional policy attention, particularly in regard to national interests and foreign and MNC research sponsorship.

The Global Innovation Index ranks **regional clusters** according to international (PCT) patent applications and scientific publications.[22] While not exclusive to universities, such clusters, as noted earlier, depend on local universities as anchor institutions, sources of collaborations and expertise, lab access, and student talent, among other roles. As with measures such as the *Nature Index*, *Reuters*, and *Times Higher Education*, total R&D size appears as the dominant factor, with the US leading, followed by China, Japan, and Germany. That is, greater the total R&D spend in a country corresponds to more regional clusters, seemingly without regard to university model. Figure 12 presents this dataset.

[20] Times Higher Education. https://www.timeshighereducation.com/student/best-universities/most-international-universities-world
[21] UNESCO. http://data.uis.unesco.org/Index.aspx?DataSetCode=SCN_DS&lang=en#
[22] WIPO. https://www.wipo.int/edocs/pubdocs/en/wipo_pub_gii_2020.pdf (pp. 44–45)

While admittedly incomplete, the above metrics suggest countries and universities might be able to – with appropriate care and discretion – adjust and adapt either away from or towards (and borrow aspects among) centralized, hybrid, and decentralized models, without negatively impacting their education and research outputs. Further, it would seem there are a wide range of policy and management tools that nations can choose from to promote academic freedom and maintain international movement of ideas and talent, while preserving affordable domestic student costs and host nation economic and technological benefits. Of course, every such action involves tradeoffs and risks, and global rankings alone do not suffice on advising appropriate governance and coordination of a country's higher education institutions and systems. Topic-based and case study instances are presented in subsequent sections to provide greater context in university and industrial policy considerations.

University Mission Statements: Implications for National Treatment and Reciprocity

University charters and mission statements, as largely symbolic and non-binding documents, set the tone for an institution and its relations with the host country, and with institutional-level partners and collaborators.[23] They may also allude to the degree of direct connection between the university and with national interests and development. Third, a university charter that appears to challenge academic freedom can reveal a situation that other universities and countries might need to respond to in order to maintain fair national treatment and reciprocity of international engagements.

In a well-reported late 2019 incident, Shanghai's Fudan University updated its institutional charter. According to a National Public Radio article from January 2020, "Fudan is one of at least three universities that have revised their charters since 2018, emphasizing [...] loyalty to the Communist Party, an NPR analysis found. They have downgraded or erased language about academic freedom from their charters, while adding a new clause: 'The university Communist Party committee is the core leadership of the school.'[24]

There is considerable variance among charters from different institutions and countries in other R&D intensive countries. The connection to the nation is one such variable. Charters and mission statements in liberal democracies may speak to the nation and the state. However, they do not address ruling political parties.

In the US, the University of California mission describes state and national service: "through its public service programs and industry partnerships, UC disseminates research results and translates scientific discoveries into practical knowledge and technological innovations that benefit California and the

[23] It is acknowledged that charters and mission statements are one form among several on the position and future intent of HEIs. These documents often center on the perspectives of administrators and governing boards, while students and faculty often lean more closely to the positions of their academic disciplines, and regional and national governments frequently aspire to introduce reach goals beyond those of existent charters. The author appreciates the insights of the members of the working group on this topic.

[24] Feng, E. https://www.npr.org/2020/01/20/796377204/chinese-universities-are-enshrining-communist-party-control-in-their-charters

nation."[25] While this reference, plus mention of the national labs that UC operates, are the only instances of "nation" or "US" in the 480-word mission statement, "California" and "state" appear in about ten additional places. This orientation is common among US public universities.

In Germany, TU Munich's mission statement does not mention a national role. Instead, its language orients towards personal, societal, and technical development: "We inspire, promote and develop talents in all their diversity to become responsible, broad-minded individuals and empower them to shape the progress of innovation for people, nature and society with the highest scientific standards and technological expertise, with entrepreneurial courage and sensitivity to social and political issues, as well as a lifelong commitment to learning."[26]

As an example of a centralized model, the preface to the University of Tokyo's charter does address a national responsibility, as well an evolving global role. It includes the statement, "As a representative of Japan, it has greatly contributed to the development of the modern Japanese state." Several paragraphs later, it continues, "By promoting international education and research, the University of Tokyo shall strive to broaden its internationalism and deepen its understanding of the various regions of the world, as it promotes education and research that aspires for truth and peace. While being constantly aware of its status as a Japanese university located in Asia, The University of Tokyo, shall strive to strengthen its links with Asia and advance mutual exchanges with diverse parts of the world by taking advantage of its accumulated expertise, knowledge-base and research capacity."[27]

The above three statements do not appear to present conflicts for national treatment or reciprocity. While they differ in local stakeholder arrangements, they are similar in their promise of international academic relations based on liberal and global values. They represent their home state or country, but do not reference government institutions or political organizations.

The charter revisions at Fudan and other Chinese institutions might impact perceptions and practices of both national treatment and reciprocity among international universities. It is not immediately clear whether an academic institution referencing a political party will be able to fairly administer national treatment in its programs. Likewise, such a statement could result in other academic institutions around the world to limiting or ending reciprocal programs with such a university, based on concerns over academic freedom, open international exchange, and research in emerging technological areas.

It is also possible to frame the language updates at Fudan as not carrying much substantive impact to its other institutional documents or its teaching and research programs. For instance, the vision statement for Fudan, as of late 2020, includes commitment to, "[…] a time-honored tradition of academic independence and free exploration […]."[28] Elsewhere on its website, the institution promotes academic developments and highlights as would any global university, including featured publications in leading

[25] University of California. https://www.ucop.edu/uc-mission/
[26] Technical University of Munich. https://www.tum.de/en/about-tum/our-university/mission-statement/
[27] University of Tokyo. https://www.u-tokyo.ac.jp/en/about/charter.html
[28] Fudan University. https://www.fudan.edu.cn/en/About/main.htm

journals, such as an article in *Science* in September 2020 co-authored by researchers from Fudan and the University of Toronto.[29]

In 2013, Fudan was one of nine Chinese universities (the C9 Group) to sign the Hefei Statement. This document, also signed by the Association of American Universities (AAU), the Group of Eight (Australia), and the League of European Research Universities (LERU), laid out ten "characteristics of a research university" in a global context. Point Six addressed academic freedom, and Point Seven spoke to diverse viewpoints.[30]

The ways for universities to reconcile statements and actions of foreign collaborating institutions might not always be uniform. They could vary depending on the curricular or scholarly characteristics, for instance, whether the collaboration encompasses politically-influenced content, or has close connections to data privacy or dual-use purposes. One option is to allow partnerships with individual researchers or labs at an institution with academic freedom concerns (but not with the university as a whole), or review all collaborations on a case-by-case basis. There do appear to be necessary tradeoffs between unrestricted academic freedom at the individual faculty level, and regulations that constrain or deny engagements with states not practicing major aspects of academic freedom in their academic institutions. An updated set of international standards in this area appears worthy of consideration among both university and government stakeholders, in order to ensure academic freedom at the institutional and national level in every R&D intensive country and in global R&D networks.

COVID and Higher Education Revenues: Similarities and Differences Among University Models

The COVID-19 pandemic has affected universities, and national higher education systems, in myriad ways. However, these impacts differ by country. Most notable is the decline in tuition revenues and auxiliary student income from heavily depopulated university campuses. The largest financial toll has likely occurred in countries with decentralized university models, with strong reliance on tuition and international students. Although moves in recent decades, such as in the UK, to develop more flexible and decentralized tuition revenue models have seen positive outcomes, as David Willetts describes in *A University Education*[31], such approaches bring risks in the event of sudden decreases in student presence on campuses.

On November 14, 2020, *The Guardian* described the current sector status in the UK, noting (admittedly on a preliminary basis), "The Institute for Fiscal Studies has calculated that about 13 universities risk going bankrupt during the pandemic, because their already weak finances make it harder for them to weather losses in their teaching, commercial and research revenue. In May, the government refused pleas from Universities UK, the vice-chancellors' body, for a £2bn bail-out package for universities."[32]

[29] Fudan University. https://www.fudan.edu.cn/en/FacultywResearch_367/list.htm
[30] AAU, LERU, GO8, C9. https://www.leru.org/files/Hefei-Statement-Full-paper.pdf
[31] Willetts, D. *A University Education*. Refer to Chapter Three, "How to Pay for It".
[32] Fazackerley, A. https://www.theguardian.com/education/2020/nov/14/fears-economic-hit-squad-will-use-covid-crisis-to-kill-off-some-uk-universities

University World News reported, also in November 2020, "International student enrolments in United States universities declined 16% in autumn 2020 and drops in new student enrolments were more than twice as steep, at 43% […]".[33] An OECD report notes, "public institutions in Australia, Canada and the United States charged foreign students over USD 13 900 more per year than national students on average in 2017/18."[34] A rough calculation suggests if approximately 150,000 fewer international students come to the US, the cumulative revenue drop would exceed $2 billion USD. Australia, with the highest number of international students per capita, could see a loss of nearly $14 billion USD by 2023, according to a report from Victoria University.[35]

Although centralized model nations have lower numbers of international students, their university models still depend on tuition revenue. COVID has caused impacts in these countries as well. A CSIS blog post about Japan, for example, highlights, "In 2017, about 39 percent of current university students had taken out loans and the number of student loans has tripled over the past 15 years."[36] Amidst the pandemic, the education ministry "is currently providing cash hand-outs of 200,000 yen to 'those who face difficulties continuing their studies at their university or other educational institutions so that they do not abandon their studies.' The recession in Japan could damage the economic outlook for the less than one fifth of low-income students that make it to university."[37]

Hybrid models have also encountered challenges with non-tuition revenues and student participation and enrollment stability during the pandemic. In April 2020, *France24* reported, "At the end of March, the Ministry of Higher Education released €10 million in 'specific emergency aid' for students […] 'Only 20,000 students will be able to benefit from the extra money. It's a positive step, but unfortunately it's also ridiculous, given the number of students in urgent need: Remember that nearly one in two students work in normal times,' the students' union said."[38]

These examples of student and institutional financial hardship are unique to the pandemic. However, they generally speak to the ramifications of revenue shortfalls on the ability of HEIs to continue their ongoing roles in creating in-country know-how and advancing national interests. While lack of government subsidies and competition among institutions can, possibly, help promote excellence among universities, and lead to globally-ranked institutions (by ongoing effort and innovation), insolvent universities present threats to national well-being in any country. Resulting cutbacks and closures, in addition to impacts to student degree completion and staff and community economic hardships, could harm national treatment and reciprocity, as institutions abroad would be increasingly reluctant to collaborate with universities at high operational risk. Academic knowledge networks function on the

[33] Marklein, M.B. https://www.universityworldnews.com/post.php?story=20201116050900954
[34] Schleicher, A. https://www.oecd.org/education/the-impact-of-covid-19-on-education-insights-education-at-a-glance-2020.pdf
[35] Hurley, P. https://theconversation.com/australian-universities-could-lose-19-billion-in-the-next-3-years-our-economy-will-suffer-with-them-136251
[36] Fraser, J. https://www.csis.org/blogs/new-perspectives-asia/impact-covid-19-education-inequality-japan
[37] Ibid.
[38] Makooi, B. https://www.france24.com/en/20200417-food-vouchers-and-overdrafts-covid-19-puts-france-s-poorest-students-in-a-tight-spot

principle that universities, and their policies and practices, will remain in place for the long-term, and lack of confidence in this area threatens global networks at large.

Solutions could appear in the form of shared lessons among the three models. For instance, hybrid countries might charge tuition in some cases to recover increasing costs, while decentralized countries could, as hybrid countries have, see tertiary education as a national benefit worthy of greater subsidies. The basic income style approach taken by Japan in the academic sector could be viable for other countries. Finally, international alliances on matters such as foreign student tuition and degree completion time, as exemplified in the European Union, could provide positive outcomes for students, universities and nations.

Allegations Regarding Foreign Influence in Academia: Potential Challenges to Globalization

Perceptions that foreign countries seek advantage through covert means within universities can jeopardize academic national treatment and reciprocity. If County A is thought to engage in these actions, other countries will consider its citizens as security risks, whether justifiably or not, and open exchange and knowledge sharing opportunities will be lost out of fears of non-compliance and unwarranted knowledge transfer. While some reporting on this topic appears thorough and even-handed, disinformation, stereotypes, and xenophobia seem to have roles in other accounts, as do broad judgments from limited numbers of incidents, overly conclusive assessments, and strong condemnations of hypothetical worst-case scenarios.

More research and analysis are needed on international academic exchanges and partnerships, in terms of both benefits and risks to universities and national industrial policies. Existing general media stories on supposed cases of academic espionage and related acts, of which many have appeared in recent years, sometimes imply potential, rather than actual or proven, unfair benefits to connected government, military and business entities from questionably obtained overseas scientific knowledge.

As one reported example, in the early 2000s, Liu Ruopeng, who later founded a successful Shenzhen-based diversified technology company, pursued a PhD in electrical and computer engineering at Duke University. A *C&EN* article suggests as follows: "Liu returned to China in 2010 and has since amassed a large number of Chinese patents on metamaterials. He heads Kuang-Chi Group, a Chinese government-supported firm with interests in areas including metamaterials, telecommunications, and artificial intelligence. A collaboration set up by Liu between Smith's lab and Southeast University in Nanjing […] transferred intellectual property from Duke to China […]"[39]. However, a report from NBC News

[39] Reisch, M. https://cen.acs.org/policy/intellectual-property/Acknowledging-spies-campus/96/i27. While noting media coverage of academic topics can sometimes present tentative conclusions and involve less rigor than other sources, this paper nonetheless makes extensive use of press articles, due to the in-progress and recent nature of the subjects discussed. The author thanks the members of the working group for comments and suggestions on sources.

indicated the FBI did not find evidence of theft, and Liu countered the allegations by asserting any information transferred was simply fundamental research.[40]

Covert action and influence-seeking in academia are long-standing phenomena. Many accounts exist of both liberal and non-democratic governments using covert means to engage in university activities in other countries.[41] There do appear to be two unique factors in regard to China in this area. First, the country has undergone impressive and unparalleled growth in the last twenty years to become a major entity in global R&D and higher education, on par with or exceeding the United States in some measures. A fast-rising international research and education player in key technological fields will invariably attract considerable foreign attention on its activities and plans. Second, the volume of recently reported cases of illicit IP transfers and influence peddling with connections to Chinese actors and entities, in press coverage, academic analysis, and government and NGO policy briefings and studies, exceeds the level of discussion pertaining to other nations.

For context, however, a 2019 *Foreign Policy* essay points out that more than 30 countries are the US Trade Representative watch list for intellectual property concerns. The authors note, "Historically, rapidly growing emerging market economies tend to be cited as they transition to higher income levels […] Many countries have followed this blueprint, but China draws special attention because of its size and its top-down, state-led model."[42] [43]

Efforts to counter espionage and sharp practice must be careful to not inhibit mutually-beneficial research exchanges, collaborations, and visits by academics from any country and its diaspora, China included. A 2019 law review article concluded, "Chinese and other Asian-Americans are disproportionately charged under the Economic Espionage Act, receive much longer sentences, and are significantly more likely to be innocent than defendants of other races."[44]

Two further media reports of academic partnerships with Chinese institutions are presented here:

- Australia: An August 2020 *Nature* article described, "(T)he Commercial Aircraft Corporation of China (COMAC), signed a memorandum of understanding with Monash University in Melbourne in May 2017 to design 3D-printed aircraft components. The collaboration will also fund a Aus$10-million (US$7-million) Aeronautical Research Centre that will be established at the university […]"[45]. While there are concerns of easily re-purposing civilian aircraft know-how

[40] McFadden, C, et al. https://www.nbcnews.com/news/china/education-or-espionage-chinese-student-takes-his-homework-home-china-n893881
[41] Golden., D. *Spy Schools*. Chapter 7 presents a history of US national security interactions with domestic and international universities since the mid-20th century.
[42] Huang, Y, and Smith, J. https://foreignpolicy.com/2019/10/16/china-intellectual-property-theft-progress/
[43] USTR. https://ustr.gov/sites/default/files/2020_Special_301_Report.pdf. The 2020 Special 301 Report has ten countries on the Priority Watch List and 23 others on the Watch List.
[44] Kim, A.C. http://cardozolawreview.com/prosecuting-chinese-spies-an-empirical-analysis-of-the-economic-espionage-act/
[45] Lewis, D. https://www.nature.com/articles/d41586-020-02188-6

towards military applications, Monash has responded it has followed the *Australian Code for the Responsible Conduct of Research*.

- Germany: *Inside Higher Ed*, featuring *Times Higher Education* reporting, detailed a February 2020 situation at the Free University of Berlin, in which "it had signed a contract binding it to abide by Chinese law while accepting hundreds of thousands of euros from China to set up a professorship to establish a Chinese-teacher training program."[46] The contract allegedly included unequal termination clauses favoring Hanban, the entity overseeing Confucius Institutes, over Free University in the event of a cancelled partnership.

It should be noted that both of the above descriptions can allude to a level of "what if" questioning of new and foreign partnerships (rather than on conduct that has already occurred or is likely to occur), and to the management of university international collaborations in general, as much as to engagements with China in particular. A third news story suggests the need for greater oversight and guidance of all such cross-border exchanges and visits, regardless of country:

- Japan: *Japan Times* reported in October 2020 that universities in the country in recent years favored international collaborations and revenue-generating foreign students over any concerns of inappropriate activity. This is alleged to have resulted in some lack of oversight: "According to a 2018 survey conducted by the industry ministry on nearly 300 national universities as well as public and private universities with medical and science departments, only 40% said they had administrative protocols for controlling the export of sensitive technology. Among institutions without such internal guidelines, a mere 6% said they evaluated international students and foreign researchers from a national security perspective during the admissions process."[47]

Developing alliances among countries is a frequently mentioned solution to ensuring both open exchange and research security. The logic is that every nation wishing to engage in open collaboration, national treatment, and reciprocity in university settings, will need to adhere to principles and practices meeting international standards, with sanctions for failure to act accordingly. Nations would only be able to join the alliance by demonstrating a commitment to the standard, and those that do not would be effectively shut out. Implementation and operationalization of such an approach could be done through existing international alliances and networks, or through a new organization.

Higher Education, Tech-Based Disruption, and Immigration: Global Talent and the National Workforce

While many colleges and universities are internationally-minded educational and research institutions, every institution of higher education has a role in developing the workforce human capital of its host nation. Technological growth broadly, and the pandemic specifically appear as disruptive forces in this

[46] Matthews, D. https://www.insidehighered.com/news/2020/02/07/questions-raised-about-chinese-contract-german-university
[47] Osaki, T. https://www.japantimes.co.jp/news/2020/10/15/national/crime-legal/japan-chinese-students-campus-espionage/

regard, and to how universities in different countries can interact with each other and with international students and researchers.

The past decade has seen increasing amounts of globalized, massified, and online higher education. Many of these developments focus on teaching professional and technical skills to both traditional-age and later-career students. Through platforms such as Coursera and edX (and via university-based and faculty-generated content), students in virtually any nation with an internet connection can complete a self-study class, a graded course, micro-credential, or fully-online accredited degree program. In aggregate, such offerings could yield the partial dissolution of national-level centralized, decentralized and hybrid frameworks in favor of a new global decentralized approach to higher education – between an institution and a student, irrespective of country. As with other tech-based disruptions – from ride sharing to social media – this prospective model can have unwanted consequences, especially over time and when implemented across nations.

A global decentralized approach to higher education could impact the ability for countries to teach in areas critical for national social, economic, and security well-being, and also to national treatment and reciprocity in course access. That is, if pricing is determined through a licensing agreement with a software company, policies on student access and fees could vary in ways that are out of the control of the host university or nation. Tech-focused online programs, such as Google's new Career Certificates, offer promise in educational reach, as well as future partnerships and engagement with research universities. However, it remains to be seen whether they can ensure adequate attention to national educational and labor needs, versus short-term MNC balance sheet gains and momentary trends in subject areas from students. The issues compound if a major EdTech company operates from, or is invested in or controlled by, a strategic competitor nation.

In all likelihood, most research universities will continue to operate predominantly on-campus in one country in the near future. However, through increasing global brands, accentuated by online offerings, they will also likely attract more foreign students and researchers, many of whom will seek to become part of the host nations skilled labor force. Connecting universities and workforce to immigration and intellectual property, Lee Bollinger of Columbia University wrote as follows in the *Washington Post* in August 2019:

> "The unauthorized use of intellectual property by overseas competitors is a serious problem. But the surveillance of foreign-born scholars in this country is the wrong solution. If law enforcement agencies have legitimate concerns, it seems to me that they should identify and monitor those they designate as 'suspicious people' based on real threats, not broad worries about entire nationalities."
>
> "A more effective approach — advocated by many of my colleagues in higher education as well as the bipartisan Commission on the Theft of American Intellectual Property — is to expand the

> number of green cards awarded to foreign-born graduates of our great colleges and universities."[48]

Bollinger's comments illustrate linked considerations among immigration, openness, national security and national economic and workforce development. They echo those of L. Rafael Reif, president of MIT, that excessive security restrictions only harm the country imposing them.[49] Throughout research-intensive nations, universities are major entities in attracting, and the primary ones in training, current and future high-skilled technical and managerial talent, who frequently remain in the host country long-term to start, lead, and advise technology-intensive companies. The Partnership for the New American Economy in 2015 indicated, "Every foreign-born worker in the United States with a U.S. STEM degree creates 2.62 jobs for U.S.-born workers."[50]

In another national example, high-skilled immigration has been a major factor in Israel's innovation ecosystem success. The development of this densely connected domestic and international model includes strong university roles. In particular, large numbers of scientists and engineers from former Soviet states from the early 1990s onwards have helped establish a dense network of domestic and international industry-university collaborations, with ongoing and evolving interactions between research groups.[51] As a 2019 infographic ranking highlighted by the World Economic Forum shows, Israel is by no means alone among R&D-intensive countries in the use of universities to attract and develop overseas talent.[52] The country places 35th among nations in this ranking, with the Netherlands, the US and Denmark placing first, second, and third. Clearly there is competition among nations and global universities for elite talent, and this has enabled positive developments in global knowledge networks and local university clusters.

As a case in a specific industry, Steve LeVine writes of the predominance of immigrants in American battery research: "though John Goodenough grew up in Connecticut, Stanford's Yi Cui was born in China, Berkeley's Venkat Srinivasan in India, and MIT's Yet-Ming Chiang in Taiwan" (p. 91).[53] However, immigration policy is more complex than ending restrictions on student visas and skilled immigration. A 2019 comparative analysis from the Scottish Government concluded, in Australia, "It has been found that the oversupply of graduates in certain fields increases competition for employment and leads to lower employment rates, underemployment, lower wages, and lower job satisfaction for international graduates in comparison to Australian citizens and permanent residents of migrant background."[54]

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[48] Bollinger, L. https://www.washingtonpost.com/opinions/no-i-wont-start-spying-on-my-foreign-born-students/2019/08/29/01c80e84-c9b2-11e9-a1fe-ca46e8d573c0_story.html
[49] Reif, R.L. http://president.mit.edu/speeches-writing/chinas-challenge-americas-opportunity
[50] Partnership for a New American Economy. https://www.newamericaneconomy.org/wp-content/uploads/2015/04/12-Associations-High-Skilled-Facts-You-Can-Use-4-24-2015.pdf
[51] Senor, D. and Singer, S. Start-up Nation:
[52] Desjardins, J. https://www.weforum.org/agenda/2019/03/which-countries-are-set-to-attract-the-highest-skilled-workers-from-abroad
[53] LeVine, S. *Powerhouse: America, China, and the Great Battery War*.
[54] Scottish Government. https://www.gov.scot/publications/post-study-work-visa-options-international-comparative-review/pages/6/

This finding parallels a 2014 review paper on international high-skilled migration, which noted, "The most obvious takeaways from the literature are the importance of pro-skills migration policy, and the need to develop programmes to actively select stars and those with high entrepreneurial potential." [55] Further, without monitored and adjusted policies, university-centered immigration practices can also lead – in reality and in perception – to domestic graduates not being able to find satisfactory long-term employment, risking resentment, xenophobia, and out-migration and brain drain.

The above trends – globalized online courses, global higher education brands, and a global market for elite talent, have and will continue to foster national benefits courtesy of university entities. However, when considered alongside strategic competitor nations, espionage risks, lack of labor force supply and demand, and uncoordinated course offerings and talent supply and demand among nations, new and potentially large risks also emerge, among them the ability for universities to continue to offer national treatment and reciprocity for education and research offerings. The issues are complicated, and universities and governments should discuss the ongoing and evolving issues of global talent development in a manner that can enable win-wins for universities, nations, and citizens.

International Academic-Industry Collaborations: Global Engagement, Risks and Opportunities

With the growth of MNCs, virtual communication methods, and increasingly specialized know-how, university-industry collaborations will continue to grow, particularly internationally. It is often the case that a company in Country A will only find the expertise to their particular technical challenge from a university researcher in Country B, who is also collaborating with a government lab employee in Country C. Such arrangements work as long as all involved countries play by the same rules, preventing and curtailing intellectual property theft and industrial espionage, through commonly accepted ethical rules and enforcement of violations.

However, here are three possible international collaboration risks. First, a partner company might not follow the above practices, and could be headquartered in a country without equal access to legal protections on innovation. Second, foreign collaborations could result in less commercialization domestically, in favor of more later-stage innovation abroad and without adequate national value capture. Third, MNCs could engage in collaborative efforts with multiple universities in multiple countries, and then only pursue technology transfer in the nations with the lowest wages, regulations, and tax rates. Should any of these risks develop into common real-world scenarios, universities will be in a weakened position to offer national treatment and reciprocity in their collaborations with industry, potentially harming global knowledge transfer and knowledge networks.

For individual universities, industry collaborations often represent clear short-term gains: employment opportunities for students, and revenue opportunities for the institution outside of government funding rules and restrictions. An international engagement, or one with a major MNC, can also raise an institutional profile in a competitive higher education landscape. Further, the challenge is often securing collaborations in the first place. A 2016 UNESCO study noted, based on 2014 data, "More than one-fifth of firms reported university–industry collaboration in just two of the countries surveyed:

[55] Nathan, M. https://izajodm.springeropen.com/articles/10.1186/2193-9039-3-4#Sec14

Finland (33.8%) and Austria (24.7%)."[56] In most countries, less than ten percent of innovative manufacturing firms had university collaborative activities. Based on this data, and the earlier discussion of growing business funding of higher education based R&D (especially relative to government funding sources) in many countries since 2014, universities appear to have incentives to collaborate with industry, and potential motivations to avoid calling out sharp practice by corporate partners. The risks can multiply with international engagements.

One option is to prioritize domestic collaborations. A 2018 Council of Canadian Academies report suggested developing in-country university-industry ecosystems to promote collaboration and value capture at home. The evolution of AI research and development in the nation was presented as an example of what can happen without a complete ecosystem: "As international opportunities in AI research and the ICT industry have grown, many of Canada's AI pioneers have been drawn to research institutions and companies outside of Canada. According to the OECD, Canada's share of patents in AI declined from 2.4% in 2000 to 2005 to 2% in 2010 to 2015. Although Canada is the sixth largest producer of top-cited scientific publications related to machine learning, firms headquartered in Canada accounted for only 0.9% of all AI-related inventions from 2012 to 2014" (p. 98).[57]

On the same theme, in May 2020, *Nature* described Samsung's connections to South Korean universities. The article highlighted the country's many researchers moving between both industry and academia and the other way around, as well as a strong network of research collaborations between the company and domestic universities such as SKKU, SNU, and KAIST. Significantly, the reporting portrays the late 1990s financial crisis as a motivating factor in developing consortia to create higher-value innovative products:

> "The centre brought industry R&D and production infrastructure together with local and national universities and research facilities. For instance, the Gyeonggi-based Samsung Electronics, Samsung's flagship subsidiary, is collaborating with SKKU Chemistry to develop a semiconductor material that can reduce the amount of radiation exposure while taking medical X-ray images. / By 2010, South Korea had 105 regional innovation centres and 18 techno-parks, as well as 7 federal programmes to strengthen the competitiveness of industrial cluster programmes."[58]

Established university-based and university-adjacent research centers and consortia could expand to include academic and industrial collaborators from allied nations, perhaps prioritized for institutions and countries that agree to comparable national treatment and reciprocal arrangements for their own research centers.

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[56] UNESCO. http://www.unesco.org/new/en/media-services/single-view/news/only_a_minority_of_innovative_firms_collaborate_with_univers/

[57] Council of Canadian Academies. https://cca-reports.ca/wp-content/uploads/2018/09/Competing_in_a_Global_Innovation_Economy_FullReport_EN.pdf

[58] Dayton, L. https://www.natureindex.com/news-blog/how-south-korea-made-itself-a-global-innovation-leader-research-science

A question is how well the consortia and cluster approach could work in a larger economy with uneven regional development, such as a declining manufacturing base in certain regions. A preference for region-specific licensing and commercialization of university research might create more benefits for local communities than an approach which finds the most lucrative licensing opportunity regardless of scale-up location. Any industry-university collaboration over a certain value threshold, for instance, could be required to offer a first right of refusal, or similar mechanisms, for local companies as additional partners, subcontractors, or manufacturers – or for programs to build capabilities in these areas.

In an interesting data point regarding the centralized-decentralized spectrum, a 2016 comparison of US and Chinese university-industry collaborations found the latter tended to be more internationally-oriented that the former.[59] Specifically: "Most of the Chinese universities leading in UIC publications collaborate more with domestic than foreign industry and with high variation [...] Most industrial partners of the leading Chinese universities are located further than 50 kilometers away from the city center where the university (or its main campus) is located [...] which implies less importance of the geographical distance in determining domestic university-industry collaborations in China."[60]

The same article indicated for the US, "all of the leading US universities mainly collaborate with domestic industry. Similar to the situation described in China, distance is not critical in establishing domestic university-industry collaborations."[61] One potential policy approach could be to require any university-industry collaboration, regardless of the location of the partnering company, to show benefits to the host nation and the local region where the engagement will take place – with added protections for value capture in the event of foreign or MNC partnerships.

A useful illustration of the importance of domestic university-industry collaborations, and the impossibility of truly one-country arrangements, is shown in *AI Superpowers*, authored by Kai-Fu Lee. Lee, the founding head of Microsoft Research Asia and then the president of Google in China, highlights these related trends in Chinese AI research:[62]

1. In 2006 to 2015, the percentage of Chinese authors cited from the top hundred AI publications grew from about 20 to 40 percent of the global total.
2. China ranked second to the US for the most cited institutions in AI from 2012 to 2016 – with Tsinghua outplacing Stanford.
3. Many top Chinese AI researchers have worked at Microsoft Research Asia and then moved to other entities – both for Chinese and foreign entities.

The building of domestic university capabilities and industrial collaborations seems to offer a path to national development in a particular technical field. However, not every country can do this in every field, and, as the above examples demonstrate, scientists and engineers shift across institutions and

[59] Zhou P., et al. https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0165277
[60] Ibid.
[61] Ibid.
[62] Lee, K.F. *AI Superpowers: China, Silicon Valley, and the New World Order.*, p. 89.

nations as projects and disciplines evolve and coalesce. A win-win option could be via alliances among countries. This solution could pool expertise in complex and emerging fields, allowing universities to generate value from research, and in student training and knowledge production, and still capture it in the form of equal access to the know-how generated from other countries.

COVID research and treatment provide further illustration of the need for global university-industry collaboration. From vaccine development, to therapeutics and PPE prior to vaccine availability, and to public health data and responsive measures, it has been necessary for universities to work with industry in rapid and collaborative ways, using data and literature from global sources. No country or university can go it alone, even in a matter of national public health and well-being.

For all of the particulars described in university-industry engagement, discussion within and among countries is needed, both to better understand outcomes from particular programs and approaches, and to attempt to develop standards of conduct between universities and companies collaborating across borders.

Guidance on International University Collaborations: Reconciling National Interests and Globalization

Abundant literature and guidance has been published in the last few years on managing international university research and education collaborations to help ensure host university and host nation benefits and protections. Select examples are presented here. Additional user-friendly documentation should be developed in more forms – checklists, instructional videos, interactive exercises, and so forth – and such guidance should be regularly updated. As with regulatory instruction writ large, the more complex, the more it is ignored. In general, regulations need to be simple and clear, in a referential or step-by-step type format.

Much of the publication matter in this area comes from decentralized model countries with high numbers of individual university research and education partnerships with overseas components. In October 2020, *Science Business* reported, "The UK on Thursday saw first-of-its-kind guidance issued to universities on how to tackle foreign interference and preserve the free flow of ideas. Among the recommendations issued by Universities UK, the umbrella body for 139 universities, are more training for researchers how to protect against intellectual property (IP) theft and new means of protecting students, with rules of confidentiality on seminars."[63]

A three-page checklist from the Australian Government, as posted online by Flinders University, serves as a "guide to undertaking international innovation, science and research collaboration. The document proceeds through sixteen considerations, organized into planning, negotiation, and management stages. Among its questions are, "What is your organisation's policy and strategy to manage Intellectual Property with both domestic and international partners? How will this apply?"[64]

[63] Kelly, E., and Burke, F. https://sciencebusiness.net/universities-wrestle-question-how-open-be-china
[64] Australian Government Department of Innovation, Industry, and Science. https://staff.flinders.edu.au/content/dam/staff/research/funding/a-guide-to-undertaking-international-collaboration.pdf

The University of Michigan has an interactive webpage on "International Research & Scholarship Guidance," beginning with topical areas, including disclosure of outside interests and conflicts of commitment. The page also includes an FAQ section, video of a recent town hall discussion, and links to more detailed regulatory and policy guidelines.[65] The University of Chicago has a simpler numbered checklist, with items including, "Contact the URA Export Control Compliance Manager to understand government restrictions on proposed research that involves sanctioned countries and before sending items, data, and software to foreign collaborators."[66]

In August 2020, *Nature* described government efforts in Japan to focus on international academic partnerships. Some of the work aimed to adapt guidance found in the 2019 JASON report from the US, "Fundamental Research Security," which was published online. The Council for Science, Technology, and Innovation (CSTI) has coordination among its aims, as, per a CSTI working group member and additional researchers interviewed, "many of these activities have been regulated by a patchwork of rules and guidelines, and by voluntary oversight in universities […] For instance, some universities collect information about researchers' foreign income, but it is not required."[67]

A ten-page booklet released in Sweden in February 2020 by the non-profit organization STINT, "Responsible Internationalisation: Guidelines for Reflection on International Academic Collaboration," addresses many policy and procedural questions that universities can and should consider in regard to international engagements, such as legal and ethical issues, and the government connections of the foreign partners.[68]

Working groups, and meetings at the university, national, and international levels could create further guidance, know-how, documentation, and templates in this area. Such publications and statements could both align different countries (and university models) in areas of concern relative to international engagement, while still allowing for national and institutional differences and academic freedom in as many areas as possible.

Alliances and University Organizations: Established Institutional Frameworks and Guidance

University alliances and organizations serve as communication channels for the particulars of higher education operations, finances, and day-to-day aspects of education and research management to a policymaking audience. They can also help facilitate review and implementation of proposed guidance and regulations, such as for university international engagements, national treatment, and reciprocity, balancing the dual need of university autonomy and national responsibility.

Many existing national and international alliances of universities explain the benefits of tertiary institutions to governments and the public, and address challenges within the sector. The U7 Alliance is

[65] University of Michigan. https://research.umich.edu/research-u-m/international-partnerships/international-research-scholarship-guidance
[66] University of Chicago. https://ura.uchicago.edu/page/international-research-collaborations
[67] Mallapaty, S. https://www.nature.com/articles/d41586-020-02273-w
[68] Shih, T., et al. https://www.stint.se/wp-content/uploads/2020/01/STINT_rapport_Responsible_internationalisation.pdf

a new entity, set up in 2019 by members from the G7 countries. The second of two organizational missions of the U7 is as follows: "[…]in the major industrialized countries, higher education faces significant challenges related to funding, digital technology, ability to promote access to employment for entire age cohorts while contributing to economic growth in a totally globalized environment, responding to growing demands for mobility, supporting scientific research to respond not only to the great challenges of the contemporary world, but also to those we do not know yet."[69] The U7 could also lead to a role for university-specific working groups and sub-associations within larger tent international organizations, such as the D-10, G20 and the OECD.

The League of European Research Universities (LERU) notes its global collaborative efforts, including, "Aiming at the creation of a Global Council of Research-Intensive Universities, LERU has been gradually intensifying its contacts with sister organisations worldwide such as the Association of American Universities, the Association of East Asian Research Universities, the Group of Eight in Australia, the U15 in Canada, the C9 in China, the U15 in Germany, the RU11 in Japan and the Russell Group in the UK."[70] LERU also refers to its contribution to recent international higher education guidance documents, such as the Shanghai statement on university participation in global innovation systems.

In the United States, the Council on Government Relations (COGR) aims to ensure university sector interests are considered in the processes and outputs of US policymaking, legislation, and administrative regulations. A recent open letter, co-authored by other entities including the Association of American Universities and the Association of Public and Land-grant Universities, focused on reasons why overly broad export controls on foundational technologies, even with fundamental research exemptions, could harm academic research as well as national competitiveness and security.[71] Similar to how many scientific ideas succeed or fail based on engineering implementations, effective national treatment and reciprocity policies often transpire through the seeming minutiae of uncelebrated regulatory details – yet they are just as important as larger-scale statements, policies, and laws, in how effectively research and education programs are carried out.

As referenced earlier, the European Union has established university sector alliances and cooperation as a matter of international governance. The Bologna Process sets out standard degree completion times, and the Erasmus Programme ensures national treatment and reciprocity for certain segments of EU tertiary students partaking in study in other EU nations. The Horizon 2020 and its successor Horizon Europe programs offer competitive research funding opportunities at a continental level, enabling greater diversity of projects than would be possible in any one countries. The processes and frameworks involve compromises from researchers, universities, and nations. However, the end result is both generally beneficial for all involved parties, and the alternative among nearly thirty countries (as partially witnessed during Brexit) is far from desirable.

[69] SciencesPo. https://newsroom.sciencespo.fr/45-world-class-universities-launch-the-u7-alliance/
[70] League of European Research Universities (LERU). https://www.leru.org/activities/partnerships-collaboration
[71] Council on Government Relations (COGR) https://www.cogr.edu/sites/default/files/AAU_COGR_ACE_APLU_AAMC_ANPRM%20Foundational%20Technologies.pdf

Tiered Dialogues and Meetings: Communication and Cooperation Strategies to Balance Globalization, National Interests and Industrial Policies, and University and Community Benefits

Forums and ongoing dialogue, in some manner, will likely be needed to create workable agreements on optimal benefits from university activities (for students, researchers, institutions, and countries) in every joining R&D intensive nation. The outcomes could include widespread and multi-area international alignment mechanisms such as those in the EU, or more tailored approaches such as agreements on research knowledge sharing between universities and companies in different countries. Among many possible programs and benefits for broad stakeholders are pooled research and education funding programs, harmonized student visa and recent graduate work programs, and local community set asides from university IP licensing and commercialization.

Figure 13 presents one suggested negotiation and agreement development cycle process. It is shown and described here as a possible example rather than as a prescriptive course of action. In this cycle, the iterations begin with small working group meetings among tertiary sub-sectors. The step includes sub-sector dialogue by institution type (e.g., by level of research intensity), organizational role (e.g., faculty, administrators), or by topic (e.g., international students, foreign program sponsorship, overseas IP licensing). The meetings start to coalesce priorities for national policies and international agreements relevant to universities.

The second stage consists of national-level meetings encompassing the tertiary sector as a whole. In this step, national tertiary representatives decide upon recommendations for subjects and approaches in agreements and alliances to bring to the third stage, national meetings encompassing cross-sections of delegates from all R&D sectors (academia, government, industry). Once national priorities are established, in the fourth stage, multilateral tertiary sector meetings, representatives from multiple countries determine how to align shared university and college objectives and priorities into mutually agreeable cross-border engagement principles.

At the fifth stage, multilateral S&E negotiations parallel step three, with all participating countries. The forum has similarities to international trade and investment agreement summits. At this point, national representatives craft new international agreements, statements, and principles intending to benefit all member nations, including research universities in each country. Upon ratification, universities and countries work on implementation, which also starts a new cyclical process, beginning with tertiary sector working groups. As before, these meetings evaluate existing conditions, and suggest actionable changes and updates for the benefit of colleges and universities.

In this model, each stage could involve, either in a managerial or an advisory capacity, existing alliances and organizations, such as higher education associations, national-level coordinating bodies, and international entities such as the U7, G7, G20, and OECD. In general, for universities to obtain maximum benefit from the model-developed national and international agreements and alliances, they will need to remain engaged in ongoing agreement and alliance creation and refinement processes.

Appendix: Comparative Higher Education Metrics

Figure 1

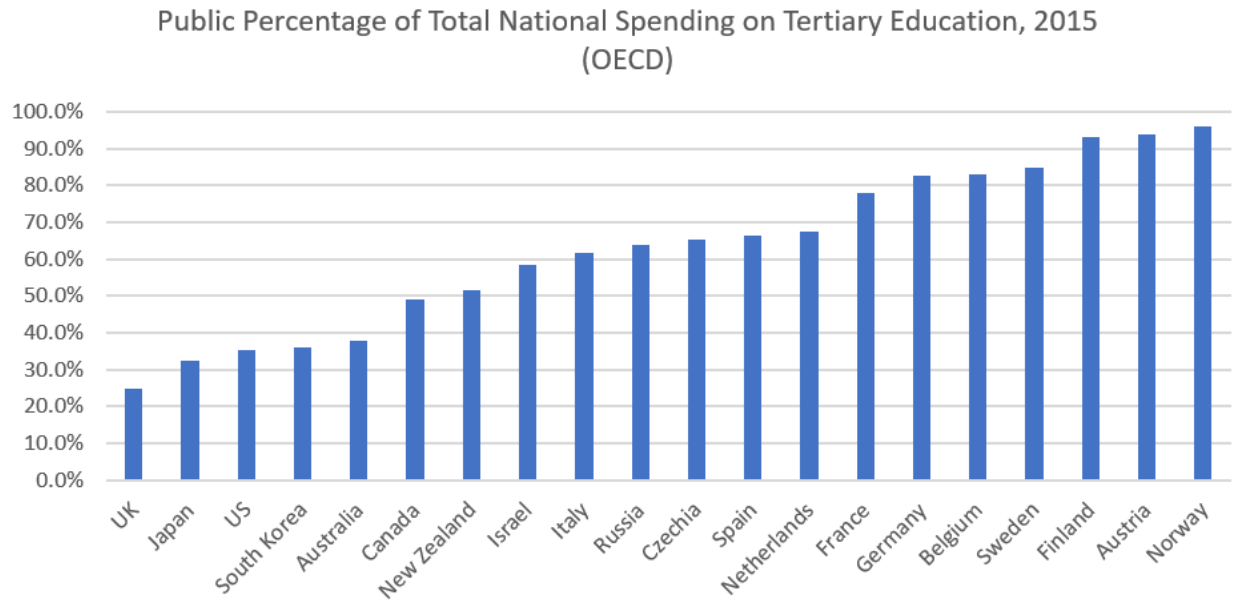


Figure 2

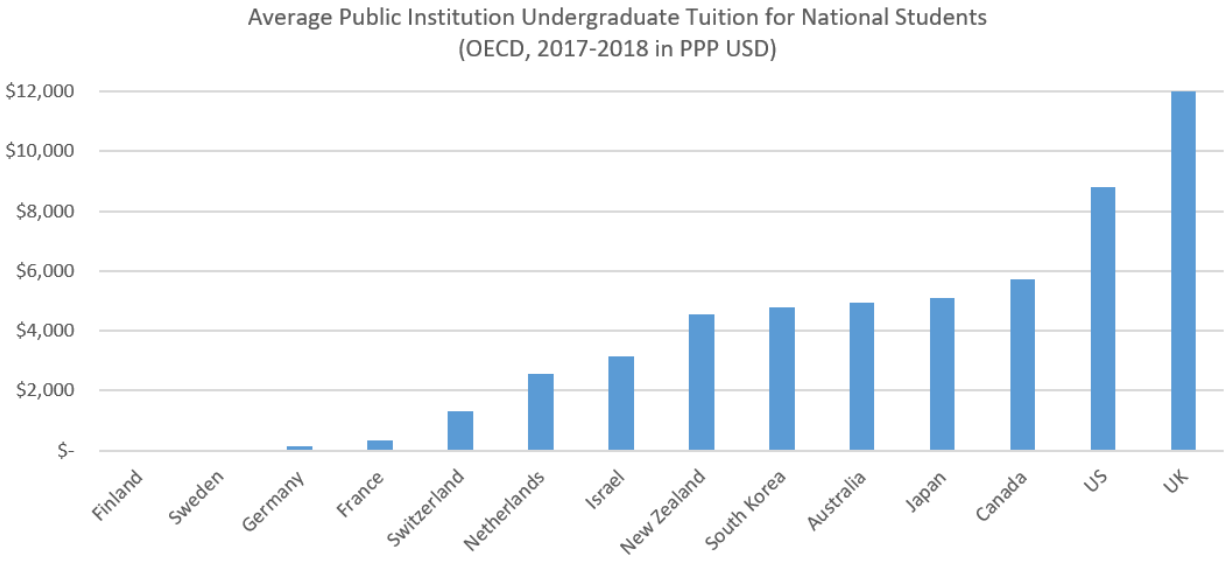


Figure 3

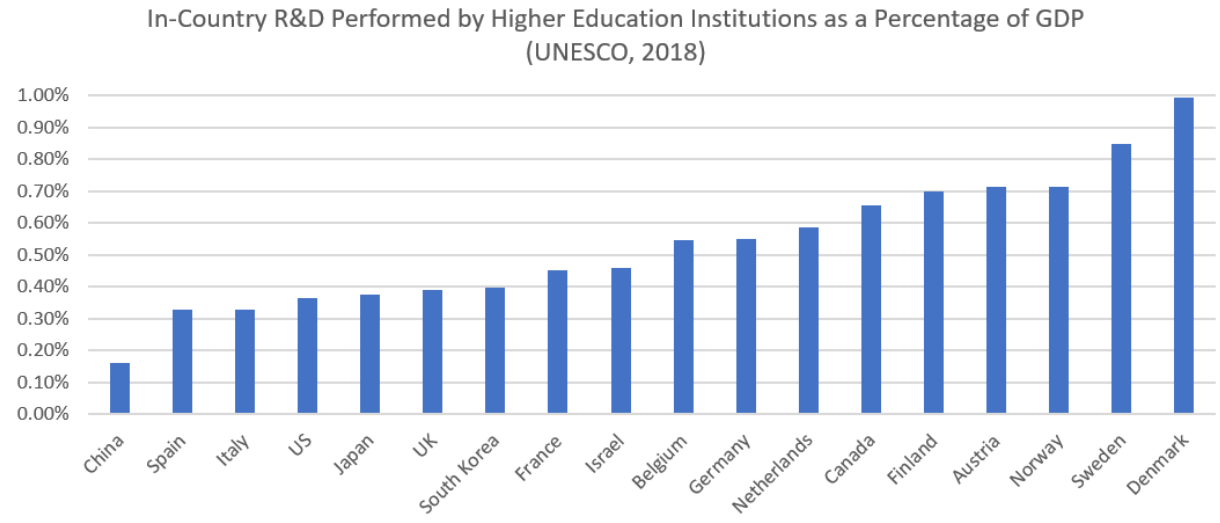

In-Country R&D Performed by Higher Education Institutions as a Percentage of GDP
(UNESCO, 2018)
1.00%
0.90%
0.80%
0.70%
0.60%
0.50%
0.40%
0.30%
0.20%
0.10%
0.00%
China
Spain
Italy
US
Japan
UK
South Korea
France
Israel
Belgium
Germany
Netherlands
Canada
Finland
Austria
Norway
Sweden
Denmark

Figure 4

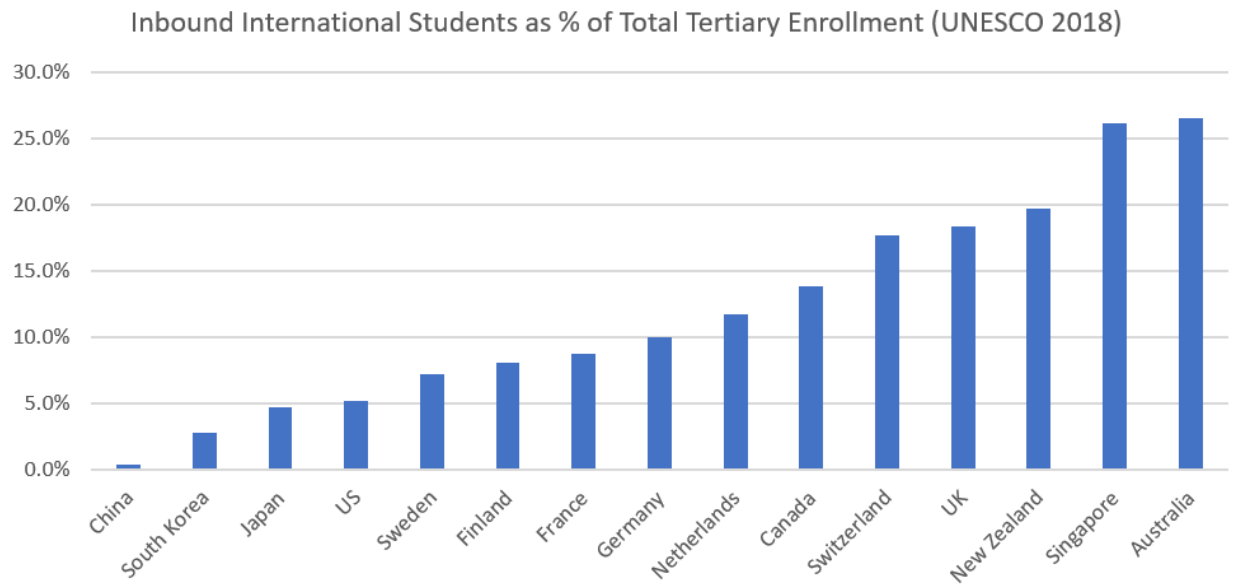


Figure 5

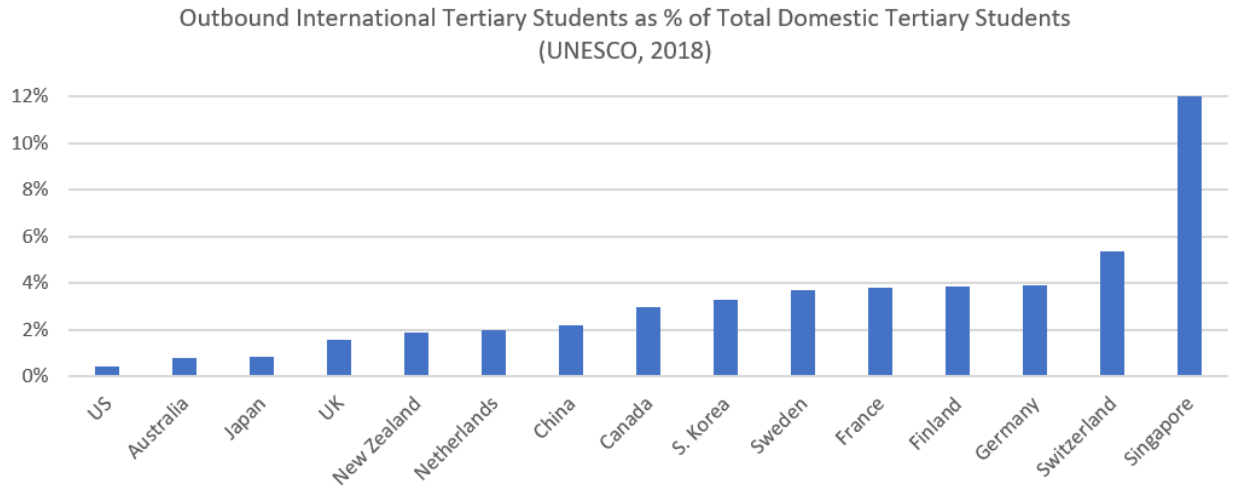


Figure 6

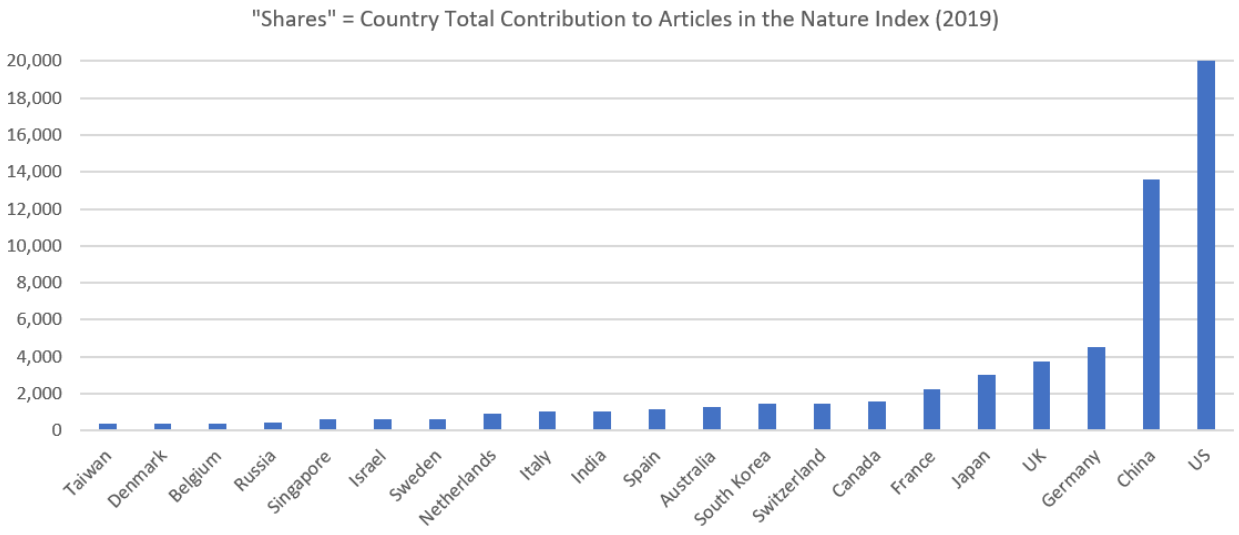


Figure 7

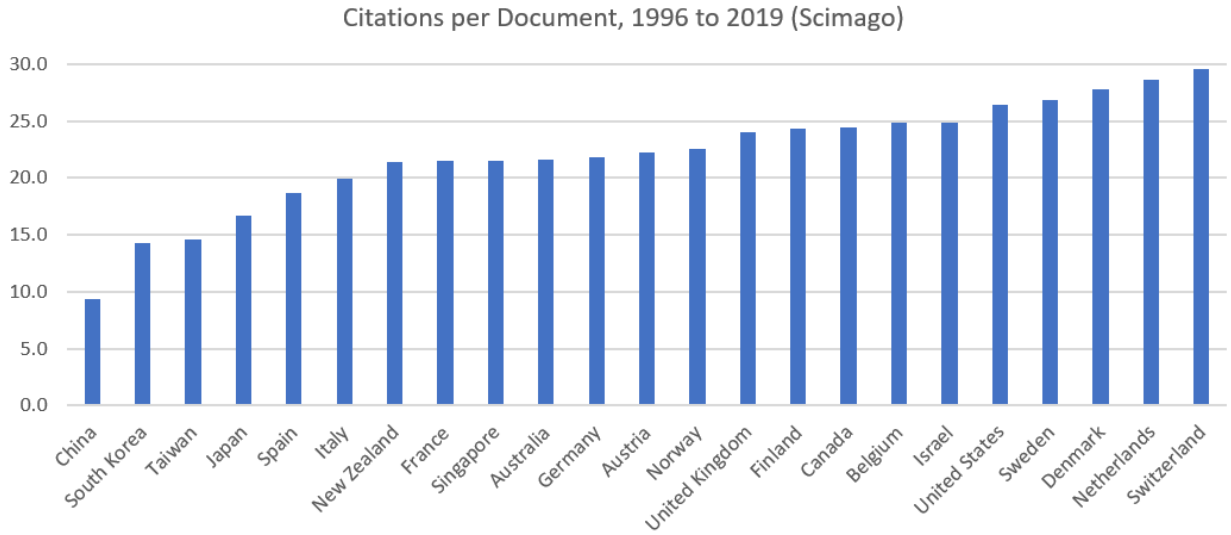


Figure 8

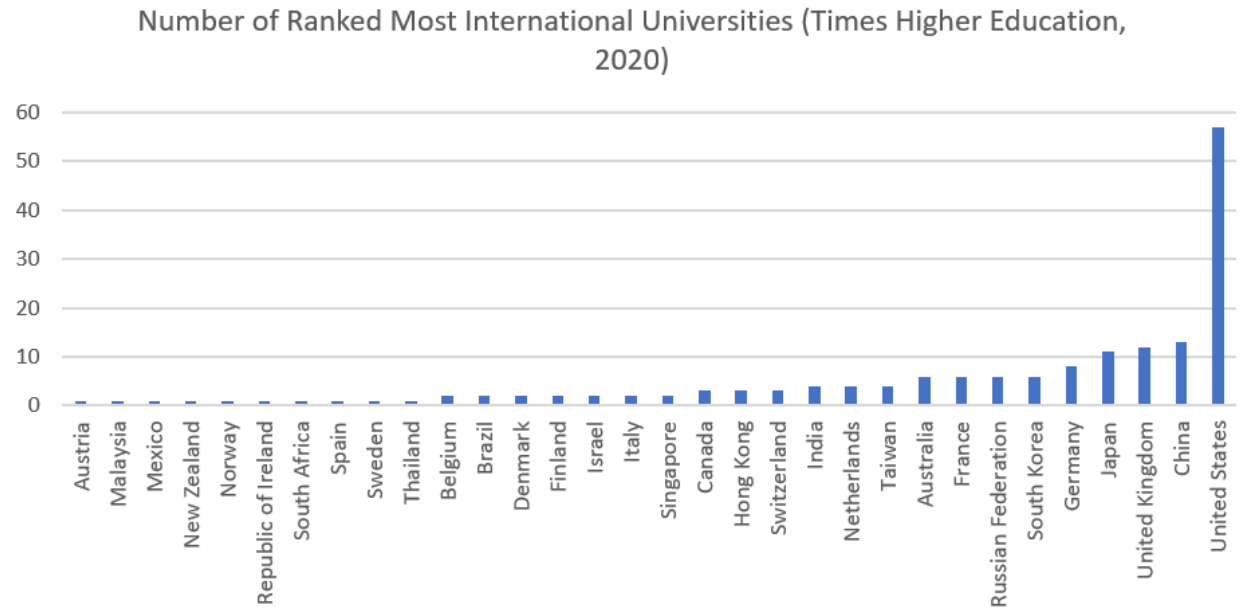


Figure 9

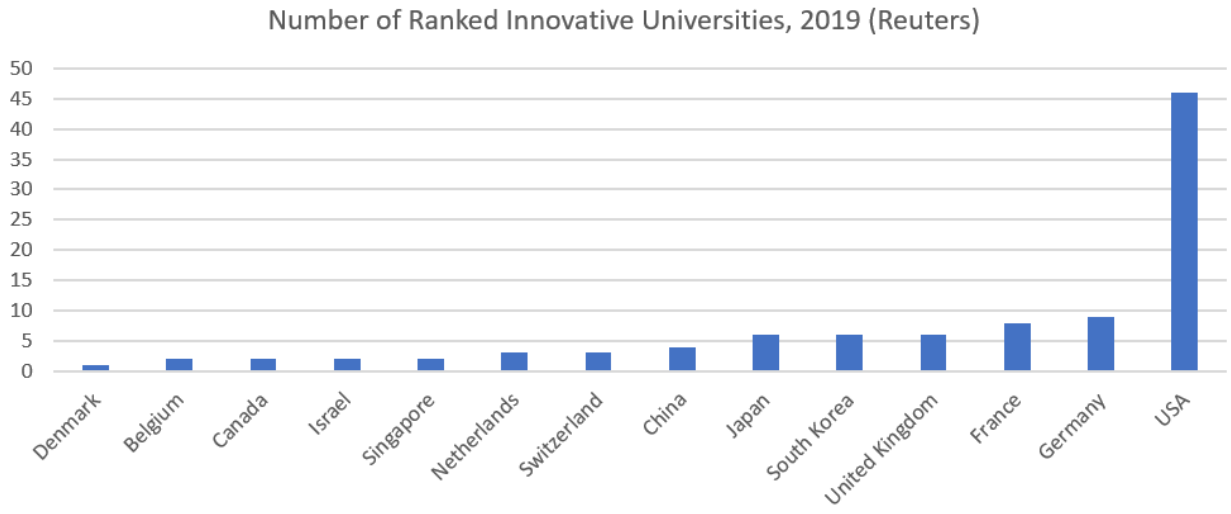


Figure 10

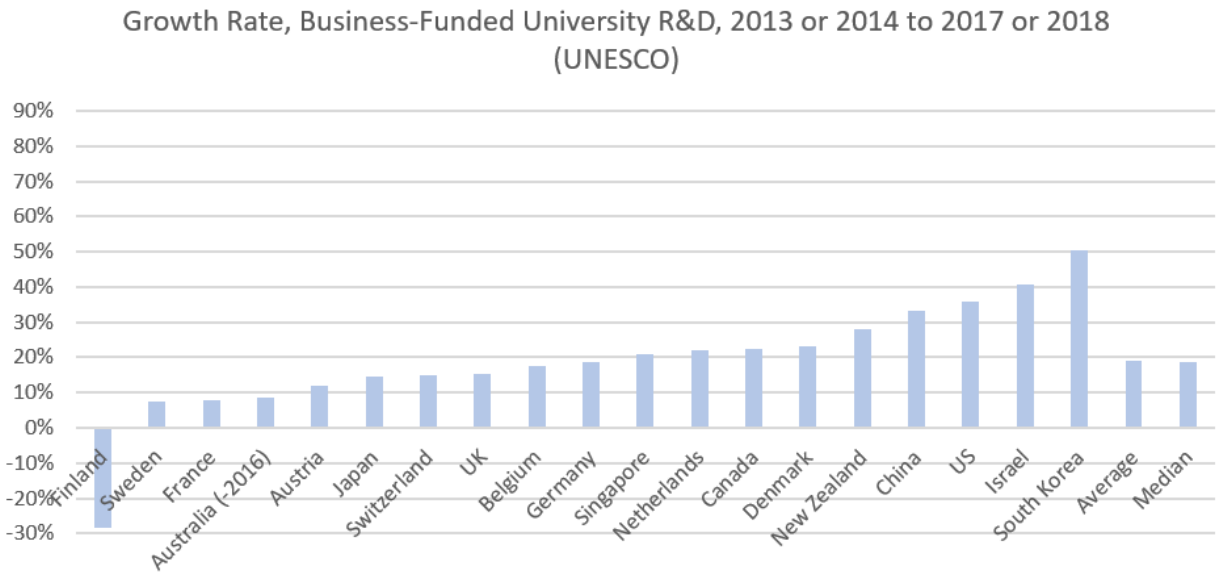


Figure 11

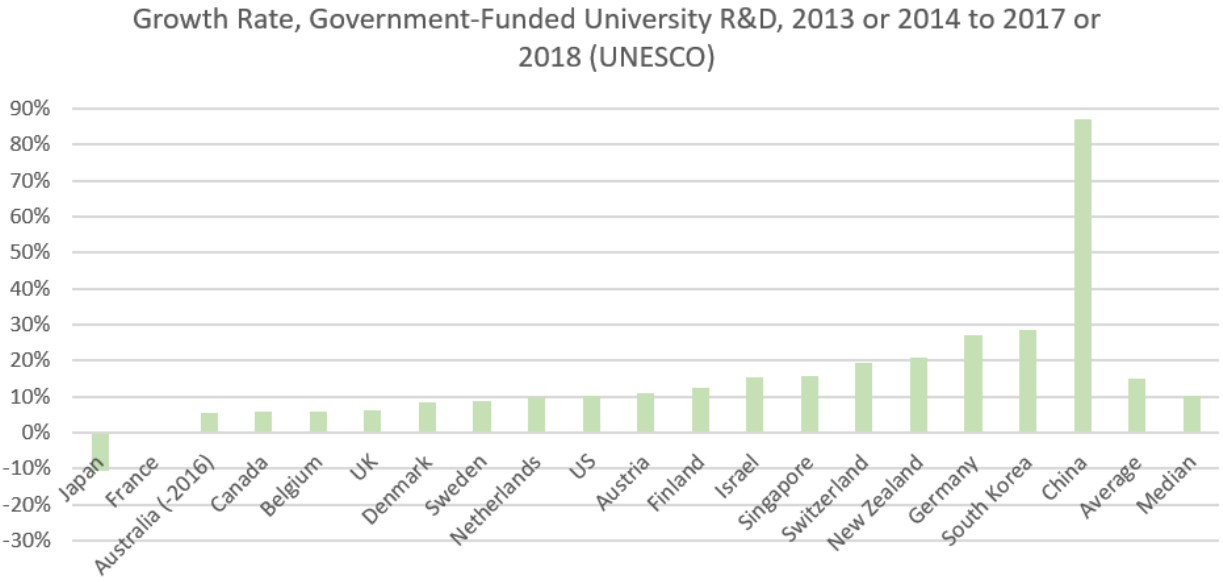


Figure 12

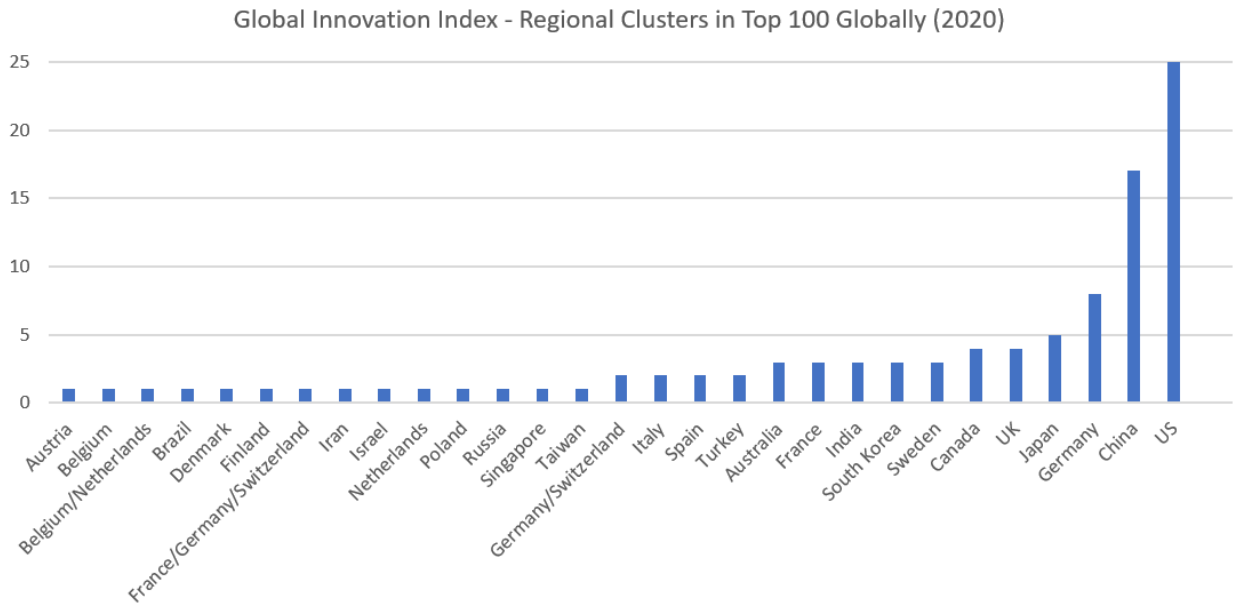
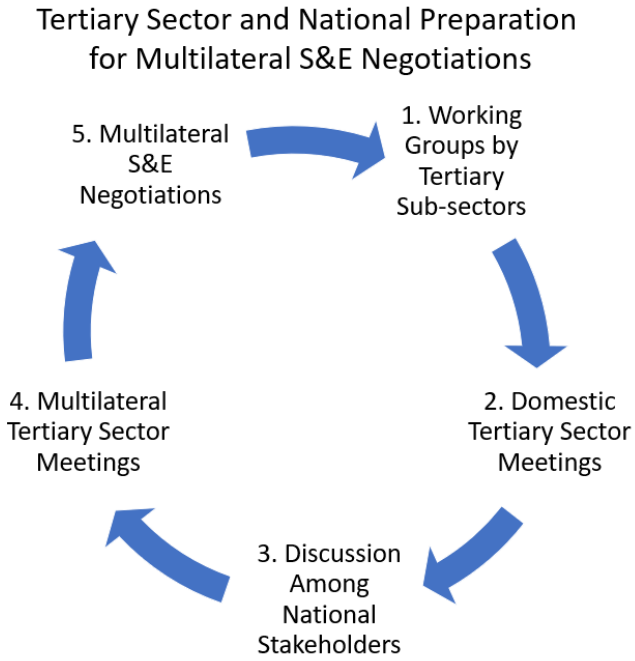


Figure 13



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