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AI Hubs

Europe and CANZUK

CSET Data Brief

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Executive Summary

With the increasing importance of artificial intelligence to national and economic security, and the growing competition for AI talent globally, it is essential for U.S. policymakers to understand the landscape of AI talent and investment. This knowledge is critical as U.S. leadership develops new alliances and works to curb the growing influence of China. As an initial effort, an earlier CSET report, "AI Hubs in the United States," examined the domestic AI ecosystem by mapping where U.S. AI talent is produced, where it is concentrated, and where AI private equity funding goes. That work showed that AI talent and investment was concentrated in specific, well-defined geographic centers referred to as "AI Hubs."

Given the global characteristics of the AI ecosystem and the importance of international talent flows, it is equally important to consider the AI landscape outside of the United States. To provide insights to U.S. policymakers on the larger aspects of international AI talent, this paper builds on our earlier U.S. domestic research by exploring the centers of AI talent and investment in countries and regions that are key U.S. partners: Europe and CANZUK (Canada, Australia, New Zealand, and the United Kingdom). As before, we examine patterns of investment into privately held AI companies, the geography of top AI research universities, and the location of self-reported AI workers.

The key findings:

- Traditional treaty partners, including France, Germany, and CANZUK countries, contain both a high number of the top AI research universities and a high number of workers with self-reported AI skills.
- Overall investment into privately held AI companies in Europe and CANZUK is clustered in the United Kingdom, Canada, Germany, and France.
- Chinese investment into privately held AI companies in Europe and CANZUK from 2015 to 2019 is consistently low (less than 3 percent).

Introduction

The competition for international leadership in AI research and development is growing. Furthermore, in contrast to the era of the space race where government funds were the largest source of R&D, private industry now plays the major role in general R&D spending.[1] This is true also in the case of AI R&D.[2] An assessment of which countries will lead in AI R&D must then also consider the role of nongovernment investment.

Yet AI R&D does not happen in a vacuum: the countries that dominate will likely be those that can cooperate most effectively with others. As of 2018, global R&D was $2.2 trillion with half of that from outside of the United States and China.[3] The United States could augment its R&D capability significantly by leveraging the resources of its allies, many of which are formidable sources of AI R&D themselves.

However, given the current tensions with China a few concerns remain. If the United States is going to truly collaborate with its allies and partners, it needs to understand the extent to which China is following suit. How worried should the United States be about Chinese investment into its allies? What are the opportunities for the United States to pursue strategic alliances that support AI R&D while maintaining its national security integrity?

The previous paper explored these questions from a U.S. domestic perspective, finding a richer and more diversified set of AI talent centers, or AI hubs, than expected, and that China's disclosed investment comprises a relatively small portion of total investment in U.S. AI companies.[4] This paper examines these same questions by exploring the AI hubs among certain U.S. allies and partners. Specifically, we focus on universities producing talent relevant to AI (using computer science programs as a proxy) and the investment into privately held companies for countries in Europe and the CANZUK community (Canada, Australia, New Zealand, and the United Kingdom). While these variables are not exhaustive, we believe this analysis, and our ability to compare it to our assessment of the U.S. AI hubs, provides a valuable input for

decisionmakers when considering policies ranging from R&D alliances to high-skilled immigration.

This brief contains four sections. The first three sections examine patterns of *privately held AI investment*, *research talent production*, and *worker concentration*, respectively. The final section proposes recommendations for policymakers on how to use the information presented.

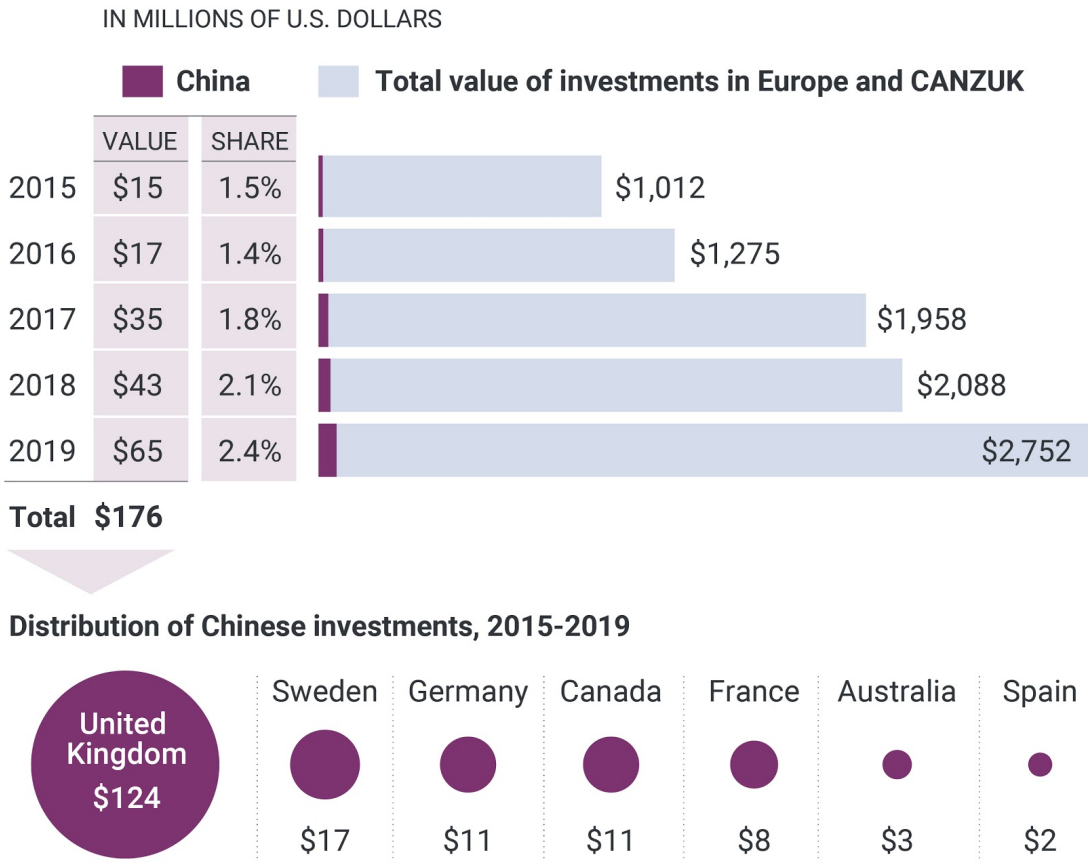
Privately Held AI Investment

In this section, we examine trends in private AI investment in Europe and CANZUK. These regions and countries are strong traditional partners for the United States and understanding their competitive and complementary ecosystems is valuable to crafting strategic R&D policy. We focus on private AI investment as it is a less common focus than the big tech companies like Facebook and Google. Additionally, the startup community is often seen as a source of innovation, even for large companies. By private AI investment, we mean venture capital investment into non-publicly listed AI companies, as defined by our search criteria. By Chinese investment, we mean publicly disclosed Chinese investors whose organizations are headquartered in the People's Republic of China and Hong Kong. Further discussion of methodology can be found in the appendix.

Chinese investors have a weak presence in Europe and CANZUK.

Chinese investment into private AI startups in Europe and CANZUK remains limited. As we show in Figure 1, Chinese funding is a modest total source of funding in the countries of interest. Investments from entities headquartered in China never exceed 3 percent as a source of private AI investment in Europe and CANZUK. Furthermore, the disclosed funding from China is present in only seven countries. Most countries in Europe and CANZUK have zero disclosed venture capital investment from entities headquartered in China.

Figure 1. Total disclosed value of venture capital investments in privately held AI companies within Europe and CANZUK



Source: CSET Analysis of Crunchbase and Refinitiv Data.

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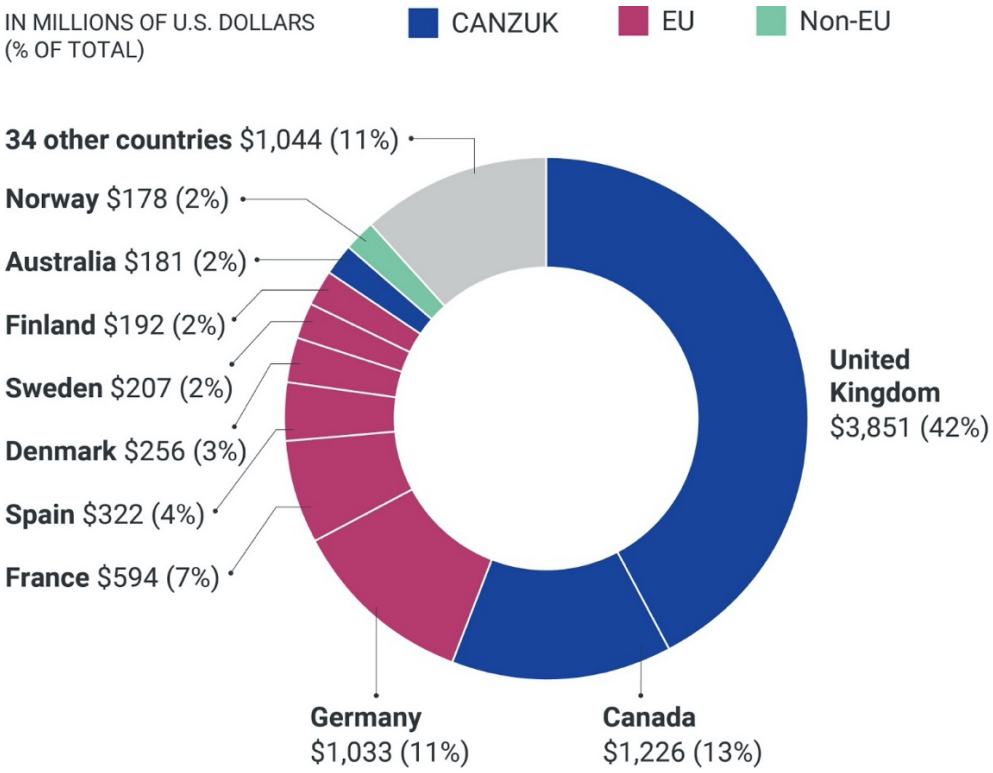
In previous research, we found that private AI startups in the United States reflect a similarly small proportion of Chinese investments over the last 20 years.[5] These findings can be

understood as a reflection of two separate trends. The first, more stable trend is the tendency of Chinese investors to fund their own domestic, rather than international, technology companies.[6] The second, more recent trend is the reduction of Chinese investment into AI companies in general since 2017.[7]

Among countries in Europe and CANZUK, disclosed investment in privately held AI companies is clustered in a small number of countries.

While the United States and China are understood to be the dominant players in terms of private AI startup value, the distribution of private AI funding across Europe and CANZUK is less commonly discussed. Our research indicates that the vast majority of venture capital funding is concentrated within four countries in the EU and CANZUK: the United Kingdom, Canada, Germany, and France.

Figure 2. Top 10 countries with highest disclosed venture capital investment across Europe and CANZUK, from 2015 to 2019.



Source: CSET Analysis of Crunchbase and Refinitiv Data.

Figure 2 indicates that the majority of funding over the past five years for privately held AI startups in Europe and CANZUK is concentrated in the top three to four countries. The United Kingdom alone has received nearly $4 billion, or 42 percent of total funding across Europe and CANZUK. The top four targets of investment, the United Kingdom, Canada, Germany, and France, collectively account for 73 percent of total funding across Europe and CANZUK.

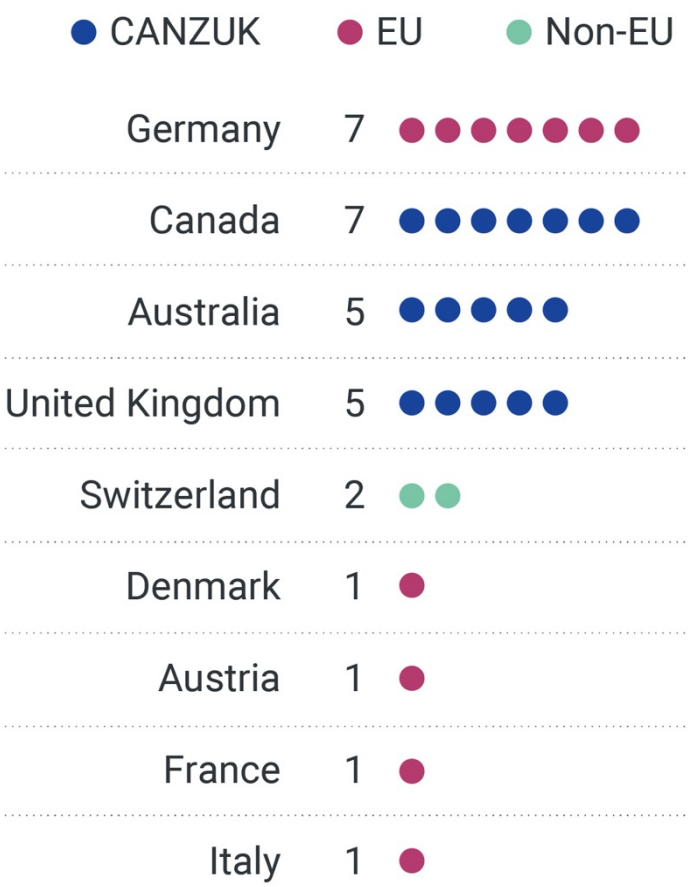
AI Research Universities—the talent pipeline

In this section, we examine the distribution of the top computer science programs at research universities across Europe and CANZUK countries as a proxy for research programs that produce AI-relevant research talent. For more detail on the methodology, see the appendix.

The majority of top AI-relevant university programs are located in CANZUK countries.

Within Europe and CANZUK, the top four countries—Germany, Canada, Australia, and the United Kingdom—account for 80 percent of the top 30 AI-relevant research universities. Three of these four countries are part of CANZUK. In other words, CANZUK countries contain the majority (57 percent) of the top 30 AI-relevant research universities across all of Europe and CANZUK.

Figure 3. Top 30 AI research institutions in Europe and CANZUK, grouped by countries.



Source: CSRankings Data, 2010 to 2020.

While five of the nine countries that contain the top 30 AI research universities are in the European Union, they collectively make up only 37 percent of the top 30. The vast majority of this EU fraction is accounted for by Germany. In contrast, the CANZUK countries contain a relatively even distribution of the top AI research universities. Overall, the nations with the largest university programs producing AI-related talent are all strong traditional U.S. allies.

AI Worker Clusters

Just as many AI scientists and engineers conduct their research abroad, workers with AI-related skills are also scattered across the

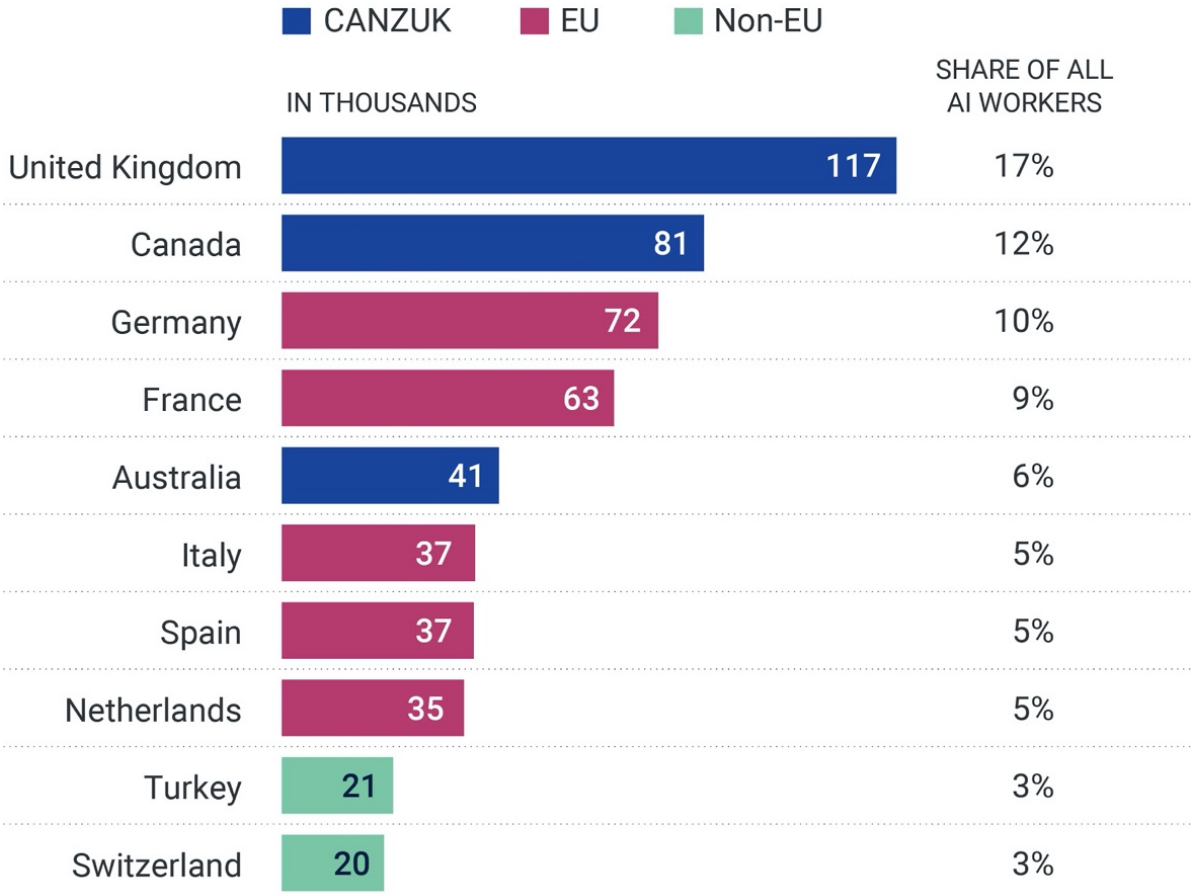
world. We used LinkedIn to search for the number of employees with self-reported AI skills using a number of specific search terms.

The fraction of a population that uses LinkedIn varies by country. This is a challenge as it is unclear whether workers with AI skills mirror the overall national population on LinkedIn making an ideal adjustment infeasible.[8] In this section, we analyze both the raw numbers and the LinkedIn usage-adjusted number of workers with AI skills. We find that our high-level results are largely consistent between the two analyses.

Traditional U.S. allies Germany, France, and CANZUK collectively possess the majority of the AI workforce across the analyzed countries.

Based on raw counts in LinkedIn data (Figure 4), the top 10 countries in our geographical areas of interest host over a half million workers with AI skills. While CANZUK makes up roughly 35 percent of that workforce, it is important to note that France and Germany alone make up another 19 percent, demonstrating the strength of the EU in this arena and the strength of historical U.S. alliances as continued valuable mechanisms for accessing the best and brightest AI talent.

Figure 4. Top 10 countries in Europe and CANZUK, by non-normalized number of employees with self-reported AI skills.



Source: CSET Analysis of LinkedIn Data.

Raw LinkedIn counts indicate that CANZUK countries account for over one-third of workers with AI skills, despite comprising only 17 percent of the population of Europe and CANZUK.[9] When adjusted for variation in LinkedIn usage rates, however, CANZUK decreases from 35 percent to 20 percent.

Nonetheless, the top 10 countries remain largely the same. Notably, the Netherlands drops out of the top 10, and is replaced by Poland. Our larger findings— that Germany, France, and CANZUK together possess the majority of the AI workforce across Europe and CANZUK—are consistent between raw and adjusted counts of AI workers.

Discussion

When considering a country's ability to lead in AI R&D, relying solely on government spending will not suffice. Here we broaden the scope to include consideration of privately held AI startups, AI-relevant research universities, and workers with AI skills across Europe and the CANZUK region.

First, we found consistently low Chinese investment across Europe and CANZUK in the last five years. Second, our findings suggested investment and the top research universities are clustered in the United Kingdom, Germany, and Canada. Finally, we found that Canada, Australia, and the United Kingdom have an especially high concentration of self-reported AI skills.

We believe this provides compelling evidence for the benefit of strengthening historic relationships with countries in Europe and CANZUK. Specifically, increased private sector collaboration would appear helpful considering the strong role of private R&D in today's global environment.

From a national security perspective, the low presence of Chinese investment across Europe and CANZUK appears reassuring. Minimal investment suggests that the likelihood of the sensitive intellectual property transfer through ownership stakes in privately held AI companies is lower than in countries with higher Chinese investment. Strategic alliances on a whole, then would benefit the United States and its partners.

In 2019, the Turing Award, informally known as the Nobel prize of computing, was awarded to the three pioneers of deep learning, a keystone of the contemporary approach to AI. They conducted their groundbreaking research in Canada, France, and the United Kingdom.[10] If the past is any indication of the future, the next generation of AI pioneers will come from a number of different countries. The United States would benefit from creating opportunities for U.S. researchers to collaborate with scientists in these regions.

CANZUK is particularly appealing on many fronts. Its countries have many of the top research university programs outside of the

United States, a high concentration of workers with self-reported AI skills, and low Chinese investment. There is also historical precedent for partnerships between the United States and CANZUK; the Five Eyes alliance was established shortly after World War II for intelligence sharing.[11] Moreover, the Technical Cooperation Program was created during the Cold War for the sharing of defense science and technology.[12] Partnerships with key European allies, such as France and Germany, are also of obvious benefit and would build upon a long history of similar agreements.[13]

Given that most R&D is now private, however, U.S. policymakers should consider how best to engage private industry in cross-country collaborations. Whether through international research consortiums, or export control reform to ease restrictions for specific nations and companies, the U.S. government must engage partners, both private and international, if it wants to remain a leader in AI innovation.

Authors

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Appendix

Identifying AI Investments

This brief applies the same methodology as CSET's recent *Tracking AI Investment* issue brief.[14] For an in-depth explanation of investment analysis, please see the appendix of the aforementioned issue brief. The most notable caveats are mentioned below.

In this brief, we consider only *disclosed venture capital investment* into privately held AI companies. Importantly, this does not include mergers and acquisitions (M&A) or initial public offerings. Because public offerings tend to include a variety of technological domains other than AI, we do not see this as problematic. Furthermore, as discussed in *Tracking AI Investment*, since there is generally very little disclosed M&A investment, we believe our restriction meaningfully captures the higher-level trends discussed above.

AI companies were identified using a custom regular expression search term.[15]

Chinese investment was indirectly calculated by considering the number and value of investments with at least one publicly disclosed Chinese investor. An investor is considered Chinese if their organization is headquartered in the People's Republic of China or Hong Kong. For further discussion, see the "Identifying Chinese Investments" section in the *Tracking AI Investment* issue brief.[16]

Identifying Top AI Research Institutions

In order to find the top 130 AI research universities, we used CSRankings, a metrics-based ranking system of the top computer science programs around the world. We examined institutions from 2010 to 2020 using the 'AI' and 'Interdisciplinary Areas' criterias.

Identifying AI Worker Clusters

For each country, we used LinkedIn Talent Insights—a talent intelligence platform with over 12 billion data points on talent, companies, jobs, skills, and schools—to identify the talent pool of professionals in a given country who had at least one of the following skills: artificial intelligence, machine learning, computer vision, deep learning, artificial neural networks, neural networks, and natural language processing. These searches were run on July 29, 2020 and reflect Talent Insights data as of that date.

The normalization used estimates of LinkedIn usage across different countries. We are cautious about extrapolating from these estimates, however, because this assumes consistent parallel trends between LinkedIn usage by workers with AI skills and overall LinkedIn usage.

Additionally, in order to estimate usage across different countries, we subdivided larger groups of LinkedIn regions into countries. The LinkedIn DACH region contains Austria, Germany, and Switzerland, which we had to subdivide assuming uniform LinkedIn use across all three countries.

Endnotes

[1] See pg. 19 of Mark Boroush, "Research and Development: U.S. Trends and International Comparisons," National Science Foundation and National Science Board, January 15, 2020, https://ncses.nsf.gov/pubs/nsb20203/.

[2] As pointed out in CSET's "Tracking AI Investment" report, privately held AI companies attracted nearly $40 billion in disclosed equity investment. The U.S. and Chinese governments are investing on the order of a couple billion at most. See also Ashwin Acharya and Zachary Arnold, "Chinese Public AI R&D Spending: Provisional Findings" (Center for Security and Emerging Technology, December 2019), https://cset.georgetown.edu/research/chinese-public-ai-rd-spending-provisional-findings/.

[3] See, e.g., Melissa Flagg, "Global R&D and a New Era of Alliances" (Center for Security and Emerging Technology, June 2020), cset.georgetown.edu/research/global-rd-and-a-new-era-of-alliances/.

[4] Melissa Flagg and Justin Olander, "AI Hubs in the United States" (Center for Security and Emerging Technology, May 2020), cset.georgetown.edu/research/ai-hubs-in-the-united-states/.

[5] See Flagg and Olander, "AI Hubs in the United States," 4.

[6] Zachary Arnold, Ilya Rahkovsky, Tina Huang, "Tracking AI Investment: Initial Findings from the Private Markets" (Center for Security and Emerging Technology, September 2020), https://cset.georgetown.edu/wp-content/uploads/CSET-Tracking-AI-Investment.pdf.

[7] See, e.g., "The Inflow of Funds into the Primary Market Has Been Reduced by 50%. Have You Been "Optimized"?" (流入一级市场资金减少50%, 你被"优化"了吗), WeiXin, January 3, 2019, https://mp.weixin.qq.com/s/um1vlYLfgPo85FJ2_YUq8Q; "Investors Escape Artificial Intelligence" (投资人逃离人工智能), 36kr, September 26, 2019, https://36kr.com/p/5250586; Rita Liao, "China Startup Deals Shrink as Fundraising for Investors Plummets," *TechCrunch*, July 16, 2019, https://techcrunch.com/2019/07/16/vc-pe-funding-slows-in-china/; "China's Venture Capital Boom May Be Turning into a Bust," *The Straits Times*, July 9, 2019, https://www.straitstimes.com/business/banking/chinas-venture-capital-boom-may-be-turning-into-a-bust.

[8] Specifically, we can multiply the number of LinkedIn AI workers by the fraction of the country that uses LinkedIn to return a normalized count of total AI workers.

[9] 740 million in Europe + 38 in Canada + 25 in Australia + 5 in New Zealand = 808 million total. 135/808 = 17 percent.

[10] Yann LeCun, Geoffrey Hinton, and Yoshua Bengio were researchers at Sorbonne University, the University of Edinburgh, and McGill University, respectively.

[11] "UKUSA partners," Government Communications Security Bureau, New Zealand, March 23, 2021, https://www.gcsb.govt.nz/about-us/ukusa-allies/.

[12] "The Technical Cooperation Program (TTCP) II Memorandum of Understanding (MOU)," Defense Acquisition University, June 3, 2018, https://www.dau.edu/training/career-development/intl-acq-mgmt/blog/The-Technical-Cooperation-Program-(TTCP)-II-Memorandum-of-Understanding-(MOU).

[13] France and Germany are both NATO members. See "The North Atlantic Treaty Organization," NATO official website, March 23, 2021, https://www.nato.int.

[14] See Arnold, Rahkovsky, and Huang, "Tracking AI Investment," 1-6.

[15] See Appendix 2 of Arnold, Rahkovsky, and Huang, "Tracking AI Investment."

[16] See Arnold, Rahkovsky, and Huang, "Tracking AI Investment," 35.