

Issue Brief

# Which Ties Will Bind?

Big Tech, Lessons from Ukraine,  
and Implications for Taiwan

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## Executive Summary

Several U.S. technology companies have played important roles in supporting Ukraine's military to combat Russia's full-scale invasion of the country and in helping the Ukrainian government maintain critical functions. Companies like Maxar and Planet Labs have provided intelligence, surveillance, and reconnaissance (ISR) capabilities, and established defense contractors like Palantir have informed targeting, while tech giants like Amazon and Microsoft have contributed to safeguarding government data and securing software services. Overall, their assistance has supported the resilience of the Ukrainian government and military during the ongoing conflict.

U.S. tech companies' assistance in the war in Ukraine has provoked questions about how they might act in a hypothetical Taiwan contingency. The respective Russia-Ukraine and China-Taiwan situations are, however, different in many substantive ways. For one, while most of the U.S. tech companies assisting Ukraine had limited economic stakes in Russia, their relationships with China are much deeper and more complicated.

In this report, we seek to trace and analyze the complex financial and economic linkages that leading U.S. tech companies that supported Ukraine have to China. Business considerations are certainly not the only variables influencing boardroom decisions amid major geopolitical events; company reputation, corporate responsibility, value alignment, and public pressure are all important drivers of business behavior as well. That said, understanding the financial stakes U.S. tech companies have in China can help provide insights into the incentives and pressures these companies might face in a potential contingency related to Taiwan. Although this research is not without limitations, we hope it can provide analysts and policymakers with valuable context for evaluating, if not anticipating, the decisions and behaviors of some of the major U.S. tech companies in a variety of crisis scenarios involving China.

We focus on the following 18 companies based on their involvement in Ukraine: Amazon, Apple, Capella Space, Cisco, Clearview AI, Cloudflare, Fortem Technologies, Google, Mandiant, Maxar, Microsoft, Oracle, Palantir, Planet Labs, Primer, Recorded Future, SpaceX, and Tesla.

We rely on data from fDi Markets, Crunchbase, and myriad reputable open sources to estimate the type and scale of economic and financial linkages between these U.S. companies and China. We focus on indicators such as overall revenue from business in

China, greenfield foreign direct investment (FDI) projects, supply chains and supplier information, data and cloud computing centers, and venture capital and private equity investments in Chinese companies. We also analyze factors such as the number of company employees or the type of research and development (R&D) operations that these U.S. tech companies have in China.

With these indicators in mind, we define vulnerable companies as those that could suffer potential economic costs including lost revenue, production capacity, sunk costs from FDI, curtailed research output, and loss of access to China's technology innovation ecosystem and labor pool. Relatedly, when discussing (actual and potential) Chinese coercion, we are referring to the use of threats or negative actions to force a change in a corporation's behavior. The limitations of this research design and our data sources are discussed in detail in the methodology section of this report.

We find that of the 18 U.S. technology companies that provided assistance to Ukraine, **none had significant economic or financial linkages to Russia** across the variables we examined. However, the situation with regard to China is different. While ten of these 18 companies have little or no linkages with the country, **four companies have extensive economic linkages with China.**<sup>1</sup> Tesla, Apple, Amazon, and Microsoft draw revenue from selling products in China, have made greenfield foreign direct investments and venture capital investments in Chinese companies, operate data or R&D centers, and/or maintain supply chains in the country. Four other companies, Cloudflare, Google, Oracle, and Cisco, have notable, but less extensive, ties to China.

The linkages between these eight U.S. tech companies and China vary in type and depth. Some companies extensively rely on Chinese factories for manufacturing products, while others simply run local data and cloud computing centers. Specifically, we find that:

- **Compared to the other companies reviewed in this report, Apple and Tesla have the most extensive economic and financial ties to China, based on indicators such as revenue, supply chains, and greenfield FDI.**
  - Product sales in China accounted for about 20 percent of Tesla's and Apple's sales revenue in 2022.
  - 80 percent of Apple's suppliers operate in China and 17 percent of Tesla's suppliers are located in the country, making these two companies highly

dependent on China-based factories and supply networks for the manufacturing of their products.

- 95 percent of Apple's iPhones, AirPods, Macs, and iPads are assembled in China, while Tesla's Shanghai Gigafactory produces over 50 percent of the company's electric vehicles.
- Tesla and Apple's greenfield FDI capital expenditures in China account for 32 percent and 19 percent of their respective global totals.
- **Amazon and Microsoft also have notable linkages to the Chinese economy and R&D ecosystem, albeit to a lesser extent than Tesla and Apple.**
  - Amazon maintains robust supply chains in China, as 32 percent of its total suppliers are located in the country.
  - Amazon's China-based R&D labs conduct research on natural language processing, machine learning, and deep learning, among other advanced computer and data science-related topics.
  - Microsoft has extensive R&D operations and involvement in China's technology innovation ecosystem.
    - China-based Microsoft Research Asia, for instance, has produced over 9 percent of the company's total conference research papers in fields such as artificial intelligence and computer vision.
- **By contrast, Cloudflare, Google, Cisco, and Oracle maintain less robust linkages to China, though they still draw revenue from China and/or have greenfield FDI and PE/VC investment, R&D centers, and data and cloud computing centers in the country.**

To be clear, we do not claim that these linkages, entanglements, and vulnerabilities will definitely influence corporate decision-making and actions in the event of a Taiwan crisis. Indeed, it is impossible to project how these companies may react. Moreover, while we refrain from speculating about the nature of a potential Taiwan-related contingency, it is likely that the type of scenario itself—including its severity and scope—would heavily shape company responses. That said, our analysis suggests that

the decision to support Taiwanese (and/or U.S.) efforts may be more complicated for some of the U.S. tech companies that provided support to Ukraine than for others.

In particular, we find that, due to their reliance on China for revenue and manufacturing, Apple and Tesla, and to a lesser extent, Amazon, may be especially vulnerable to Chinese coercion or economic pressure in a potential Taiwan crisis. Due to its investments in R&D and entanglements with China's innovation ecosystem, Microsoft may also be particularly vulnerable should it be forced to curtail its activities in China or, in a more extreme scenario, withdraw from the country.

That said, China may also be vulnerable should these companies wind down their local operations. For example, the departure of Apple, Tesla, and Amazon could lead to job losses and harm the business prospects of their suppliers. Moreover, as these companies, as well as Microsoft, Google, and Cisco, conduct R&D activities in China, Beijing may have difficulty accessing global networks of science and technology experts should the firms wind down their local operations.

This suggests that in a potential Taiwan crisis, the support of U.S. technology companies should not be taken for granted, as they will have to make complex decisions and could suffer substantial costs. The United States and its allies should temper their expectations that all of the U.S. technology companies that supported Ukraine's war effort will similarly back the United States, Taiwan, and like-minded countries in a potential contingency. In particular, Taipei should not anticipate automatic support from those U.S. technology companies that have more substantial economic and financial ties to China. U.S. defense planners, meanwhile, would benefit from closer coordination and engagement with those U.S. tech companies to gauge their position and inform planning in case of a Taiwan contingency.

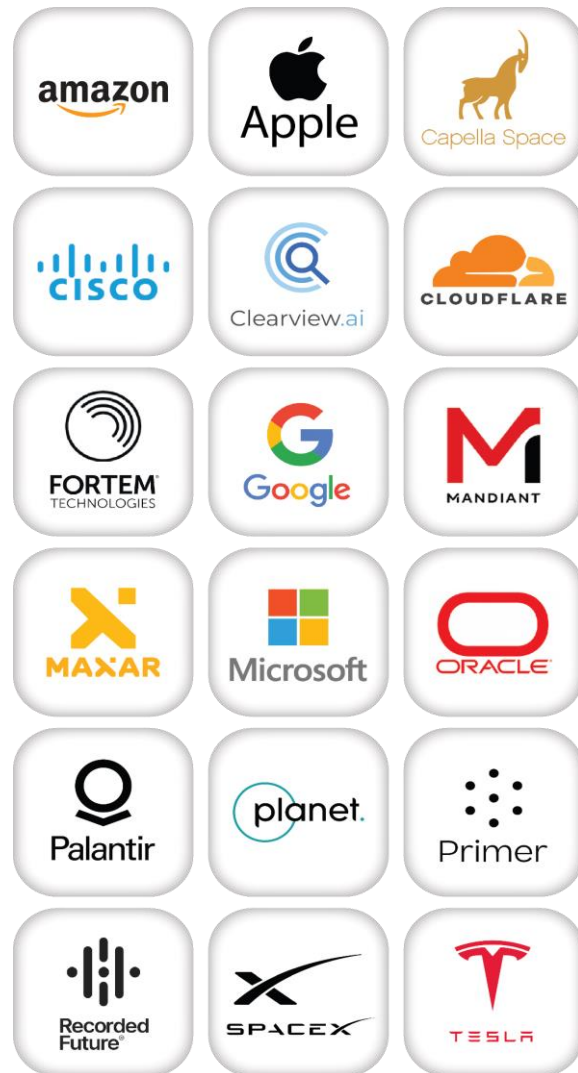
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## Introduction

Over the course of Russia's full-scale invasion of Ukraine, at least 18 privately held and publicly traded U.S. technology companies, including Amazon, Apple, Capella Space, Cisco, Clearview AI, Cloudflare, Fortem Technologies, Google, Mandiant, Maxar, Microsoft, Oracle, Palantir, Planet Labs, Primer, Recorded Future, SpaceX, and Tesla, have offered various services, often pro bono, in support of Kyiv's war effort.\* These companies have provided support for communications and intelligence, reconnaissance, and surveillance (ISR) functions, delivered information that helped inform target selection, as well as protected Ukraine's critical infrastructure from cyberattacks. Overall, such contributions have been essential to helping Ukraine combat Russia's initial assault and conduct offensive operations.



For a decisive majority of these companies, the financial calculus behind the decision to back Ukraine may have been relatively simple. Several of them, including Palantir and Fortem Technologies, did not appear to conduct any business in Russia prior to the full-scale invasion in February 2022.<sup>2</sup> Of the seven companies that did have economic ties to Russia, all but Cloudflare curtailed or eliminated their operations in the country shortly after the war

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\* Mandiant was acquired by Google in 2022, after the invasion. SpaceX owns and operates the satellite internet company Starlink.

began. These companies made relatively little revenue from their product sales, operations, or investments there.<sup>3</sup>

Russia's full-scale invasion of Ukraine, once thought unlikely, has reinforced the international community's concern about Taiwan's future amid China's ongoing military buildup and increasingly threatening behavior toward the self-governing island.

The historical, political, geographic, economic, and security realities of Russia-Ukraine and China-Taiwan relations are different. However, given the aforementioned companies' contributions to Ukraine's war effort, there is a growing debate about how these and other U.S. tech companies might respond in the event of Chinese aggression against Taiwan, armed or otherwise. Though these companies had relatively limited economic and financial ties to Russia, and were therefore largely not threatened by Russian pressure or coercion before February 2022, several of them have extensive financial linkages with, make billions of dollars in, and maintain supply chains throughout China.

This report focuses on 18 U.S. tech companies that have provided support to Ukraine's war effort, seeking to better understand their economic and financial linkages and footprints in mainland China, Hong Kong, and Macau (hereafter referred to simply as "China"). We analyze these linkages by assessing the companies' revenues, FDI, supply chains, and research and development (R&D) activities in China, among other indicators discussed in the following section. Through this exercise, we aim to aggregate and contextualize relevant, albeit often incomplete, information about the presence of key U.S. technology companies in China in order to help U.S. policymakers better understand some of the factors that will likely influence these companies' decision-making in the event of a potential crisis involving China and Taiwan. This analysis also seeks to elucidate some of the areas in which these U.S. companies might be more or less susceptible to Chinese coercion, for instance, the use of threats or negative actions to force a change in behavior, in the event they decide to support Taiwan in a hypothetical contingency.<sup>4</sup>

That said, we refrain from speculating about the particular nature, scope, or severity of such a contingency, and we do not attempt to predict the ways in which China may attempt to coerce or harm these companies, or how the companies might respond. In other words, we focus on mapping a limited but important part of the landscape of economic and financial connections between U.S. tech companies and China to identify



the factors that might shape companies' decisions and actions, rather than speculate about the nature or impact of said decisions and actions.

The remainder of the paper proceeds as follows: First, we discuss the report's methodology and scope, then analyze the companies' pre-invasion footprints in Russia, their contributions to Ukraine's war effort, and how the full-scale invasion has affected their operations in Russia. The following portion of the paper examines prior incidents of Chinese economic coercion before providing detailed case studies of each company's financial and economic footprints in China. The final section consists of key takeaways from the analysis. Our research suggests that based on their linkages to the Chinese market and innovation ecosystem through revenue, supply chains, FDI, venture capital investments, and R&D partnerships, Tesla, Apple, Amazon, and Microsoft are the four companies most vulnerable to Chinese coercion.

## Methodology and Scope

This report focuses on 18 U.S. technology companies that have supported Ukraine's war effort (see Appendix A), providing direct assistance on the battlefield and/or services to maintain critical infrastructure or government functions. We do not include companies that solely provided humanitarian or other relief aid. There are also likely companies that have aided Ukraine about which we were unable to find data. Thus, we do not include them in our analysis.

To estimate U.S. tech companies' economic and financial ties to and footprints in Russia and China, this report relies on two financial databases, Crunchbase and the *Financial Times'* fDi Markets, as well as extensive open-source research. Estimating each company's activities in both countries is difficult because of data limitations, including both the availability and representativeness of the data. While no single proxy, or group of proxies, is a perfect measure of U.S. companies' linkages to, or presence in China or Russia, we collected information on the indicators listed in Table 1.

Table 1. Indicators for U.S. Companies' Economic and Financial Linkages to and Presence in China and Russia Analyzed in this Report

Indicator		Function	Data Source
<b>Greenfield foreign direct investment (FDI)</b>		Measures investors' long-term interest and production of goods and services in a foreign country	<i>Financial Times'</i> fDi Markets <sup>5</sup> (January 2003-June 2023)
<b>Research centers</b>	Initial investment	Measures the frequency of investment in, and value of new facilities that carry out R&D	fDi Markets (January 2003-June 2023)
	Ongoing activity	Measures the number of R&D centers, research activity, and output where applicable (e.g., Microsoft)	Various open sources as indicated in company case studies
<b>Data and cloud computing centers</b>		Measures a company's offerings of data processing, hosting, and other data-related and cloud services	Various open sources as indicated in company case studies
<b>Supply chains</b>		Measures U.S. companies' supplier networks in country of interest	Corporate supplier lists and open-source research
<b>VC and PE investment</b>		Measures investment frequency and value to understand strategic relationships among foreign investors and local companies	Crunchbase (2004-June 2023)
<b>Revenue</b>		Measures a company's proportion of sales in a country or region	Open-source research, company 10-Ks, offices, retail stores, and service centers
<b>Employees</b>		Measures the number of company personnel in country of interest	Open-source research

**Greenfield foreign direct investment (FDI) flows:** FDI flows are often used as a proxy for a company's long-term economic interest in a particular host country, in part because the data is widely available and comparable across countries.<sup>6</sup> Greenfield FDI is generally defined as activities where investors set up new facilities, expand existing investment projects, or establish joint ventures.<sup>7</sup> These investments add novel elements to the economy, including new facilities, new jobs, and additional production capacity.<sup>8</sup> Drawing on the Financial Times' fDi Markets database, the best available tool for tracking global FDI flows, we searched for information about the 18 U.S. tech companies' greenfield FDI projects in Russia and China between January 2003 and June 2023, and found results for seven companies in Russia (Apple, Amazon, Microsoft, Google, Cloudflare, Cisco, Oracle) and eight companies in China (Tesla, Apple, Amazon, Microsoft, Google, Cloudflare, Cisco, Oracle).

Greenfield FDI data has limitations. Because of the increasing political sensitivity of doing business in China, U.S. companies may have become more reluctant to publicly announce their investments in the country. Since fDi Markets captures only publicly-disclosed, newly-announced FDI transactions, this report may be underestimating FDI flows from U.S. tech companies into China. Even if companies announce the investments, they do not always disclose the value of these investments. Where the actual value is unknown, fDi Markets creates estimates based on the target country, sector, and business activity using known project funding figures. Moreover, given that the database does not capture divestments or liquidations of assets, the value of current FDI figures may be overestimated. Finally, FDI only captures a part of a company's investment in a country; once a project has been completed, companies often expand beyond the initial investment, including by transferring staff, maintaining facilities and equipment, and conducting research (in instances where R&D centers are constructed), among other activities. Therefore, we cannot simply treat initial investments as the sole signal of a company's footprint in a country; to supplement this measure, where possible, we also analyze companies' ongoing activities in R&D.

Greenfield FDI data offers a glimpse of companies' initial investments in a host country, but we also track ongoing activities that follow investments in **R&D centers**. We rely

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\* We chose not to include mergers and acquisitions in our analysis since the U.S. companies observed in this report have seldom used this approach to enter the Chinese or Russian market. Crunchbase data shows only one transaction: Amazon's 2004 acquisition of Joyo, a Chinese company.

on fDi Markets and open-source research to determine the number of R&D centers associated with the 18 U.S. tech companies to examine their R&D presence in China and Russia. While several of the U.S. companies maintain R&D centers in China, given data limitations, we pay particular attention to Microsoft's research activity in the country via Microsoft Research Asia (MSR Asia), which publishes papers on various topics related to computer science and artificial intelligence (AI). There are two important limitations. First, the data is not exhaustive and not comparable across companies. Second, where applicable, we note the number of R&D centers the U.S. tech companies we focus on have announced in China or Russia, but we do not definitively know whether some of these facilities are still in operation.

We also track **data and cloud computing centers**. We rely on company websites to locate their presence in China and Russia. Establishing and running data and cloud computing centers reveals companies' interest in data processing, hosting, and other data-related and cloud services and is a means through which to generate revenue. Yet, there are some limitations worth noting. Not all of the companies in this report publicize the exact number of data centers they operate in China or Russia. As a result, we approach each case slightly differently based on data availability: we count the number of Apple's data centers, the locations of Cloudflare's data centers, the locations of Microsoft Azure regions, and the number of Amazon's AWS availability zones in China and Russia.

The **supply chain** analysis focuses on Tesla, Apple, and Amazon's manufacturing operations and supplier networks in China. The three companies do not maintain supply chains in Russia. Our analysis depends on Apple and Amazon's latest self-published supply chain information, but there are notable differences in how the companies present this data. Amazon, for example, provides a list of the specific sites at which manufacturing of its products occurs in China, while Apple lists only the Chinese provinces or municipalities in which each of its suppliers manufacture their products in the country.<sup>9</sup> Because of this difference, it is impossible to tell how many individual sites are engaged in manufacturing Apple's products in China. We list the number of Amazon manufacturing sites in China and the number of Apple suppliers that manufacture components for, or assemble its products in the country. For analysis of Tesla's supply chain, we rely on publicly available reports on the company's China-based suppliers.

The data shows these three U.S. companies all rely on China-based supply chains for the manufacturing of their products, albeit to varying degrees. It is also worth noting

that, given China's prominent role in manufacturing and assembling hardware and electronics, most, if not all, of the companies in our study likely use products or components made in China. These inputs are difficult to identify and fall outside the scope of this report. A significant limitation of our data is that it only includes first-order suppliers and does not capture those further upstream.

We use Crunchbase to track **VC and PE investment** aimed at funding early-stage companies.<sup>10</sup> These kinds of financial relationships between investors and portfolio companies, although shorter-term and usually involving less tangible infrastructure than greenfield FDI projects, indicate a degree of connection between the two parties, where in addition to capital, the investor often provides intangible benefits such as mentoring, coaching, and networking opportunities.<sup>11</sup> While based on Crunchbase data, VC or PE investment is not a common tool U.S. companies observed in this report use to enter the Chinese or Russian markets, we discuss a number of instances where such investments have enhanced the companies' footprints in China or Russia. However, there are a few notable limitations regarding VC and PE investment data.<sup>12</sup> For example, it is difficult to ascertain how much money a company receives from one specific investor in a given funding round, since investment transactions are often reported as a lump sum of money without specific breakdowns of investor contributions. Therefore, we do not aggregate transaction value by company and only discuss the value of specific transactions if they are known.

Data for **revenue** earned in China and Russia was sourced from each company's 10-K financial documents and open sources. Revenue data provides information on a company's proportion of sales in a certain market. We only include information on revenue for publicly traded companies, as that of privately held companies is not publicly disclosed. To supplement the 10-K information, we used open-source research to find any statements from companies or executives declaring revenue figures for a given year in China or Russia. We also use additional information on offices and retail stores to further understand the scale of a company's sales of products and services that typically correlate with revenue. There are a few limitations worth noting. The revenue data for each company is sparse and not easily comparable across the companies. Most of them do not consistently break down their revenue by country or region. For example, we faced difficulties in determining revenue for China, as companies themselves report revenue for various geographies such as China, Greater China (including Macau, Hong Kong, and/or Taiwan), or the broader Asia-Pacific. These

inconsistencies make it difficult to determine how much each company earned in Russia or China during a given year.

We also looked at the number of **employees** each company has in Russia and China, deriving information from company blogs, corporate reports, or statements made by executives. That said, determining the number of employees in China or Russia for each company, including those engaged in R&D and in manufacturing, was difficult; while we were able to find information about the number of employees in a particular factory or a research center, we were unable to find reliable information about the total number of employees each of the companies in our analysis has in China.

Our methodology comes with additional limitations that merit attention. For instance, several of the U.S. tech companies we analyze in this report have economic linkages to and physical presence in Ukraine and Taiwan. That said, in this report, we restrict the analysis to include only U.S. companies' economic linkages to and footprints in China and Russia. We do this to assess each company's relative vulnerability to Chinese or Russian coercion. Although our report does not provide an assessment of the U.S. companies' economic ties to Taiwan or Ukraine, these linkages may also influence company decision-making in the event of a crisis.

Furthermore, our analysis excludes U.S. companies' ties to Russia and China that go beyond each country's borders. There is some evidence that several of the companies we examined for this report conduct business with Russian or Chinese entities that is not reflected in Russia- or China-specific data sources. For example, Oracle reportedly stores TikTok's U.S. user data on U.S.-based servers as part of its partnership with ByteDance, a Chinese company.<sup>13</sup> Moreover, Microsoft, and likely other companies in the report, provide services for Chinese companies based outside of China, the value of which is difficult to capture.<sup>14</sup>

Given the limitations of our research approach and the difficulty of obtaining comprehensive and representative data, we aim to provide a rough measure of each company's potential vulnerability to Russian or Chinese coercion by examining the aforementioned indicators. In the "U.S. Companies and China" section of this report, we discuss the most relevant indicators for each U.S. company and note the lack of data availability or the lack of specific indicators in China appropriately.<sup>15</sup> That said, we believe that our compilation of indicators provides insights into each company's respective footprints in Russia and China. Again, we do not argue that these factors will necessarily influence a company's behavior in a crisis.



## U.S. Companies' Aid to Ukraine, Russia's Response, and How the Invasion Affected Company Operations in Russia

### ***How U.S. Companies Have Contributed to Ukraine's War Effort***

Since the start of Russia's full-scale invasion of Ukraine in February 2022, several U.S. private and public companies have supported the Ukrainian military and government in significant ways. For example, satellite imagery companies, with the help of the U.S. National Geospatial-Intelligence Agency (NGA), have shared synthetic aperture radar data and other imagery directly with Ukrainian servicemembers.<sup>16</sup> Such support has helped Ukraine detect Russian troops, identify weapons and equipment, and anticipate battlefield movements. Apple and Google have also directly aided Ukraine by disabling traffic and incident reporting in their map applications, which Russia had been using to track troops and civilians in the war's early stages.<sup>17</sup>

Several smaller AI start-ups have also come to Ukraine's aid. The AI-enabled software developed by Primer has reportedly been used to capture, translate, and analyze unencrypted communications between Russian soldiers.<sup>18</sup> In some instances, the Ukrainian government has reportedly used facial recognition software provided by Clearview AI to identify prisoners of war, as well as the identities of soldiers who have died in the conflict.<sup>19</sup>

Over the course of the war, Russia has combined kinetic operations with cyberwarfare. However, with the assistance of companies like Microsoft and Cisco, Ukraine has been able to defend against Russian cyberattacks and harden its networks against future aggression.<sup>20</sup> Cloud infrastructure supplied and supported by several companies has also allowed Ukraine to modernize its military operations, protect sensitive data, and maintain critical government functions.<sup>21</sup>

Perhaps the most significant contributions for Ukraine's military operations have come from SpaceX and Palantir. SpaceX's Starlink satellite internet service has played a critical role in allowing the Ukrainian armed forces to maintain communications despite damage to cell towers and internet networks.<sup>22</sup> As of July 2023, Ukraine was using more than 42,000 Starlink terminals.<sup>23</sup> The technology has aided the Ukrainian military in everything from holding Zoom calls to coordinating artillery strikes.<sup>24</sup> Analysts believe that without access to Starlink, Ukraine's army would be "operating in the blind

in many cases,” though SpaceX CEO Elon Musk has reportedly limited access to its services in some instances.<sup>25</sup>

Palantir has supplied Ukraine with software that helps the military visualize Russian positions and deploy resources to respond to threats. Although such statements are impossible to verify, Palantir’s CEO Alex Karp claimed in early 2023 that the company’s technologies were “responsible for most of the targeting in Ukraine.”<sup>26</sup> More recently, Palantir shared that it is helping pull together data on suspected Russian war crimes in order to facilitate the prosecution of perpetrators.<sup>27</sup>

Not all U.S. tech companies’ contributions have been digital. According to defense startup Fortem Technologies, the company has provided Ukraine with drones that are capable of “remov[ing] [other] drones from the sky autonomously day and night.”<sup>28</sup> They have played a role in protecting energy infrastructure from Russia’s Iranian-made Shahed drones which have challenged Ukrainian air defenses.<sup>29</sup>

Overall, these contributions have aided Ukraine in defending itself from, and responding to, Russian attacks. Without them, Kyiv may have found itself in a more difficult position than it occupies today. Further examples of the contributions made by American technology companies are provided in Appendix A.

### ***The Impact on Companies’ Business in Russia***

While only seven of the 18 companies analyzed in this paper operated in Russia prior to the full-scale invasion, our research suggests all except Cloudflare have since reduced or eliminated their presence in the country. The combination of highly negative U.S. public opinion toward Russia and wide-ranging sanctions and export controls on the Russian financial and technology sectors likely played a role in motivating most of the companies to wind down their local operations.

Since Russia’s invasion of Crimea in 2014, Americans have viewed Russia increasingly negatively, but the full-scale invasion led to the further souring of U.S. public opinion toward Russia.<sup>30</sup> According to a Pew Research Center poll conducted in March 2022, 70 percent of Americans viewed Russia as an enemy of the United States, a 29 percent increase from the previous poll, which took place a month before the full-scale invasion.<sup>31</sup> After the invasion commenced, the companies faced growing public pressure to take action against Russia, and several believed that continuing their in-country sales and operations constituted a reputational risk.<sup>32</sup>

Following the outbreak of the war, U.S. and international sanctions and export controls targeted at Russia's financial and technology sectors damaged the Russian economy. These restrictions did not directly hamper the activities of the companies with business in Russia covered in this report, but they played a role in the deterioration of domestic economic conditions and made it more difficult, and less profitable, to operate in Russia.<sup>33</sup> For example, due to sanctions on major Russian banks, many foreign corporations found it increasingly difficult to partner with local banks to process transactions.<sup>34</sup> The restrictions may have also influenced with whom the firms did business, as companies would have been disallowed from working with sanctioned Russian organizations and individuals.

Several of the companies covered in this report operate in democracies, autocracies, and countries governed by hybrid regimes. They are usually reluctant to criticize the domestic or foreign policies of the countries in which they operate, but several of them released strongly worded statements illustrating their concerns about Russia's actions.<sup>35</sup> For example, Microsoft stated it was "horrified, angered and saddened" by Russia's actions in Ukraine.<sup>36</sup> The company also "condemn[ed] this unjustified, unprovoked and unlawful invasion."<sup>37</sup> Amazon, meanwhile, noted it was "watching what's happening in Ukraine with horror, concern, and heavy hearts," while Google said the invasion was "both a tragedy and a humanitarian disaster."<sup>38</sup>

The combination of public support for Ukraine, disapproval of Russia, difficulty conducting business in the country, and the companies' own limited vulnerability to Russia's actual or potential economic pressures likely combined to propel those that did have business in Russia out of the market. Table 2 illustrates select companies' actions to halt or scale back their operations in Russia.

Table 2: Select U.S. Companies' Business Decisions in Russia Post-Invasion

Company	Business Decisions in Russia Post-Invasion
Apple	Suspended sales of its products in Russia in March 2022, blocked downloads of state-backed media Russia Today (RT) and Sputnik News outside of Russia, paused exports to its Russian sales network, and limited the availability of Apple Pay. <sup>39</sup>
Google	Suspended advertising services for Russian clients on Google Search and YouTube, blocked Russian state-backed media globally, and disallowed Russians from signing up for Google Cloud or using its payment services. <sup>40</sup>
Microsoft	Suspended new sales to Russia after the invasion, announced during the summer of 2022 that it would scale down its operations in the country while honoring existing contracts, laid off 400 Russian employees and blocked Windows updates in the country. <sup>41</sup>
Amazon	Stopped accepting new cloud computing customers, cut access to its Prime Video service, and discontinued retail shipments to customers in Russia. <sup>42</sup>
Cisco	Halted sales in Russia in March 2022, and in June 2022 decided to exit the market altogether. During its withdrawal, Cisco destroyed over \$23 million worth of equipment and laid off the majority of its staff. <sup>43</sup>
Oracle	Suspended all operations in Russia in March 2022. <sup>44</sup>

### ***Russian Actions Against U.S. Tech Companies Aiding Ukraine***

The Russian government has also taken actions against these U.S. firms, though the extent to which the companies' aid for Ukraine influenced Moscow's punishments remains unclear. Some companies were caught in the Kremlin's crosshairs even before the war began. Months ahead of the invasion, Moscow reportedly threatened to

imprison Russia-based Apple and Google employees if the companies did not remove an app from their digital stores that President Vladimir Putin reportedly disliked.<sup>45</sup> In late 2021, Russia fined Google around \$100 million for what the government claimed as “failure to remove banned content.”<sup>46</sup>

Since the invasion, Google has continued to face scrutiny for failing to remove content that the Russian government deems illegal. In March 2022, the Kremlin blocked access to Google News and referred to YouTube as a “tool in the anti-Russian information war.”<sup>47</sup> Despite blocking Instagram, Facebook, and X (formerly Twitter), Russia has not blocked YouTube.<sup>48</sup> In May 2022, Moscow seized Google’s primary Russian bank account, and a month later, the company’s Russian subsidiary declared bankruptcy, with a spokesperson noting the seizure of the bank account “made it untenable for our Russia office to function.”<sup>49</sup> That July, Russia fined Google \$370 million for what it has described as repeated content violations regarding the war in Ukraine.<sup>50</sup> Then again in 2023, Russia fined Google for failing to remove what the government deemed as misinformation about the war on YouTube and for not storing Russian citizens’ personal data inside the country.<sup>51</sup> It is unclear whether Google has paid any of these fines, and it has yet to comment on the Russian court rulings. Though the company began relocating employees outside of Russia soon after the full-scale invasion began, it now plans to no longer base any workers in the country.<sup>52</sup>

Since the start of the full-scale invasion, the Kremlin has also fined Apple over \$17 million for violating antitrust laws and failing to abide by Russian data localization rules, though it is unclear to what extent the fine is connected to Apple’s actions regarding the war.<sup>53</sup> Last August, Moscow also fined the company for “spreading false information” about the war in Ukraine.<sup>54</sup>

The Kremlin has also targeted companies’ equipment in Ukraine, although it is not clear if Moscow is targeting these companies in retaliation for their support to Kyiv or as part of a broader attack on Ukrainian infrastructure and networks. This is particularly relevant to the Starlink satellite services in Ukraine which, according to SpaceX CEO Elon Musk, Russia jammed right before the start of the war.<sup>55</sup> SpaceX countered these jamming attacks with a software update, but this did not stop Russia’s continual attempts to block Starlink services and those of other Low Earth Orbit (LEO) satellite constellations. Russia’s Tobol electronic warfare system, while still a work in progress, is designed to jam the Starlink satellites on which Ukraine depends for communications.<sup>56</sup>

These fines and lawsuits notwithstanding, the Kremlin's actions did not have a particularly severe effect on most of the aforementioned firms. This is in large part because the majority did not have business in Russia. And even the seven companies that did had only a limited stake in the Russian market prior to the full-scale invasion. Several companies, however, had to scramble to relocate their Russia-based employees toward the outset of the war.<sup>57</sup> The following section details the companies' economic and financial linkages to Russia prior to the full-scale invasion.

### ***Companies' Pre-Invasion Footprints in Russia***

11 of the 18 U.S. companies that have provided assistance to Ukraine did not have any operations in Russia in the lead-up to the February 2022 full-scale invasion. Specifically, Palantir, Maxar, Recorded Future, SpaceX, Tesla, Primer, Capella Space, Fortem Technologies, Planet Labs, Mandiant, and Clearview AI had no discernable business, investments, or supply chains in the country based on the indicators and data sources we focused on for this report.<sup>58</sup>

The four U.S. Big Tech companies (Google, Microsoft, Apple, and Amazon), as well as Cloudflare, Cisco, and Oracle did, however, conduct business in Russia prior to February 2022. Our analysis suggests that their footprints were relatively limited. In 2020, less than 1 percent of Apple and Google's revenues reportedly came from Russia.<sup>59</sup> Similarly, Microsoft CFO Amy Hood said in 2022 that sales in Russia made up under 1 percent of the company's global revenue.<sup>60</sup> Cisco's 2021 Russia revenue constituted just a fraction of a percentage of its total earnings.<sup>61</sup> Amazon, for its part, did not operate its e-commerce business in Russia prior to the invasion; its only economic linkage consisted of a limited number of contracts for cloud services.<sup>62</sup> Cloudflare, however, continued to operate there as of February 2024.<sup>63</sup>

These seven companies also had limited investments in Russia prior to the invasion. According to the fDi Markets database, since January 2003, Microsoft undertook only four greenfield FDI projects in Russia valued at \$83 million, less than 1 percent of its global total during that time. Over the same period, Cloudflare invested in four projects worth \$129 million, which accounted for only 1 percent of the company's global FDI expenditure. Apple and Google each invested in three FDI projects. Google's were valued at \$30 million and Apple's at \$12 million. These expenditures made up less than 1 percent of each company's global FDI total since January 2003. While a number of companies have pursued FDI in Russia, however limited, Microsoft is the only company to make venture capital investments in Russia, providing \$60,000 in seed

funding to MD.Voice, a healthcare company in 2013, and \$80,000 in pre-seed funding to ePythia, a location tracking firm in 2011.

Based on the information we were able to locate, six of the companies that had economic and financial linkages with Russia prior to February 2022 also maintained a limited physical presence in the country.\* Microsoft, for instance, signed an agreement to open a joint research center with the Russian government in the Skolkovo innovation hub outside of Moscow over 10 years ago, and Apple opened an office in Russia in February 2022, the month the invasion began, but later closed it.<sup>64</sup> Cloudflare, for its part, maintains five data centers in Russia that support the operations of tens of thousands of Russian websites.<sup>65</sup> Oracle, Cisco, and Google each maintained offices in Russia prior to the full-scale invasion.<sup>66</sup>

In terms of supply chains and production and manufacturing of components for products, none of the 2,226 manufacturing sites on Amazon's 2023 supplier list were located in Russia; and none of the companies on Apple's 2022 supplier list were located in the country.<sup>67</sup> Russia is, however, a significant source of several raw materials necessary for electronics manufacturing despite not being an important site for component or device production.<sup>68</sup>

While the aforementioned seven companies maintained some economic and financial linkages with Russia, they had comparatively low levels of vulnerability in terms of revenue, investment ties, and supply chains to any potential or actual pressure or economic retaliation from Moscow. In short, supporting Ukraine and winding down business in Russia were likely largely uncomplicated business decisions given the relative lack of disruption to these companies' sales and operations. As the next section outlines, the companies' much closer integration with and vulnerability to Chinese economic pressure and coercion could complicate their decision-making in the event of a Taiwan contingency.

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\* Amazon did not have data centers, offices, or other infrastructure in Russia.



## U.S. Companies and China

The involvement of U.S. companies in the war in Ukraine is raising questions about their response to a potential Taiwan crisis. For example, though the Taiwanese government is aware of the utility of satellite internet, it is reportedly reluctant to depend on SpaceX's Starlink system because Elon Musk, who owns both SpaceX and Tesla, has extensive business interests in China.<sup>69</sup> Such considerations, Taiwanese policymakers fear, could lead Musk to restrict Starlink services in a potential contingency. Moreover, there is evidence that several of the companies featured in this report are aware of the challenging decisions a China-Taiwan contingency might pose.<sup>70</sup>

We do not, however, attempt to predict the behavior of these tech companies, nor do we forecast how exactly China might react in the event that these American companies support Taiwan. That said, China has a history of using economic coercion to achieve its geopolitical goals and in response to what it perceives as threats to its territorial integrity, national security, or the political legitimacy of the Chinese Communist Party (CCP). For instance, in 2010, China barred rare earth mineral exports to Japan in the wake of a maritime dispute and limited salmon imports from Norway after a Chinese human rights activist received a Nobel Prize.<sup>71</sup> Since then, Beijing has suspended tropical fruit imports from the Philippines due to a territorial dispute in the South China Sea, temporarily curtailed Chinese tourism in South Korea after Seoul allowed the deployment of U.S. Terminal High Altitude Area Defense (THAAD) missile systems on its territory, and sanctioned several imports from Australia, including barley and wine, after Canberra called for an international investigation into the origins of the COVID-19 pandemic.<sup>72</sup>

In some instances, China has also targeted specific companies or commercial entities. During the aforementioned THAAD dispute in 2016, for example, Beijing restricted the China-based operations of the South Korean conglomerate, Lotte.<sup>73</sup> In 2019, China suspended broadcasts of NBA games after a team executive publicly supported Hong Kong protesters.<sup>74</sup>

China has already targeted several of the U.S. companies examined in this report. Many Google services such as YouTube, Search, Gmail, and Maps have been banned in China, while Microsoft has placated Beijing by heavily censoring Bing search.<sup>75</sup> More recently, China has blocked some government officials and employees at state-owned

enterprises from using Apple's iPhones, and Tesla's electric vehicles (EVs) have been banned from roads during various events due to concerns that they may collect sensitive data.<sup>76</sup>

In light of these previous actions, in advance of, or during a Taiwan contingency, China could take a wide range of economic actions to pressure U.S. companies that have stakes in its market or depend on it for production, ranging from leveling fines to boycotting products to disrupting manufacturing operations. The potential effects of such measures would vary significantly—anywhere from a limited loss of China-based revenue streams to more extreme outcomes such as the inability to assemble and export products. Additionally, the extent to which the companies we examine in this report would be affected by such coercive measures depends on myriad factors, including their degree of reliance on China for R&D, revenue, and manufacturing, as well as the breadth and depth of their investments in the country. Given such complexities and the unpredictable nature of global markets, we do not attempt to predict specific Chinese actions or the impact that such moves might have on these companies, nor do we attempt to anticipate the companies' response. Rather, the following section outlines U.S. tech companies' economic ties to and footprints in China to better understand how and to what extent these companies might be affected by a range of Chinese actions in the event of a Taiwan crisis.

### ***Companies' Footprints in China***

This section examines the extent to and ways in which U.S. technology companies are entangled with China's economy, markets, and innovation ecosystem based on the indicators discussed in the methodology section. It also highlights issues that might influence each company's response to a Taiwan contingency. Ultimately, our analysis suggests that four of the 18 U.S. tech companies that have been providing assistance to Ukraine—Tesla, Apple, Microsoft, and Amazon—are most exposed to Chinese coercion, while Cloudflare, Google, Oracle, and Cisco also have notable economic and financial ties to and footprints in China. As previously mentioned, we pay particular attention to the revenue companies generate in China, their greenfield FDI projects and supply chains in the country, and their China-based research centers, data and cloud computing centers, VC and PE investments, and employees. Taken together, these indicators provide a snapshot of each company's relative vulnerability to potential Chinese coercion. On the other hand, 10 U.S. companies including Maxar, Capella


Space, Recorded Future, Planet Labs, Clearview AI, Mandiant, Palantir, SpaceX, Primer, and Fortem Technologies, have little or no presence in China.

Once again, given the indicators we rely on to proxy the companies' economic linkages to and presence in China, we conceptualize vulnerable companies as those that could suffer potential economic costs including lost revenue, production capacity, disruptions to supply chains, sunk costs from FDI, curtailed research output, and loss of access to China's skilled high-tech labor pool. Our analysis finds that based on the breadth and depth of their economic linkages to China, most specifically their China-based supply chains and revenue figures, (and to a lesser extent, greenfield FDI, R&D centers, and data and cloud computing centers), Tesla, Apple, and Amazon, may be the most vulnerable to Chinese economic coercion. Microsoft may also be vulnerable due to its extensive R&D footprint and entanglement with China's technology innovation ecosystem. Meanwhile, Cloudflare, Google, Cisco, and Oracle maintain less robust linkages with China, at least according to the indicators we analyze, and thus, are likely less vulnerable to Chinese economic coercion.

## Tesla

Tesla has bet on China as both the base of significant manufacturing operations and as an important market for the company's products. It now assembles around a million and sells hundreds of thousands of electric vehicles in China each year.<sup>77</sup> Tesla's reliance on China for manufacturing and revenue generation, however, comes with some risks. The company invested billions in its Shanghai Gigafactory, and disruptions to the facility's operations would hinder Tesla's ability to sell EVs not only in China but also globally, threatening a large portion of its global revenue. Its investments in China could be difficult to recover should it leave the country.<sup>78</sup> Tesla's China-based workforce could also be affected should the company decide to aid Taiwan in a contingency. Tesla's linkages to China are discussed below.

Figure 1: Snapshot of Tesla’s Footprint in China



Indicator	In China	Globally	Shares of Total in China
<b>Greenfield FDI</b>	\$6.8 Billion <sup>a</sup>	\$21.4 Billion <sup>a</sup>	32%
	18 Projects <sup>a</sup>	88 Projects <sup>a</sup>	20%
<b>Supply Chains (manufacturing capacity &amp; suppliers)</b>	711,000 Vehicles <sup>c</sup>	1.37 Million Vehicles <sup>d</sup>	52%
	Unknown number of suppliers	Unknown number of suppliers	17% <sup>e</sup>
<b>Revenue</b>	\$18.2 Billion in 2022 <sup>b</sup>	\$81.5 Billion in 2022 <sup>b</sup>	22%
<b>Employees</b>	More than 20,000 <sup>f</sup>	Unknown	Unknown
<b>R&amp;D Centers</b>	1 <sup>g</sup>	Unknown	Unknown
<b>Data and Cloud Computing Centers</b>	1 Data Center <sup>h</sup>	Unknown	Unknown

Source: <sup>a</sup> fDi Markets; <sup>b</sup> Tesla’s annual report; <sup>c</sup> Business Times; <sup>d</sup> CNBC; <sup>e</sup> Nikkei Asia; <sup>f</sup> Reuters; <sup>g</sup> Reuters; <sup>h</sup> Nikkei Asia.

Note: Our data shows that Tesla has not made VC or PE investments into Chinese companies.

### ***Greenfield Foreign Direct Investment***

Among the eight U.S. tech companies with greenfield FDI projects in China, Tesla has invested the most over the past two decades, with nearly \$6.8 billion distributed across 18 different projects. These 18 China-based projects represent about 20 percent of Tesla’s global greenfield FDI projects, and account for approximately 32 percent of the company’s total FDI expenditure.

The vast majority (91 percent) of Tesla's FDI expenditure in China went toward manufacturing (see Figure B1 in Appendix B). The \$5 billion Shanghai Gigafactory was the company's largest project. In addition, Tesla announced the construction of a battery factory in 2023 to complement the existing Shanghai plant, one that will produce megapacks, or large batteries that utilities use to store energy and prevent power outages.<sup>79</sup> Tesla's greenfield FDI in China demonstrates the company's long-lasting interest in producing and selling EVs and other products in the country.<sup>80</sup>

### **Supply Chains**

The Shanghai Gigafactory is the company's largest global manufacturing center. In 2022, for instance, it produced 711,000 vehicles, or 52 percent of Tesla's global total.<sup>81</sup> If the factory were not temporarily shut down that year due to COVID-19-related restrictions, it would have likely produced even more vehicles.<sup>82</sup> According to Tesla's manufacturing figures, the Gigafactory is reportedly now able to produce nearly 1 million EVs per year.<sup>83</sup>

All of Tesla's China-produced EVs are assembled at the Gigafactory, and the company relies on networks of China-based suppliers for components. For example, a recent *Nikkei* analysis of Tesla's supply chain found that 17 percent of the company's total suppliers are located in the country, including some that have ties to the Chinese government.<sup>84</sup> 40 percent of the suppliers involved in its EV battery production chain are based in China; Tesla is particularly reliant on lithium product manufacturer Ganfeng, inorganic compound producer Novoray, and cobalt supplier Zhejiang Huayou Cobalt.<sup>85</sup>

### **Revenue**

Tesla's initial greenfield FDI in China has paid off, as the company has become an important foreign player in the Chinese EV market. According to data from the China Passenger Car Association (CPCA), Tesla controlled 10 percent of China's EV market in 2022, a notable percentage given that Chinese companies generally dominate the domestic EV market.<sup>86</sup> The company's 10-K financial report reveals that its revenue from China was nearly \$18.2 billion in 2022, a 31 percent increase from the previous year, which accounted for over 22 percent of its global revenue.<sup>87</sup> The growth in China sales contributed to the 52 percent increase in Tesla's overall revenue in 2022.<sup>88</sup> As of October 2023, the company had 64 stores and 46 service centers across 28 Chinese

cities to boost sales and maintain its growing fleet of EVs.<sup>89</sup> Still, these figures do not fully capture Tesla's reliance on China to generate revenue in other parts of the world. For example, the company exports approximately half of its made-in-China EVs to Europe.<sup>90</sup>

### ***Employees***

Tesla's Shanghai Gigafactory alone reportedly employs over 20,000 people.<sup>91</sup> The total number of Tesla employees in China, however, is likely higher considering the company also has stores and service centers across the country.<sup>92</sup> Although there is no concrete information about company employee demographics, the majority of Tesla's employees in China are most likely local rather than international staff.

### ***R&D Centers and Data and Cloud Computing Centers***

In 2021, Tesla also opened a R&D center in Shanghai, the company's first such international lab, which focuses on "software, hardware, electronics, materials and power engineering."<sup>93</sup> The company also built a data center to store locally produced information in accordance with Chinese law.<sup>94</sup>

### **Microsoft**

Despite having entered the Chinese market in 1992, the company has invested a relatively small percentage of its total FDI in China and draws a modest share of its global revenue from the country.<sup>95</sup> That said, Microsoft has established a cutting-edge computer science R&D center—Microsoft Research Asia (MSR Asia)—which, alongside other innovative research, produces a notable percentage of the company's AI-related research papers.<sup>96</sup> Should China pressure Microsoft amid a potential crisis related to Taiwan, the company could lose a small portion of its global revenue. If the company is forced to sever ties with MSR Asia, the loss in research output and innovation could be compounded by the loss of access to China's innovation ecosystem, particularly the country's many entrepreneurs and talented computer scientists and engineers. Finally, Microsoft for Startups (formerly Microsoft Accelerator), a startup incubator, would likely lose its ability to track Chinese tech developments that might prove valuable to its parent company.

Figure 2: Snapshot of Microsoft's Footprint in China



Indicator	In China	Globally	Shares of Total in China
Revenue	\$3 Billion in 2020 <sup>a</sup>	\$143 Billion in 2020 <sup>b</sup>	1.8% <sup>c</sup>
Greenfield FDI	\$2.1 Billion <sup>d</sup>	\$27.5 Billion in 2020 <sup>d</sup>	7%
	52 Projects <sup>d</sup>	472 Projects <sup>d</sup>	11%
R&D Centers (conference publications)	736 Publications <sup>e</sup>	17,006 Publications <sup>e</sup>	4.3%
Data and Cloud Computing Centers	6 Azure Regions <sup>f</sup>	21 Azure Regions <sup>f</sup>	28%
Employees	More than 9,000 <sup>g</sup>	Unknown	Unknown
VC and PE Investment*	29 Transactions <sup>h</sup>	360 Transactions <sup>h</sup>	14%

Source: <sup>a</sup> Authors' calculation; <sup>b</sup> Microsoft's annual report; <sup>c</sup> The Wire China; <sup>d</sup> fDi Markets; <sup>e</sup> Microsoft Research and Microsoft Research Asia's websites; <sup>f</sup> Microsoft Azure's website; <sup>g</sup> Microsoft's website; <sup>h</sup> Crunchbase.

Note: \*Transaction value is not included given that most transactions do not disclose value as discussed in the methodology section. This figure does not include Microsoft's supply chains in China because of the lack of data availability.

### Revenue

According to Microsoft President Brad Smith, 2019 sales in China were approximately \$2.26 billion, or 1.8 percent of Microsoft's total revenue that year.<sup>97</sup> As of September 2022, the company had established offices in 13 Chinese cities to facilitate sales and operations.<sup>98</sup> Microsoft's search platform, Bing, has become more popular in China, and



as of late 2023, had captured a 13 percent share of the internet search market, up from 2 percent in late 2018.<sup>99</sup>

### ***Greenfield Foreign Direct Investment***

Microsoft's greenfield FDI projects in China amount to about \$2.1 billion; these investments, however, account for only about 11 percent of the company's FDI projects worldwide and 7 percent of its total FDI expenditure.

93 percent of Microsoft's \$2.1 billion in FDI capital expenditure in China went toward constructing facilities for R&D activities (See Appendix B, Figure B1). The company's highest-value greenfield project is a \$280 million R&D center in Beijing, established in 2008 as part of MSR Asia, Microsoft's largest R&D facility outside of the United States.<sup>100</sup>

### ***R&D Centers***

Established in 1998, MSR Asia is a lab where researchers conduct "basic and applied research in areas central to Microsoft's long-term strategy and future computing vision . . . in areas including natural user interface, artificial intelligence, [and] cloud and edge computing."<sup>101</sup> Overall, from March 1998 to September 2023, MSR Asia published 4.3 percent of Microsoft's total conference research papers.<sup>102</sup> The lab is an important contributor to Microsoft's advanced technology research efforts: conference research papers authored or co-authored by MSR Asia researchers account for 9.3 percent of the company's AI conference papers and 9.5 percent of computer vision conference papers.<sup>103</sup>

It is worth noting that given intensifying tensions between the United States and China, Microsoft's leadership is reportedly debating whether to continue conducting AI-related research in China.<sup>104</sup>

### ***Data and Cloud Computing Centers***

Microsoft offers services and makes revenue through its network of 21 Azure regions, six of which are located in China.<sup>105</sup> The company's Azure cloud service platform is operated by Shanghai Blue Cloud Technology Co., Ltd. ("21Vianet").<sup>106</sup> While 21Vianet-operated Azure regions are physically separated from Microsoft's global cloud infrastructure, they use the same technologies and offer similar products. Some

of these products include Azure AI Vision, AI language, and AI speech, as well as compute capabilities like virtual machines to access open-source software and high-performance computing.<sup>107</sup> In particular, Microsoft Azure in Hong Kong reportedly saw booming demand for AI services, as it is working to leverage generative AI models.<sup>108</sup>

### **Employees**

Microsoft's China-based employees play a vital role in the company's ability to produce cutting-edge research and develop innovative products. According to an article by MSR Asia, as of September 2022, Microsoft had more than 9,000 full-time employees in China, 80 percent of whom were involved in local R&D initiatives.<sup>109</sup> We believe that MSR Asia employs both Chinese and non-Chinese researchers given that some of the 3,000 scientists and engineers who, according to McKinsey, worked at MSR Asia were transferred from its U.S. headquarters.<sup>110</sup> Most recently, the *Financial Times* reported that in response to heightened tensions between the United States and China, however, Microsoft is planning to move a number of its MSR Asia-based researchers to Canada.<sup>111</sup>

### **VC and PE Investment**


Microsoft has also embedded itself in China's technology ecosystem by acting as a corporate venture capital investor and mentoring Chinese tech startups. Among the companies covered in this report, Microsoft, primarily through its subsidiary, Microsoft for Startups, has been the most active in financing Chinese tech startups, with a total of 52 VC investment transactions (or 14 percent of the company's global total) since 2012. Microsoft for Startup's role in China's tech ecosystem also includes incubating companies preparing to receive initial rounds of funding from other investors.<sup>112</sup> In 2022, the company claimed to have supported the growth of over 700 startups in China.<sup>113</sup> It is clear that Microsoft, given its familiarity with China's technology ecosystem, believes that it can generate some returns on investment by focusing on young companies and startups.<sup>114</sup>

### **Apple**

The vast majority of Apple products are assembled in China, and most of the company's suppliers produce components for Apple devices in the country. China has also become a key market for Apple. Were its manufacturing operations to be

disrupted due to Chinese pressure or coercion amid a crisis involving Taiwan, the company would face severe challenges in assembling most of its products, which would also threaten its global revenue. It could also lose a significant chunk of its global greenfield FDI.

Figure 3: Snapshot of Apple’s Footprint in China



Indicator	In China	Globally	Shares of Total in China
Revenue	\$74.2 Billion (including Taiwan) in 2022 <sup>a</sup>	\$390 Billion in 2022 <sup>a</sup>	19%
Supply Chains (suppliers)	151 Suppliers in 2022 <sup>b</sup>	188 Suppliers in 2022 <sup>b</sup>	80%
Greenfield FDI	\$1.17 Billion <sup>c</sup>	\$6.1 Billion <sup>c</sup>	19%
	13 Projects <sup>c</sup>	98 Projects <sup>c</sup>	13%
R&D Centers	4 <sup>d</sup>	Unknown	Unknown
Data and Cloud Computing Centers	2 Data Centers <sup>e</sup>	10 Data Centers <sup>e</sup>	20%
VC and PE Investment*	2 Transactions <sup>f</sup>	24 Transactions <sup>f</sup>	8%

Source: <sup>a</sup> Apple’s annual report; <sup>b</sup> Apple’s published supplier list; <sup>c</sup> fDi Markets; <sup>d</sup> CNBC, Reuters, and Bloomberg; <sup>e</sup> Apple’s Environment Progress Report FY2022; <sup>f</sup> Crunchbase.

Note: \*Transaction value is not included given that most transactions do not disclose value, as discussed in the methodology section. This figure does not include Apple’s employees in China because of the lack of data availability.

## **Revenue**

China's market serves as an important source of revenue for Apple. As of October 2023, the company had 53 stores across the country. Apple drew \$74.2 billion, or 19 percent of its total revenue from China (including Hong Kong and Taiwan) in 2022, primarily due to increasing demand for iPhones and services.<sup>115</sup>

## **Supply Chains**

According to the *Financial Times*, over 95 percent of iPhones, AirPods, Macs, and iPads are assembled in China.<sup>116</sup> In contrast to Tesla, which constructed its own factory to assemble EVs in China, Apple relies on a disparate network of suppliers to manufacture the components for, and assemble, the vast majority of its products in the country.

Approximately 80 percent of Apple's suppliers which provide the company with materials, manufacturing, and assembly services have facilities in China, and more such facilities were added last year.<sup>117</sup> While Apple also has suppliers that operate in Japan, Taiwan, Vietnam, Singapore, Thailand, and now India, the company remains highly reliant on China-based suppliers to manufacture and assemble its products.<sup>118</sup>

## **Greenfield Foreign Direct Investment**

Unlike Tesla, Apple does not appear to have built its own factories in China through greenfield FDI. As Figure 3 shows, 13 percent of Apple's global FDI projects (13 projects) and 19 percent of the total value of its FDI (\$1.17 billion) have been aimed at China. Almost 70 percent of Apple's greenfield FDI expenditure in China has gone toward building facilities for R&D activities (See Appendix B, Figure B1).

## **R&D Centers**

Apple reportedly operates R&D centers in Beijing, Shanghai, Shenzhen, and Suzhou.<sup>119</sup> These research centers are aimed at reducing the distance between R&D and production, as the vast majority of Apple's hardware is produced in China.<sup>120</sup> Apple's first R&D center in China—a \$45 million facility in the Zhongguancun Science Park, Beijing's version of Silicon Valley—was established in 2016.<sup>121</sup> All four centers were scheduled to open by the end of 2017. That said, it is unclear whether they are still in operation, though job postings advertised by the company suggest they are.<sup>122</sup>

## ***Data and Cloud Computing Centers***

Apple operates 10 data centers worldwide, two of which are located in China.<sup>123</sup> These two data centers in Ulanqab city, Inner Mongolia, and Guiyang city, Guizhou province store local customers' personal data in compliance with Chinese law.<sup>124</sup>

## ***VC and PE Investment***

Apple is not a particularly active VC and PE investor, with a total of just 24 investment transactions globally as of August of 2023. Two of these investments targeted Chinese companies, including the \$1 billion investment in DiDi, the Chinese rideshare app. While the investment initially earned Apple a seat on the company's board, it gave up that seat in 2022.<sup>125</sup>

## **Amazon**

Amazon fell short in its attempt to become a major e-commerce player in China and no longer competes with internet shopping giants Alibaba or JD for local market share. We were unable to determine Amazon's revenue in China based on available data, but it does appear that the company operates three availability zones, its version of data and cloud computing centers, in the country. However, the company's most significant vulnerability to Chinese coercion amid a potential Taiwan-related crisis lies in its large network of China-based production facilities. Furthermore, Amazon maintains two R&D centers engaged in advanced computer science and AI-related research. As such, disruption to Amazon's operations in China could imperil the company's access to the country's vibrant science and technology R&D and innovation ecosystem, as well as its manufacturing capacity.

Figure 4: Snapshot of Amazon’s Footprint in China



Indicator	In China	Globally	Shares of Total in China
<b>Greenfield FDI</b>	\$1.4 Billion <sup>a</sup>	\$101 Billion <sup>a</sup>	1%
	17 Projects <sup>a</sup>	957 Projects <sup>a</sup>	2%
<b>Data and Cloud Computing Centers</b>	3 Availability Zones <sup>b</sup>	81 Availability Zones <sup>b</sup>	4%
<b>Supply Chains (suppliers)</b>	719 Suppliers <sup>c</sup>	2,226 Suppliers <sup>c</sup>	32%
<b>R&amp;D Centers</b>	2 <sup>d</sup>	Unknown	Unknown

Source: <sup>a</sup>fDi Markets; <sup>b</sup>AWS’ website; <sup>c</sup> Amazon’s supplier list; <sup>d</sup> Amazon’s websites.

The following indicators are not included due to either the lack of data availability or the company’s presence in China: information on Amazon’s employees and revenue in China is unavailable, and our data shows that the company has not made VC and PE investments into Chinese companies.

### **Greenfield Foreign Direct Investment**

Since January 2003, Amazon has been the most active greenfield FDI investor worldwide among the companies examined in this report, having pursued nearly 1,000 such projects around the world that are worth over \$100 billion, according to fDi Markets. Amazon’s greenfield FDI projects in China, however, make up only a fraction of these investments, with just 17 projects valued at a total of \$1.4 billion, only 1 percent of its global FDI expenditure.

### **Supply Chains**

In its 2023 Supplier List, Amazon includes 2,226 distinct facilities that produce the company’s branded products, ranging from electronics to home goods. Of those facilities, 719 (32 percent) are located in China.<sup>126</sup> By comparison, Amazon’s production operations include almost 400 manufacturing sites in India, and an additional 170

throughout Southeast Asia. Although Amazon appears to be less reliant on China-based suppliers than Apple, the company has a stake in ensuring the resilience of its China-based supplier networks and value chains.

### ***Data and cloud computing centers***

Amazon has recently expanded its Amazon Web Services (AWS) business in China. While AWS operates at least 81 availability zones (i.e., the company's version of data and cloud centers) around the world, only three are located in China. There are two in Beijing, operated and owned by Sinnet, though AWS controls the intellectual property. The one in Ningxia is operated by Ningxia Western Cloud Data Technology Co., Ltd. (NWCD).<sup>127</sup> These corporate partnerships bring AWS into compliance with Chinese regulations.<sup>128</sup> In 2017, Amazon issued a statement denying rumors that AWS might exit China, stating that it is “excited about the significant business we have in China and its growth potential over the next number of years.”<sup>129</sup>

### ***R&D Centers***

Amazon maintains R&D centers in Beijing and Shanghai that, according to their web pages, produce research on a variety of advanced computer science-related topics.<sup>130</sup> The Beijing center highlights its work on “data science, deep learning, natural language processing,” and machine learning models, while the Shanghai center notes its research on machine learning, deep learning, graph neural networks, and data science.<sup>131</sup> We were unable to determine how many papers these facilities produce or the number of people they employ.


### **Cloudflare**

Cloudflare, a cybersecurity company, operates a global network of data centers with built-in distributed denial-of-service (DDoS) mitigation, web application firewall (WAF), and zero trust security services to provide customers with secure internet connectivity.<sup>132</sup> The company's commitment to extending its services across China's Great Firewall has helped Chinese companies reach the global internet and foreign companies operate in China.<sup>133</sup> Additionally, Cloudflare maintains 39 data center locations in China which provide a range of services, including those related to cybersecurity, to both Chinese and foreign companies. Disruption to the company's operations would likely result in some revenue loss. Overall, these linkages shed light



on potential areas of vulnerability to Chinese pressure that might complicate Cloudflare’s decision calculus in a Taiwan contingency.

Figure 5: Snapshot of Cloudflare’s Footprint in China



Indicator	In China	Globally	Shares of Total in China
Revenue	\$133 Million in Asia-Pacific in 2022 <sup>a</sup>	\$975 Million in 2022 <sup>a</sup>	14%
Greenfield FDI	\$244 Million <sup>b</sup>	\$12.8 Billion <sup>b</sup>	2%
	3 Projects <sup>b</sup>	119 Projects <sup>b</sup>	3%
Data and Cloud Computing Centers	39 Data Center Locations <sup>c</sup>	295 Data Center Locations <sup>c</sup>	13%

Source: <sup>a</sup> Cloudflare’s annual report; <sup>b</sup> fDi Markets; <sup>c</sup> Cloudflare’s website.

Note: The following indicators are not included due to either the lack of data availability or the company’s presence in China: information on Cloudflare’s employees and supply chains in China is unavailable, and our research shows that the company appears to have no R&D centers or VC and PE investments in China.

### Revenue

While Cloudflare records do not provide revenue information specific to China, in 2022, the company reportedly made \$133 million, or 14 percent of its global revenue, in the Asia-Pacific region.<sup>134</sup>

### Greenfield Foreign Direct Investment

Cloudflare has a limited history of FDI in China, having dedicated only 2 percent of its global greenfield FDI capital expenditure and 3 percent of its total projects to the country.

## ***Data and Cloud Computing Centers***

According to the company's website, Cloudflare operates 39 data center locations in China.<sup>135</sup> Cloudflare has partnered with a number of leading Chinese companies to build up its business in the country. For instance, the company has worked closely with the Chinese cloud provider JD Cloud to expand its network.<sup>136</sup> Cloudflare has also received investment from and partnered with Baidu, whose engineers reportedly operate Cloudflare's data centers across China.<sup>137</sup>

Cloudflare's website also states that it provides many Chinese companies with cybersecurity services, helping these clients protect their customers against DDoS and other cyber-attacks.<sup>138</sup> For instance, the company supplies Beijing-based Newborn Town, a mobile internet company, with routing capabilities, which has helped the Chinese firm become one of the first local internet companies to expand overseas; it now serves over 1.3 billion users globally.<sup>139</sup>

## **Google**

Google entered the Chinese search engine market over 15 years ago but failed to break through. Its search function has been largely unavailable in China since 2010. Despite the company's limited market access, Google has not shown any signs it plans to leave China altogether and continues to draw revenue from sales and operations in the country, although exact figures are difficult to determine. Based on the indicators examined below, Google is less entangled with China than companies like Tesla or Apple, and it would likely be less directly impacted by Chinese economic pressure and possible coercion in the case of a crisis related to Taiwan.

Figure 6: Snapshot of Google’s Footprint in China



Indicator	In China	Globally	Shares of Total in China
Revenue	\$47 Billion in Asia-Pacific in 2022 <sup>a</sup>	\$283 Billion in 2022 <sup>a</sup>	16% in Asia-Pacific in 2022
Greenfield FDI	\$137 Million <sup>b</sup>	\$101 Billion <sup>b</sup>	1%
	10 Projects <sup>b</sup>	153 Projects <sup>b</sup>	7%
R&D Centers	2	Unknown	Unknown
VC and PE Investment*	13 Transactions <sup>c</sup>	1,304 Transactions <sup>c</sup>	1%

Source: <sup>a</sup> Google’s annual report; <sup>b</sup> fDi Markets; <sup>c</sup> Crunchbase

Note: \*Transaction value is not included given that most transactions do not disclose value as discussed in the methodology section. This figure does not include Google’s data and cloud computing centers, supply chains, and employees in China because of the lack of data availability.

### Revenue

Though Google’s search engine and app store have been unavailable for over a decade, the company nonetheless provides some goods and services to Chinese consumers through offices in Beijing, Shanghai, Shenzhen, and Hong Kong.<sup>140</sup> For example, Chrome was the most popular web browser in China as of 2020, and Google sells Chinese companies advertising space on non-China-based web pages.<sup>141</sup> In 2022, Google’s revenue in the Asia-Pacific region was \$47 billion, or 16 percent of its global total.<sup>142</sup> Google operates more extensively in Southeast Asia, India, and Japan than it does in China, but it is difficult to say for certain what share of its total revenue comes from China without precise publicly available information on these measures.<sup>143</sup>

### ***Greenfield Foreign Direct Investment***

According to fDi Markets data, between January 2003 and June 2023, Google pursued only 10 greenfield FDI projects in China. These projects totaled \$137 million, or only 1 percent of the company's global greenfield FDI capital expenditure.

### ***R&D Centers***

Google appears to conduct R&D at facilities in Beijing and Shanghai, but it claims to no longer do any AI research in China.<sup>144</sup> While it is unclear whether these centers are still in operation or what specific R&D-related activities are taking place, Google was advertising for technical jobs in China as of February 2024.<sup>145\*</sup>

### ***VC and PE Investment***

Google's VC and PE investments in China make up less than 1 percent of the company's total global investments since 2004. The company's first attempt at breaking into the Chinese search engine market was a \$10 million Series C investment in Baidu in 2004.<sup>146</sup>

### **Cisco**

Cisco is still holding on to its niche in the Chinese market. While it is less exposed to Chinese coercion than other companies based on our indicators, Cisco stands to lose some modest revenue and research capacity, and face sunk costs from its FDI, should it be forced to restrict its operations in China or depart the country altogether.

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\* In a phone call, Google representatives said these facilities are engaged in ad marketing and internal engineering projects.

Figure 7: Snapshot of Cisco's Footprint in China



Indicator	In China	Globally	Shares of Total in China
<b>Revenue</b>	\$8 Billion in Asia-Pacific, Japan, and China in 2022 <sup>a</sup>	\$51.5 Billion in 2021 <sup>a</sup>	15.6% in Asia-Pacific, Japan, and China in 2022
<b>Greenfield FDI</b>	\$439 Million <sup>b</sup>	\$9.3 Billion <sup>b</sup>	5%
	13 Projects <sup>b</sup>	167 Projects <sup>b</sup>	8%
<b>R&amp;D Centers</b>	5 <sup>c</sup>	Unknown	Unknown
<b>Data and Cloud Computing Centers</b>	1 Data Center <sup>d</sup>	45 Data Centers <sup>d</sup>	2%
<b>VC and PE Investment*</b>	4 Transactions <sup>e</sup>	203 Transactions <sup>e</sup>	2%

Source: <sup>a</sup> Cisco's annual report; <sup>b</sup> fDi Markets; <sup>c</sup> Cisco's website; <sup>d</sup> Cisco's website; <sup>e</sup> Crunchbase.

Note: \*Transaction value is not included given that most transactions do not disclose value, as discussed in the methodology section. Information on Cisco's employees and supply chains in China is not included due to the lack of data availability.

### Revenue

In 2022, Cisco reported that it earned 15.6 percent of its total revenue in the Asia-Pacific, Japan, and China.<sup>147</sup> The company further reported that while its revenue increased 18 percent in China that year, it also cited rising geopolitical tensions, including between China and Taiwan, as one of the factors that may harm its financial condition in the years to come.<sup>148</sup> Cisco's fortunes in China have ebbed and flowed. In 2012, it won 60 procurement contracts from the Chinese government but, none in 2014.<sup>149</sup> At the height of the U.S.-China trade war in 2019, Cisco had reportedly lost 25 percent of its business in China.<sup>150</sup>

## ***Greenfield Foreign Direct Investment***

Cisco has established a small FDI footprint in China, having invested \$439 million (5 percent of its global FDI capital expenditure) across 13 greenfield projects (8 percent of its global total). One notable greenfield FDI project was Cisco's \$100 million investment with Inspur Group—a Chinese tech conglomerate on the U.S. Entity List since March 2023—to form a joint venture (JV) company, Inspur-Cisco Network Technology, in Jinan city, Shandong province in 2016.<sup>151</sup> The JV works on advanced technologies related to IT infrastructure, cloud, data centers, smart cities, and big data, among others and appears to be in business. The Cybersecurity Administration of China also certified network equipment operated by the JV in November 2023, indicating it is still in operation.<sup>152</sup> Moreover, as of January 2024, Cisco still listed the Inspur-Cisco JV as part of its portfolio.<sup>153</sup>

## ***R&D Centers***

Cisco's first greenfield FDI project in China was a \$32 million Cisco China Research and Development Center (CRDC) in Shanghai in 2004.<sup>154</sup> CRDC is one of Cisco's largest global R&D centers, aiding the company in localizing existing products, designing and testing products sold worldwide, and working with Chinese universities and their affiliates to develop products for local and international markets.<sup>155</sup> As of February 2024, Cisco appeared to operate CRDC branches in Hangzhou, Suzhou, Hefei, and Beijing.<sup>156</sup> In 2008, Cisco also invested \$20 million in collaboration with Peking University to establish the Guanghua-Cisco Leadership Institute which, though not a fully-fledged R&D center, is aimed at cultivating local talent and improving research capacity in China.<sup>157</sup>

## ***Data and Cloud Computing Centers***

Cisco operates 45 data centers worldwide, including one facility in Hong Kong.<sup>158</sup>

## ***VC and PE investment***

Cisco's VC and PE investment in China is limited, with only 2 percent of its global investment transactions targeting Chinese companies. One company that received Cisco's VC backing, however, is worth noting. In 2020, Chinese AI company 4Paradigm, a known PLA supplier, raised \$230 million in Series C from seven investors, one of which was Cisco.<sup>159</sup>

## Oracle

According to our indicators, Oracle's vulnerability to Chinese economic coercion is relatively limited. Should it decide or be compelled to restrict its operations or exit China altogether, the company stands to lose millions of dollars in greenfield FDI and a portion of its global revenue (albeit it is difficult to determine how much).

Figure 8: Snapshot of Oracle's Footprint in China

ORACLE			
Indicator	In China	Globally	Shares of Total in China
Revenue	\$6.75 Billion in Asia-Pacific in 2022 <sup>a</sup>	\$42.4 Billion in 2022 <sup>a</sup>	16% in Asia-Pacific in 2022
Greenfield FDI	\$472 Million <sup>b</sup>	\$8.4 Billion <sup>b</sup>	6%
	24 Projects <sup>b</sup>	242 Projects <sup>b</sup>	10%

Source: <sup>a</sup> Oracle's annual report; <sup>b</sup> fDi Markets; <sup>c</sup> Oracle's website.

Note: The following indicators are not included due to either the lack of data availability or the company's presence in China: information on Oracle's employees and supply chains is unavailable, and our research shows that the company has not made VC and PE investments into Chinese companies.<sup>160</sup> Oracle also operated five research centers in China before shutting them down in 2019.<sup>161</sup>

### Revenue

Oracle's 2022 10-K report shows that 16 percent of its revenue came from the Asia-Pacific region, though it is unclear how much money it makes in China.<sup>162</sup>

### Greenfield Foreign Direct Investment

Oracle has a limited investment footprint in China. It has disbursed \$472 million in China-bound FDI spread across 24 projects. This accounts for 6 percent of its global FDI capital expenditure and 10 percent of its FDI projects.

## Mapping U.S. Tech Company Vulnerabilities to China

Based on our analysis of Tesla, Apple, Amazon, Microsoft, Cloudflare, Google, Cisco, and Oracle's respective economic and financial linkages with and footprints in China, this section outlines their potential vulnerabilities to Chinese economic coercion in the event of a Taiwan crisis. As previously noted, China could take a wide range of steps to pressure U.S. companies that have a stake in its market—from fining them to disrupting their local manufacturing operations. The Chinese government could also pressure the local employees of these companies or restrict local scientists from participating in collaborative research through the companies' R&D centers. It could also seize assets from companies, or purchase them at fire sale rates, much as Russia has done since the full-scale invasion.<sup>163</sup> The potential effects of such measures would vary significantly, from loss of sales to the inability to assemble and export products.

Additionally, the extent to which the companies examined in this report would be affected by such or other coercive measures depends on myriad factors, including the breadth and depth of their investments, their degree of reliance on China for component manufacturing and product assembly, and their dependence on the country for revenue generation, among others. Given such complexities and the unpredictable nature of global markets, we do not attempt to predict the impact Chinese actions might have on these companies, nor do we attempt to anticipate their responses. Rather, below, we illustrate the main takeaways from our analysis, focusing on Tesla, Apple, Microsoft, and Amazon, the four companies with the most extensive linkages to China according to our indicators, and as such, potentially most vulnerable to Chinese pressure and coercion. That said, we do cover aspects of Cloudflare, Google, Cisco, and Oracle's links to and footprints in China.

Not discussed in this section is the group of companies that have no, or negligible, publicly discernible economic or financial linkages with, revenue from, or supply chains in China. This group consists of Maxar, Capella Space, Recorded Future, Planet Labs, Clearview AI, Mandiant, Palantir, SpaceX, Primer, and Fortem Technologies.<sup>164</sup> Based on these measures, it is possible to say these companies are considerably less vulnerable to Chinese economic pressure than the other eight companies in our study, though many likely depend on at least some hardware produced or assembled in China. Such inputs are very difficult to track and are outside the scope of this report.



## **Main Takeaways**

**Analysis of revenue, investments in manufacturing facilities, and supplier networks suggests that Apple and Tesla, and to a lesser extent, Amazon, may be particularly susceptible to Chinese economic pressure and coercion amid a potential Taiwan crisis.**

Based on the companies' respective financial disclosures, Apple and Tesla each make around 20 percent of their revenue in China. Given their reliance on the Chinese market, the companies may be vulnerable to public boycotts of their goods and products, which while not a direct consequence of government action, could nonetheless negatively impact revenue and, as such, possibly influence their decision-making. Were they to face pressure to reduce their operations in China, or in a more extreme case, be banned by the government or choose to exit on their own, the companies would lose significant revenue streams.

The issue of supply chains is particularly significant. As mentioned above, the vast majority of Apple's iPhones, AirPods, Macs, and iPads are made in China. Moreover, 80 percent of the company's suppliers operate at least one production facility in the country. Given Apple's reliance on China for assembling its signature products, Beijing could undercut the company's business by obstructing either local sales or exports.

Tesla, though not as dependent on Chinese suppliers as Apple, nonetheless relies quite heavily on Chinese component producers. Around 17 percent of Tesla's suppliers operate in China, and the company produces over 50 percent of its EVs at its Shanghai Gigafactory. Any disruption to supplies of components could undermine not only Tesla's China sales, but also its global revenue. Although boardroom decisions are difficult to predict, such financial considerations could also influence how SpaceX, which, like Tesla, is partially owned by Elon Musk, may react to a Taiwan contingency. Indeed, the Taiwanese government is reportedly reluctant to rely on SpaceX for satellite internet access because of Musk's (and Tesla's) strong business interests in China.<sup>165</sup>

Amazon also depends on China for manufacturing, as 32 percent of its total suppliers are based in the country. Without speculating about how these companies may behave, due to the concentration of Apple, Tesla, and Amazon manufacturing in China,

the Chinese government has many avenues through which to pressure or coerce them that could complicate their decision-making in a crisis.

**Although eight companies have injected FDI into China, our research demonstrates that Tesla and Apple may be most adversely affected should the Chinese government force them to divest, disallow them from divesting, or seize their assets.**

Among the companies with significant greenfield FDI in China, Tesla and Apple have spent the largest share of their global FDI in China. Tesla has the strongest stake in this area, having recently invested over \$6.8 billion into China, most of which went toward constructing manufacturing facilities. Its FDI expenditures in China make up 32 percent of its total global outlay. Apple’s FDI spending in China makes up 19 percent of its global total. In comparison, even though Amazon has injected more FDI into China than Apple, its \$1.4 billion local expenditure makes up only 1 percent of its global total. Figure 9 provides a breakdown of the companies’ FDI activities in China.<sup>166</sup>

Figure 9: Greenfield FDI Activities by Select Company (January 2003-June 2023)

Company	Capital expenditure in China (in millions USD)	FDI projects in China	Share of total capital expenditure in China	Share of total FDI projects in China
Tesla	\$6,805	18	32%	20%
Microsoft	\$2,053	52	7%	11%
Amazon	\$1,421	17	1%	2%
Apple	\$1,173	13	19%	13%
Oracle	\$472	24	6%	10%
Cisco	\$439	13	5%	8%
CloudFlare	\$244	3	2%	3%
Google	\$137	10	1%	7%

Source: fDi Markets

**While it is difficult to measure R&D-related vulnerabilities, Microsoft, followed by Amazon, might be the most negatively affected by disruptions to, or closures of its China-based research facilities. Apple, Tesla, Cisco, and Google also conduct R&D in China, but their activities appear more limited by comparison.**

As noted above, over 9 percent of Microsoft's AI- and computer vision-related conference papers are authored or co-authored by researchers at the China-based MSR Asia. Amazon, however, also conducts computer science and AI-related research and would likely be adversely impacted were it pressured to limit or altogether stop operating its two R&D centers in China, albeit it is difficult to determine to what degree. To a lesser extent, Apple and Tesla reportedly carry out some R&D for their China-manufactured products, while Cisco, like other foreign data or cloud center operators, works with Chinese partners to localize its products, and Google may be conducting non-AI-related research at its local R&D center.<sup>167</sup> These companies could presumably be negatively affected by suspensions of their research activities. The loss of access to skilled Chinese researchers, as well as to China's broader innovation ecosystem, could hinder these companies' hardware or software innovation capacity. The potential impact, however, is unknown and beyond the scope of this paper.

**Several companies, including Microsoft, Amazon, Cloudflare, and Cisco, could lose access to potentially useful Chinese data, should they cease operating data and cloud computing centers in China. These companies are required by data security regulations to partner with Chinese companies, but policy uncertainty and changes in the regulatory landscape threaten these agreements.<sup>168</sup>**

Foreign companies in China are already operating data and cloud computing centers in an uncertain environment with party-state overreach and strict regulation of cross-border data flows.<sup>169</sup> If tensions around Taiwan escalate, the Chinese government could tighten its grip and alter the conditions of foreign-local firm partnerships to impact data-related operations in the country. In that case, the companies could lose a portion of their sales in China, specifically from their inability to offer cloud services to Chinese clients. If the Chinese government were to threaten their ability to store Chinese citizens' data in the country, the companies might be unable to continue local operations which may impact their revenue, although it is difficult to say to what extent.

## Mapping China's Vulnerabilities to U.S. Tech Companies

Any serious disruption to the operations of U.S. tech companies in China, and in an extreme scenario, their departure from the country, would damage not only the firms, but also the Chinese economy. Millions of Chinese people are employed in factories making components and assembling products for these companies and thousands more work in R&D.<sup>170</sup> The suppliers that make components or assemble products for companies like Apple and Amazon would likely lose significant revenue streams, at least in the short term, should these companies suspend or discontinue manufacturing operations. China's technology innovation ecosystem might also suffer from deteriorating relations with and certainly the exit of these companies, as several, and especially Microsoft, have played a critical role in boosting domestic science and technology industries. While China could take myriad actions to counter the negative economic impacts caused by a potential crisis involving Taiwan, our goal is not to present any of those alternatives. Instead, we hope to offer a broad, if incomplete, overview of the vulnerabilities China may have as a result of its ties to the U.S. tech companies examined in this report, as discussed below.

### *Main Takeaways*

**Severe disruptions to operations or in an extreme situation, the departure of U.S. technology companies from China, especially Apple, Tesla and Amazon, could lead to widespread job losses in China and damage their suppliers' business outlooks.**

Millions of Chinese workers are involved in component manufacturing and product assembly for Apple, Amazon, and Tesla. Apple's suppliers alone reportedly employ three million workers in China.<sup>171</sup> Tesla, as previously noted, has over 20,000 Chinese employees spread across its factories and stores who could lose their jobs should the company limit its operations in China, or in a more severe situation, close these facilities.<sup>172</sup> It is unclear how many workers Amazon's China-based production facilities employ, but with over 30 percent of Amazon's suppliers located in China, the figure may be in the hundreds of thousands, if not more. Production suspensions, therefore, could threaten millions of local jobs.

In addition to the jobs lost, the hundreds of suppliers producing components and assembling products for Apple, Amazon, and Tesla would see demand for their goods

and services temporarily fall should these companies be forced to reduce operations in, or exit China, with potentially serious implications for the Chinese economy writ large.

**Given the R&D activities in China that Microsoft, Amazon, Tesla, Apple, Cisco, and Google conduct, Beijing could find it more difficult to access international networks of science and technology experts, potentially damaging its future innovation capacity, should these U.S. companies wind down local R&D operations.**

This is especially true in the cases of Microsoft and Amazon, as these companies are most engaged in China-based AI-related research. But China's hardware innovation ecosystem could also be negatively impacted should the U.S. firms decrease their local manufacturing operations. U.S. firms, especially Apple, have helped China develop process knowledge, or "the capacity to scale up whole new industries," that then become internationally competitive.<sup>173</sup> There is evidence, moreover, that working with leading U.S. companies may help Chinese suppliers become more competitive and improve their own products.<sup>174</sup> China is a leading science and technology power in its own right, but like many countries, it still benefits from and relies on international collaborations to augment its S&T capabilities.<sup>175</sup>

**Though the U.S. firms covered in this report have made relatively limited venture capital and private equity investments in Chinese companies, the cessation of such transactions would reduce the flows of tacit knowledge from these firms to their Chinese portfolio companies, which could have negative impacts not only on individual Chinese companies but also on the broader Chinese technology industry.**

Perhaps more importantly, if these companies reduce their operations in China, limit their research partnerships with Chinese institutions, and/or cut back on manufacturing operations with Chinese suppliers, they would send a signal to other investors and countries that the technology industry is no longer a safe investment. Such actions could lead to reduced FDI in China or even trigger capital flight.

## Conclusion

Overall, we find that several of the companies examined in this report could be vulnerable to coercive actions that may adversely affect their sales, production networks, research activities, data and cloud computing centers, and/or investments in China. Given these companies' reliance on China as a production base and revenue generator, we argue that Tesla and Apple are the most vulnerable to Chinese coercion. Apple derives around 20 percent of its global revenue from China and produces the vast majority of its hardware in the country. Tesla's entanglement with China is particularly noteworthy for Taiwan, as its government officials have noted that it may be unable to rely on Starlink satellite communications to the same degree as Kyiv.

Meanwhile, to a lesser extent, Amazon's reliance on China-based suppliers for assembling its products also increases its vulnerability, while the combination of Microsoft's extensive R&D activities and entanglement with China's technology ecosystem also exposes the company to Chinese coercive actions.

Our study has a number of limitations, related both to data availability and the representativeness of that data. We were unable to find information on many indicators for several companies, and even the more data-rich case studies can only reveal so much. As such, our conclusions regarding vulnerabilities are influenced by the indicators most relevant to the respective companies. Moreover, the presence of vulnerabilities does not necessarily mandate a particular course of action, as there are a wide range of factors that influence company decision-making.

These limitations notwithstanding, our findings could provide useful insights to the U.S. government as it doubles down on its efforts to work more closely with large technology companies on defense-related issues.<sup>176</sup> The four large U.S. tech companies with the most extensive ties to China—Apple, Tesla, Amazon, and Microsoft—are among those with which the Department of Defense is increasingly interested in working. Amazon and Microsoft, in particular, have established and growing businesses focused on contracting with the federal government.<sup>177</sup> Still, as these business ventures continue to develop, it is important to understand that while the U.S. government and many technology companies' incentives have largely aligned regarding the war in Ukraine, the latter's enmeshment in China's market and innovation ecosystem may complicate potential future synergies on foreign and security policy goals related to Taiwan. This has potential implications for the U.S. and Taiwanese

militaries, as they may seek to work with U.S. technology companies in the event of a Taiwan contingency.

Russian coercion of and actions against the companies that supported Ukraine did not appear to impact their decision-making in the aftermath of the full-scale invasion. This was partly because the companies had negligible, and in most cases, nonexistent stakes in the Russian market. But in the event of a Taiwan crisis, Chinese retaliation, or threats thereof, would be only one of several factors influencing corporate decision-making. The companies examined in this report would likely need to respond to a raft of U.S. and potentially Group of Seven (G7) sanctions, which could threaten their continued operations in China. Furthermore, the U.S. government maintains considerable leverage over these companies as they still rely more on the U.S. market than on China's. Many of the companies would also need to determine how best to manage their reliance on Taiwan for advanced-node semiconductors. Overall, these and other companies with economic interests in China could face limited choices, as they would be operating in a constrained environment shaped by sanctions, supply chain disruptions, and restrictions on the movement of goods and people, among other challenges. Given the complexities such a contingency would entail, this report deals solely with China-related links and pressures.

Ultimately, the complex linkages and entanglements outlined in this report reveal that U.S. and Taiwanese policymakers may need to temper their expectations regarding some U.S. technology companies' contributions to Taiwan in a contingency. That said, 10 of the 18 U.S. companies that have supported Ukraine's war effort have limited, or negligible, economic entanglements with China. Given their insignificant footprints in China, these companies may have little to lose if they choose to back Taiwan in a hypothetical crisis. However, in the case of a Taiwan contingency, U.S. policymakers should be cognizant of the complications that companies with more extensive linkages to China may have to navigate due to their supply chains, revenue, investments, and research partnerships.

## Authors

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## Appendix A: Additional Information on U.S. Companies' Contributions to Ukraine

Table A1: American Tech Company Defense and Technology Contributions to Ukraine

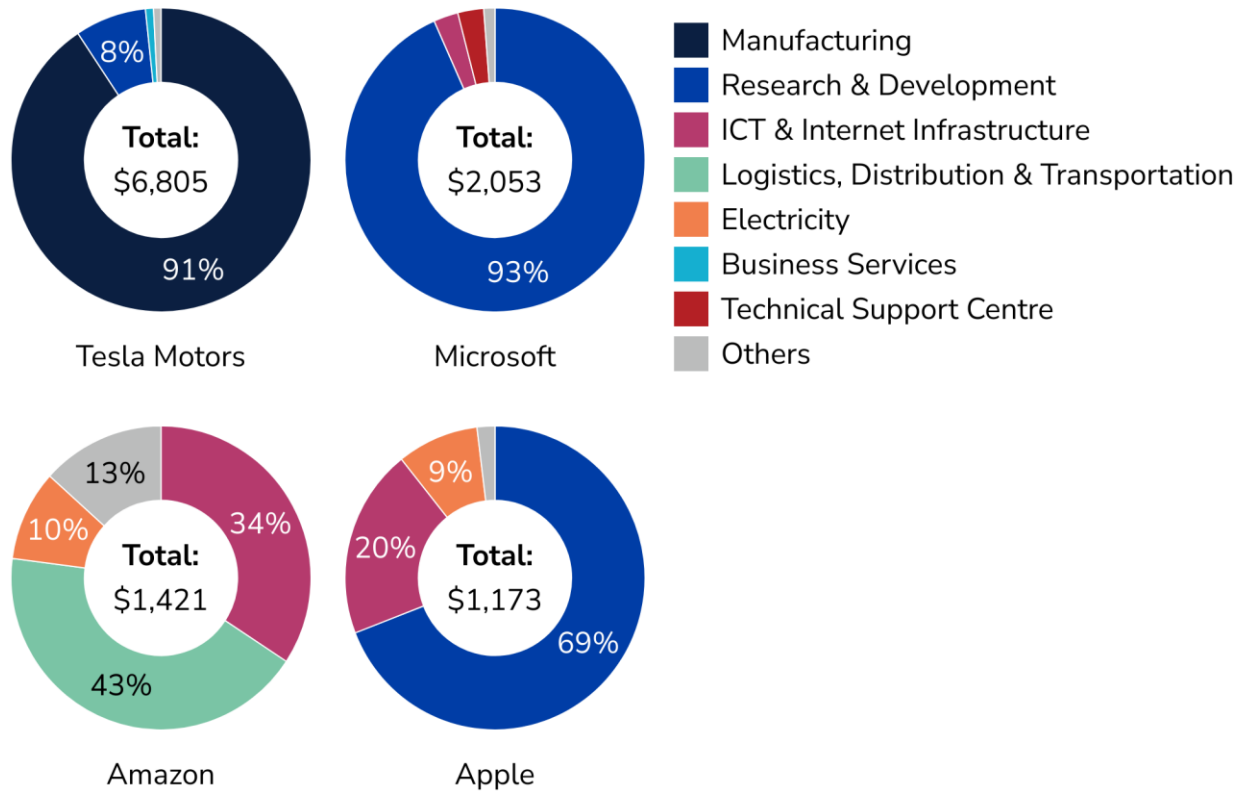
Company	Contribution
<b>Amazon</b>	Donated items and services worth \$75 million; <sup>178</sup> renewed MoU with Ukraine for 2023; canceled referral fees for Ukrainian entrepreneurs for 1 year; <sup>179</sup> helped the Ukrainian government transport over 10 million gigabytes of data out of the country via Snowball Edge solid-state computer storage units before uploading the data into its cloud system. <sup>180</sup>
<b>Apple</b>	Disabled traffic and live incidents in Apple Maps in Ukraine. <sup>181</sup>
<b>Capella Space</b>	Captured first satellite imagery of Russian invasion that helped the Ukrainian military respond. <sup>182</sup>
<b>Cisco Technologies</b>	Defended Ukraine against cyberattacks; signed a 2023 MoU to continue assisting Ukraine in expanding its critical digital infrastructure and provide cybersecurity education to Ukrainians. <sup>183</sup>
<b>Clearview AI</b>	Supplied Ukrainian authorities with facial recognition capabilities to identify prisoners of war, as well as the identities of soldiers who have died in the conflict. <sup>184</sup>
<b>Cloudflare</b>	Provided cyber defense, removed cryptographic material from servers in Ukraine. <sup>185</sup>
<b>Fortem Technologies</b>	Deployed counter-UAS system in direct response to the Russian invasion. <sup>186</sup>

<b>Google</b>	Turned off traffic data in Google Maps; <sup>187</sup> paused monetization of Russian state-funded media; <sup>188</sup> provided counter-DDOS services donated via Project Shield; <sup>189</sup> added air raid alerts to Android phones in Ukraine; <sup>190</sup> donated 50,000 workspace licenses to Ukraine government; <sup>191</sup> provided free workspaces for Ukraine's government. <sup>192</sup>
<b>Mandiant</b>	Released Russian invasion threat overview. <sup>193</sup>
<b>Maxar</b>	Released satellite imagery of Russian troop build ups pre-invasion; provided imagery throughout the conflict. <sup>194</sup>
<b>Microsoft</b>	Aided Ukraine in cyber defense; <sup>195</sup> provided tech support to Ukraine exceeding \$100 million in value <sup>196</sup> ; published intelligence reports that describe lessons learned from the cyber side of the conflict and attributed various attacks to specific Russian units; <sup>197</sup> neutralized the internet launching points Russia used for cyberattacks. <sup>198</sup>
<b>Oracle</b>	Assisted in preserving government registers and databases transferring them and saving them in a secure location. <sup>199</sup>
<b>Palantir</b>	Provided aid to Ukraine including image collection for data integration; provided assistance with targeting. <sup>200</sup>
<b>Planet Labs</b>	Captured satellite imagery of Russian invasion that aided Ukrainian military. <sup>201</sup>
<b>Primer</b>	Provided the Ukrainian army with AI-enabled analysis of text, images, audio, and video on social media, as well as translation and analysis of unencrypted communications from Russia's military leaders. <sup>202</sup>
<b>Recorded Future</b>	Provided protection to critical infrastructure and data; provided cyber defense; provided intelligence insights. <sup>203</sup>

<b>SpaceX</b>	Deployed 50 Starlink satellites for Ukraine; <sup>204</sup> prioritized cyber defense after Russian jamming caused comms outage; <sup>205</sup> provided Starlink services for free to Ukraine; helped restore connections in Ukraine after Russian missile strikes. <sup>206</sup> As of the summer of 2023, Ukraine was using 42,000 Starlink terminals. <sup>207</sup>
<b>Tesla</b>	Sent Powerwalls to Ukraine. <sup>208</sup>

## Appendix B: Additional Figures on U.S. Companies' Greenfield FDI in China

Figure B1: Greenfield FDI Capital Expenditure (Millions USD) by Business Activity



Source: fDi Markets

## Endnotes

<sup>1</sup> Though SpaceX has no publicly discernable footprint in China, its linkage with Tesla through Elon Musk, the CEO and partial owner of both companies, would likely complicate its decision-making in a Taiwan contingency.

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