

The MITRE logo is positioned in the top left corner of the image. It consists of the word "MITRE" in a bold, white, sans-serif font. To the right of the word is a vertical line, followed by the tagline "SOLVING PROBLEMS FOR A SAFER WORLD" in a smaller, white, sans-serif font. The background of the entire image is a photograph of a large indoor space, likely a convention hall or exhibition center, with a complex network of metal trusses and lighting rigs. A large, illuminated red Huawei logo is visible in the upper left, and the word "HUAWEI" is written in large, glowing white letters across the center of the ceiling.

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The word "HUAWEI" is displayed in large, three-dimensional, glowing white letters that appear to be suspended from the ceiling of a large indoor arena. The letters are illuminated from within, creating a bright, modern look. The background shows the intricate metal structure of the ceiling and various stage lights.

BATTLE DAMAGE ASSESSMENT **OF U.S. ACTIONS TOWARD HUAWEI** **(2019–2020): THE NON-TRADITIONAL** **DATA APPROACH**

Connor E. Fairman, Catherine J. O'Saben, Claire Wooster, Emily Sutherland, Calen A.L. Jahan, Ariana K. Tutko,
Larson J. Miller, Lincoln Davidson, and Vanessa McBride

Executive Summary

The Joint Chiefs of Staff define Battle Damage Assessment (BDA) as:

A component of [Combat Assessment] CA, BDA is the estimate of damage composed of the physical damage assessment (PDA) and functional damage assessment (FDA), as well as target system assessment, resulting from the application of lethal or nonlethal military force.¹

This report describes MITRE's Cross-Cutting Urgent Innovation Cell's (CUIC's) use of non-traditional data (NTD)² for BDA to develop methodologies and identify datasets and commercially available tools and analytics so that analysis can fully bring to bear the explosion of NTD that has taken place over the past decade. Moreover, the datasets used in this study were evaluated to glean unique insights impossible to obtain when viewing different categories of data in silos.

Analysis leveraged NTD to conduct BDA of three rounds of U.S. sanctions in 2019 and 2020 that targeted Chinese company Huawei's access to products made with U.S. technology. Eight data sources acquired from commercial vendors, in addition to free, open-source datasets, were leveraged to analyze the effects of U.S. actions from multiple dimensions: financial health, shipments, employment, intellectual property, online discourse, internet metadata, global transactions, and venture capital.

Following U.S. sanctions, Huawei's revenue and shipments of its products declined, while the company's major competitors, both domestically and internationally, experienced higher revenue and volume of shipments. Social listening and internet metadata tools detected increased interest in alternatives to Huawei products and discussion of how sanctions affected U.S.-China relations. Huawei also invested aggressively in later stage Chinese companies linked to semiconductor technology.

Huawei's donations to other countries increased noticeably after the first round of sanctions in May 2019. Every country that received donations had used Huawei previously for 4G, and the vast majority were countries that were still deliberating using the company's equipment in their upcoming 5G networks and had signed a Memorandum of Understanding with China regarding the Belt and Road Initiative. Other recipients included countries such as Brazil that are both "digital swing states" and crucial markets for Huawei products. Compared to its venture capital strategy, Huawei's donation activity reflects its investment in social and political capital. All of these data sources provided insight into how Huawei's behavior changed following U.S. actions.

Aside from NeoPhotonics, which derived the largest share of its revenue from sales to Huawei at almost 50 percent, the sanctions did not adversely affect the bottom line of Huawei's U.S. suppliers. Its competitors, including Apple, experienced a steady increase in shipments to Mexico after sanctions took effect, while Huawei's fell substantially.

¹Joint Chiefs of Staff, *Methodology for Combat Assessment*, J-2 (Washington, DC: Joint Chiefs of Staff, 8 March 2019), https://www.jcs.mil/Portals/36/Documents/Doctrine/training/jts/cjcsi_3162_02.pdf?ver=2019-03-13-092459-350

²Non-Traditional Data (NTD) refers to both open source and commercially available data. NTD is alternatively known as Publicly Available Information (PAI).

**BATTLE DAMAGE ASSESSMENT OF U.S. ACTIONS TOWARD HUAWEI (2019-2020):
THE NON-TRADITIONAL DATA APPROACH**

Greater visibility into Huawei’s post-sanctions hiring behavior would have provided greater insight into how the company is responding to U.S. restrictions. For example, more detailed employment data would have revealed whether the company has been pivoting to produce different products or develop new intellectual property in-house.

Findings from NTD sources support the hypothesis that U.S. sanctions inflicted severe damage on Huawei in multiple domains. Beyond more obvious indicators such as financial health and shipments, online discourse and internet metadata indicate that U.S. sanctions also had an impact on trust in the company’s ability to deliver its products in the future, which consequently affects consumer demand. These results highlight the utility of using a range of different types of NTD for BDA of economic actions.

This use case should inform future efforts to leverage NTD for BDA by demonstrating capabilities, limitations, and areas in which analysis should further probe how to integrate data from different sources. Future analysis can expand the findings of this BDA by obtaining more granular data about Huawei’s hiring activities and more complete shipping data. Nonetheless, this case serves as a clear example of how to leverage NTD successfully for BDA.

Summary of Findings

DATA TYPE	FINDING	UTILITY FOR BDA
Shipping	Shipments of Huawei products decrease in multiple markets as its competitors’ shipments erode Huawei’s market share.	Although shipping data reliability varies between countries, select data, particularly from Mexico, helped identify downward trends in Huawei market share in smartphone shipments following U.S. restrictions.
Investment	Following U.S. restrictions in 2019, 87 percent of Huawei’s external investment has been directed toward microelectronics companies, mainly mature, privately owned firms based in China.	Critical finding that demonstrated how U.S. sanctions changed Huawei’s behavior and strategy.
Staffing	Huawei experienced lower relative employee growth rates compared to its competitors after the implementation of sanctions. It did not experience a drop in staffing levels commensurate with its declining revenue.	Staffing data would have been more useful for BDA of U.S. sanctions targeting Huawei if the data provided insight into the kinds of roles that Huawei has been hiring since the onset of sanctions. This would have enabled the analysis to identify whether the company has sought to bring microelectronics R&D in-house.

BATTLE DAMAGE ASSESSMENT OF U.S. ACTIONS TOWARD HUAWEI (2019-2020): THE NON-TRADITIONAL DATA APPROACH

DATA TYPE	FINDING	UTILITY FOR BDA
Patents	There was no noticeable trend of Huawei producing microelectronics-related patents after the announcement of U.S. sanctions.	Demonstrated that Huawei does not appear to be attempting to develop their own microelectronics intellectual property in-house. This is corroborated by its heavy investment in later-stage Chinese microelectronic companies.
Financial Performance	Huawei's revenue declined substantially following U.S. sanctions and experienced negative annual revenue growth in 2021 after years of double-digit growth leading up to 2019.	Critical finding that highlights how U.S. sanctions inflicted damage to Huawei's overall financial health.
Donations	Huawei made thirty-four donations of medical and technical equipment, mainly to Belt and Road Initiative participants and key markets for its products, like Brazil, which until Fall 2021 was debating allowing Huawei to participate in its 5G auctions, after U.S. sanctions.	Donation activity reflects Huawei's investment in social and political capital after incurring reputational damage from U.S. sanctions and efforts like the Clean Network Initiative. Although not as useful as investment and financial performance data, donation data similarly reflects Huawei's strategy and behavior following U.S. sanctions.
Social Listening	There was a decline in consumer trust in Huawei products and increased interest in those of Huawei's competitors following U.S. sanctions. There was also interest among Russian-speaking Twitter users in how sanctions will affect U.S.-China relations.	Corroborated findings from shipping data and provided insight into how foreign audiences reacted to U.S. sanctions against Huawei.
Internet Metadata	Foreign language attention to Huawei's products declined at an average rate of 3.2 percent following the first round of sanctions in 2019. Interest in Huawei's competitors' products simultaneously grew by double digits.	Supported findings from social listening and shipping data.

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Introduction and Background

On May 15, 2019, President Trump signed the Executive Order on Securing the Communications Technology and Services Supply Chain, which effectively banned the Chinese technology company Huawei from operating and selling its products in the United States.³ The following day, the U.S. Department of Commerce's Bureau of Industry and Security (BIS) added Huawei to its Entity List, imposing an export license requirement on all exports, re-exports, and transfers of items to Huawei. This barred the company from directly purchasing U.S.-made equipment critical to making components for its high-end products under a policy of "presumption of denial."

One year later, on May 15, 2020, BIS closed a loophole that allowed foreign companies to use U.S. technology to fill custom orders for Huawei. This new restriction prohibited Huawei's non-U.S. suppliers from using U.S. technology to manufacture any products for the company if the process involved more than *de minimis* use of any U.S. technology. However, this only applied to foreign companies that used U.S. technology to fill Huawei's custom orders, mainly for advanced chips that power its newest and most sophisticated products. In other words, even after this second round of restrictions, Huawei was still technically allowed to purchase off-the-shelf products that were manufactured using U.S. technology.

Finally, on August 17, 2020, only a few months after it unveiled its second round of sanctions, BIS closed the loophole that allowed Huawei to purchase off-the-shelf goods, even those designed by other firms, if U.S. technology was involved in

the manufacturing process. This cut off Huawei's access to the chips that it needs to power its most advanced products because U.S. technology is so crucial throughout the semiconductor supply chain.

MITRE's Cross-Cutting Urgent Innovation Cell (CUIC) sought to leverage a wide range of Non-Traditional Data (NTD) data sources to assess the impact of these U.S. sanctions on Huawei, its competitors, and its top U.S. suppliers. This approach involved the use of shipping, business intelligence, information environment, and internet metadata sources. The combination of these different tools enabled the observation of how sanctions affected not only Huawei's bottom line but also the company's survival strategy, captured in this report by its investments and donations. The analysis also assessed how U.S. sanctions affected online discourse and attention related to Huawei, its competitors, and U.S.–China relations across several countries and languages. The remaining sections of this report describe the type of data that was observed, and some sections, such as "Hubble's Strategic Investments," combine multiple different data sources. Data regarding Huawei's international donation activity that was acquired from a vendor was supplemented with open-source datasets.

The following sections describe the capabilities and limitations of the sources used and inform the ideal circumstances for their application in BDA. Future efforts can analyze the data in greater detail and expand the inquiry into how U.S. sanctions affected Huawei. This assessment outlines where additional data would add value and further probes new areas for leveraging NTD.

³"Executive Order on Securing the Information and Communications Technology and Services Supply Chain," May 15, 2019, <https://web.archive.org/web/20190516023500/>, <https://www.whitehouse.gov/presidential-actions/executive-order-securing-information-communications-technology-services-supply-chain/>

Analytic Approach

The analysis described in this report of U.S. sanctions targeting Huawei utilized a combination of free open-source data and data acquired from commercial vendors. Analysis favored data and analytics that could feed an automated model rather than manual open-source analysis, and therefore used automated inquiries into commercial data as the primary data source.

This report includes derivative analysis from the raw data accessible on vendor platforms or via Application Programming Interfaces (APIs), in accordance with terms of service. Each vendor agreed to partner with MITRE on this report to help further the use of NTD for Battle Damage Assessment (BDA).

The following sections describe the commercial datasets and tools that the analysis used as sources to produce this report:

Information Environment

Pulsar: Pulsar measures sentiment and engagement of various audiences based on their location, language, and use of key topics. It leverages sophisticated artificial intelligence (AI) and data visualizations to provide data-driven social media insights on user-defined queries. Collection was limited to the following sources and timeframes:

- Twitter historical data is available as of January 2006.
- Tumblr historical data is available on a 25-month rolling period.
- Forum Sites are available on a 25-month rolling period (this includes Reddit).
- News is available on a twenty-five-month rolling period.

- Blog Posts are available on a 25-month rolling period.
- Review Sites are available on a 25-month rolling period.
- VK is only available in real time.

Predata: The analysis used Predata to analyze web flow metadata to quantify audience attention to online public topics. It used these analytics to assess attention to identified topics of interest by tracking the language used by users to access web page, video, and domain-level traffic. In some cases, analytics are also available to determine the country of origin of user attention to the topic. For the purposes of this examination, trends were examined to glean insight into demographics of users showing attention to certain events or actions, to shed light on the languages and/or countries that react to events of interest. Predata leverages AI/Machine Learning (AI/ML) to mark and visualize periods of increased interest.

Webcrawler: A webcrawler was used to collect samples of publicly available information and fill gaps in collections of social media listening, specifically for time periods where collection of social media content in other sources was restricted due to the historical timeframe of interest. After collection by the webcrawler, content was segmented based on authorship, language, and other high-level attributes based on user-defined keyword collection.

Botometer: Botometer is an algorithm developed by the University of Kentucky to identify potential bot accounts on Twitter. The analysis used it in conjunction with other social listening datasets to identify social media activity by bot accounts related to topics of interest.

Shipping

S&P Panjiva: The analysis used data from Panjiva, a platform produced by S&P Global Market Intelligence that provides import and export data on commercial shipments from the United States, Mexico, Bolivia, Brazil, Chile, China, Colombia, Costa Rica, Ecuador, India, Indonesia, Pakistan, Panama, Paraguay, Peru, Philippines, Sri Lanka, Uruguay, Ukraine, and Venezuela. The platform includes tools that enable dynamic data visualizations and analysis of buyers, sellers, and shipments.

Business Intelligence

S&P CapitalIQ: CapitalIQ is a business and financial intelligence platform produced by S&P Global that provides profiles of global companies, including information about company relationships, leadership, activities, and financials. CapitalIQ includes tools that enable analysis of company and sector performance.

Pitchbook: Pitchbook is a business and financial intelligence platform that provides a wide range of data on venture capital, private equity, corporate transactions, companies, employees, and company financials. It lists a company's investors, investments, subsidiaries, senior leadership, contact information, employee count, funding, dry powder, funds, and other detailed information. It also provides comparative analytics for companies, investors, and funds.

Sayari Graph: Sayari Graph is a business intelligence platform that provides data related to corporate ownership, registration, leadership, and relationships extracted from public records, including intellectual property registries, corporate and tax records, ownership records, and foreign investment information. It allows users to build dynamic visualizations of commercial relationships.

RWR IntelTrak: IntelTrak is an analytic tool developed by RWR Advisory Group that tracks daily international operations of Russian and Chinese state-owned and private enterprises based on analysis of individual business transactions and office locations.

Shipping Data

Analysis used Panjiva to assess shipping data and determine if U.S. sanctions targeting Huawei impacted shipments of its products worldwide. The analysis contrasted Huawei shipments, including the type and number of items shipped, with those of competitors to compare trends and remove noise from data pertaining to factors such as seasonal shipping trends and the emergence of the COVID-19 pandemic.

Although import and export data from China became unavailable after 2018, import data containing shipments of Huawei items is available from a few countries. However, the availability and reliability of that data varies; for example, Indonesia's data only covers the period after January 2019. Thus, analysis included information on Indonesian imports of Huawei and competitor products in the five months prior to U.S. sanctions in May 2019 to baseline pre-sanction import trends. Much earlier import data is available for the other countries observed; some U.S. shipment data dates back to July 2007. The most complete and

reliable data was available from the Indonesia and Mexico datasets, although other countries' imports were assessed as well. Where data from May 2018 to April 2019 was available, the analysis included it to create a baseline of shipping trends before the enactment of U.S. sanctions.

Because Mexico's data is the most complete and reliable among the countries observed, analysis focused primarily on Mexican imports of products made by Huawei and its competitors to determine if Huawei shipments decreased relative to its competitors after U.S. restrictions. **Figure 1** depicts the changes observed.

Overall, Huawei is the fifth most prominent shipper by volume of shipments after Cisco, Apple, Siemens, and Motorola. Although all suppliers of Mexican imports experienced drop-offs in shipments in June 2019, one month after the first U.S. sanction against Huawei, all but Huawei have recovered.

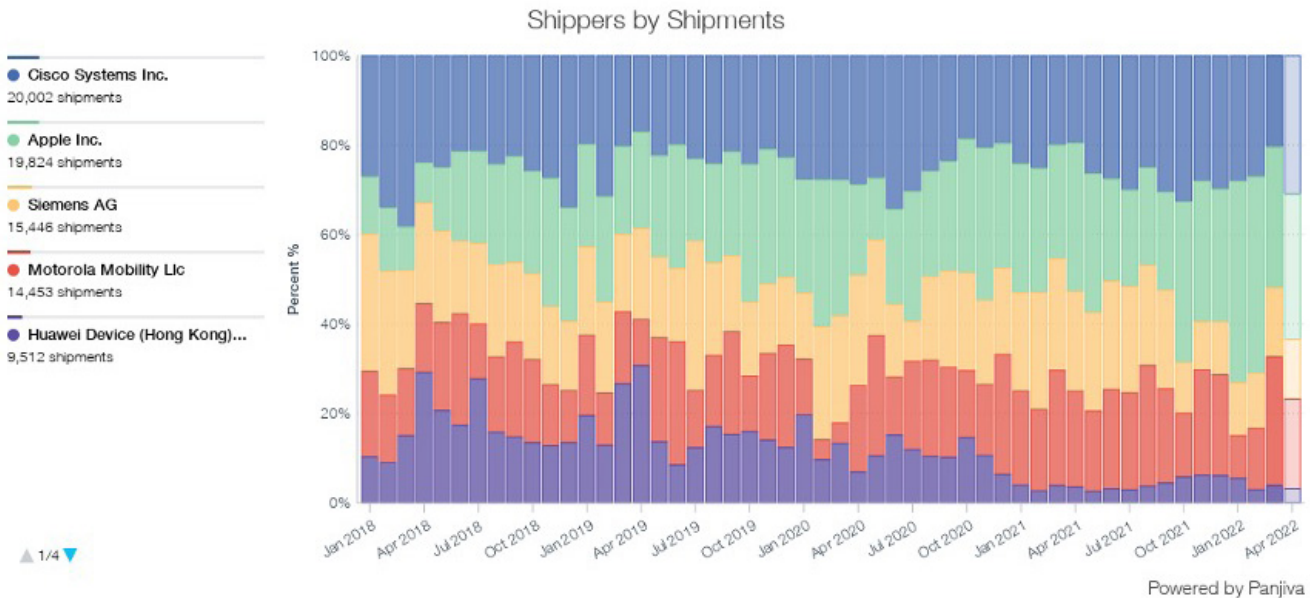


FIGURE 1. MEXICO'S TOP TELECOM SUPPLIERS BY SHIPMARKET SHARE

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Exports of Huawei products to Mexico peaked at 662 in April 2019 and declined steadily after the first round of U.S. sanctions against the company in May 2019. By May 2021, shipments of Huawei products to Mexico reached a low of 84, representing an 87 percent decrease over two years. This is a large decline, even accounting for the drop in shipments that occurred at the beginning of the COVID-19 pandemic in early 2020, because, unlike its competitors, Huawei's shipment volume never recovered during the following months. Moreover, the decrease in Huawei shipments to Mexico is steady despite seasonal shipping trends that tend to bring about increases and decreases in shipment volume.

Similarly, Huawei shipments to Indonesia and Mexico declined noticeably following U.S. sanctions. Mexico's import data, which was the most complete and reliable dataset available, displayed a significant decrease in demand for Huawei's goods, including cellphones, while demand for competitors' products gradually increased.

Mexico's demand for Huawei cellphones peaked in April 2019, according to the breakdown of Huawei items shipped to Mexico (see **Figure 2**). In fact, during the months leading up to May 2019, the number of cellphones shipped by Huawei exceeded the number for all other handheld device makers, except for Apple, which it closely trailed. Following the introduction of the three U.S. restrictions against Huawei, demand for Huawei cellphones has diminished by 77 percent, while demand for its competitors' products has steadily increased. Huawei now ranks nineteenth among all handheld device suppliers to Mexico.

Following U.S. sanctions, Indonesia, the country with the highest volume of Huawei imports, decreased its imports of Huawei products (see **Figure 3**). For example, prior to the May 2019 restrictions, Indonesia's imports of Huawei products peaked at over 2,000 shipments in April. By June 2019, shipments had dropped to a new low of just under 1,000. In the aftermath of the first round of restrictions, Huawei shipments to

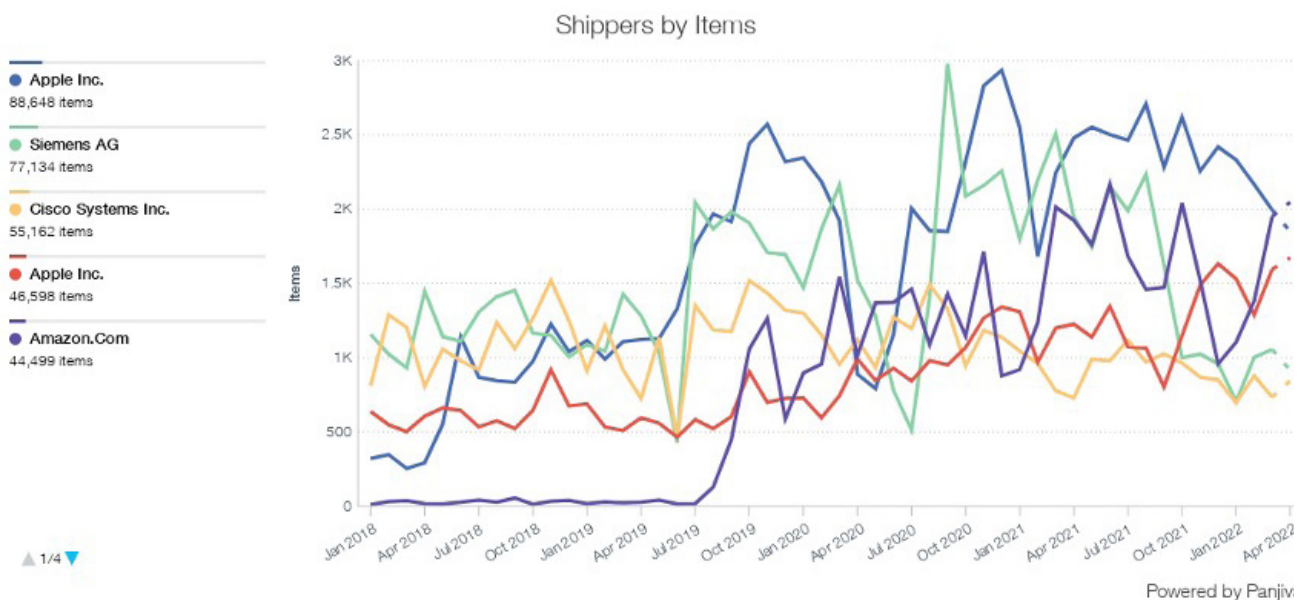


FIGURE 2. SUPPLIERS OF MEXICO'S CELLPHONE IMPORTS

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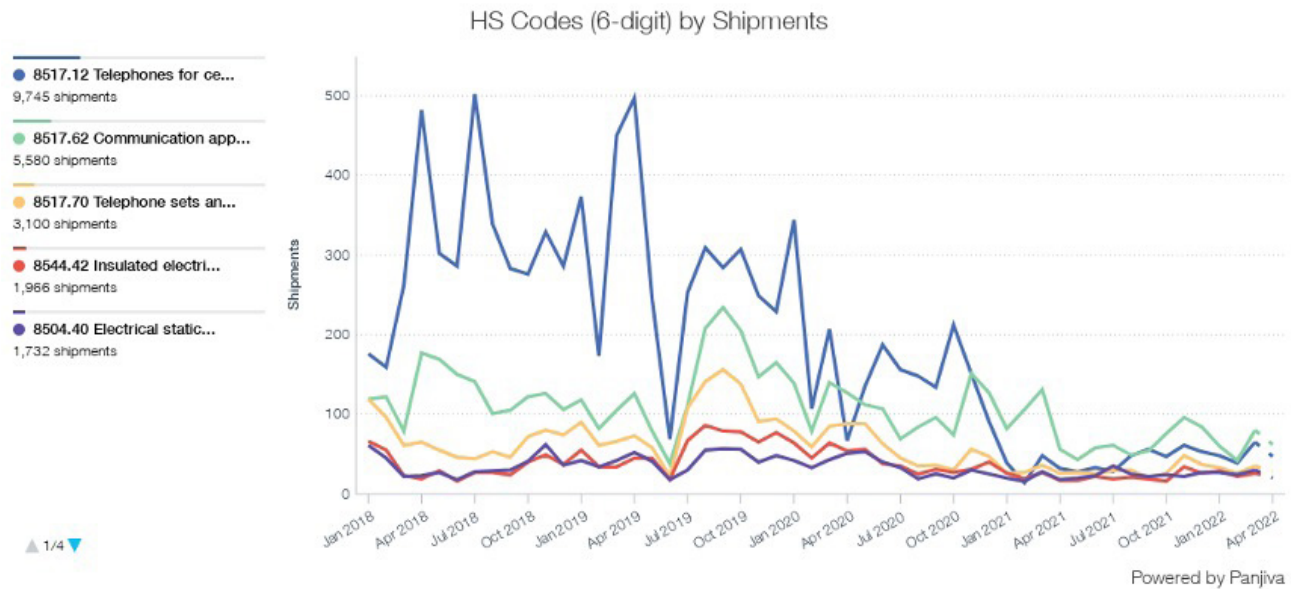


FIGURE 3. INDONESIA IMPORTS OF HUAWEI PRODUCTS

Indonesia recovered by nearly 50 percent until the emergence of the COVID-19 pandemic in early 2020, when they again dropped, but eventually recovered to over 1,500 by April 2020. Finally, after the second and third rounds of U.S. sanctions in May and August 2020, import data from Indonesia shows another steep drop in Huawei shipments that lasted through October 2020. The increase in shipments that began in November 2020 is likely due to the 5G agreement signed between Huawei and Indonesia that month.⁴

Analysis revealed that, following U.S. sanctions, each country surveyed experienced an all-time low in the volume of its Huawei imports, and none has returned to peak levels. Every minimum has occurred after 2020, with six of the eight countries experiencing minimums after September 2020. Moreover, Huawei’s competitors, particularly in Mexico, appear to demonstrate upward sales trajectories as Huawei’s market share decreases.

There are numerous difficulties when analyzing shipping data. Often, the data is incomplete and only available for narrow timeframes. Identification of product manufacturer is also sometimes not available in some countries’ datasets. For example, this prevented assessments of Huawei shipments to Ethiopia and Ukraine. De-noising data is a necessity, particularly during this timeframe, as supply chain disruptions, seasonal trends, and global events such as the pandemic can cause sudden and dramatic changes in shipping activity.

Even accounting for the pandemic and seasonal trends, U.S. sanctions seem to have dislodged Huawei from its leading position in Mexico’s consumer electronics and telecommunications markets. Although data pertaining to the shipments of Huawei’s competitors to Indonesia was spotty across time, the data available showed noticeable decreases in shipments of Huawei products coinciding with and following the announcement of U.S. sanctions.

⁴Koya Jibiki and Takashi Kawakami, “Huawei’s 5G Deal With Indonesia Spearheads Southeast Asia Push,” December 2, 2020, *Nikkei*, <https://asia.nikkei.com/Spotlight/Huawei-crackdown/Huawei-s-5G-deal-with-Indonesia-spearheads-Southeast-Asia-push>

Business Intelligence

Hubble's Strategic Investments

Investment data from S&P Capital IQ and Pitchbook was used to observe Huawei's investment activity after sanctions. Hubble Technology Investment Co., Ltd. (Hubble) is the investment arm of Huawei Investment & Holding Co., Ltd. Huawei founded Hubble in April 2019, roughly one month before U.S. government actions targeted Huawei's access to advanced U.S. technology.

Given the coincident timing of Hubble's founding and U.S. restrictions targeting Huawei, the analysis included all available data on Hubble's investments to observe the company's investment trends. Hubble's founding in April 2019 occurred as the U.S. government sought to reduce Huawei's global footprint; Huawei had been stockpiling advanced U.S. chips since at least 2018.⁵

Between the first round of U.S. government restrictions aimed at cutting off Huawei's access to U.S. semiconductor technology in May 2019 and December 2021, Hubble invested in at least 55 companies, all of which are headquartered in China. Of these companies, 48 (87 percent) primarily manufacture semiconductor technology. The rest are technology companies that are either crucial to Huawei's pivot to new business areas following U.S. actions, such as GritWorld, which develops software for computer vision and game engines, or could add value further downstream of microelectronics manufacturing, such as Open Source China or New Consensus (see **Figure 4**).

⁵Sean Keane, "Huawei Ban Timeline: Detained CFO Makes Deal with US Justice Department," *CNET*, September 30, 2021, <https://www.cnet.com/tech/services-and-software/huawei-ban-timeline-detained-cfo-makes-deal-with-us-justice-department>

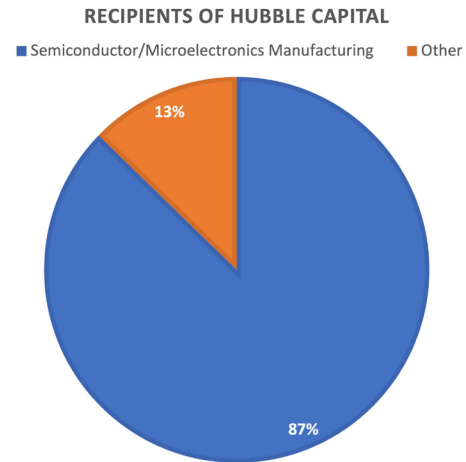


FIGURE 4. RECIPIENTS OF HUBBLE CAPITAL BY SECTOR

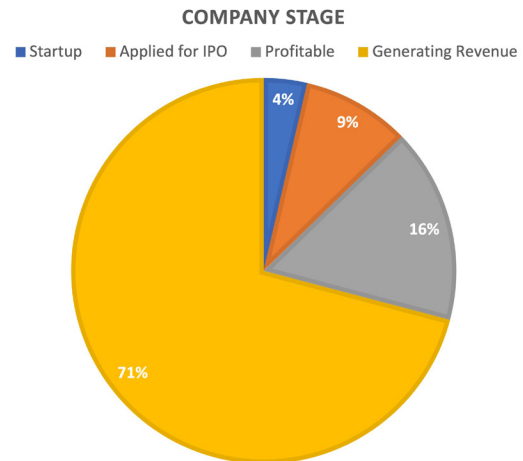


FIGURE 5. COMPANY STAGE WHEN RECEIVING CAPITAL

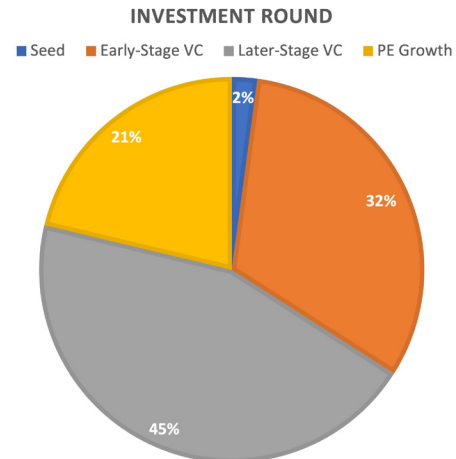


FIGURE 6. HUBBLE INVESTMENT BREAKDOWN BY ROUND

At the time of analysis, Hubble had only made one seed round investment and invested in only two non-revenue-generating startups since its establishment. Its other 53 investments (96 percent) were in companies that are already generating revenue, applying to go public, or profitable (see **Figure 5**). Although the amount invested by the company is often not publicly revealed, available data when Hubble was the sole investor shows that it invests on average \$8.7 million per round (see **Figure 6**). Nine (16 percent) of the companies in which Hubble invested were already profitable, and at least 31 (66 percent) capital injections took the form of either late-stage venture capital or private equity. In short, Hubble almost exclusively invested in mature companies, many of which were profitable and in the process of going public, rather than investing in early-stage startups.

Unfortunately, amounts invested by Hubble are sometimes not publicly disclosed, which makes it difficult to develop a good understanding of how much money Hubble injects into companies. Even when tools state how much was invested into a particular company during a round in which Hubble participated, it is unclear how much the company contributed when other companies also participated in the same round; the amount shown to have been invested is an aggregate of the capital contributed by all investors.

It is possible that the tools failed to capture every investment made by Hubble and that the company had invested in more than fifty-five companies; There are likely more investments that have not been publicly disclosed. Furthermore, some of the companies that do not manufacture semiconductor technology may be more involved in the semiconductor industry than publicly available information suggests. For example, the two consulting firms in which Hubble invested might specialize in these areas, given Huawei's difficulties there.

Huawei's efforts to invest in more mature companies in these fields reflect not a desire to earn dividends but the imperative to acquire the technology that it needs to survive and adapt its business to a future in which U.S. sanctions will remain a major obstacle. Without an alternative source of advanced chips now that those made with U.S. technology are unavailable, Huawei will be unable to make its most sophisticated products. Hubble's investment record thus reflects Huawei's survival strategy following U.S. restrictions.

Staffing Levels

Analysis leveraged data from Pitchbook to measure the number of employees and estimated increase in staffing for Huawei and 12 of its competitors from 2017 to 2021 to determine how U.S. actions may have affected Huawei's staff numbers compared to major competitors. A baseline for pre-sanction employee growth was established by viewing the total number of Huawei employees from 2017 to 2018. Analysis subsequently observed trends in the number of Huawei employees after U.S. sanctions were introduced in May 2019, May 2020, and August 2020.

Huawei has significantly more employees than its domestic and foreign competitors, with approximately 190,000 employees in FY 2020. Its top competitors – Apple, Samsung, and Ericsson – trail with approximately 147,000, 109,000, and 101,000 registered employees respectively. Huawei's registered employee count remained steady before, during, and after U.S. sanctions, slightly increasing each year (**Figure 7**). Most of its domestic and foreign competitors experienced similar trends during the same timeframe (**Figure 8; Figure 9**), except for Nokia and Shenzhen Aisidi Technology, which both experienced a slight decline.

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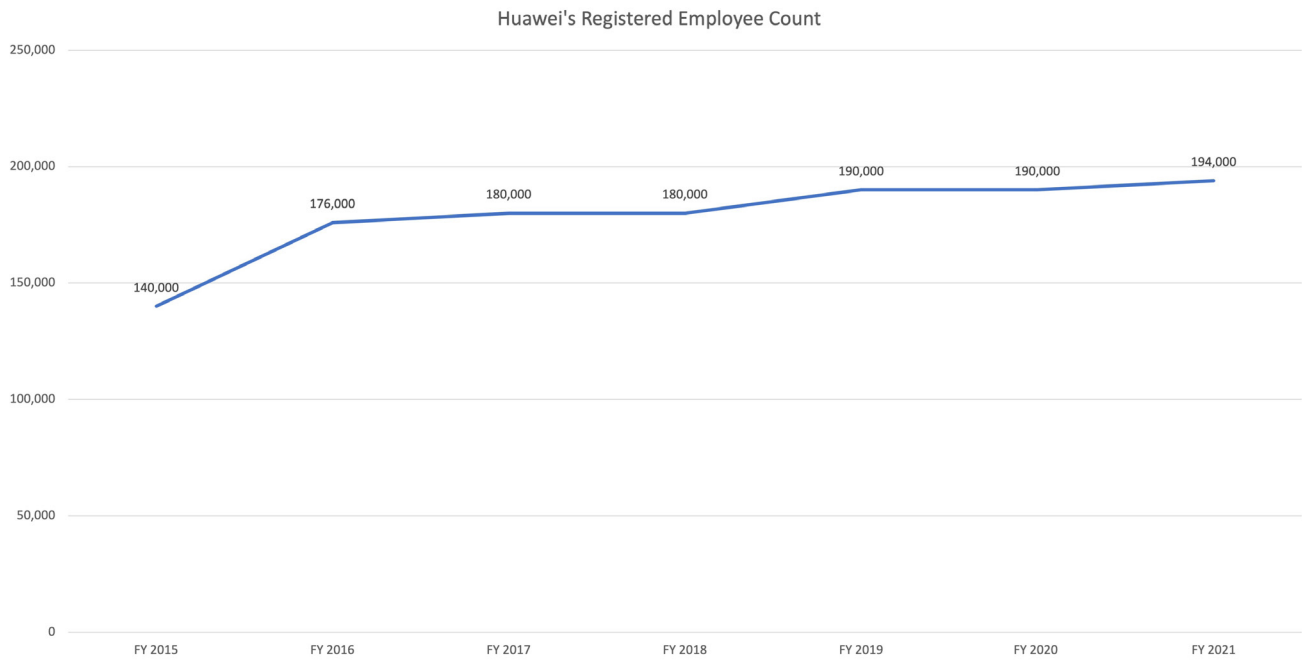


FIGURE 7. HUAWEI'S REGISTERED EMPLOYEE COUNT (2015-2021)

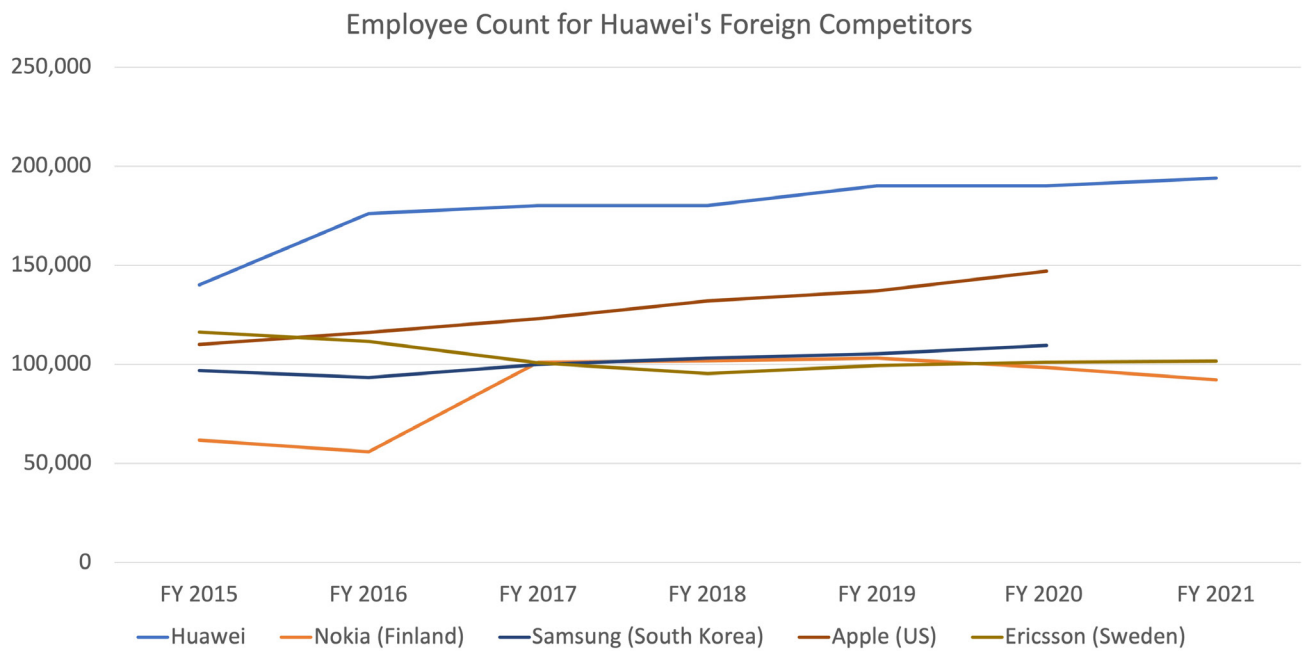


FIGURE 8. EMPLOYEE COUNT FOR HUAWEI'S FOREIGN COMPETITORS (2015-2021)

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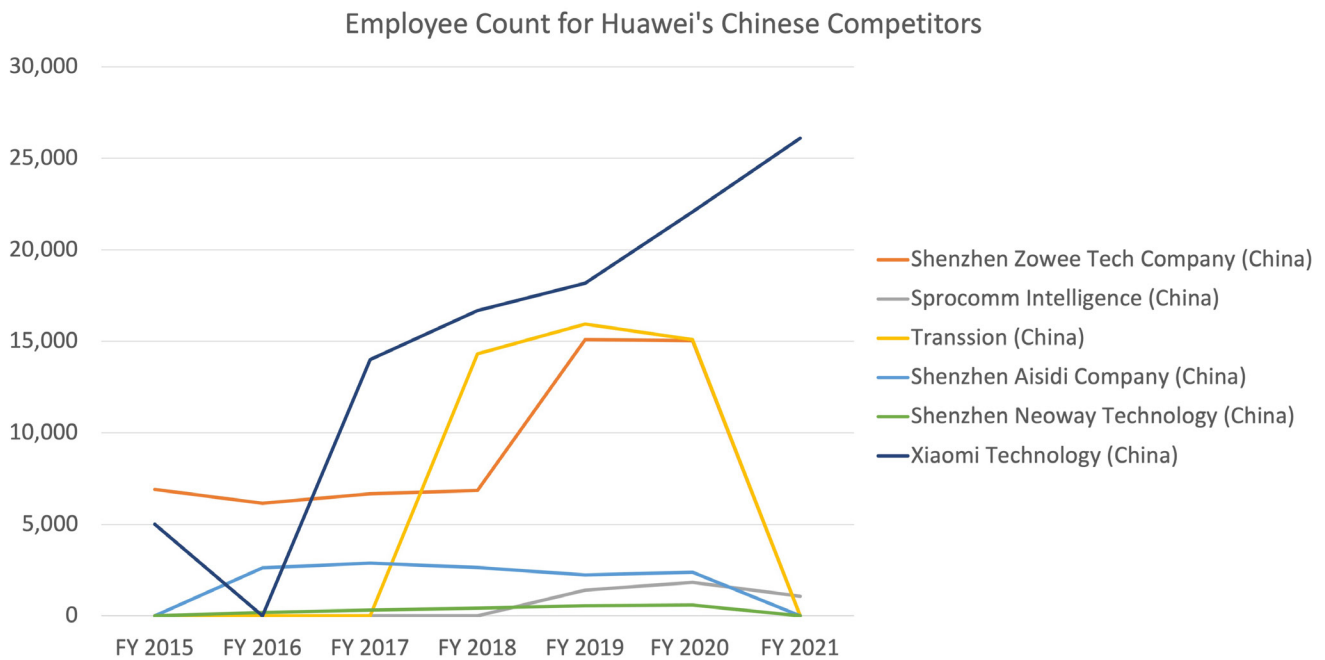


FIGURE 9. EMPLOYEE COUNT FOR HUAWEI'S CHINESE COMPETITORS (2015–2021)

Next, the employee growth rate for Huawei and its competitors was calculated, which highlights the degree of change over time. From FY 2018 to FY 2020, Huawei's rate of change was slightly below average, as it experienced a 5 percent increase (Table 1). Five of Huawei's competitors – Shenzhen Zowee Tech Company, Shenzhen Neoway Technology, Xiaomi Technology, Motorola, and Apple – saw significant increases in the number of their employees, experiencing increases between

10 percent and 119 percent. Moreover, out of the 11 competitors analyzed, only three had lower growth rates than Huawei: Shenzhen Aisidi Company, Nokia, and Transsion. When comparing the growth rate from FY 2015 to FY 2017, prior to U.S. actions, Huawei's was well above average, reaching 28 percent. Only two of its competitors, Xiaomi Technology and Nokia, had higher growth rates.

TABLE 1. RELATIVE CHANGE IN EMPLOYEE COUNT FOR HUAWEI AND ITS COMPETITORS

Company (Registered Employee Count)	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	Percent Change from FY15-FY17	Percent Change from FY18-FY20
Huawei	140,000	176,000	180,000	180,000	190,000	190,000	194,000	28.5714286	5.5555556
Shenzhen Zowee Tech Company (China)	6,914	6,144	6,671	6,851	15,093	15,030		-3.51460804	119.38403
Transsion (China)				14,317	15,933	15,085			5.3642523
Shenzhen Aisidi Company (China)		2,619	2,882	2,644	2,228	2,378			-10.060514

BATTLE DAMAGE ASSESSMENT OF U.S. ACTIONS TOWARD HUAWEI (2019-2020): THE NON-TRADITIONAL DATA APPROACH

Company (Registered Employee Count)	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	Percent Change from FY15- FY17	Percent Change from FY18- FY20
Shenzhen Neoway Technology (China)		184	304	414	549	594			43.478261
Xiaomi Technology (China)	5,001		14,000	16,683	18,170	22,074	26,110	179.944011	32.314332
Nokia (Finland)	61,656	55,718	101,000	101,731	103,083	98,322	92,039	63.8121189	-3.3509943
Motorola (US)	21,000	14,000	14,000	15,000	16,000	17,000	18,000	-33.3333333	13.333333
Samsung (South Korea)	96,898	93,200	99,784	103,011	105,257	109,490		2.97838965	6.2896196
Apple (US)	110,000	116,000	123,000	132,000	137,000	147,000		11.8181818	11.363636
Cisco Systems (US)	70,000	72,385	72,900	74,200	75,900	77,500	79,500	4.14285714	4.4474394
Ericsson (Sweden)	116,281	111,464	100,735	95,359	99,417	101,113	101,624	-13.3693381	6.0340398

The number of employees for most of Huawei's competitors and subsidiaries for FY 2021 was not available in the data, so the assessment was limited to FY 2018–FY 2020. Moreover, the availability of registered employee counts over the years is inconsistent among some of Huawei's competitors and all its subsidiaries. For example, there was no employee count for some of Huawei's competitors (Oppo, BBK Electronics, Vivo, ITEL, Tecno, and Infinix) and subsidiaries (Hubble Investment and Caliopa). Other competitors (Sprocomm Intelligence, Intex Technologies, Trinity Communications, and TEC&CO) and subsidiaries (Neul, HexaTier, and Toga Networks) did not publish employee counts for several years, which made it difficult to establish consistent trendlines. Finally, insight into the specific roles for which Huawei was hiring staff, which would have provided greater insight into its behavior and goals following U.S. actions, was unavailable.

Huawei experienced lower relative employee growth rates compared to its competitors after the implementation of sanctions. It went from having one of the highest employee growth rates at 28 percent before May 2019 to a relatively average growth rate of 5 percent among its major foreign and domestic competitors. Moreover, there was no decline in the number of Huawei employees commensurate with the company's dramatic drop in revenue following sanctions. Even if Huawei laid off many of its workers based in the United States, as it said it would, this did not offset its net hiring rate.⁶

Greater insight into the job categories that Huawei sought to fill after May 2019 would have provided greater insight into whether the company has been hiring different talent than in the past. For example, it could be increasingly hiring employees that it needs to develop the technology that U.S. sanctions restrict it from accessing. If such data were available, parallels between Huawei's investment and hiring strategies could be observed.

⁶Dan Strumpf, "Huawei Plans Extensive Layoffs in the U.S.," July 14, 2019, *Wall Street Journal*, <https://www.wsj.com/articles/huawei-plans-extensive-layoffs-in-the-u-s-11563071144>

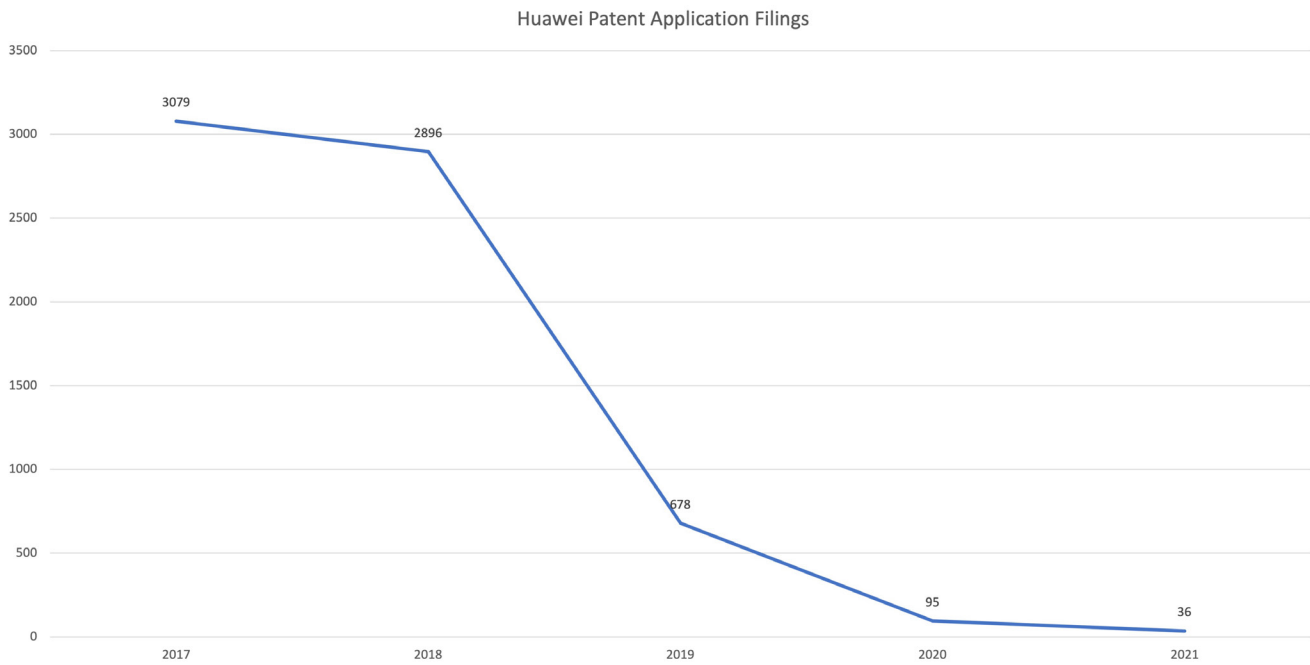


FIGURE 10. HUAWEI'S PATENT APPLICATION FILINGS (2017-2021)

Patent Trends

The analysis took a similar approach to assessing employee growth to identify trends in Huawei's patent applications, particularly in relation to its major competitors. Patent application filings for Huawei, seven its competitors, and one of its subsidiaries from 2017 to 2021 were collected.

The number of patent applications that Huawei filed decreased substantially from 2,896 in 2018, to 678 in 2019, to 95 in 2020, and finally to 36 in 2021 (**Figure 10**). Pitchbook provided coverage of Huawei's patent application filings in the United States and Europe.

TABLE 2. HUAWEI'S PATENT APPLICATIONS BY COUNTRY OF FILING (2017–2021)

Huawei Patents by Country of Filing	Total (2017–2021)	2017	2018	2019	2020	2021
Australia	410	184	166	59	0	0
Canada	350	138	162	49	0	0
European Patent Office	5615	2739	2552	306	18	0
Spain	14	12	1	0	0	0
Japan	742	576	152	11	3	0
US	6160	2987	2603	446	88	36
Germany	4	2	0	2	0	0
UK	10	1	1	6	2	0

Huawei's Patent Application Filings by Country

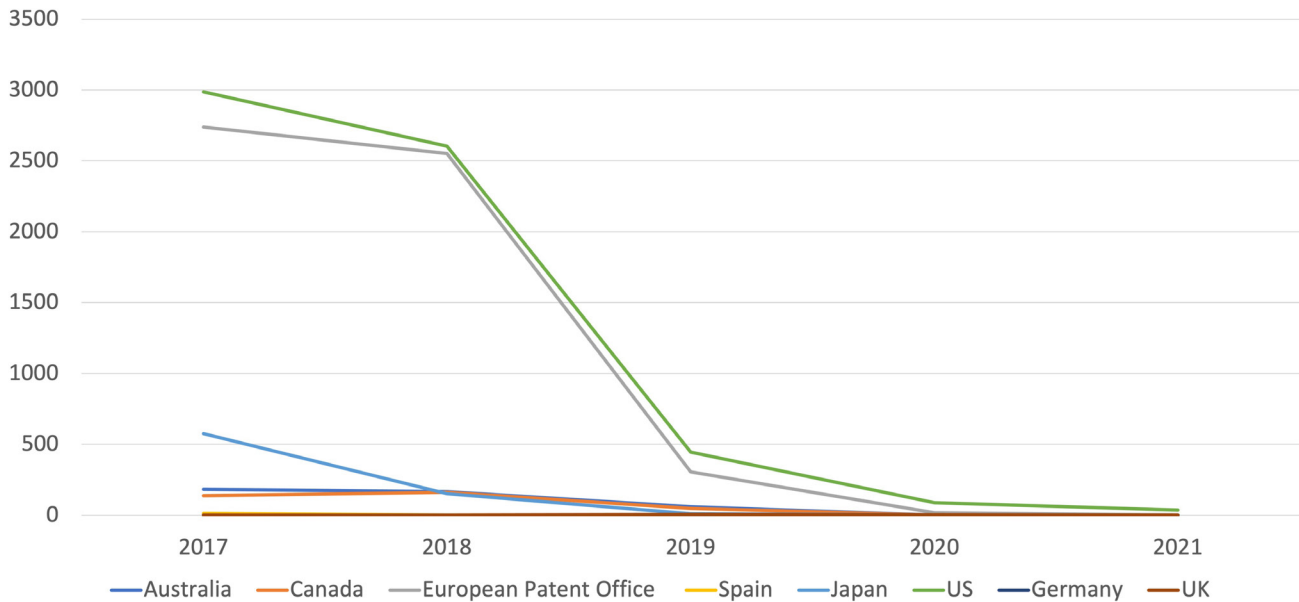


FIGURE 11. HUAWEI'S PATENT APPLICATIONS BY COUNTRY OF FILING (2017–2021)

Huawei's U.S. and European patent applications experienced a slight decline from 2017 to 2018 by a few hundred each. However, the decline became significant after U.S. sanctions were unveiled, with U.S. filings dropping from 2,603 in 2018 to 446 in 2019. European patent applications also

dropped from 2,552 in 2018 to 306 in 2019 (Table 2 and Figure 11). Huawei also filed fewer patent applications in other countries, including Australia, Canada, Spain, and Japan, after the U.S. sanctions.

BATTLE DAMAGE ASSESSMENT OF U.S. ACTIONS TOWARD HUAWEI (2019-2020): THE NON-TRADITIONAL DATA APPROACH

Huawei’s competitors also filed far fewer patent applications from 2019 to 2020 (**Table 3** and **Figure 12**). In fact, the rate of decrease in patent applications for Huawei and its competitors was roughly the same. This could indicate an industry-wide trend, such as an increased emphasis on the “quality over quantity” of patents. Among all the patent applications filed by these companies in the timeframe of analysis, only a negligible number (nearly 0 percent) were granted by 2021. It takes on average 22 months for a patent to be granted once an application has been filed, yet of the 3,079 patent applications that Huawei filed in

2017, only 39 have been approved. As a result, the trend of fewer patent applications filed by Huawei and its competitors likely has little to do with U.S. sanctions and more to do with the small percentage of their applications that have been approved.

Contrasting its post-sanctions investment behavior, almost none of the patent applications filed by Huawei are related to semiconductors; of the 6,784 filings from 2017 to 2021, only 47 are for “semiconductor devices” (in contrast, 42 are for “musical instruments”).

TABLE 3. PATENT APPLICATIONS BY HUAWEI AND COMPETITORS (2017-2021)

Number of Patent Applications Over Time	2017	2018	2019	2020	2021	Percent Change from 2017 to 2019	Percent Change from 2019 to 2020	Percent Change from 2020 to 2021
Huawei	3079	2896	678	95	36	-77.97986359	-85.98820059	-94.69026549
Transsion (China)				3	1			
Xiaomi Technology (China)	406	402	365	91		-10.09852217	-75.06849315	-100
Nokia (Finland)	63	2	2	1		-96.82539683	-50	-100
Motorola (US)	158	171	148	36	2	-6.329113924	-75.67567568	-98.64864865
Samsung (South Korea)	913	9200	8971	1611	1	882.584885	-82.04213577	-99.98885297
Apple (US)	1498	1524	1185	206	5	-20.89452603	-82.61603376	-99.57805907
Ericsson (Sweden)	1495	1323	108	12	7	-92.77591973	-88.88888889	-93.51851852

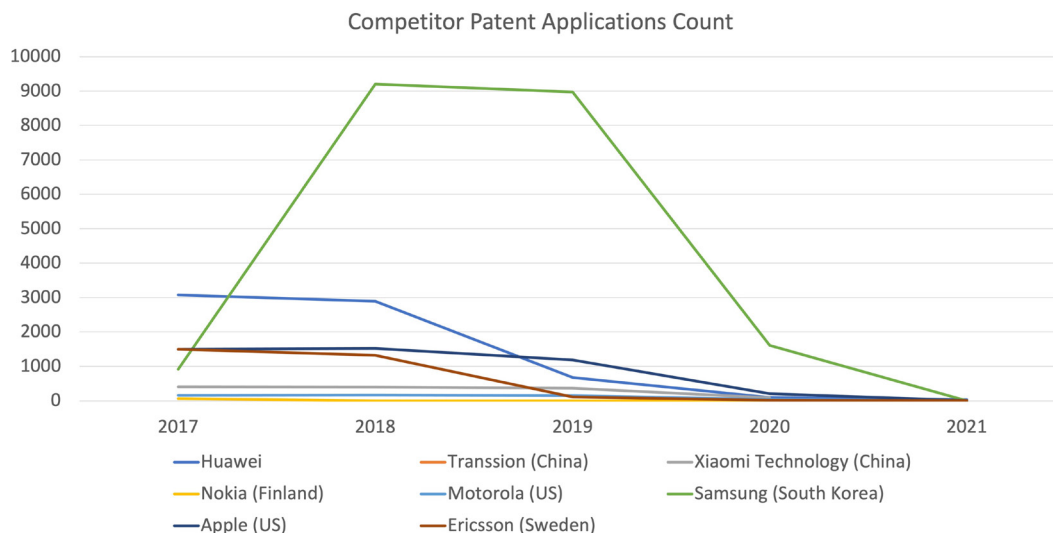


FIGURE 12. PATENT APPLICATIONS BY HUAWEI AND COMPETITORS (2017–2021)

Some patents lacked a date of application and were not included in the analysis. Further, not all of Huawei’s competitors have registered patents, so comparisons were limited to only six other companies. Otherwise, like with many other datasets, the challenge of analyzing patents was contextualizing the raw data.

The data showed an industry-wide trend of fewer patent applications being filed by large technology companies following the implementation of U.S. sanctions. Almost none of Huawei’s patent applications were for semiconductor technologies, in contrast to its investment behavior, which has almost entirely targeted companies in the semiconductor and microelectronics industries.

Post-Sanctions Financial Performance

Financial information reported by Huawei’s parent company, Huawei Investment & Holding Co., Ltd., was accessed through S&P Capital IQ to determine the effect of U.S. economic action on the company’s finances. When

available, the same type of data was retrieved for Huawei’s major competitors in the cell phone and telecommunications sectors and high-tech suppliers, particularly of semiconductors.

Data from December 31, 2016, to June 30, 2021, was assessed to compare Huawei’s financial performance before and after restrictions were imposed in 2019 and 2020. The financial performance of Huawei’s competitors was also observed to determine if they followed similar patterns. Huawei’s Suppliers, particularly those from the United States, were monitored over the same period to capture potential collateral damage from U.S. sanctions.

Huawei’s annual revenue growth rate peaked during this timeframe in 2016 at 32 percent over the previous year (see **Figure 13**). It decreased by nearly half in 2017, then remained at 19 percent for 2018 and 2019. By the end of 2020, after all three U.S. restrictions had taken effect, Huawei’s annual revenue growth rate had declined to 3.8 percent, the lowest since the company began publishing its financial data in 2005. As shown

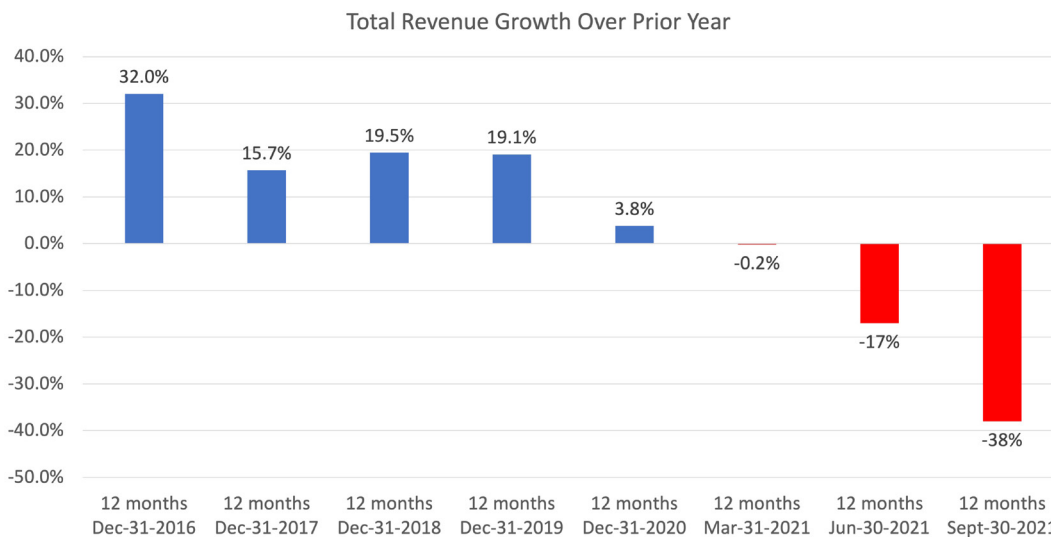


FIGURE 13. HUAWEI TOTAL REVENUE GROWTH OVER PRIOR YEAR

⁷Dan Strumpf, “U.S. Sanctions Cut Huawei’s Revenue for Fourth Straight Quarter,” *Wall Street Journal*, October 29, 2021, <https://www.wsj.com/articles/u-s-sanctions-cut-huaweis-revenue-for-fourth-straight-quarter-11635502615>

in **Figure 13**, during the first three quarters of 2021, every quarter's growth rate compared to the same quarter in the previous year was increasingly negative, putting the company on the path toward its first year of negative growth on record.⁷

Huawei's competitors did not experience the same decline in revenue observed in Huawei's financial reports. Although Huawei, due to its size and reach, is involved in numerous industries, analysis focused on competitors in the two sectors most likely to be influenced by U.S. actions aimed at cutting off Huawei's supply of advanced chips: smartphones and telecommunications equipment.

Huawei's main Chinese competitors in the smartphone and telecommunications sectors performed well during the period following U.S. sanctions against Huawei. In 2020, Transsion's annual revenue grew by almost 50 percent, and its FY21 Q3 revenue was 2.3 times its revenue in FY19 Q2, the quarter during which the first round of U.S. restrictions against Huawei was revealed. Similarly, Xiaomi's annual revenue grew by 20 percent in 2020, while its most recently reported quarterly revenue in FY21 Q2 is around 1.7 times higher than its revenue in FY19 Q2. Another Chinese company involved in both the smartphone and telecommunications sectors, ZTE, saw its annual revenue increase by 12 percent in 2020 after growing by 6 percent in 2019. Overall, every major Chinese competitor in the smartphone and telecommunications sectors experienced double-digit annual growth following U.S. restrictions against Huawei's access to advanced chips, while Huawei's annual revenue has steadily declined into the negative ranges. This supports the

narrative captured in data obtained from social listening datasets that Chinese competitors have benefited from U.S. scrutiny of Huawei, even if its competitors' primary markets are outside of the United States.⁸

Huawei's non-Chinese competitors in the telecommunications space have also not experienced declining revenue following U.S. sanctions. Ericsson's revenue has steadily increased every year since 2019, and Nokia's increased in 2019, decreased in 2020, and at the time of analysis was on target to increase in 2021. In the mobile phone sector, Huawei's major non-Chinese competitors in the high-end smartphone market, Apple and Samsung, experienced higher annual revenue in 2021 than in 2019.

When the United States unveiled restrictions against selling products made with U.S. technology to Huawei, industry groups expressed concern that the measures would inadvertently hurt the competitiveness of Huawei's U.S. suppliers.⁹ Analysis tested whether this occurred by observing changes in total revenue for the set of U.S. companies that derive the highest portion of their revenues from sales to Huawei (see **Figure 14**).

In 2019, the most exposed company in the set, NeoPhotonics, relied on Huawei for nearly 50 percent of its revenue. Although the company's revenue did not decrease during the period between the first two restrictions (Q2 FY19 and Q2 FY20), following the third restriction in Q3 FY20 NeoPhotonics' total revenue dropped from \$103.2 million in Q2 FY20 to \$102.4 million in Q3 FY20. It then decreased to \$68.2 million in

⁸Dan Strumpf, "The World's Hottest Smartphone Brand Is Chinese—and It Isn't Huawei," *Wall Street Journal*, August 23, 2021, <https://www.wsj.com/articles/the-worlds-hottest-smartphone-brand-is-chineseand-it-isnt-huawei-11629711005>

⁹"SIA Statement on the Scope of the Addition of Huawei to the Commerce Department's Entity List," Semiconductor Industry Association, <https://www.semiconductors.org/sia-statement-on-the-scope-of-the-addition-of-huawei-to-the-commerce-departments-entity-list>

BATTLE DAMAGE ASSESSMENT OF U.S. ACTIONS TOWARD HUAWEI (2019-2020): THE NON-TRADITIONAL DATA APPROACH

MOST EXPOSED

Pct of revenues from Huawei

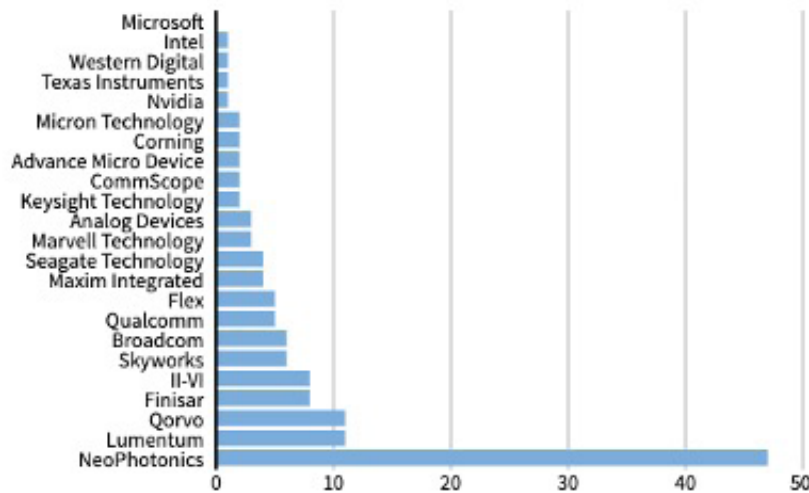


FIGURE 14. MOST EXPOSED U.S. COMPANIES BY PERCENT OF REVENUE DERIVED FROM SALES TO HUAWEI GROWTH OVER PRIOR YEAR¹⁰

Q4 FY20 and \$60.92 million in Q1 FY21. Its total revenue for Q2 FY21 was \$65 million, demonstrating three consecutive quarters of total revenue of only around 60 percent of its all-time-high before the U.S. restrictions against sales to Huawei were unveiled in 2020 (see **Figure 15**).

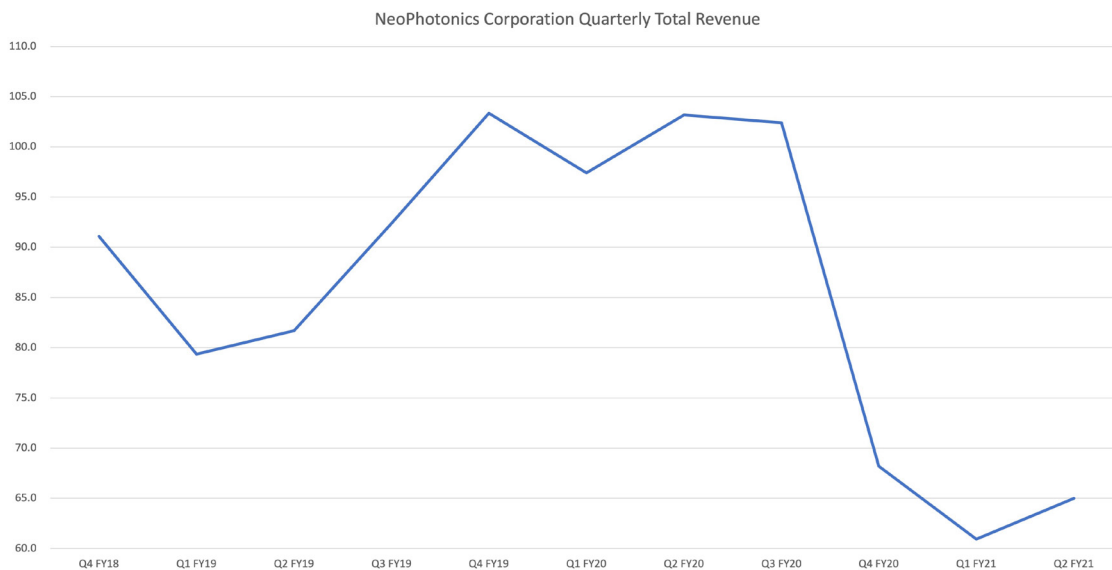


FIGURE 15. NEOPHOTONICS CORPORATION QUARTERLY TOTAL REVENUE

¹⁰Sijia Jiang, Michael Martina, “Huawei’s \$105 billion business at stake after U.S. broadside,” *Reuters*, May 16, 2019, <https://www.reuters.com/article/us-usa-trade-china-huawei-analysis/huaweis-105-billion-business-at-stake-after-u-s-broadside-idUSKCN1SM123>

BATTLE DAMAGE ASSESSMENT OF U.S. ACTIONS TOWARD HUAWEI (2019-2020): THE NON-TRADITIONAL DATA APPROACH

Aside from NeoPhotonics, which was the most exposed U.S. supplier to Huawei by almost 40 percent in 2019, U.S. restrictions did not have an overall negative effect on the revenue of U.S. companies that derived a large portion of their revenue from sales to Huawei. The revenues of only nine (41 percent) of the companies decreased during the quarter coinciding with the first round of restrictions in May 2019, while only eight (36 percent) and six (27 percent) of the companies experienced declines in the same quarters as the 2020 restrictions. When revenues decreased during the same quarters as restrictions, they only decreased by an average of 4.71 percent. When revenues increased in the same quarters as U.S. restrictions, they increased by an average of 18.61

percent. Overall, only four (18 percent) of the 22 most-exposed companies had a lower annual total revenue in 2020 than in 2018, indicating that U.S. restrictions did not have a negative impact on the financial well-being of companies that derived a large portion of their revenue from sales to Huawei in the long term.

Changes in revenue might be due to factors other than U.S. actions targeting Huawei. For example, the outbreak of a global pandemic, and geopolitical issues between China and countries such as India and Australia, during this time could have further exacerbated Huawei's financial difficulties. Nonetheless, the company has repeatedly blamed its decline in revenue and decision to spin off its smartphone brand on U.S. sanctions.

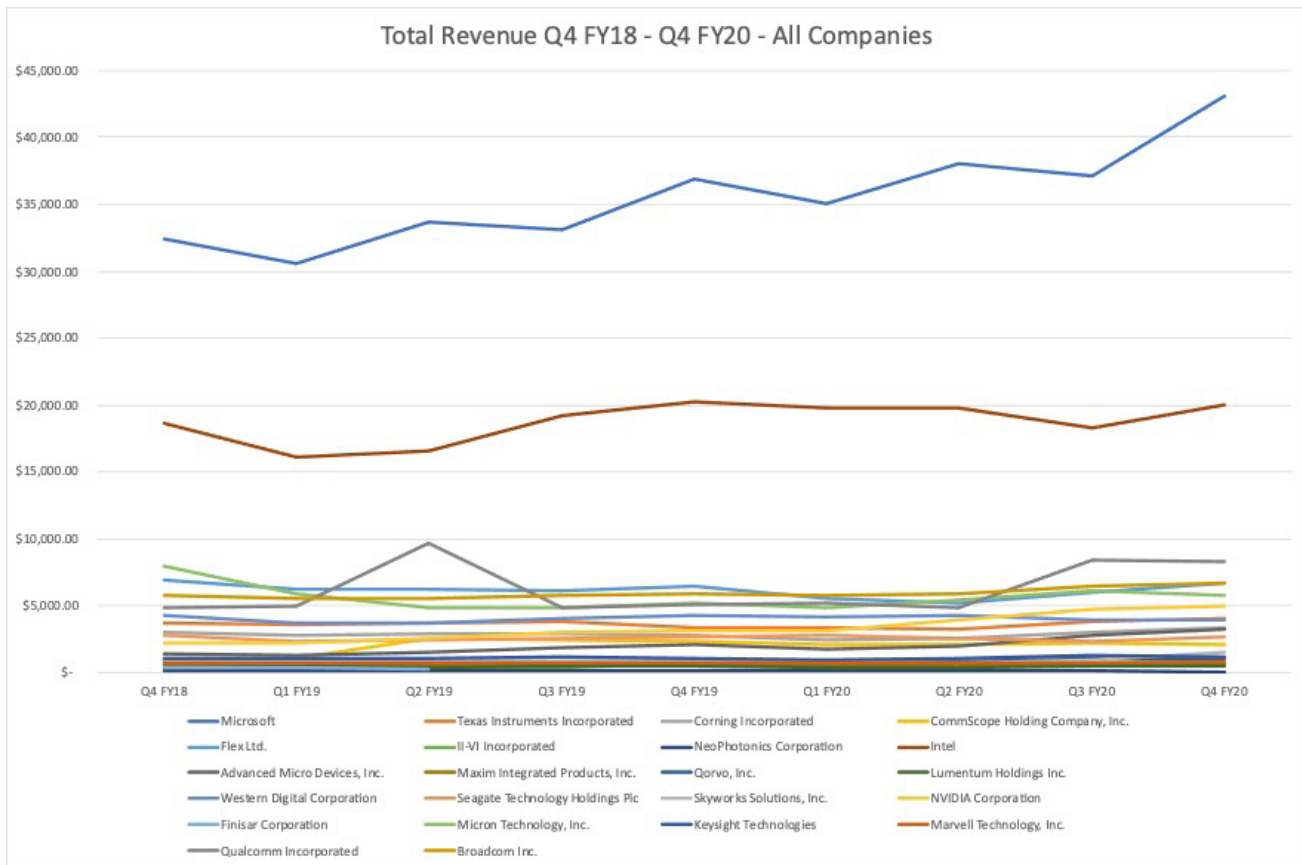


FIGURE 16. TOTAL REVENUE OF MOST-EXPOSED U.S. SUPPLIERS

BATTLE DAMAGE ASSESSMENT OF U.S. ACTIONS TOWARD HUAWEI (2019-2020): THE NON-TRADITIONAL DATA APPROACH

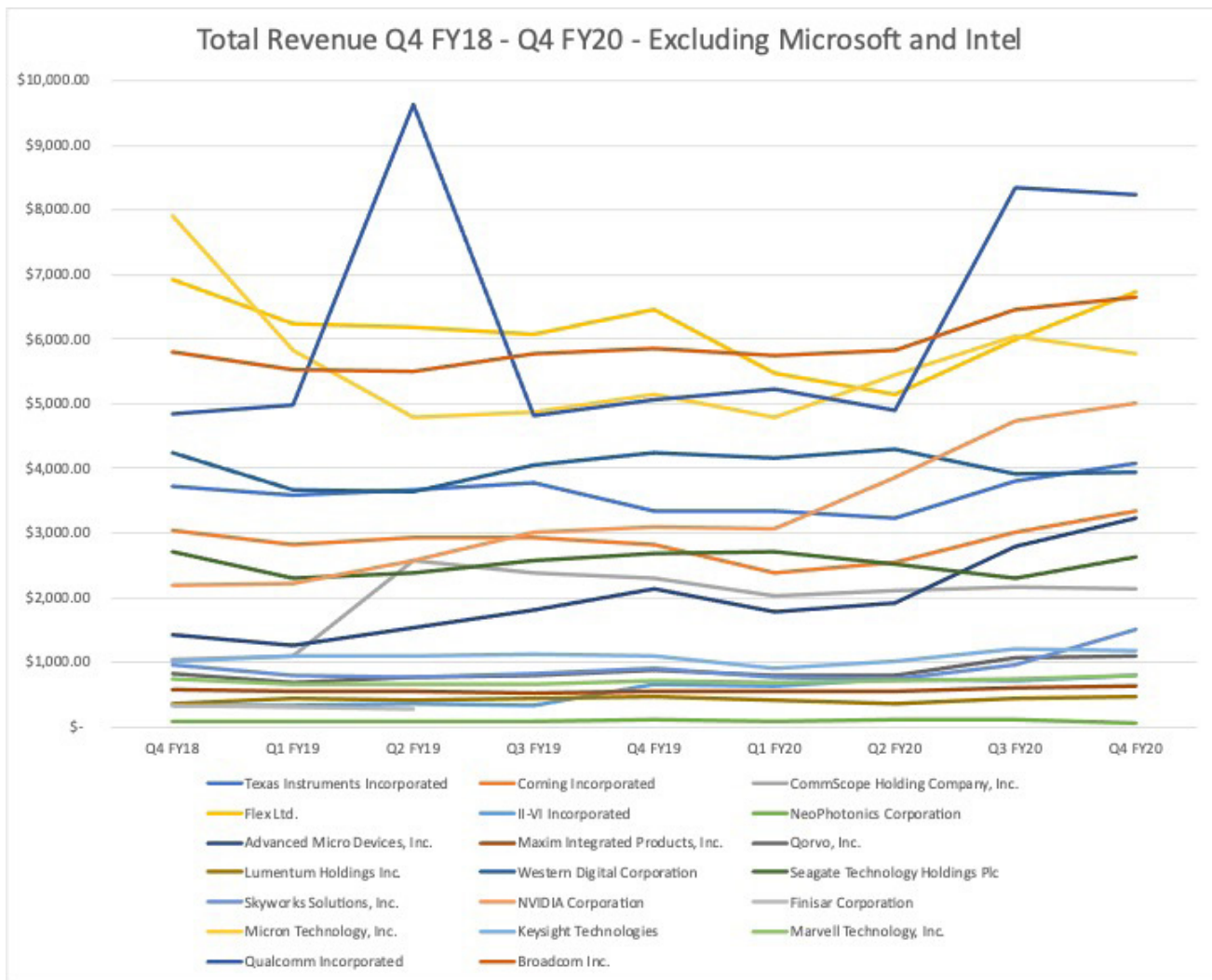


FIGURE 17. TOTAL REVENUE OF MOST-EXPOSED U.S. SUPPLIERS, EXCLUDING MICROSOFT AND INTEL

The Analysis reflected a trend of Huawei’s revenue declining severely after the announcement of U.S. restrictions against the company’s access to advanced chips made with U.S. technology. The data showed limited negative effects on Huawei’s U.S. suppliers, except for NeoPhotonics Corp., its most exposed supplier, whose revenue decreased significantly after the United States announced additional restrictions. As narratives identified in social listening data predicted, the revenues of Huawei’s Chinese competitors surged

following the U.S. actions, with these companies perhaps benefiting from the vacuum left by Huawei’s withdrawal from its dominant position in many smartphone markets. Overall, the data demonstrates that Huawei’s revenue decreased into the negatives after the implementation of U.S. sanctions, with negligible impact observed in the revenue of U.S. and foreign suppliers and competitors.

Donation Activity

Data from IntelTrak was used to assess Huawei's global donations, including humanitarian aid and medical technology, from 2017 to 2021 to determine if U.S. sanctions prompted a change in the company's behavior toward other countries, especially those where it already had a substantial presence and was seeking to increase its foothold.

As the United States imposed restrictions and escalated efforts to reduce Huawei's global presence, Huawei made donations to 27 countries that shared two or more of the following traits: Huawei 4G, Huawei 5G, a Huawei safe city, a Huawei data center, or a memorandum of understanding (MOU) between itself and China regarding the Belt and Road Initiative (BRI). The data demonstrates that Huawei has greatly increased its donation efforts in the wake of the first sanction unveiled on May 15, 2019.

The data shows a correlation between current or former use of Huawei products in a 4G network and whether a country received donations and humanitarian aid, as all 27 recipient countries fulfilled both conditions. Ten of these countries either already use or plan to adopt Huawei 5G, fifteen have yet to implement 5G or are considered unlikely to include Huawei in their 5G network, and two have banned Huawei outright.

Most recipient countries already contain Huawei infrastructure in the form of safe city technology or data centers; 21 of the countries have hosted or announced safe cities, while 23 of the countries have hosted data centers. Moreover, 23 of the 27 recipient countries have signed MOUs with China related to the Belt and Road Initiative, representing a degree of support for the Chinese project.

Country	Continent	Start Date	Huawei 4G	Huawei 5G	Safe City	Data Center	BRI MOU
			(current or former; open source)	(current or planned; CFR)	(per CFR/ASPI)	(ASPI)	(GFDC)
Argentina	South America	3/27/2020	Y	Y	Y	Y	N
Azerbaijan	Asia	3/1/2020*	Y	Y	Y	Y	Y
Bangladesh	Asia	7/9/2020	Y	N	Y	Y	Y
Botswana	Africa	11/7/2019	Y	N	Y	Y	Y
Brazil	South America	1/24/2021	Y	Y	Y	Y	N
Ecuador	South America	3/17/2020	Y	Y	Y	Y	Y
Ethiopia	Africa	6/1/2021	Y	N	Y	Y	Y
Gambia	Africa	7/30/2020	Y	N	N	N	Y
Greece	Europe	3/13/2020	Y	N	N	N	Y
Indonesia	Asia	3/25/2020	Y	Y	Y	Y	Y
Italy	Europe	3/16/2020	Y	N	Y	Y	Y
Kenya	Africa	10/29/2019	Y	N	Y	Y	Y
Lithuania	Europe	3/20/2020	Y	N	N	N	Y
Myanmar	Asia	12/27/2017	Y	N	Y	Y	Y
Nigeria	Africa	11/30/2020	Y	N	Y	Y	Y
Pakistan	Asia	3/21/2020	Y	N	Y	Y	Y
Singapore	Asia	3/24/2020	Y	N	Y	Y	Y
South Africa	Africa	3/23/2020	Y	Y	Y	Y	Y
Sri Lanka	Asia	5/5/2020	Y	Y	Y	Y	Y
Tanzania	Africa	12/12/2019	Y	N	Y	Y	Y
Thailand	Asia	4/15/2020	Y	Y	Y	Y	Y
United Arab Emirates	Asia	10/20/2019	Y	Y	Y	Y	Y
United Kingdom	Europe	2/10/2021	Y	N	Y	Y	N
United States of America	North America	3/26/2020	Y	N	N	N	N
Uzbekistan	Asia	3/20/2020	Y	Y	Y	Y	Y
Zambia	Africa	3/26/2020	Y	N	N	Y	Y
Zimbabwe	Africa	5/18/2019	Y	N	N	Y	Y

TABLE 4. HUAWEI'S GLOBAL DONATIONS

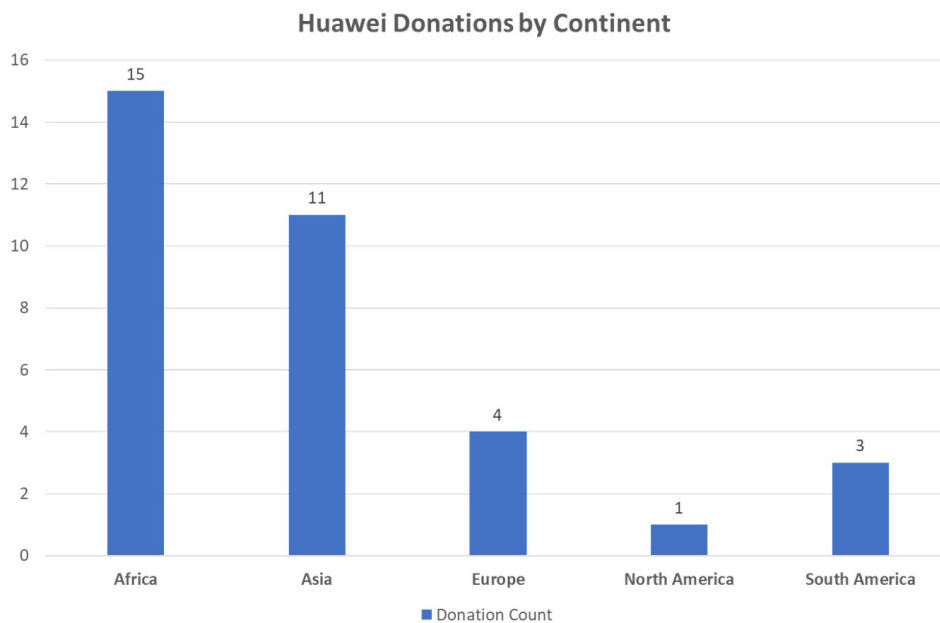


FIGURE 18. HUAWEI DONATIONS BY CONTINENT

The data reflects Huawei’s strategy to advance its interests in countries that satisfy several of the aforementioned conditions and protect its positions against U.S. restrictions and scrutiny. Several recipients benefit from their significance to Huawei’s expansion, both in the past and going forward. For example, Greece served as Huawei’s entry point into Europe and was one of Huawei’s first customers outside China;¹¹ additionally, Greece serves as a key node in BRI due to its hosting of the Piraeus Port megaproject.¹²

Huawei’s donations of healthcare equipment to Brazil coincided with a surge in Brazil’s COVID-19 cases and the lead-up to its 5G auctions.

Moreover, it occurred following the change in U.S. administration; the close friendship enjoyed by Presidents Trump and Bolsonaro contributed to the Brazilian government’s previous skepticism toward Huawei products.¹³

The United States and United Kingdom (UK), two countries that have banned Huawei products, also received donations. The United States received medical donations during the onset of the COVID-19 pandemic and after the imposition of sanctions, while the UK’s Greater Manchester Combined Authority received free educational technology seven months after the British government announced its decision to remove Huawei technology from all 5G networks.¹⁴

¹¹Eliza Gkritsi, “How Huawei hooked Greek telcos,” December 9, 2020, *technode*, <https://technode.com/2020/12/09/how-huawei-hooked-greek-telcos/>

¹²Jennifer Hillman, Alex Tippett, “The Belt and Road Initiative: Forcing Europe to Reckon with China?,” April 27, 2021, *Council on Foreign Relations*, <https://www.cfr.org/blog/belt-and-road-initiative-forcing-europe-reckon-china>

¹³“Brazil regulator approves 5G spectrum auction rules, no Huawei ban,” February 25, 2021, *Reuters*, <https://www.reuters.com/business/media-telecom/brazil-regulator-approves-5g-spectrum-auction-rules-no-huawei-ban-2021-02-26/>

¹⁴“Huawei to be removed from UK 5G networks by 2027,” July 14, 2020, *Gov.uk*, <https://www.gov.uk/government/news/huawei-to-be-removed-from-uk-5g-networks-by-2027>

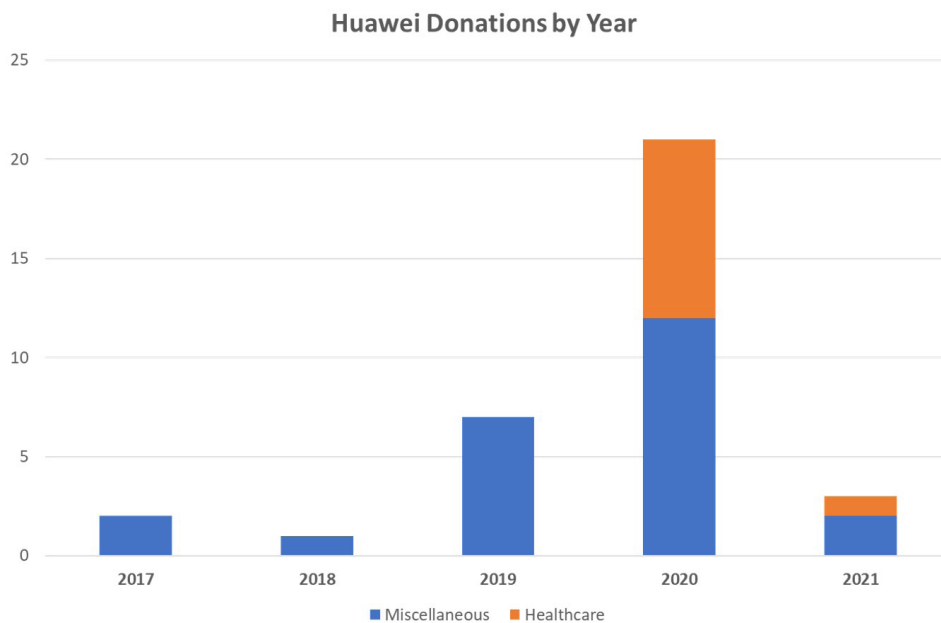


FIGURE 19. HUAWEI DONATIONS (2017-2021)

Twelve of the countries that received donations are “digital swing states,” or countries that play an influential role in global internet governance, an area in which Huawei has begun to play a major role in recent years, most notably with its “New IP” proposal at the United Nations (UN).¹⁵ In particular, Brazil, Indonesia, Singapore, Argentina, and South Africa have been regarded as highly influential in deliberations on global internet governance at the UN, due to the need by states on opposing sides of the internet control spectrum, usually the United States and Russia, to recruit them to their camp.

In public statements, Huawei has framed humanitarian efforts as part of its country-level approach. When asked about Huawei’s plans for Azerbaijan in the wake of U.S. sanctions by the

Baku Tribune, Huawei Technologies Azerbaijan Chief Executive Officer (CEO) Xu Hui described the company’s business philosophy as consumer centric and characterized medical donations at the onset of COVID-19 as “corporate social responsibility.”¹⁶

Transaction data supports Xu’s statement. After making only three total donations from 2017 through 2018, Huawei’s total donations jumped to seven in 2019 (five of which occurred after the May 15, 2019 sanctions), twenty-one in 2020, and three at the time of analysis in 2021. Though this spike coincided with the emergence of the COVID-19 pandemic, only 10 of the 29 post-sanction donations involved COVID-related healthcare equipment.

¹⁵Anna Gross and Madhumita Murgia, “China and Huawei Propose Reinvention of the Internet,” March 27, 2020, *Financial Times*, <https://www.ft.com/content/c78be2cf-a1a1-40b1-8ab7-904d7095e0f2>

¹⁶Seymur Mammadov, “The chief of Huawei responded to the topical questions of Baku Tribune – EXCLUSIVE,” May 18, 2021, *Baku Tribune*, <https://bakutribune.com/en/news/593/what-are-huaweis-plans-for-azerbaijan-exclusive->

While IntelTrak offers comprehensive coverage of Huawei's donations, additional open-source research was required to contextualize these investments and gain insight into Huawei's overall strategy. Particularly useful resources included the Australian Strategic Policy Institute (ASPI), the Council on Foreign Relations (CFR), and several telecommunications-focused online publications.

In contrast to data highlighting Huawei's investment in companies that specialize in advanced semiconductor and microelectronics technologies, transaction data demonstrates Huawei's investment in social and political capital. Trends illuminated by the raw data, along with additional context provided by other open-source resources, reflect how the company has shifted its behavior in response to U.S. actions.

Information Environment

Online Discourse and Bot Activity Around U.S. Sanctions

Data from Pulsar and Botometer enabled the collection of content in social media, news, and review data from Twitter, Facebook pages, Tumblr, YouTube, VK, blogs, forums, news, reviews, Aliexpress, Amazon, Baidu, Expedia, Naver, Reddit, Taobao, Tripadvisor, and Trustpilot. This data was used to measure differences in audience attention, sentiment, and narratives related to Huawei both before and after the sanctions, and monitor social listening attributes for Huawei competitors to determine shifts in consumer behaviors.

Analysis included data from the nine months before and after U.S. sanctions against Huawei in 2020:

- January 1, 2020–October 1, 2020: May 2020 action
- April 1, 2020–January 1, 2021: August 2020 action [overlap with May 2020 action timeframe].

During the two weeks following the May 2020 restrictions (May 15–29), these websites contained a total of 49,780 posts and 32,820 engagements. In the two weeks following the August 2020 event (August 17–31), the sites contained a total of 38,000 posts and 16,300 engagements. The list below gives a breakdown of the data by query.

English-language Query:

- May 15–29, 2020 (two weeks post-sanction): 23,700 posts, 15,300 engagements
- August 17–31, 2020 (two weeks post-sanction): 18,700 posts, 6,860 engagements
- Russian-language Query: May 15–29, 2020: 13,000 posts, 4,880 engagements

- August 7–31, 2020: 10,600 posts, 4,850 engagements
- Chinese-language Query:
 - May 15–29, 2020: 10,700 posts, 11,200 engagements
 - August 7–31, 2020: 7,100 posts, 4,340 engagements
- Spanish-language Query:
 - May 15–29, 2020: 2,380 posts, 1,440 engagements
 - August 7–31, 2020: 2,120 posts, 255 engagements

Attention to U.S. sanctions waned between the May and August 2020 restrictions, coinciding with Huawei temporarily dethroning Samsung as the number one global smartphone provider in July 2020. In Chinese, English, and Spanish, conversation among individual commenters focused more on competition between companies rather than on competition between countries. The data revealed substantial public interest in determining which companies might benefit from the gaps left behind by Huawei following U.S. restrictions. For example, analysis noted over eight million English-language discussions of investment in stocks, particularly in Qualcomm and Ericsson. Commenters also discussed how the ban would affect their personal devices, usually expressing interest purely in the technology itself (i.e., having the newest technology, most user-friendly device, most reliable device, etc.) rather than discussing the bans themselves. This trend appeared regardless of the company with which the commenters seemed most familiar. In other words, discussion among Apple, Huawei, Xiaomi (etc.) users revolved around whether or not they should switch phones.

However, in the immediate wake of each ban (two weeks following each one), the postings in different languages showed more distinct focuses. Highly engaged content in Chinese included news sources, such as *Global Times* and *Nanyang Business Daily*, highlighting Huawei's willingness to "fight back" as well as China's overall strategies to advance technologically and surpass the United States; notably, postings and discussions in Vietnamese showed similar sentiments.

The most highly engaged English content had a similar focus—it tended to refer to U.S. news sources, such as the U.S. publication of the *Daily Mail*, *Daily Wire*, and CNBC, some of which mentioned the possibility that China would retaliate. However, these articles showed more varied opinion. Many drew attention to the potential backlash toward specific companies, such as Apple and Boeing, but either declared it unlikely that China would act on its threats and that these threats were therefore not a concern or were concerned about how the ban could negatively affect the U.S. economy.

There was less content in Spanish overall, but the content captured was largely matter of fact, referring to fewer news sources and containing less clear judgements. Most of the content came from Spain, but the United States and Mexico often had more emotionally engaged Spanish-language content around the time of the bans. The official state news source of Cuba, *Presna Latina*, was especially vocal during the May 2020 ban, appearing to support China.

In contrast to postings in other languages, Russian-language content at both the individual and news media level focused significantly less on either ban and expressed less engagement with posted content. However, Russian language postings constituted the only context in which more nuanced discussion about the bans'

implications occurred. For example, the top posts in Russian two weeks following the May 2020 ban contained more detail that explained what strategic responses to expect from China, particularly technologically, rather than the vaguer posts about retaliation common in English, Chinese, and Spanish. Throughout the year, Russian content also appeared to maintain a slightly greater focus on competition between countries as opposed to between companies. Russian-language conversation continued to return to overall global technological dominance, influence, and trade among Russia, China, and the United States.

Data also revealed an interest in U.S. actions as they related to bans, or possible bans, in other countries. For example, in June 2020, English-language content included discussion about Huawei bans in the UK following U.S. actions. Once the UK banned Huawei products, July 2020 conversation shifted to pressure to ban Huawei in Canada, reiterating former President Trump's declaration that countries wishing to do business with the United States must impose their own ban. Similarly, Russian-language content discussed the Huawei ban in Ukraine, often declaring it the result of U.S. pressure.

Analysis leveraged the data to identify top influencers within each query. These sources were scored based on their uniqueness in attention relative to the global population. English, Chinese, and Spanish queries did not display significant changes to top influencers between the nine-month timeframes surrounding the second and third event.

Most top individual influencers were, and remained, government officials. In the English and Chinese queries, this included both U.S. politicians such as former President Donald Trump (as well as his archival account) and Mike Pompeo, as well as Taiwanese President Tsai Ing Wen and Hong Kong

political activist Joshua Wong. Elon Musk was also a consistent top influencer within these queries. In the Spanish postings, top government officials included former Ecuadorian president Rafeal Correa, and Venezuelan President Nicolás Maduro. Pope Francis was also a consistent top influencer cited in this material.

Only the Russian-language material displayed significant changes in its most influential individuals as well as most influential news sources. Top individuals during the nine months surrounding the second event (May 2020) were more similar to those cited in other languages in that they were mostly government or politically oriented officials. This included individuals such as Aleksey Pushkov, a Russian senate member and chairman of the Federation Council Commission of Information Policy; Armen Gasparyan, a Russian political scientist and journalist; and Sergei Mikheev, a Russian political scientist. However, in the nine months following the third event (August 2020), top influencers shifted to more technology-oriented individuals, including Eldar Muritazin, a Russian blogger who focuses on phone-related topics; Elon Musk; and a seemingly anonymous Twitter account called “evskrieks” whose biography reads “phone enthusiast, political officianado.”

Russia’s major state-owned news source, TASS, remained the most influential online news source across timeframes. However, other state-owned channels, primarily *RIA Novosti*, lost their top influencer status within the second timeframe and were overtaken by independent sources such as Russia’s RBC Group and Latvia-based *Meduza*.

Analysis captured bot activity on Twitter and observed that it increased following major Huawei-related events within this timeframe. Throughout the year, most content appeared to be news channel bots tweeting headlines or event summaries to draw traffic to linked

articles. Bots came mostly from the United States, but China, India, Brazil, and the UK were also significant contributors to bot activity. Russia, although active, was a less significant contributor. The bot postings that attracted the greatest attention dealt with competition between companies, such as changes in global provider ranking or competing technological products and advancements. The third Huawei restriction in August 2020 did not trigger a significant increase in bot activity.

The greatest overall increase in bot activity occurred in June and July 2020, between the second (May) and third (August) restrictions. During these months, bot activity from the United States and China peaked. Russian bot activity did not increase significantly during this time. The United States and China displayed similar content; in June, this content focused largely on pressures in Canada to ban Huawei, as well as Canadian companies, such as Canada Bell and Telus, opting for Ericsson and Nokia over Huawei for their 5G networks. Chinese bots pointed to Singaporean operators making the same choice. They also noted that Samsung and Japan’s NEC were poised to fill gaps left behind by Huawei’s then most recent ban. July content varied more, but centered on Huawei overtaking Samsung to become the top global smartphone provider.

February 2020 also revealed an increase in bot activity, particularly from the United States and Russia. During this time, U.S. bot content appeared to come largely from news sources tweeting about Huawei outselling Apple in 2019, as well as various posts about France selecting Ericsson and Nokia rather than Huawei to lead 5G efforts amid U.S. and European pressure. Some posts also drew attention to Xiaomi, Huawei, Oppo, and Vivo joining the Global Developer Service Alliance (GDSA) to create an alternative to Google

Play Store. However, Russian bots, including bots that did not appear to be news sources, showed the greatest focus on drawing attention to this event. In fact, Russian bots were more active this month than in any other month that year. This may have occurred because Russia was one of the nine countries where GDSA was set to debut the following month.

Pulsar's sentiment gauge could not be utilized because it was unclear why engagements received a positive, negative, or neutral score, when the content suggested otherwise. This could have been due to the content that was collected from this query. When engagement scores lack explainability, sentiment analysis is hindered.

Analysis found that the public shows interest in technology bans, but that interest may decrease over time. It also revealed that the public, except in Russia, was generally more concerned with how each ban might affect their personal needs, such as phone functionality or which stocks to buy, and less concerned with the overall political or trade consequences of the action. Among those who did express concern over political or trade implications, conspiracy theories, as well as concern over espionage in general, emerged and became topics of discussion. Social media content expressed greater concern over what caused the ban, to include bans outside the United States, than over the consequences of the ban itself.

Online Discourse about U.S. Sanctions

Analysis also leveraged a webcrawler to gather data from international news sources, technical publications, social media, and other online forums to measure differences in audience attention and popular narratives related to Huawei before and after sanctions and monitor these social listening attributes for Huawei competitors to

determine shifts in consumer behaviors. Like the methodology used with Pulsar, data was collected from the nine months before and after each of the three U.S. actions targeting Huawei between 2019 and 2021:

- January 1, 2019–October 1, 2019: May 2019 action
- January 1, 2020–October 1, 2020: May 2020 action
- April 1, 2020–January 1, 2021: August 2020 action [overlap with May 2020 action timeframe].

For each nine-month timeframe, there was consistency among the most common sources identified, organizations discussed, topics, and significant locations of conversation:

- Top five Sources: Instagram, YouTube, Google, Google News, Google Images or Vkontakte
- Most Common Content Topic: Technology and Computing
- Top 5 Organizations: Huawei, Samsung, Apple, Nokia, Google
- Top 3 locations: China, U.S and Russia.

For the first round of U.S. restrictions in May 2019, sources showed a small spike in content leading up to and after the action. Most of the content came from social media sources and news forums discussing the implications of the ban for additional stakeholders and Huawei users, and consequences for U.S.–China relations. Only limited content addressed the effects of the ban for the United States and China in terms of security concerns, revenue loss, etc. After June 1, there was a decline in content, with a steady stream until August to September, when there was close to a 50 percent increase in content.

Overall, for the second round of U.S. restrictions in May 2020, more content was available than after the first ban, but the content showed similar trends, as a plateau occurred before and after the May 2020 sanction. Social media platforms and news forums generated most of the content, with conversation centering on TSMC and Huawei, as well as Huawei's involvement in Africa. Content about consequences for international relations and stakeholders was very limited. Similar to the first sanction, the online content showed a significant increase from August to September, and a Reddit post, "Hu Xijin: China is not afraid of a hot war," generated some attention, with comments from both ends of the spectrum.

Data from the time of the third sanction in August 2020 exhibited similar trends. The period from April to August exhibited a plateau, and a significant spike occurred in September. The content of this spike echoes previous findings identified after the May 2020 sanction. Following the August to September spike, a significant amount of content came from news forums covering international conflicts. A limited amount of Huawei content after October 1 consisted of social media platform and news forum discussions of Huawei's involvement in Africa.

As with Pulsar, the webcrawler enabled the observation of increased content around the time of all three U.S. actions. Unique to the webcrawler is content discussing Huawei's involvement in Africa, which was not assessed with Pulsar. Both tools revealed discussions around how the bans will affect users, companies, and U.S.–China relations. Overall, the webcrawler and Pulsar were equally effective for viewing trends in the information environment related to the three U.S. actions directed toward Huawei.

Online Audience Attention to Huawei and Competitor Products

The analysis leveraged Predata to observe metadata from web traffic to Wikipedia pages, YouTube videos, and domain-to-subdomain-level web addresses. This, in turn, enabled the measurement of audience attention to Huawei products (both legacy and modern) as compared to its competitors. The goal of this comparison was to determine whether sanctions influenced foreign-language audience interest in Huawei products, producing either a decrease or an increase of interest in their competitors' products. Attention in English, German, Russian, Chinese, French, Spanish, and Swedish was assessed.

Quarterly audience attention metrics from January 2016 to June 2021 were analyzed to determine baseline trends for Huawei and its competitors before sanctions and observe changes afterwards.

In all language audiences of interest, online material noted that Huawei saw rapid quarter-over-quarter growth from 2016 to June 2019. During this period, English-language attention grew by 20.5 percent on average. Aggregate attention to Huawei products from all languages studied in this period averaged a quarterly growth rate of 132.5 percent. Following the first sanction in May 2019, foreign language attention to Huawei products entered its first decline, which persisted throughout all quarters of 2020 at an average of rate of 3.2 percent quarter-over-quarter in English. At an aggregate level, all foreign language attention to Huawei products beginning in 2019 averaged a 6.1 percent quarterly decline, representing an interruption in global interest and attention to Huawei products during the same period in which the sanctions were levied.

As global attention to Huawei products decreased, Spanish-language attention to Oppo and Ericsson and Chinese-language attention to Xiaomi and Motorola increased. For example, Spanish-language audience attention to Oppo increased at an average rate of 25.9 percent quarterly in 2020 and 2021. Oppo and Xiaomi are major competitors in the handheld phones space, while Ericsson and Motorola compete against Huawei in telecommunications.

Audience attention to Ericsson in all language groups saw an average annual increase of 6.6 percent from the beginning of 2016 to 2021. Spanish language attention to Ericsson products averaged 11 percent quarterly growth until the second quarter of 2020, around the time of the second round of U.S. sanctions. From that period until the end of the analysis, Spanish language attention to Ericsson increased by 12 percent quarterly.

Xiaomi, in all language groups, saw an average quarterly increase in attention of 20.4 percent until September 2019, shortly after the first U.S. action against Huawei. Until this point, Chinese language attention grew by 11 percent on average. Afterwards, Chinese attention to Xiaomi grew by 14 percent during the final eight quarters analyzed.

For all language groups, attention to Motorola decreased by an average of 4.4 percent every quarter until January 2019. Prior to this point, Chinese language attention decreased at a rate of 6 percent every quarter. Afterwards, Chinese language attention to Motorola increased by 10 percent for the remaining quarters of the analysis.

There are a few challenges to analyzing metadata for this scenario. First, while there are many product pages for consumer products, like smartphones, there are fewer product pages available online that could capture official government interest in Huawei technologies key to smart city development and 5G rollout efforts. Second, Huawei saw its first initial decline in global foreign attention to its products in January 2020, roughly coinciding with the emergence of the SARS CoV-2 virus. Due to the virus' impact on the global economy, it cannot be excluded as a potential contributing factor to the decline in international attention to Huawei's products.

Nonetheless, data obtained from Predata revealed a correlation between decreased global attention to Huawei products and initial sanctions, along with a representative increase in attention to its competitors' products. This decrease in international audience attention to Huawei products interrupted year-over-year growth that preceded U.S. sanctions.

Summary and Conclusion

This case demonstrates that NTD can be particularly effective when examining the effects of targeted sanctions against corporations. NTD revealed that Huawei shipments overseas and revenue declined at steep rates at the same time as the company's hiring rate slowed and online attention to its products declined relative to its competitors. The analysis also leveraged NTD to gain insight into Huawei's survival strategy following the announcement of U.S. sanctions that sought to deprive the company of access to the technology it needs to create its products. As investment data shows, Huawei has been investing in later-stage Chinese companies in the semiconductor industry rather than in startups. Additionally, patent data shows that Huawei is largely not filing semiconductor-related patents. Moreover, Huawei's overseas donation activity reflects how the company is increasing its donations in crucial markets, such as Brazil, which received medical donations from Huawei as the number of Brazilians infected with COVID-19 climbed and the country's 5G auction approached. Its donations also reached countries that play influential roles in multilateral forums or are key nodes in China's Belt and Road Initiative, such as Greece and Italy. This data demonstrates how U.S. sanctions changed Huawei's behavior.

Beyond assessing how U.S. sanctions affected Huawei and influenced its behavior, the analysis also examined how sanctions impacted Huawei's most-exposed U.S. suppliers and competitors across multiple areas, including shipments, financial performance, reputation, perceived reliability, and online attention. For example, aside from Huawei's most-exposed U.S. supplier, NeoPhotonics, which experienced a severe decrease in revenue following sanctions, U.S. sanctions largely had little long-term effect

on Huawei's other U.S. suppliers. Huawei's competitors in Mexico increased the volume of their shipments after the United States imposed its sanctions, while Huawei's shipments steadily declined. In the information environment, online discourse regarding the viability of Huawei's competitors following U.S. restrictions and internet metadata revealed less attention to Huawei products and more attention to its competitors'.

This study provided opportunities for different data sources to complement and supplement each other. For example, both S&P Capital IQ and Pitchbook were used to collect publicly reported investments by Hubble Technology Investment Co., Ltd., Huawei's investment arm. By considering both sources' Hubble investment data, a more complete picture of how Huawei allocated its capital was built. Though IntelTrak had an impressive list of Huawei's overseas donations, its data was supplemented with open-source datasets from ASPI, CFR, the Green Finance and Development Center and several telecommunications-focused online publications. In addition, the analysis integrated findings from Pulsar, Predata, and a webcrawler, which all indicated increased interest in the products of Huawei's competitors because of U.S. sanctions.

Huawei's official employment figures did not decline during the use case's timeframe, despite shocks to the company's revenue and online discourse and shipping data indicating decreased demand for its products. As Huawei began investing aggressively in semiconductor companies, the analysis would have benefited from insight into the kinds of talent the company was hiring. For example, because Huawei currently invests heavily in semiconductor companies, it may be hiring more staff who specialize in

nanotechnology, materials science, and electrical engineering. Because none of the data sources provide this level of insight into company hiring trends, the analysis could not test this hypothesis. If it had been supported, this would have provided an even greater understanding of how Huawei has responded to U.S. sanctions.

Because many Chinese corporations are not publicly traded, business intelligence platforms often do not contain data such as quarterly corporate revenue. However, although Huawei is officially a private company, the analysis could leverage the financial data that it reports quarterly because it has a public debt profile due to the sale of bonds to international investors. Future BDA using NTD about particular corporations must take this into account and expect to find significantly less data about private corporations that have no public debt profile.

Similarly, high volumes of social listening data and internet metadata were successfully collected because of the prominence of U.S. sanctions in media reporting and Huawei's dominance in mobile phone markets. Less prominent companies and topics would have produced fewer results to capture due to lower public awareness.

This use case only begins to explore the potential of using NTD for BDA. As noted regarding employment data, the types of data leveraged have additional dimensions that must be fully examined to understand their utility. Nonetheless, this BDA of U.S. sanctions targeting Huawei demonstrates that NTD can prove invaluable for BDA, particularly when the subject is a corporation prominent enough to become a topic of conversation in the information environment and for which business intelligence and shipping data is available. Future work should further integrate different data sources and additional scenarios to build upon the findings of this case to extend the boundaries of our understanding of what is possible using NTD.

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