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Recent Trends in U.S. Services Trade: 2022 Annual Report

May 2022
Publication Number: 5325
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United States International Trade Commission

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Preface

This report is the 26th in a series of annual reports on recent trends in U.S. services trade published by the U.S. International Trade Commission (Commission or USITC). The Commission also publishes an annual companion report on U.S. trade in goods, *Shifts in U.S. Merchandise Trade*. These recurring reports are the products of an investigation instituted by the Commission in 1993 under section 332(b) of the Tariff Act of 1930.[1] This report is one of the regular publications by the Commission that present expert analysis of trade in services industries. It draws on interviews with industry representatives as well as published sources to apprise the Commission's customers and the public of global industry trends, regional developments, and competitiveness issues.

[1] On August 27, 1993, acting on its own motion under section 332(b) of the Tariff Act of 1930 (19 U.S.C. 1332(b)), the Commission instituted investigation no. 332-345, *Annual Reports on U.S. Trade Shifts in Selected Industries*. On December 20, 1994, USITC on its own motion expanded the scope of this report to include more detailed coverage of services industries. Under the expanded scope, USITC publishes two annual reports, *Shifts in U.S. Merchandise Trade* and *Recent Trends in U.S. Services Trade* (*Recent Trends*). The Commission's current report format provides a systematic means of examining and assessing major trade developments with leading U.S. trading partners in the services, agriculture, and manufacturing sectors. Beginning in 2013, *Recent Trends* has rotated its coverage on an annual basis between four services categories: financial services, distribution services, digital and electronic services, and professional services. The 2021 report focused on professional services. The most recent report covering digital and electronic services was published in 2018.

Abbreviations and Acronyms

Terms	Definitions
AI	artificial intelligence
BEA	U.S. Bureau of Economic Analysis
COVID-19	coronavirus disease 2019
EU	European Union
FTA	free-trade agreement
FTE	full-time equivalent
GATS	General Agreement on Trade in Services
GDP	gross domestic product
GHG	greenhouse gas
IoT	Internet of Things
IT	information technology
LEO	low-earth orbit (satellite)
LTE	Long-Term Evolution (mobile technology)
MENA	Middle East and North Africa
MNE	multinational enterprises
MOFA	majority-owned foreign affiliate
MOUSA	majority-owned U.S. affiliate
ms	millisecond
NAICS	North American Industry Classification System (U.S. Census Bureau)
SSA	sub-Saharan Africa
SVOD	subscription video on demand
Tbps	terabits per second
TV	television
UBO	Ultimate beneficial owner
UK	United Kingdom
USDOC	U.S. Department of Commerce
USITC	U.S. International Trade Commission
WTO	World Trade Organization
2G	second generation (mobile technology)
3G	third generation (mobile technology)
4G	fourth generation (mobile technology)
5G	fifth generation (mobile technology)

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Executive Summary

This report covers U.S. services trade and topics pertaining to services industries. In particular, it focuses on developments in U.S. trade in digital and electronic services, highlighting aspects of the audiovisual, computer services, and telecommunications industries in two chapters organized around two over-arching themes: (1) the global reach of many services alongside their increased adaptation to local markets; and (2) the impact of new internet technologies on how many types of services are delivered and how consumers access these services.

Trade in services falls into two categories: cross-border transactions, and transactions in one country by affiliates of firms that are headquartered in another country. In 2020, the United States continued to be the world's largest exporter and importer of services with respect to cross-border transactions and transactions of foreign affiliates.[2] That same year, U.S. cross-border exports in services totaled $684.0 billion, or 13.9 percent of global services exports; U.S. cross-border services imports totaled $435.6 billion, or 9.5 percent of global services imports. Sales by the foreign affiliates of U.S. services firms (referred to here as affiliate sales) totaled $1.8 trillion in 2019 (the latest year available), while purchases from the U.S. affiliates of foreign-owned services firms totaled $1.2 trillion. Given the inherently local nature of many services—they often require in-person delivery or provision by locally regulated entities—U.S. trade in services through the foreign affiliates of U.S. services firms is consistently larger than U.S. cross-border services trade.

Report Highlights

The United States Ran a Trade Surplus in Both Cross-border Services Trade and Foreign Affiliate Sales

In 2020, U.S. cross-border services exports exceeded imports, resulting in a trade surplus of $248.0 billion. Cross-border trade surpluses were recorded in most major services sectors, with the largest surpluses in professional services, financial services, and travel services. The United States' largest cross-border trading partner in services in 2020—in terms of both imports and exports—was the United Kingdom (UK). After the UK, the top export destinations were Ireland, Canada, the UK Islands (Caribbean territories), and Switzerland, and the top import sources were Japan, Bermuda, Canada, and Germany.

In 2019, the most recent year for which data were available, affiliate sales exceeded affiliate purchases by a wide margin. In that year, the sales by U.S.-owned foreign affiliates in the digital and electronic services industry exceeded the purchases by $533.7 billion. The UK was the largest market for U.S.-owned affiliates, followed by Ireland, Canada, Switzerland, and the Netherlands. Affiliates of Japanese firms in the United States accounted for the largest share of purchases from all foreign-owned affiliates in the United States, followed by affiliates owned by firms in the UK, Germany, Canada, and France.

[2] This report uses the U.S. Department of Commerce, Bureau of Economic Analysis' definition of cross-border trade, rather than the definition used by the World Trade Organization (see box 1.1).

Digital and Electronic Services Represent a Significant Share of U.S. Cross-Border Trade and Affiliate Transactions

In 2020, digital and electronic services made up 16.1 percent of total cross-border exports and 16.4 percent of imports. In terms of value, in 2020, U.S. digital and electronic services exports totaled $110.2 billion, whereas imports of these services totaled $71.3 billion, resulting in a cross-border surplus of $38.9 billion. Top markets for U.S. cross-border services exports included the UK, Canada, and Ireland, whereas the top sources of imports were India, Canada, and the UK. In 2019, the foreign affiliates of U.S. companies supplied $421.1 billion in digital and electronic services, whereas purchases from affiliates of foreign-owned companies located in the United States totaled $196.4 billion.

Audiovisual, Computer, and Telecommunications Services Are Adapting to Local Markets

In the audiovisual industry, for example, local specialization is particularly important in the subscription video on demand segment (SVOD). In response to country-level preferences for television (TV) and movie programming in local languages,[3] and for plots that reflect the local culture, SVOD providers like Netflix, Amazon, and Disney have started to film and produce their own content in dozens of countries. Further, the ongoing need to reduce latency (i.e., network traffic delays) is causing some new data centers to be placed in coastal areas due to proximity of undersea cable landing stations. Data centers—some of which are as small as shipping containers—are also being deployed to the “edge” of the network to accommodate the requirements of customers, like manufacturers, that require low latency network connections to operate at maximum efficiency. In the mobile services segment, local specialization is driven to a great degree by a country’s level of economic development, which impacts, among other things, the predominant mobile network technologies used in a country and the rate of adoption of smartphones by the populace.

Internet Technologies Change How Services Are Supplied

Over the past several years, internet and computing technologies have become more sophisticated and have changed the way some services are delivered to customers. The catalyst for such changes has come from a variety of factors, ranging from the COVID-19 pandemic, to improved advertising techniques, to industry needs to reduce network latency. In the audiovisual services segment, for example, user-generated video platforms like YouTube and TikTok have continually improved the sophisticated algorithms that customize the viewing experience for platform users, efforts designed, ultimately, to increase advertising revenues. The COVID-19 pandemic forced millions of people to shift from working and learning outside the home to working and learning at home, a process facilitated not only by widespread broadband access but also by the widespread adoption of cloud computing

[3] Producing local-language television and movie programming in country markets also captures the cultural context of those countries in terms of both filming locations and plotlines.

platforms and software. Last, due to the growing number of computing services and applications that require low-latency network connections, the computer services industry is beginning to deploy the physical infrastructure that supports such services. Of particular note, U.S. technology companies like Google and Meta Platforms (Meta, formerly Facebook) have started to invest in undersea cables in an effort to gain management control of critical infrastructure and reduce overall network latency.

Chapter 1 Introduction

The services sector represents the largest sector of the U.S. economy, and the United States is the world's top cross-border exporter and importer of services. In 2020, the U.S. services sector accounted for 68.6 percent of U.S. gross domestic product (GDP) and for 81.2 percent of total U.S. private employment.[4] In the same year, U.S. cross-border services exports totaled $684.0 billion, whereas cross-border imports totaled $435.7 billion, resulting in a $248.3 billion trade surplus.[5]

The annual *Recent Trends in U.S. Services Trade* (*Recent Trends*) report published by the U.S. International Trade Commission (Commission or USITC) examines trends in U.S. services trade, global market and competitive conditions, and important U.S. trading partners for services, both in the aggregate and in selected industries. Each year, *Recent Trends* focuses on a specific category of services. In 2022, *Recent Trends* focuses on digital and electronic services, a category that was last covered in *Recent Trends in U.S. Services Trade: 2018 Annual Report*. Other services categories, covered in a four-year rotation, include professional services (2021), financial services (2020), and distribution services (2019).

This report is organized into five chapters. This chapter gives an overview of the domestic U.S. services sector, global cross-border trade in services, and U.S. services trade (both cross-border trade and affiliate transactions) by services sector. Chapter 2 provides an overview of trends in cross-border trade and foreign affiliate sales and purchases for the digital and electronic services category as a whole and for its three major component industry sectors: audiovisual services, computer services, and telecommunications services. Chapters 3 and 4 highlight important or emerging trends in selected subsectors of audiovisual, computer, and telecommunications services, including video streaming, user-generated video content platforms, data centers, cloud infrastructure services for communications and video gaming, mobile networks, and undersea cables. Chapters 3 and 4 are organized around two broad themes that are currently shaping global trade in digital and electronic services: the global reach of many services and their increased adaptation to local markets (chapter 3); and the impact of new internet technologies on how many types of services are delivered and how consumers access these services (chapter 4). Finally, chapter 5 summarizes the views expressed by participants at the Commission's 15th annual USITC Services Roundtable, held on October 28, 2021. Appendix A summarizes recent services-related Commission publications and staff research, and appendix B presents underlying data for the figures included in this report. The Commission website also has web-based interactive charts and tables associated with this report that allow users to explore U.S. services trade trends over time and for select industries and countries.[6]

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[4] USDOC, BEA, "Real Value Added by Industry," December 22, 2021; USDOC, BEA, table 6.5D, "Full-Time Equivalent Employees, by Industry," July 30, 2021.

[5] USDOC, BEA, table 2.1, "U.S. Trade in Services, by Type of Service," July 2, 2021.

[6] Interactive charts and alternative text are available at https://www.usitc.gov/publications/industry_econ_analysis_332/2022/recent_trends_us_services_trade_2022_annual_report.htm.

Data: Sources, Categories, and Limitations

Due to the intangible nature of services, data on trade in services tend to be more limited than data on trade in goods. As a result, this report relies on a variety of sources in addition to official services data to present a more comprehensive picture of global trade in services. Official U.S. services trade data used in this report come from the Bureau of Economic Analysis (BEA) at the U.S. Department of Commerce (USDOC), which publishes annual data on U.S. trade in services for both cross-border trade and affiliate transactions. Together, cross-border trade and foreign affiliate transactions account for a substantial portion of total services trade via all four modes of supply specified in the General Agreement on Trade in Services (GATS) of the World Trade Organization (WTO). Box 1.1 and Figure A explain and illustrate the four modes of supply for services trade, as well as where each mode falls within the trade statistics.

Box 1.1 Services Trade “Modes of Supply” under the WTO General Agreement on Trade in Services (GATS)

GATS identifies four modes of supply for services trade, or four ways that services can be traded:

Mode 1 is cross-border supply. In this mode, a service is supplied by an individual or firm in one country to an individual or firm in another (i.e., the service crosses national borders). An example is a firm’s digital file of an architectural design emailed (i.e., exported) to a foreign client.

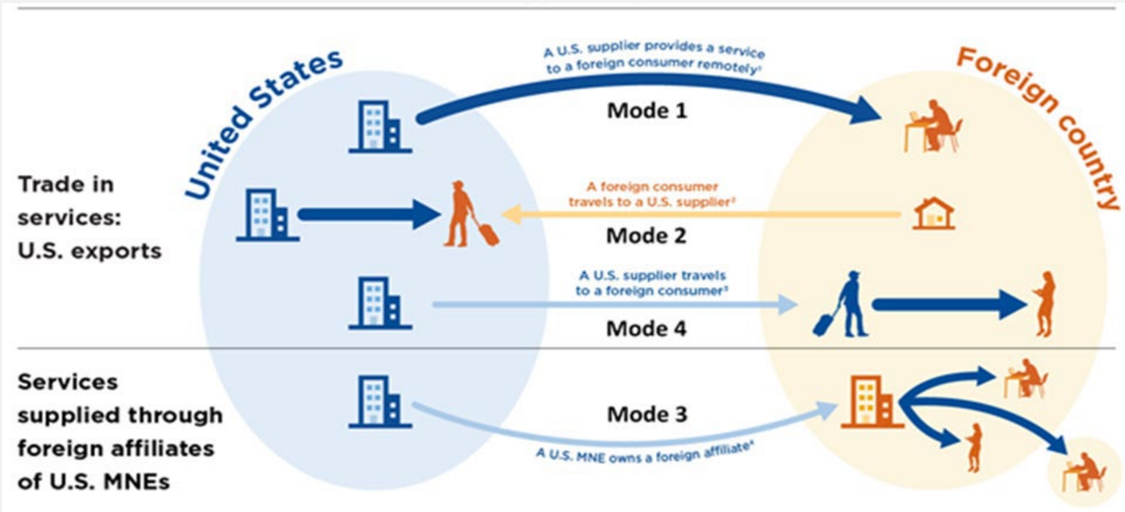
Mode 2 is consumption abroad. In this mode, an individual from one country travels to another country and consumes a service in that country. An example of mode 2 trade is mobile telecommunications services. A U.S. export of telecommunications services occurs when a foreign tourist uses a mobile phone to “roam” on domestic telecommunications networks while vacationing in the United States.

Mode 3 is commercial presence. In this mode, a firm based in one country establishes a local affiliate in another country and supplies services through that affiliate. An example is a U.S.-based telecommunications company establishing a local affiliate in a foreign country for the purpose of offering telecommunications services to businesses located in that country.

Mode 4 is the temporary presence of natural persons. In this mode, an individual from one country travels to another country on a short-term basis to supply a service—for instance, as a consultant, contract employee, or intracompany transferee at a foreign affiliate.[a] An example is a U.S.-based engineer traveling to a foreign country to help local staff on a construction project.

Figure A summarizes these four modes of supply, as well as how the modes are differentiated in BEA data.[b] Modes 1, 2, and 4 appear in the top half of the figure, under “trade in services,” while mode 3 appears under “services supplied through foreign affiliates of U.S. multinational enterprises (MNEs).”

Figure A Modes of supply in U.S. services trade



Source: Allen et al., "The Basics of How International Services Are Supplied," October 2018.
Note: MNEs—multinational enterprises.
[a] WTO, "Basic Purpose and Concepts," accessed November 15, 2018.
[b] See footnote 6. USDOC, BEA, U.S. International Economic Accounts: Concepts and Methods, September 2014.

As defined by BEA, cross-border trade occurs when suppliers in one country sell services to consumers in another country, with people, information, or money crossing national borders. Firms also provide services to foreign consumers through affiliates established in host (i.e., foreign) countries.[7] GATS mode 1 and mode 2 transactions, as well as some mode 4 transactions, are generally grouped together in BEA's data on cross-border trade, whereas mode 3 transactions are included, with some exceptions, in BEA's affiliate transactions data.[8] This report focuses on BEA's "private services" data. As a result, the export and import data presented throughout this report exclude government transactions, which primarily consist of services supplied in support of operations of the U.S. military as well as U.S. embassies in foreign countries.

At an aggregated level, data on cross-border trade in services appear in the balance of payment statistics published quarterly for the United States by the BEA, and annually in the WTO's global services trade data.[9] The term "commercial services" used in the WTO services trade data is roughly equivalent

[7] After income generated through affiliate transactions has been repatriated to the United States, it appears as direct investment income in the U.S. balance of payments.
[8] USDOC, BEA, *U.S. International Economic Accounts: Concepts and Methods*, September 22, 20214. The BEA data include only affiliate transactions between residents and nonresidents, while certain transactions that fall under GATS's mode 3 could involve only residents of the host country. Some statistics on services supplied through mode 4 may also be commingled with statistics on compensation of employees. The channel of delivery that service providers use is determined primarily by the nature of the service. For example, telecommunications services are generally supplied through affiliates, whereas audiovisual services are generally supplied across borders. The value of sales of services by foreign affiliates of U.S. firms tends to exceed that of U.S. cross-border exports of services.
[9] WTO, "Trade in Commercial Services," accessed February 9, 2022; USDOC, BEA, table 1.1, "U.S. International Transactions," December 21, 2021.

to the term "private services" used in BEA services trade data. Like BEA cross-border trade data, the WTO's cross-border trade data roughly correspond to modes 1, 2, and 4 specified in GATS.[10]

BEA also uses survey data to publish more detailed annual information on services trade data each year for cross-border and foreign affiliate transactions of the United States. These data are broken down by country and by industry at the finest level of detail that BEA's survey and confidentiality policies allow. Data are suppressed for certain industries or sectors for which disclosure could potentially reveal confidential information about the individual companies that have responded to the surveys. Disaggregated data on cross-border trade and foreign affiliate transactions are available for many digital and electronic services, including audiovisual, computer, and telecommunications services. More information on the data coverage for digital and electronic services is available in chapter 2.

Every five years, BEA conducts a benchmark survey that increases the number of firms surveyed on international trade flows in services and that enhances available data to include new categories, improve classifications, and expand geographical coverage. The latest BEA data reflect the benchmark survey revising 1999–2019 statistics.[11] Overall, data on services imports were revised differently for two sets of years during the period. Beginning in 2020, financial services trade was revised upward due to the inclusion of two financial services categories, financial intermediation services indirectly measured and market-making services. These revisions were applied retroactively to data going back to 1999. Lower estimates for 2018–19 mainly stemmed from methodological improvements in estimating travel and transport services.[12] For digital and electronic services categories, statistics were revised upward during the entire 1999–2019 period because of improved universe estimation methods.[13]

BEA's survey-based statistics are collected and published in two different ways. For cross-border services trade, statistics are based on the type of service traded, whereas for services supplied through affiliates, statistics are based on the affiliates' primary industry.[14] As a result, there is limited comparability at the sector level between statistics for cross-border trade and foreign affiliate sales. For example, a telecommunications company that provides cross-border network consulting services would report its trade data as professional services, but because it is primarily a telecommunications services firm, its foreign affiliate sales of consulting services would likely appear classified as telecommunications, rather than under the professional services category in BEA's affiliate transactions data.

This report uses the latest available services trade data for each source described above. As of the date of publication, WTO data were available through 2020. Annual data on cross-border trade from BEA were available through 2020 (with preliminary quarterly data available for part of 2021); BEA data on affiliate transactions were available through 2019. Data on market conditions in each of the specific industries in this report may also cover different years, based on the latest year for which such data are available.

[10] WTO, "Technical Notes: Definitions, Methods and Sources," accessed February 9, 2022.
[11] USDOC, BEA, "Annual Update of the U.S. International Transactions Accounts," July 2020.
[12] USDOC, BEA, "Annual Update of the U.S. International Transactions Accounts," July 2020.
[13] USDOC, BEA, "Annual Update of the U.S. International Transactions Accounts," July 2020.
[14] See chapter 2 for further discussion of the ways that services trade data are classified as well as information about sector-specific data collection and classification.

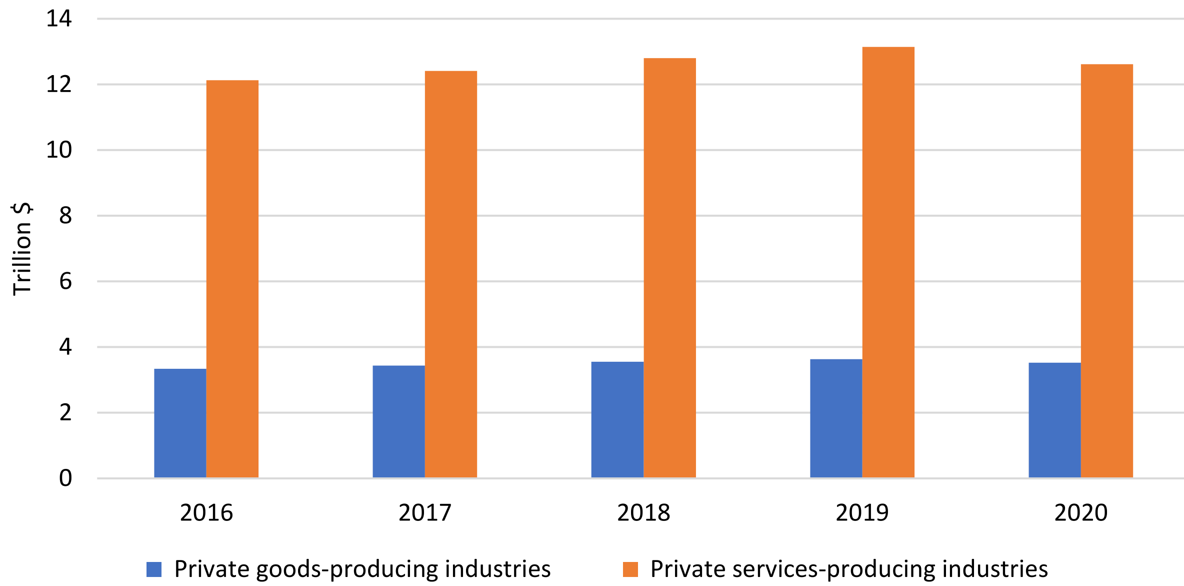
U.S. Services Sector

The U.S. services sector represented the largest share of the U.S. economy in 2020. In real value-added terms, U.S. private service-supplying industries contributed $12.6 trillion, or 68.7 percent, to U.S. GDP.[15] In contrast, goods-producing industries contributed $3.5 trillion (or 19.3 percent) to GDP.[16] In terms of employment, services-supplying industries also represented the majority of full-time equivalent (FTE) employees in the U.S. economy in 2020, accounting for 81.7 percent of all private employment, or 92.4 million FTE employees. Goods-producing industries accounted for 18.3 percent of private employment, or 20.7 million FTE employees.[17]

From 2016 to 2020, U.S. service-supplying industries increased real output by 4.1 percent, from $12.1 trillion to $12.6 trillion (figure 1.1), representing an average annual growth rate of 1.0 percent. This represents a similar growth rate to that of goods-producing industries, which grew at an average annual growth rate of roughly 1.4 percent during this same period. In terms of employment, the number of FTE employees in U.S. services-supplying industries declined by 1.4 percent from 2016 to 2020, compared to an increase of 1.1 percent for goods-producing industries.[18]

[15] USDOC, BEA, "Real Value Added by Industry," December 22, 2021. Value added is a measure of an industry's contribution to GDP and is the difference between the value of an industry's gross output and the cost of intermediate inputs. Services-supplying industries include utilities; wholesale trade; retail trade; transportation and warehousing; information; finance; insurance; real estate, rental, and leasing; professional and business services; educational services; healthcare and social assistance; arts, entertainment, recreation, accommodation, and food services; and other services, except government services.
[16] USDOC, BEA, "Real Value Added by Industry," December 22, 2021. Goods-producing industries include mining; construction; manufacturing; and agriculture, forestry, fishing, and hunting.
[17] USDOC, BEA, table 6.5D, "Full-Time Equivalent Employees, by Industry," July 30, 2021. FTE employees equal the number of employees on full-time schedules plus the number of employees on part-time schedules converted to a full-time basis. The number of FTE employees in each industry is the product of the total number of employees and the ratio of average weekly hours per employee for all employees to average weekly hours per employee on full-time schedules.
[18] USDOC, BEA, table 6.5D, "Full-Time Equivalent Employees, by Industry," July 30, 2021.

Figure 1.1 Real value added by U.S. industry, 2016–20 (in trillions of dollars)



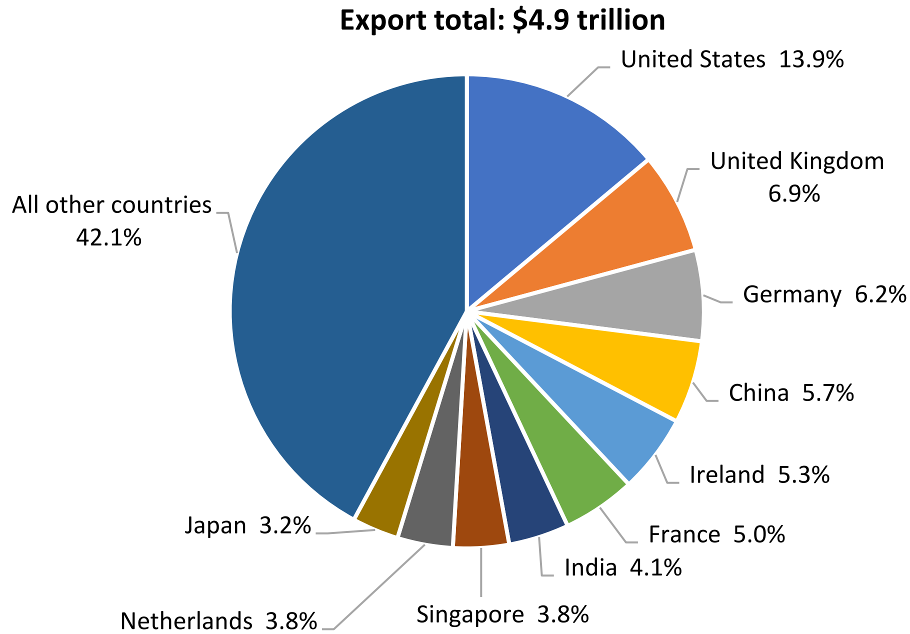
Source: USDOC, BEA, "Real Value Added by Industry," December 22, 2021.
Note: Estimates are chained 2012 dollars. Private goods-producing industries include agriculture, forestry, fishing, and hunting; mining; construction; and manufacturing. Private services-producing industries include utilities; wholesale trade; retail trade; transportation and warehousing; information; finance, insurance, real estate, rental, and leasing; professional and business services; educational services, health care, and social assistance; arts, entertainment, recreation, accommodation, and food services; and other services, except government. Underlying data for this figure can be found in appendix table B.1.

Global Services Trade

The United States was the largest cross-border exporter of commercial services[19] in the world in 2020, supplying $684.0 billion of global exports (13.9 percent) (figure 1.2). It was followed by the United Kingdom and Germany, which accounted for $338.9 billion (6.9 percent) and $305.2 billion (6.2 percent), respectively, of total global exports. The United States was also the largest global importer of services, accounting for $435.6 billion of all cross-border services imports (9.5 percent) in 2020 (figure 1.3). Other large importing countries included China, which accounted for $377.5 billion of imports (8.2 percent), and Germany, which accounted for $307.1 billion of imports (6.7 percent). Overall, the United States was a net exporter of commercial services in 2020, with a cross-border trade surplus of $248.3 billion.[20]

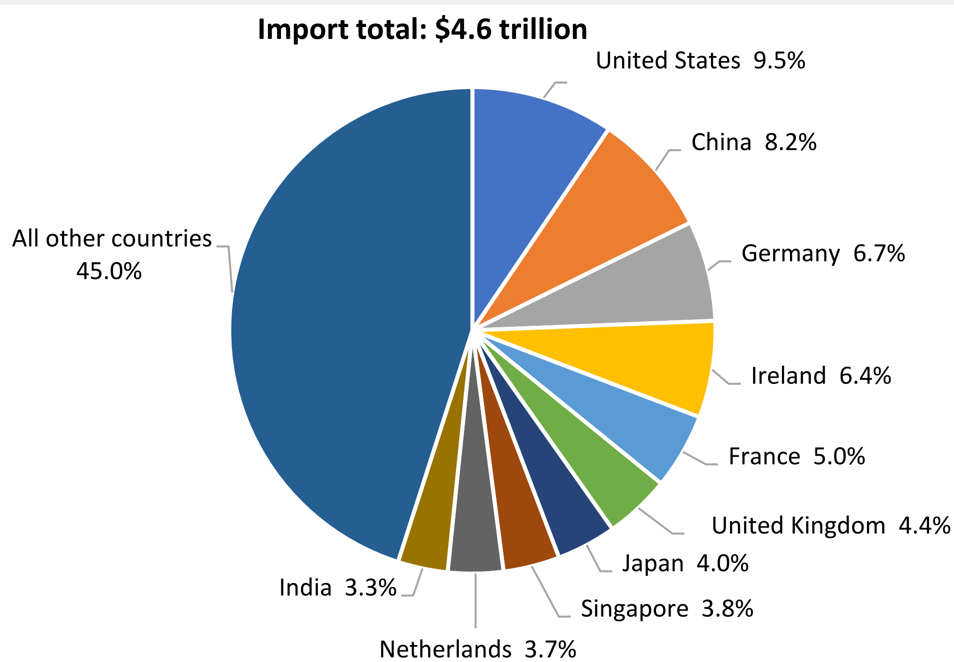
[19] The term "commercial services" refers to services provided by the private sector and therefore excludes government services.
[20] WTO, "Trade in Commercial Services," accessed February 9, 2022.

Figure 1.2 Global services: Cross-border exports of commercial services, by country, 2020 (percent)



Source: WTO, WTO STATS, "Trade in Commercial Services."
Note: Exports of commercial services exclude public-sector transactions. Due to difficulty measuring and reporting services trade data, total services exports do not equal total services imports. Due to rounding, figures may not add to 100 percent. Underlying data for this figure can be found in appendix table B.2.

Figure 1.3 Global services: Cross-border imports of commercial services, by country, 2020 (percent)

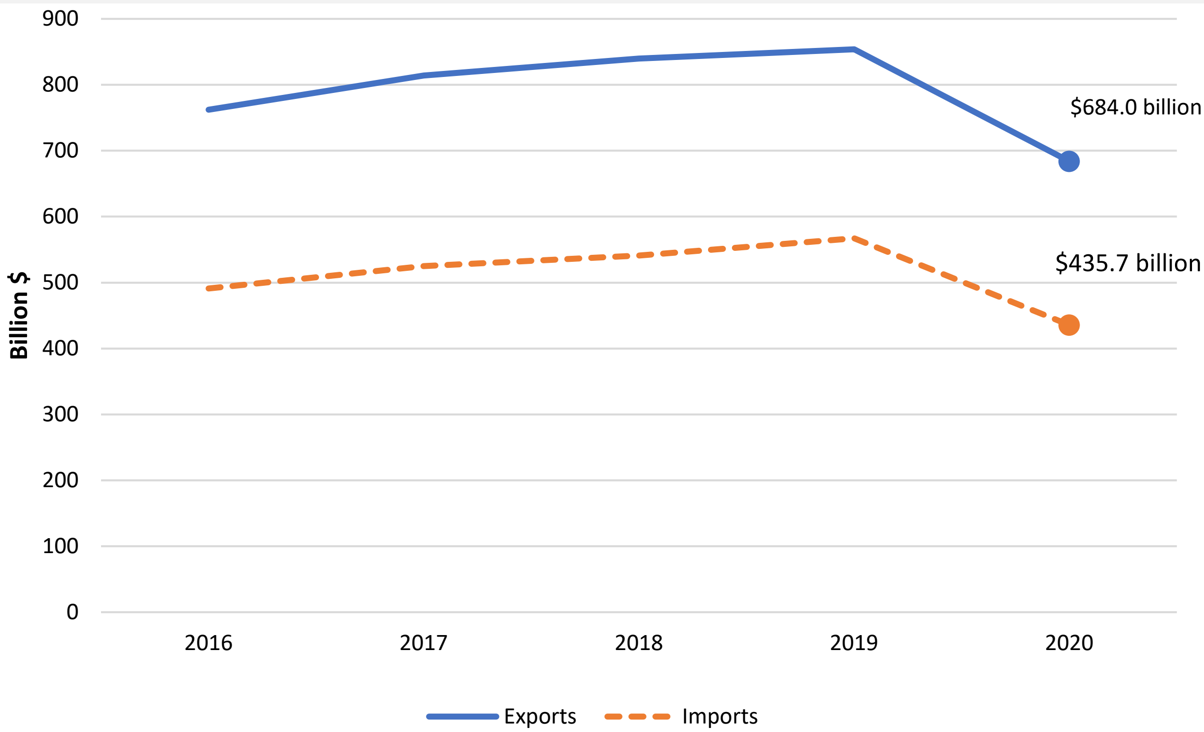


Source: WTO, WTO STATS, "Trade in Commercial Services."
Note: Exports of commercial services exclude public-sector transactions. Due to difficulty measuring and reporting services trade data, total services exports do not equal total services imports. Due to rounding, figures may not add to 100 percent. Underlying data for this figure can be found in appendix table B3.

U.S. Trade in Services

Overall, trade in services through foreign affiliate sales (based on the affiliates' primary industry) was consistently larger than cross-border trade (based on the type of service) during the period. Just as the United States consistently ran a trade surplus in cross-border trade, foreign affiliate sales exceeded purchases from domestic affiliates of foreign firms. In 2020, U.S. cross-border exports in services fell 19.9 percent, after recording an average annual growth rate of 4.9 percent during 2016–19 (figure 1.4). Similarly, U.S. cross-border imports declined 23.2 percent in 2020, after experiencing an average annual growth rate of 3.9 percent during 2016–19. Based on 2019 data, foreign affiliate transactions showed a steady increase, with the value of services supplied by U.S. foreign affiliates (i.e., U.S.-owned companies located abroad) increasing by 5.1 percent to $1.8 trillion (figure 1.5). Services supplied by the U.S. affiliates of foreign firms (i.e., foreign-owned companies located in the United States) grew more slowly in 2019 compared to the prior year, at a rate of 3.3 percent, reaching $1.2 trillion.[21]

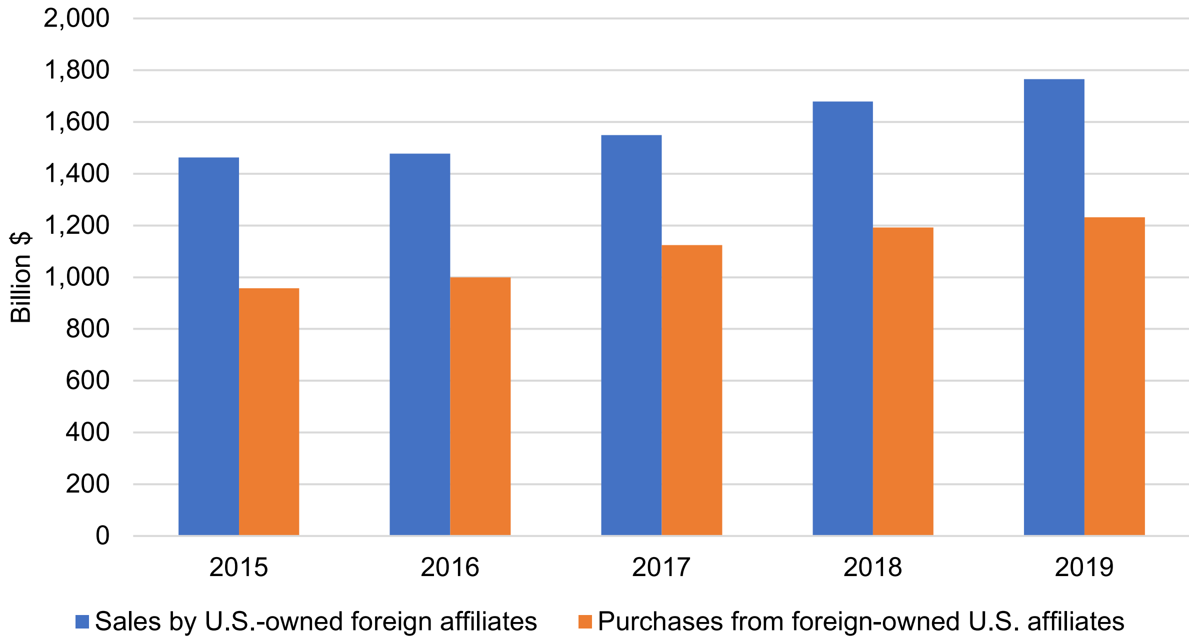
Figure 1.4 U.S. services: Cross-border exports and imports, 2016–20 (in billions of dollars)



Source: USDOC, BEA, table 2.1, "U.S. Trade in Services, by Type of Service," July 2, 2021.
Note: Underlying data for this figure can be found in appendix table B.4.

[21] USDOC. BEA, table 4.1, "Services Supplied to Foreign Persons by U.S. MNEs through Their MOFAs, by Industry of Affiliate and by Country of Affiliate," October 19, 2021; USDOC, BEA, table 5.1, "Services Supplied to U.S. Persons by Foreign MNEs through Their MOUSAs, by Industry of Affiliate and by Country of UBO," October 19, 2021.

Figure 1.5 U.S. services: Affiliate sales and purchases, 2015–19 (in billions of dollars)



Source: USDOC, BEA, table 4.1, "Services Supplied to Foreign Persons by U.S. MNEs through Their MOFAs, by Industry and Affiliate and by Country of Affiliate," October 19, 2021; table 5.1, "Services Supplied to U.S. Persons by Foreign MNEs through Their MOUSA, by Industry of Affiliate and by Country of UBO," October 19, 2021.
Note: MNEs = multinational enterprises; MOFAs = majority-owned foreign affiliates; MOUSA = majority-owned U.S. affiliate; UBO = ultimate beneficial owner. Underlying data for this figure can be found in appendix table B.5.

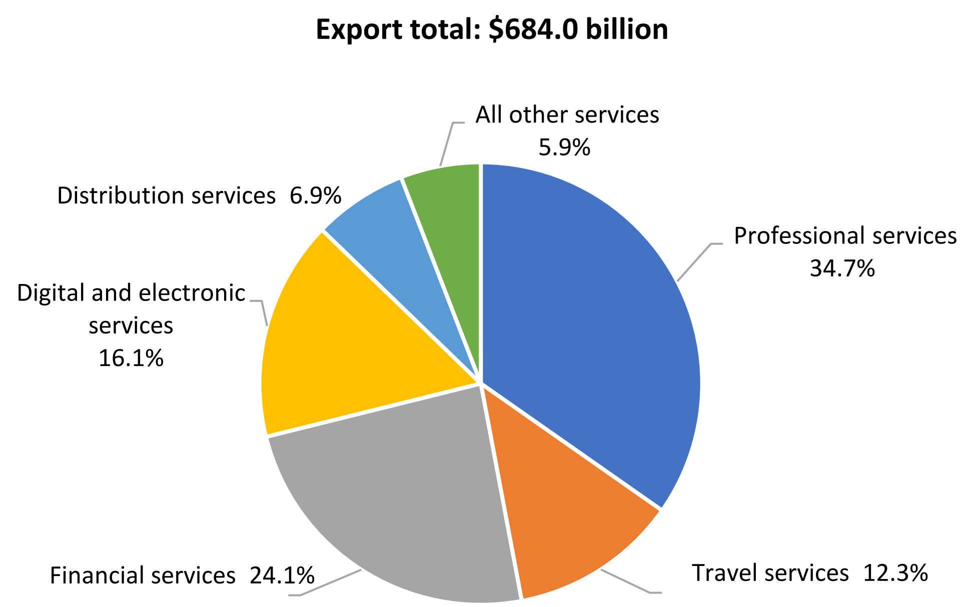
Cross-border Trade

The largest segment of both U.S. cross-border exports and imports in 2020 was professional services.[22] In that year, cross-border exports of professional services totaled $237.5 billion (34.7 percent of U.S. service exports), followed by financial services[23] ($164.8 billion; 24.1 percent) and digital and electronic services[24] ($110.2 billion; 16.1 percent) (figure 1.6). In 2020, cross-border imports of professional services totaled $146.1 billion, or 33.5 percent of total cross-border service imports, followed by financial services ($97.9 billion; 22.5 percent) and digital and electronic services ($71.3 billion; 16.4 percent) (figure 1.7). In most service sectors, the United States ran a surplus in cross-border trade, with the largest surplus in professional services ($91.4 billion), followed by financial services ($66.9 billion)

[22] Professional services include the following BEA categories: accounting, auditing, and bookkeeping services; advertising services; architectural services; business, management consulting, and public relations services; education services; engineering services; health services; legal services, licenses for the use of outcomes of research and development; maintenance and repair services not included elsewhere; research and development services; and scientific and other technical services.
[23] Financial services include the following BEA categories: insurance services and financial services.
[24] Digital and electronic services include the following BEA categories: audiovisual services, computer services, computer software, information services, and telecommunications services.

and digital and electronic services ($38.9 billion). The only sector to register a cross-border deficit was the distribution services sector ($14.7 billion).[25]

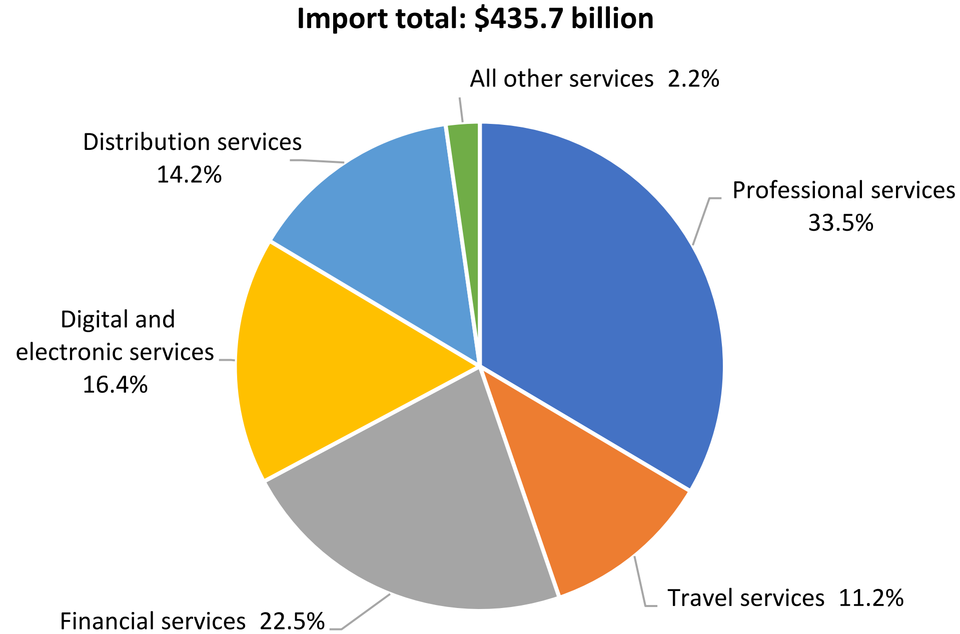
Figure 1.6 U.S. services: Cross-border exports, by category, 2020 (percent)



Source: USDOC, BEA, table 2.1, "U.S. Trade in Services, by Type of Service," July 2, 2021.
Note: Due to rounding, figures may not add to 100 percent. All other services include the following BEA categories: artistic-related services, construction services, heritage and recreational services, operating leasing services, services incidental to agricultural, forestry, and fishing, services incidental to mining and oil and gas services, other personal, cultural, and recreational services, and franchises and trademarks licensing fees. Underlying data for this figure can be found in appendix table B.6.

[25] Distribution services include air transport services (e.g., air freight and airport services); sea transport services (e.g., sea freight and port services); other modes of transport (e.g., road and rail transport); and trade-related services (e.g., auction services, business-to-business transaction fees, internet-based commercial exchanges, and commissions paid to independent sales agents.

Figure 1.7 U.S. services: Cross-border imports, by category, 2020 (percent)

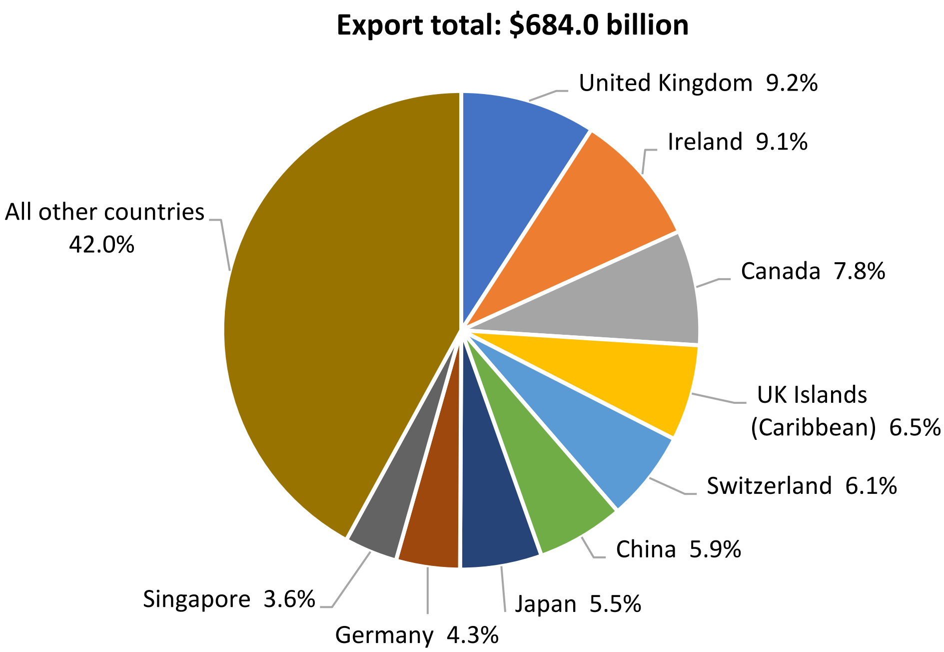


Source: USDOC, BEA, table 2.1, "U.S. Trade in Services, by Type of Service," July 2, 2021.
Note: Due to rounding, figures may not add to 100 percent. All other services include the following BEA categories: artistic-related services; construction services; heritage and recreational services; operating leasing services; services incidental to agricultural, forestry, and fishing; services incidental to mining and oil and gas services; and other personal, cultural, and recreational services. Underlying data for this figure can be found in appendix table B.7.

Regarding U.S. cross-border services trade by partner, the United Kingdom (UK) was the largest single-country U.S. trade partner in terms of both exports and imports. In 2020, U.S. exports to the UK were $62.7 billion, or 9.2 percent of total U.S. services exports, while imports totaled $51.7 billion, or 11.9 percent of total imports (figures 1.8 and 1.9). After the UK, the top destinations for exports in 2020 were Ireland ($61.9 billion; 9.1 percent); Canada ($53.2 billion; 7.8 percent); and the UK Islands (Caribbean territories) ($44.5 billion; 6.5 percent).[26] The top sources of imports, following the UK, were Japan ($30.9 billion; 7.1 percent); Bermuda ($29.2 billion; 6.7 percent); and Canada ($29.0 billion; 6.7 percent).

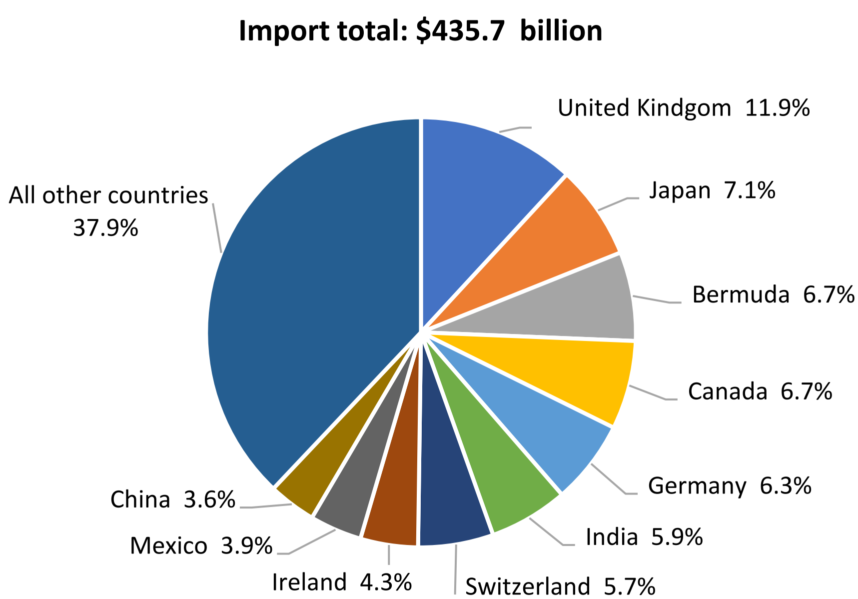
[26] The BEA category "United Kingdom Islands (Caribbean)" includes the following four U.K. overseas territories: the British Virgin Islands, the Cayman Islands, Montserrat, and the Turks and Caicos Islands.

Figure 1.8 U.S. services: Cross-border exports, by country, 2020 (percent)



Source: USDOC, BEA, table 2.2, "U.S. Trade in Services, by Type of Service and by Country or Affiliation," July 2, 2021.
Note: The BEA category "United Kingdom Islands (Caribbean)" includes the following four U.K. overseas territories: the British Virgin Islands, the Cayman Islands, Montserrat, and the Turks and Caicos Islands. Due to rounding, figures may not add to 100 percent. Underlying data for this figure can be found in appendix table B.8.

Figure 1.9 U.S. services: Cross-border imports, by country, 2020 (percent)



Source: USDOC, BEA, table 2.2, "U.S. Trade in Services, by Type of Service and by Country or Affiliation," July 2, 2021.
Note: Due to rounding, figures may not add to 100 percent. Underlying data for this figure can be found in appendix table B.9.

Preliminary 2021 Cross-border Trade

Preliminary seasonally adjusted quarterly data for U.S. cross-border services trade from January to June 2021 (available at a more broadly aggregated level than data used in the rest of this report) show that total services exports were 1.9 percent higher during the first half of 2021, compared to the first half of 2020 (table 1.1). During this period, exports in most sectors grew significantly. The most notable exception was travel and passenger services, for which exports declined by 42.6 percent, although the second quarter of 2021 grew by 24.2 percent, compared to a decline of 66.3 percent in the first quarter of 2020. The two sectors recording the largest export growth were personal, cultural, and recreational services, which grew by 27.9 percent in the first half of 2021, and professional and managements consulting services, which grew by 15.7 percent. Air transport and sea transport also grew by 14.3 percent and 14.2 percent, respectively. Exports in all sectors, except the other services category, grew during the second quarter of 2021, compared to large declines during the second quarter of 2020.

Table 1.1 Total U.S. private cross-border services exports (preliminary), by category and quarter, January–June 2020 and January–June 2021
In billions of dollars.

Services category	Q1 2020 Billion $	Q2 2020 Billion $	Q1 2021 Billion $	Q2 2021 Billion $
Financial services	35.3	35.1	39.4	40.4
Professional and management consulting services	26.9	26.3	29.8	31.8
Research and development services	22.1	24.2	25.8	26.3
Travel and passenger fares	44.2	14.9	15.1	18.8
Telecommunications, computer, and information services	14.0	13.7	14.7	15.0
Technical, trade-related, and other business services	8.0	7.8	7.7	7.8
Personal, cultural, and recreational services	4.8	4.1	5.5	5.9
Air transport (excludes passenger fares)	6.7	4.9	6.4	6.9
Sea transport	4.5	4.2	4.8	5.0
Insurance services	5.0	4.8	5.3	5.3
Other services	22.1	20.2	21.1	21.8
Total	193.7	160.1	175.6	185.1

Source: USDOC, BEA, table 3.1, "U.S. International Trade in Services," March 24, 2022.
Data for 2021 are preliminary. Data exclude public-sector services transactions. Due to rounding, figures may not add to totals. Research and development services includes licenses for the use of outcomes of research and development. Other services include maintenance and repair services not included elsewhere, other modes of transportation, construction, licenses to reproduce and/or distribute computer software and audiovisual products. Q1 = January–March, Q2 = April–June.

Overall, total U.S. cross-border services imports increased by 5.8 percent during the first half of 2021, compared to the first half of 2020 (table 1.2). During this period, services imports in most sectors grew significantly, with the exception of travel and passenger services, which fell by 26.8 percent; in the second quarter of 2021, this category grew by 59.2 percent, compared to a decline of 90.6 percent during the second quarter of 2020. The two sectors recording the largest growth during the first half 2021 were sea transport and air transport, which grew by 52.2 percent and 29.5 percent, respectively. Most sectors experienced growth during the second quarter of 2021, compared to declines during the second quarter of 2020.

Table 1.2 Total U.S. private cross-border services imports (preliminary), by category and quarter, January–June 2020 and January–June 2021
In billions of dollars.

Services category	Q1 2020 Billion $	Q2 2020 Billion $	Q1 2021 Billion $	Q2 2021 Billion $
Financial services	10.7	10.4	10.5	10.6
Professional and management consulting services	15.2	15.1	14.5	14.8
Research and development services	14.8	12.8	16.3	15.9
Travel and passenger fares	31.4	2.9	9.7	15.5
Telecommunications, computer, and information services	9.8	9.4	10.0	10.1
Technical, trade-related, and other business services	5.8	5.4	6.3	6.4
Personal, cultural, and recreational services	5.5	5.5	6.4	6.8
Air transport (excludes passenger fares)	5.7	4.8	6.4	7.3
Sea transport	7.7	7.8	10.7	12.9
Insurance services	13.5	13.4	14.1	13.9
Other services	7.0	6.6	7.7	7.8
Total	127.2	94.3	112.4	122.0

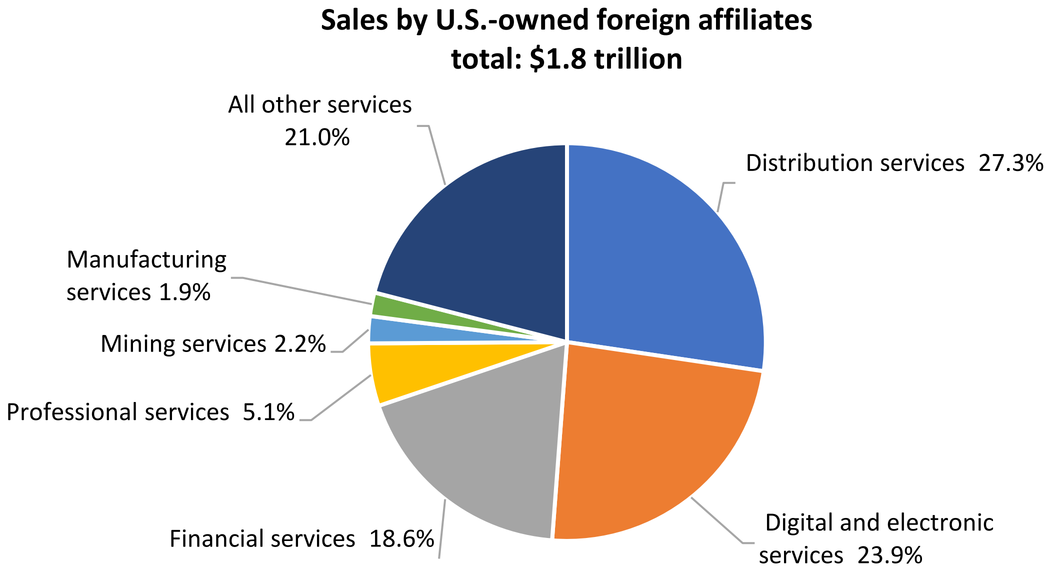
Source: USDOC, BEA, table 3.1, “U.S. International Trade in Services,” March 24, 2022.
Data for 2021 are preliminary. Data exclude public-sector services transactions. Due to rounding, figures may not add to totals. Research and development services includes licenses for the use of outcomes of research and development. Other services include maintenance and repair services not included elsewhere, other modes of transportation, construction, licenses to reproduce and/or distribute computer software and audiovisual products. Q1 = January–March, Q2 = April–June.

Affiliate Transactions

In 2019, distribution services[27] represented the largest services sector supplied through the foreign affiliates of U.S. firms ($482.7; 27.3 percent of the total) and provided by the U.S.-based affiliates of foreign firms ($355.9 billion; 28.9 percent) (figures 1.10 and 1.11).[28] Similarly, digital and electronic services represented the second-largest sector supplied through the foreign affiliates of U.S. firms ($421.1 billion; 23.9 percent) and provided by the U.S.-based affiliates of foreign firms ($196.4 billion; 15.9 percent). In 2019, the UK was the largest recipient of sales by foreign affiliates of U.S. firms, followed by Ireland, Canada, Switzerland, and the Netherlands. The affiliates of Japanese firms in the United States accounted for the largest share of purchases from all such U.S.-based affiliates of foreign firms, followed by those of the UK, Germany, Canada, and France.[29]

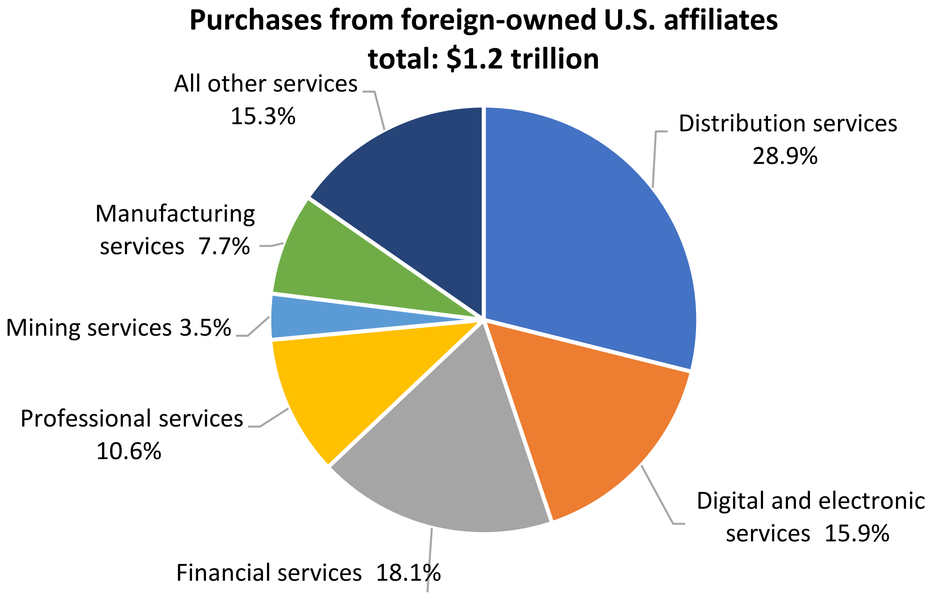
[27] For affiliate sales, distribution services include the following three BEA categories: retail trade; wholesale trade; and transportation and warehousing.
[28] Throughout this report, “U.S. firms” are entities established in the United States that have less than 50 percent foreign ownership. For more information on the treatment of firm ownership in foreign affiliate data, see USDOC, BEA, “How Are BEA’s Statistics on the Activities of U.S. Multinational Enterprises (MNE’s) Affected by the Complex Corporate Structures of MNEs,” January 23, 2020.
[29] USDOC. BEA, table 4.1, “Services Supplied to Foreign Persons by U.S. MNEs through Their MOFAs, by Industry of Affiliate and by Country of Affiliate,” October 19, 2021; USDOC, BEA, table 5.1, “Services Supplied to U.S. Persons by Foreign MNEs through Their MOUSAs, by Industry of Affiliate and by Country of UBO,” October 19, 2021.

Figure 1.10 U.S. services: Affiliate sales by U.S.-owned foreign affiliates, by industry, 2019 (percent)



Source: USDOC, BEA, table 4.1, "Services Supplied to Foreign Persons by U.S. MNEs through Their MOFAs, by Industry of Affiliate and by Country of Affiliate," October 19, 2021; USDOC, BEA, table 5.1, "Services Supplied to U.S. Persons by Foreign MNEs though Their MOUSAs, by Industry of Affiliate and by Country of UBO," October 19, 2021.
Notes: Professional services includes the following BEA categories: accounting, auditing, and bookkeeping services; advertising services; architectural, engineering, and other technical services; education services; healthcare and social assistance services; legal services; management of companies and enterprises; management, scientific, and technical consulting; specialized design services; scientific research and development, waste management and remediation services; and other professional, scientific, and technical services.
Digital and electronic services include broadcasting services; computer systems design and related services; data processing, hosting, and related services; motion picture and sound recording; software publishing; telecommunications services, and other information services. Other services include the following BEA categories: accommodation and food services; administrative and support services; arts entertainment, and recreation services; construction services; newspaper, periodical, book, and database publishers; real estate services, utilities; other services and adjustments for suppressed information. Beginning with the 2018 Recent Trends in U.S. Services Trade report, software publishing was reallocated from "Other Services" to "Digital and Electronic Services" to better reflect the industry composition. Therefore, digital and electronic services data in this report and the 2018 report cannot be directly compared with such data in USITC reports published before 2018. Due to rounding, figures may not add to 100 percent. MNEs = multinational enterprises; MOFAs = majority-owned foreign affiliates; MOUSA = majority-owned U.S. affiliate; UBO = ultimate beneficial owner. Underlying data for this figure can be found in appendix table B.10.

Figure 1.11 U.S. services: Purchases from foreign-owned U.S. affiliates, by industry, 2019 (percent)



Source: USDOC, BEA, table 4.1, "Services Supplied to Foreign Persons by U.S. MNEs through Their MOFAs, by Industry of Affiliate and by Country of Affiliate," October 19, 2021; USDOC, BEA, table 5.1, "Services Supplied to U.S. Persons by Foreign MNEs though Their MOUSAs, by Industry of Affiliate and by Country of UBO," October 19, 2021.
Notes: Professional services includes the following BEA categories: accounting, auditing, and bookkeeping services; advertising services; architectural, engineering, and other technical services; education services; healthcare and social assistance services; legal services; management of companies and enterprises; management, scientific, and technical consulting; specialized design services; scientific research and development, waste management and remediation services; and other professional, scientific, and technical services.
Digital and electronic services include broadcasting services; computer systems design and related services; data processing, hosting, and related services; motion picture and sound recording; software publishing; telecommunications services, and other information services. Other services include the following BEA categories: accommodation and food services; administrative and support services; arts entertainment, and recreation services; construction services; newspaper, periodical, book, and database publishers; real estate services, utilities; other services and adjustments for suppressed information. Beginning with the 2018 Recent Trends in U.S. Services Trade report, software publishing was reallocated from "Other Services" to "Digital and Electronic Services" to better reflect the industry composition. Therefore, digital and electronic services data in this report and the 2018 report cannot be directly compared with such data in USITC reports published before 2018.
MNEs = multinational enterprises; MOFAs = majority-owned foreign affiliates; MOUSA = majority-owned U.S. affiliate; UBO = ultimate beneficial owner. Due to rounding, figures may not add to 100 percent. Underlying data for this figure can be found in appendix table B.11.

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Chapter 2
Digital and Electronic Services

Overview

For the purposes of this report, the digital and electronic services category includes audiovisual, computer, information, telecommunications, and computer software services. These services industries are highly interdependent. Computer services, for example, are essential for the delivery of telecommunications services, whereas telecommunications networks enable trade in audiovisual content. Digital and electronic services also increase productivity and enable trade in other industries, such as education, finance, healthcare, and logistics. However, they are also traded electronically themselves, for example, when data processing services are offered by a supplier in one country to a consumer in another. U.S. digital and electronic services industries are highly competitive, and U.S. firms are among the global leaders in technology adoption and in research and development. By facilitating data and information flows, firms in the digital and electronic sector provide critical infrastructure to the U.S. and global economies.

Digital and electronic services—a data category used by the Commission for this report—comprises five categories as defined by the Bureau of Economic Analysis (BEA): telecommunications services, information services, audiovisual services, computer services, and computer software. The category of telecommunications services includes the broadcast or transmission of sound, images, data, or other content by electronic means (but excludes the value of the content itself). Information services include news agency services, database services, and internet search services. Audiovisual services comprise the production of audiovisual content (such as movies, TV shows, and sound recordings) as well as the rights to use, reproduce, and distribute such content. Computer services consist of cloud computing, data storage and processing services, and services related to computer installation and maintenance. Finally, the computer software category includes sales of software and licenses to use, reproduce, and distribute computer software (including software downloaded from the internet or subscriptions for online access), but excludes sales of software on physical media.[30] See box 2.1 (and figures 2.7 and 2.8) for a description of recent changes to the BEA's classification of certain subcategories of audiovisual services and computer software.

Cross-border Exports and Imports

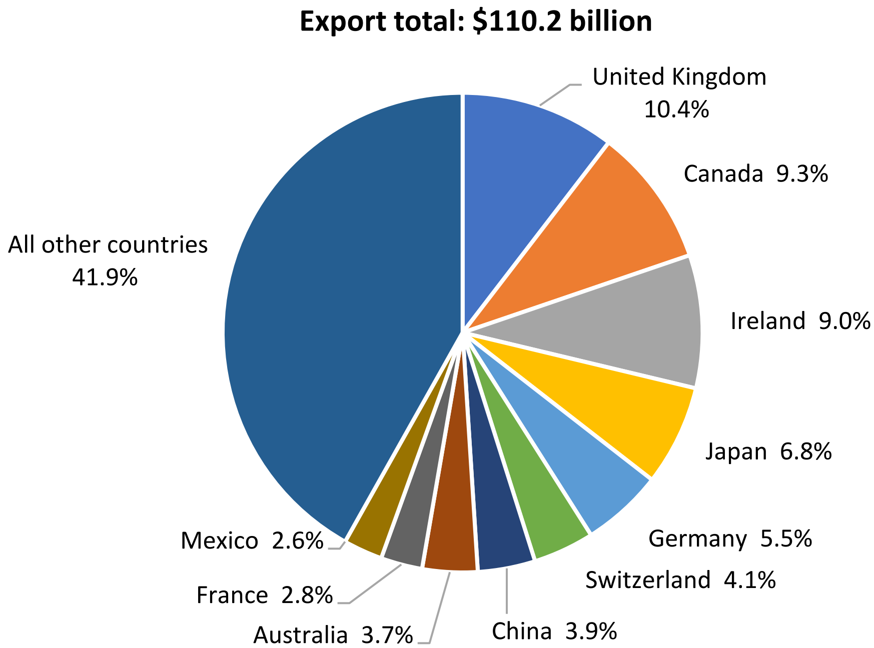
In 2020, exports of digital and electronic services totaled $110.2 billion, accounting for 16.1 percent of total U.S. cross-border exports. This represented a 3.0 percent decrease in such exports compared to

[30] USDOC, BEA, "Quarterly Survey of Transactions in Selected Services and Intellectual Property with Foreign Persons Form BE-125," October 22, 2020, 21–22; USDOC, BEA, *U.S. International Economic Accounts: Concepts and Methods*, September 22, 2014, 10–24.

2019. Top export destinations included the United Kingdom (10.4 percent), Canada (9.3 percent), and Ireland (9.0 percent) (figure 2.1).[31]

Digital and electronic services imports totaled $71.3 billion in 2020, accounting for 16.4 percent of total U.S. cross-border imports. This was a 3.8 percent decrease in such imports compared to 2019. Top sources of cross-border imports included India (17.9 percent), Canada (11.7 percent), and the United Kingdom (9.5 percent) (figure 2.2).[32]

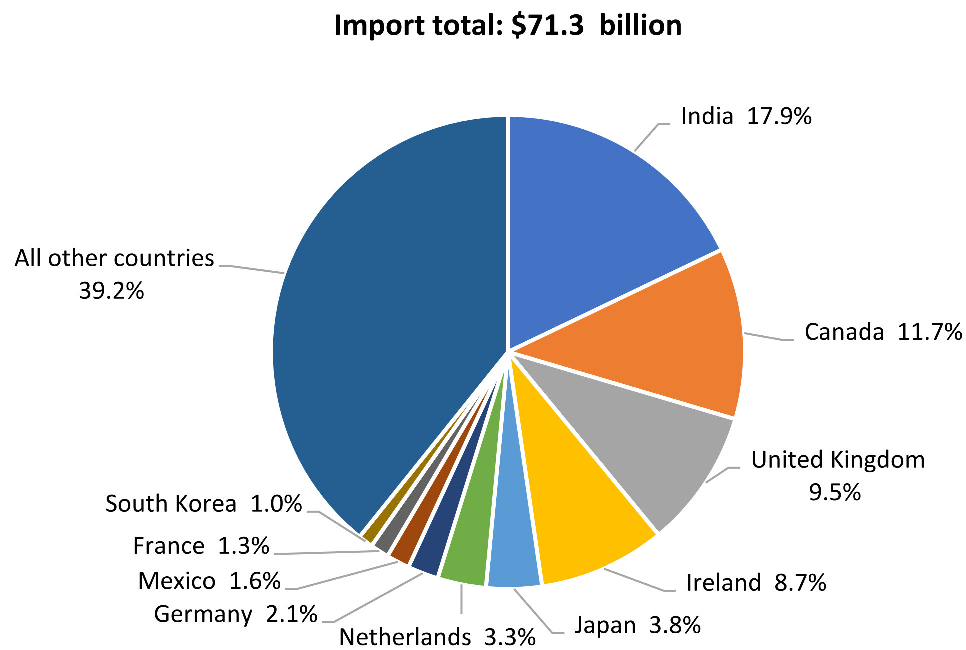
Figure 2.1 Digital and electronic services: U.S. cross-border exports, by country, 2020 (percent)



Source: USDOC, BEA, table 2.2, “U.S. Trade in Services, by Type of Service and by Country or Affiliation,” July 2, 2021.
Note: Digital and electronic services comprise five categories as defined by the Bureau of Economic Analysis (BEA): audiovisual services, computer services, computer software, information services, and telecommunications services. Due to rounding, figures may not add to 100 percent. Underlying data for this figure can be found in appendix table B.12.

[31] USDOC, BEA, table 2.2, “U.S. Trade in Services, by Type of Service and by Country or Affiliation,” July 2, 2021.
[32] USDOC, BEA, table 2.2, “U.S. Trade in Services, by Type of Service and by Country or Affiliation,” July 2, 2021.

Figure 2.2 Digital and electronic services: U.S. cross-border imports, by country, 2020

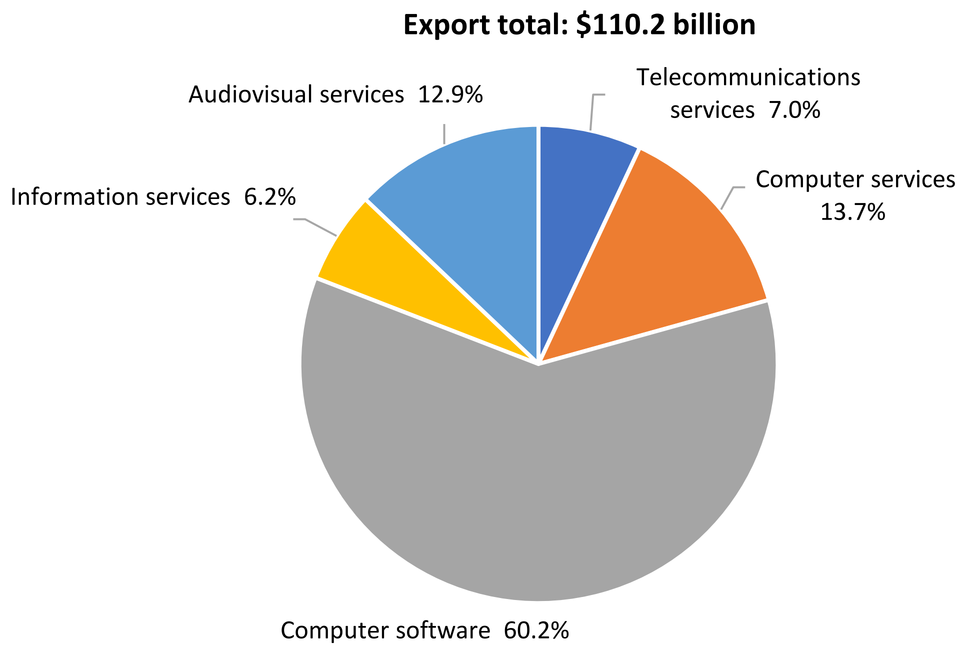


Source: USDOC, BEA, table 2.2, "U.S. Trade in Services, by Type of Service and by Country or Affiliation," July 2, 2021.
Note: Digital and electronic services comprise five categories as defined by the Bureau of Economic Analysis (BEA): audiovisual services, computer services, computer software, information services, and telecommunications services. Due to rounding, figures may not add to 100 percent. Underlying data for this figure can be found in appendix table B.13.

Computer software represented the largest share of both U.S. exports and imports of digital and electronic services in 2020, accounting for 60.2 percent and 34.3 percent of exports and imports, respectively (figure 2.3 and figure 2.4).[33] Audiovisual services were the second-largest import share (28.2 percent), whereas computer services imports (26.7 percent) and exports (13.7 percent) represented the third- and second-largest shares, respectively.

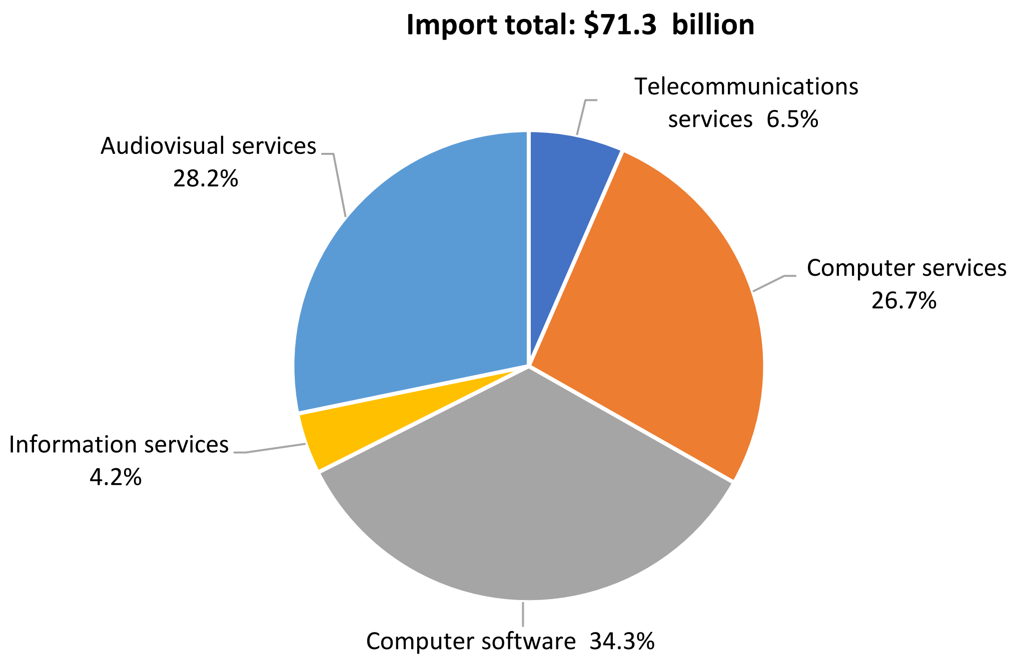
[33] USDOC, BEA, table 2.2, "U.S. Trade in Services, by Type of Service and by Country or Affiliation," July 2, 2021.

Figure 2.3 Digital and electronic services: U.S. cross-border exports, by industry, 2020



Source: USDOC, BEA, table 2.2, “U.S. Trade in Services, by Type of Service and by Country or Affiliation,” July 2, 2021.
Note: Due to rounding, figures may not add to 100 percent. Underlying data for this figure can be found in appendix table B.14.

Figure 2.4 Digital and electronic services: U.S. cross-border imports, by industry, 2020

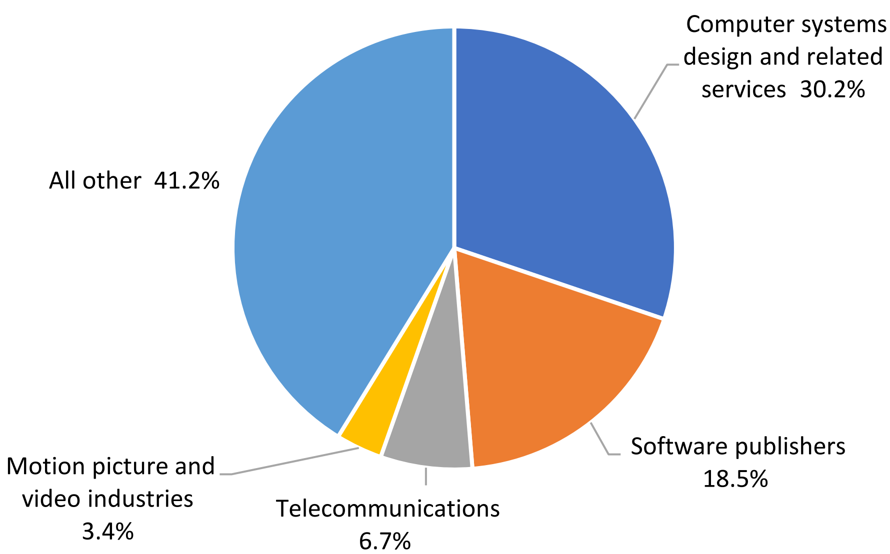


Source: USDOC, BEA, table 2.2, “U.S. Trade in Services, by Type of Service and by Country or Affiliation," July 2, 2021.
Note: Due to rounding, figures may not add to 100 percent. Underlying data for this figure can be found in appendix table B.15.

Foreign Affiliate Sales

In 2019, the latest year for which data are available, sales of U.S.-owned foreign affiliates in digital and electronic services industries totaled $421.1 billion, whereas purchases from affiliates of foreign-owned companies located in the United States totaled $196.4 billion.[34] Computer systems design and related services made up the largest share of sales of U.S.-owned foreign affiliates in the digital and electronic services sector, with 30.2 percent of total sales in 2019, followed by software publishers (18.5 percent) and telecommunications services (6.7 percent) (figure 2.5). For purchases from the U.S.-based affiliates of foreign firms, the telecommunications services industry represented the largest share of total purchases (45.6 percent), followed by computer systems design and related services (18.7 percent), and motion picture and sound recording (10.2 percent) (figure 2.6).[35]

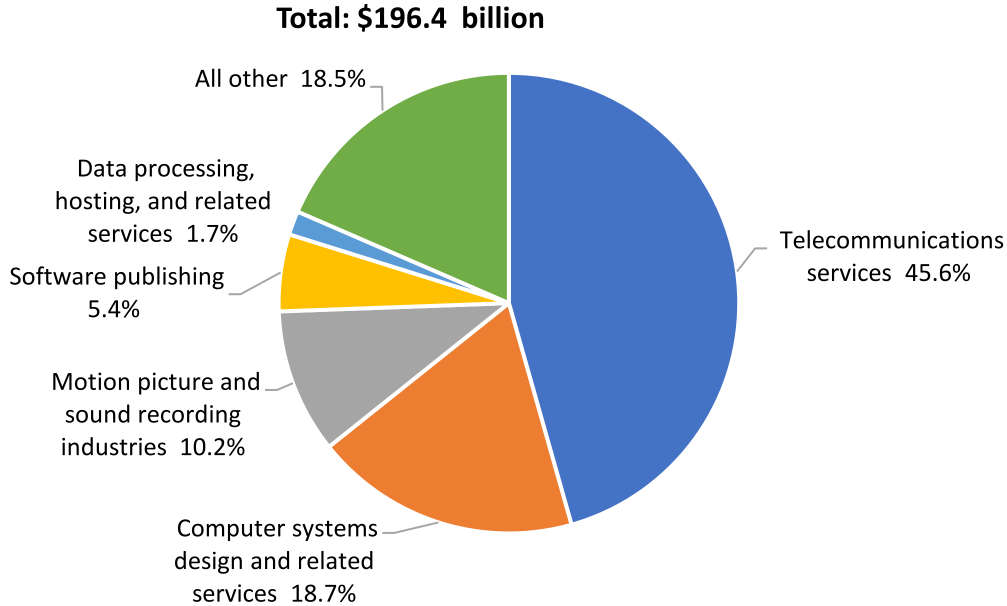
Figure 2.5 Digital and electronic services: Sales by U.S.-owned foreign affiliates, by industry, 2019



Source: USDOC, BEA, table 4.1, "Services Supplied to Foreign Persons by U.S. MNEs through Their MOFAs, by Industry of Affiliate and by Country of UBO," October 19, 2021.
Note: Data were suppressed for the motion picture and sound recording, broadcasting, data processing, hosting, and related services, and other information services categories. MNEs = multinational enterprises; MOFAs = majority-owned foreign affiliates; MOUSA = majority-owned U.S. affiliate; UBO = ultimate beneficial owner. Due to rounding, figures may not add to 100 percent. Underlying data for this figure can be found in appendix table B.16.

[34] USDOC. BEA, table 4.1, "Services Supplied to Foreign Persons by U.S. MNEs through Their MOFAs, by Industry of Affiliate and by Country of Affiliate," October 19, 2021; USDOC, BEA, table 5.1, "Services Supplied to U.S. Persons by Foreign MNEs Through Their MOUSAs, by Industry of Affiliate and by Country of UBO," October 19, 2021.
[35] USDOC, BEA, table 5.1, "Services Supplied to U.S. Persons by Foreign Multinational Enterprises through Their Majority Owned U.S. Affiliates, by Industry of Affiliate and by Country of Ultimate Beneficial Owner," October 19, 2021. Foreign affiliate sales data published by the BEA for computer services break out additional categories not shown separately in the cross-border trade data, such as computer systems design and related services, and software publishing.

Figure 2.6 Digital and electronic services: Purchases from foreign-owned U.S. affiliates, by industry, 2019



Source: USDOC, BEA, table 5.1, "Services Supplied to U.S. Persons by Foreign MNEs through Their MOUSAs, by Industry of Affiliate and by Country of UBO," October 19, 2021.
Note: Data were suppressed for the motion picture and sound recording, broadcasting, and other information services categories. MNEs = multinational enterprises; MOFAs = majority-owned foreign affiliates; MOUSA = majority-owned U.S. affiliate; UBO = ultimate beneficial owner. Due to rounding, figures may not add to 100 percent. Underlying data for this figure can be found in appendix table B.17.

Box 2.1 BEA Methodology Revised for Collecting Audiovisual Services and Computer Software Data

In 2020, the BEA introduced several methodological changes regarding how it collects and publishes international services cross-border trade data. One such change was to reclassify elements in the category "charges for the use of intellectual property" to align with international statistical guidelines.[a] Previously, the BEA generally classified intellectual property transactions by the type of product being traded (e.g., "audio-visual and related products" was a subcategory under "charges for the use of intellectual property"). Beginning in 2020, such transactions were classified by the type of rights being conveyed (e.g., rights to use, rights to reproduce/distribute, and outright sales/purchases), and then further classified by the type of product being traded (e.g., computer software or audiovisual products).[b] For example, BEA data on audiovisual content are now classified first into three types of transactions that represent a sale or purchase of: a license to reproduce or distribute audiovisual content (e.g., licensing a film to a foreign distributor), the rights to use audiovisual content (e.g., downloading a copy of a movie or streaming it online), and original audiovisual work (i.e., the sale or purchase of the master copy, which can then be licensed to a distributor or sold as a download copy to a consumer). The rights to reproduce/distribute and the rights to use audiovisual content are then further broken out by the type of content (movies and television programming, books and sound recordings, and broadcast and recording of live events).[c]

Although the sales and purchases of licenses to reproduce or distribute audiovisual content are still reported under "charges for the use of intellectual property" (as in BEA's previous structure), the licenses to use audiovisual content and the sales and purchases of audiovisual originals were both recategorized under a newly created "Personal, cultural, and recreational: services" category (figures 2.7

and 2.8). In this category, under audiovisual services there are now details for (1) audiovisual production services, (2) rights to use audiovisual products, and (3) audiovisual originals. For the latter two categories, there are also details for the type of audiovisual product: (1) movies and television programming and (2) books and sound recordings.[d]

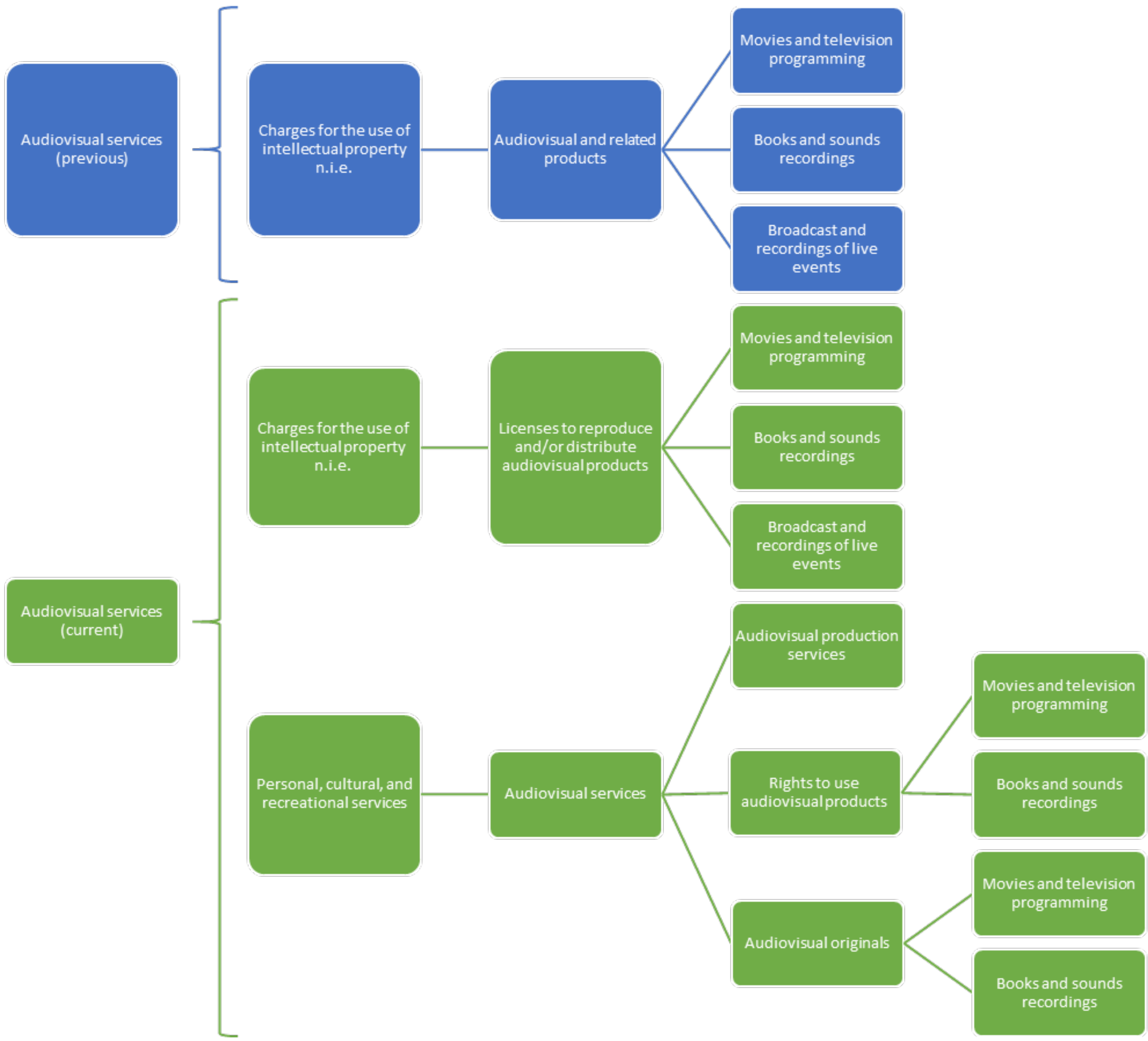
The BEA similarly divided data on exports and imports of computer software into two categories based on the type of rights being traded: sales of software including end-user licenses (now classified under the computer services category), and licenses to reproduce and distribute computer software (now classified under the charges for the use of intellectual property category).[e]

The BEA retroactively applied these revisions to past data, beginning in 2006.[f]

[a] USDOC, BEA, “Annual Update of the U.S. International Transactions Accounts,” July 2020, 57.
[b] USDOC, BEA, “Annual Update of the U.S. International Transactions Accounts,” July 2020, 57.
[c] USDOC, BEA, “Annual Update of the U.S. International Transactions Accounts,” July 2020, 57; UNECE, “International Transactions in Intellectual Property Products,” vol. ECE/CES/14, 2011; U.S. government representative, email to USITC staff, February 9, 2022.
[d] UNECE, “International Transactions in Intellectual Property Products,” vol. ECE/CES/14, 2011; U.S. government representative, email to USITC staff, February 9, 2022.
[e] Sales of computer software include sales of customized software, as well as non-customized software downloaded from the internet or accessed online through a subscription; it excludes software delivered on physical media (which is classified under trade in goods). USDOC, BEA, “Quarterly Survey of Transactions in Selected Services and Intellectual Property with Foreign Persons Form BE-125,” October 22, 2020.
[f] UNECE, “International Transactions in Intellectual Property Products,” vol. ECE/CES/14, 2011; U.S. government representative, email to USITC staff, February 9, 2022.

Figure 2.7 BEA's previous and current presentation structure for audiovisual services trade data

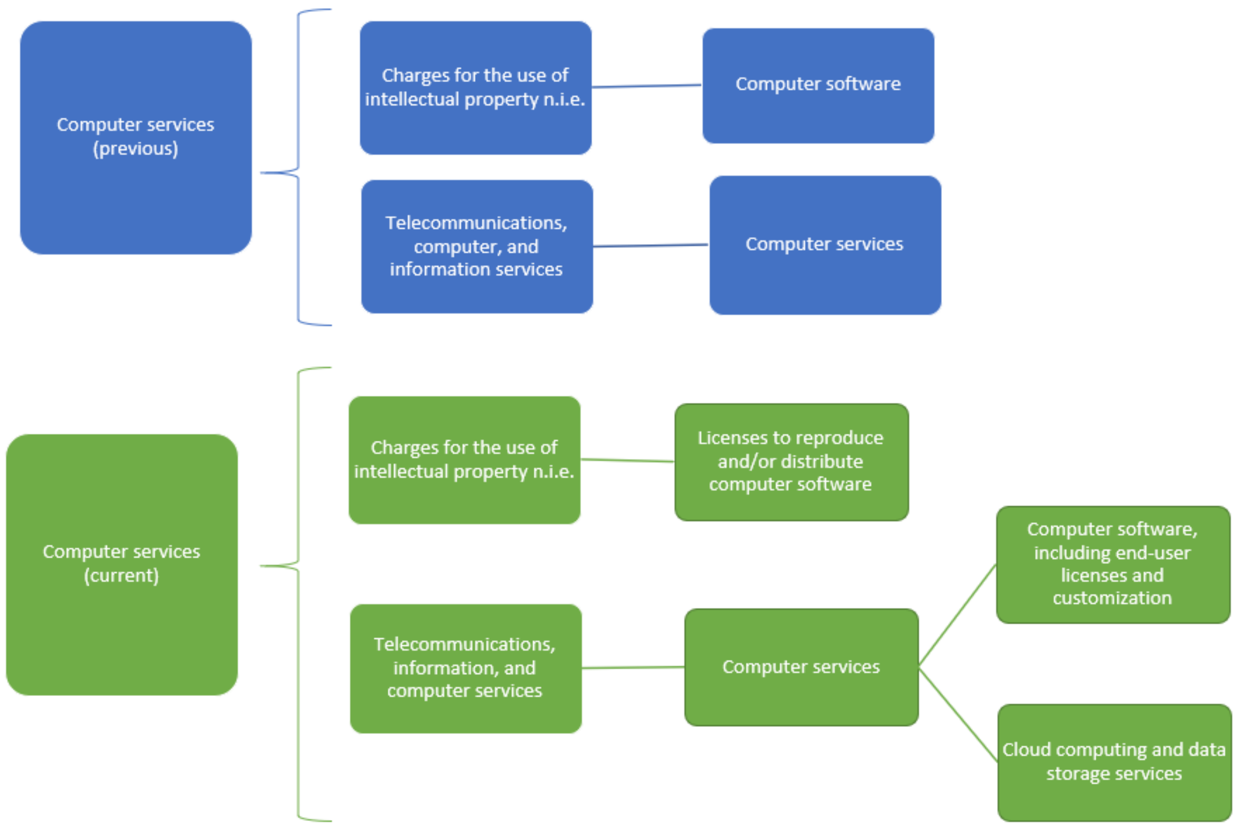
n.i.e. = not included elsewhere.



Source: USDOC, BEA, "Annual Update of the U.S. International Transactions Accounts," July 2020.
Note: Underlying data for this figure can be found in appendix table B.18.

Figure 2.8 BEA's previous and current presentation structure for computer services trade data

n.i.e. = not included elsewhere.



Source: USDOC, BEA, "Annual Update of the U.S. International Transactions Accounts," July 2020.
Note: Underlying data for this figure can be found in appendix table B.18.

U.S. Trade in Digital and Electronic Services by Sector

This section provides additional detail on trade in digital and electronic services for the three subsectors covered in this report: audiovisual services, computer services, and telecommunications services. Recent developments and trends in these three subsectors are discussed in chapters 3 and 4. Additional detail, including the sector compositions of services trade for major U.S. trading partners and for different services sectors not covered in this report, is available in the interactive tables accompanying this report.[36]

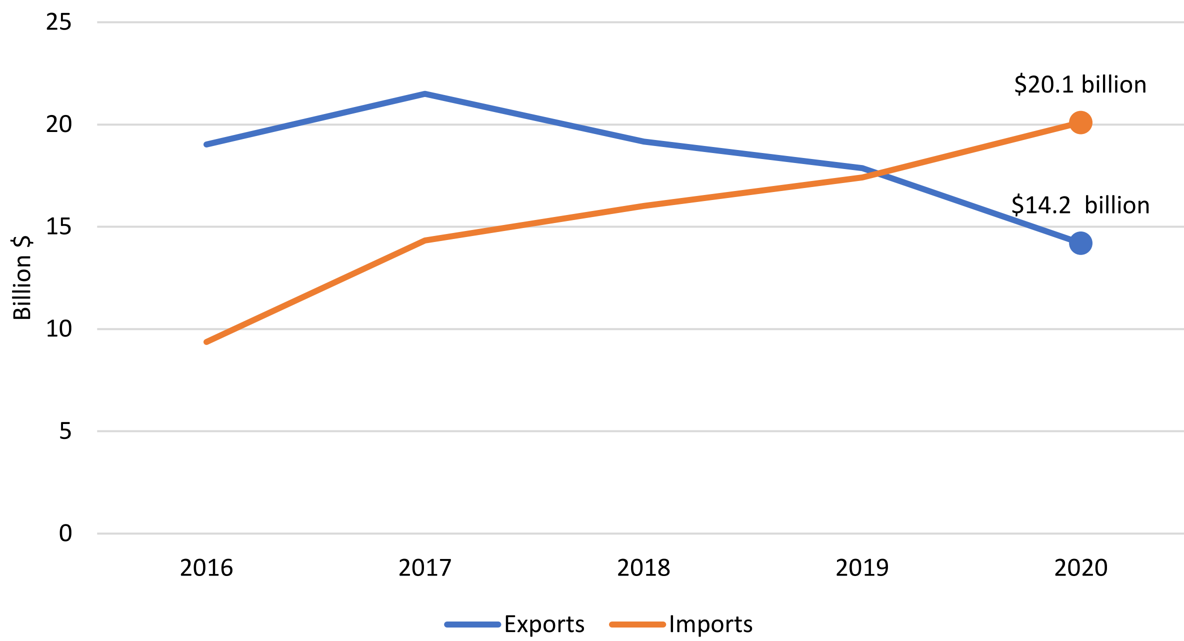
[36] Interactive charts and alternative text are available at https://www.usitc.gov/publications/industry_econ_analysis_332/2022/recent_trends_us_services_trade_2022_annual_report.htm.

Audiovisual Services

In 2020, U.S. cross-border exports of audiovisual services declined by 20.5 percent to $14.2 billion, a one-year decline that far exceeded the average annual decline of 2.1 percent recorded during 2016–19 (figure 2.9).[37] By contrast, imports grew by 15.5 percent to $20.1 billion during 2020, somewhat slower than the average annual growth rate of 22.9 percent during 2016–19.

Figure 2.9 Audiovisual services: Cross-border exports and imports, 2016–20

In billions of dollars.



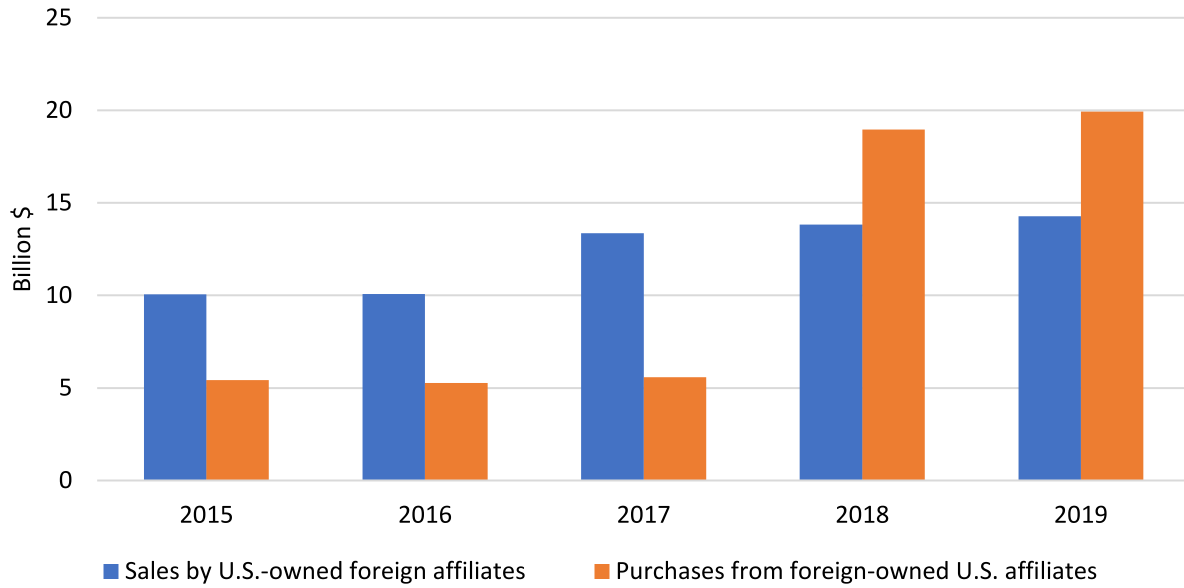
Source: USDOC, BEA, table 2.1, "U.S. Trade in Services, by Type of Service," July 2, 2021.
Note: Underlying data for this figure can be found in appendix table B.19.

The sales of audiovisual services by affiliates of U.S. companies in foreign countries totaled $14.3 billion in 2019 (figure 2.10). These sales grew by 3.3 percent in 2019, compared to an average annual growth rate of 11.2 percent from 2015 through 2018. The value of purchases from U.S. affiliates of foreign firms totaled $19.9 billion in 2019.[38] Such purchases grew by 5.1 percent in that year, significantly slower than the average annual growth rate of 51.8 percent during 2015–18.

[37] USDOC, BEA, table 2.1, "U.S. Trade in Services, by Type of Service," July 2, 2021.
[38] USDOC, BEA, table 4.1, "Services Supplied to Foreign Persons by U.S. MNEs through Their MOFAs, by Industry and Affiliate and by Country of Affiliate," October 19, 2021. USDOC, BEA, table 5.1, "Services Supplied to U.S. Persons by Foreign MNEs through Their MOUSA, by Industry of Affiliate and by Country of UBO," October 19, 2021.

Figure 2.10 Audiovisual services: Affiliate sales and purchases, 2015–19

In billions of dollars.



Source: USDOC, BEA, table 4.1, "Services Supplied to Foreign Persons by U.S. MNEs through Their MOFAs, by industry and Affiliate and by Country of Affiliate," October 19, 2021; table 5.1, "Services Supplied to U.S. Persons by Foreign MNEs through Their MOUSA, by Industry of Affiliate and by Country of UBO," October 19, 2021.
Note: Audiovisual services for services supplied by U.S. firms' foreign affiliates includes motion picture and video industries, whereas services supplied by the U.S. affiliates of foreign firms include motion picture and sound-recording industries. Sales by U.S.-owned foreign affiliates include goods and services supplied by majority-owned foreign affiliates of U.S. parent firms. Purchases from foreign-owned U.S. affiliates includes goods and services supplied by majority-owned U.S. affiliates of foreign parent firms. MNEs = multinational enterprises; MOFAs = majority-owned foreign affiliates; MOUSA = majority-owned U.S. affiliate; UBO = ultimate beneficial owner. Underlying data for this figure can be found in appendix table B.20.

Audiovisual services are discussed in case studies in both chapter 3 and 4. The case study in chapter 3 focuses on subscription-based video-on-demand services like Netflix and the competitive advantage conferred by producing proprietary television and movie programming. In chapter 4, the case study discusses user-generated content platforms like YouTube and the algorithms that customize video recommendations.

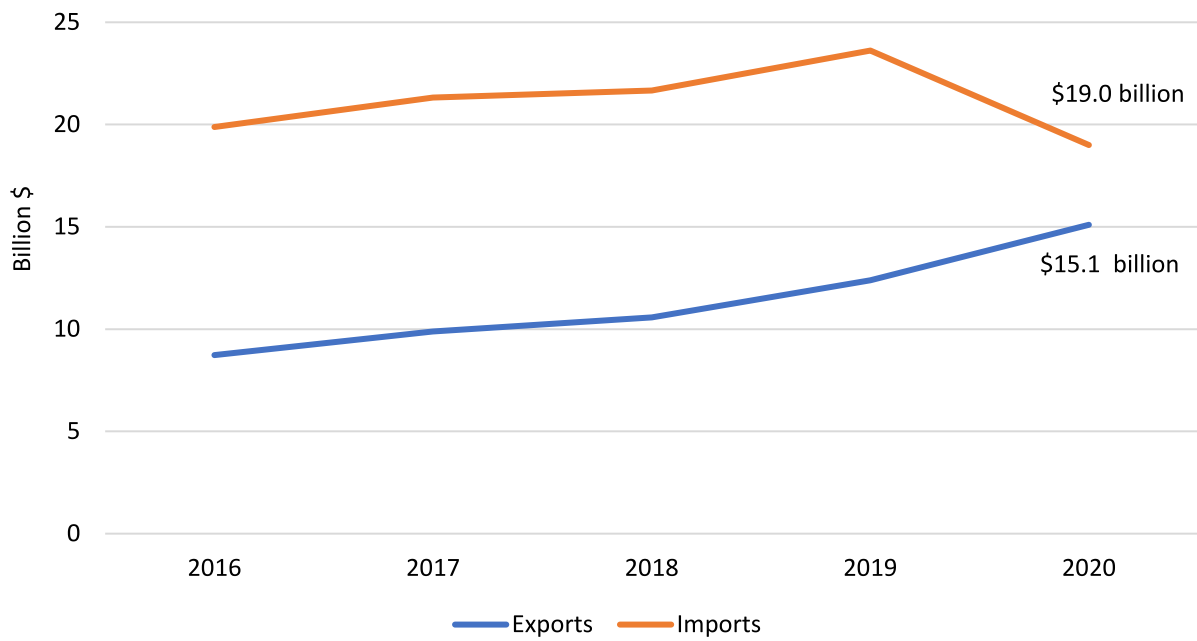
Computer Services

In 2020, U.S. cross-border exports of computer services totaled $15.1 billion, rising 21.9 percent compared to the previous year, while imports declined by 19.6 percent to $19.0 billion, resulting in a deficit of $3.9 billion (figure 2.11).[39]

[39] USDOC, BEA, table 2.1, "U.S. Trade in Services, by Type of Service," July 2, 2021.

Figure 2.11 Computer services: Cross-border exports and imports, 2016–20

In billions of dollars.



Source: USDOC, BEA, table 2.1, "U.S. Trade in Services, by Type of Service," July 2, 2021.
Note: Computer services include (1) other computer services and (2) cloud computing and data storage services. Underlying data for this figure can be found in appendix table B.21.

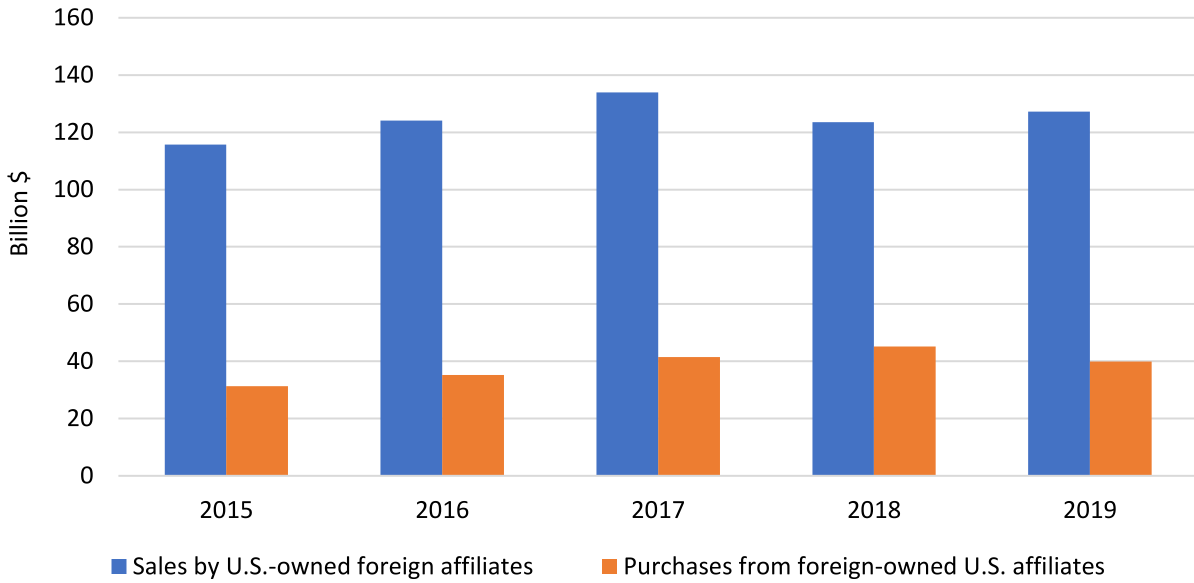
In 2019, computer services supplied by foreign affiliates of U.S. firms totaled $127.2 billion, while services purchased from U.S. affiliates of foreign firms totaled $39.9 billion (figure 2.12).[40] In 2019, foreign affiliate sales grew 3.0 percent, faster than the average annual growth rate of 2.2 percent during 2015–18. By contrast, the purchases of services from U.S. affiliates of foreign firms decreased by 11.7 percent, a notable change compared to the average annual growth rate of 13.0 percent recorded from 2015 through 2018.

Computer services are discussed in case studies in both chapters 3 and 4. The case study in chapter 3 discusses the data center industry and the factors that are increasingly driving the geographic placement of new data centers. In chapter 4, the case study covers the growth in demand for cloud computing services—with a focus on the video game industry—that occurred during the COVID-19 pandemic.

[40] USDOC, BEA, table 4.1, "Services Supplied to Foreign Persons by U.S. MNEs through Their MOFAs, by Industry and Affiliate and by Country of Affiliate," October 19, 2021. USDOC, BEA, table 5.1, "Services Supplied to U.S. Persons by Foreign MNEs through Their MOUSA, by Industry of Affiliate and by Country of UBO," October 19, 2021.

Figure 2.12 Computer services: Affiliate sales and purchases, 2015–19

In billions of dollars.



Source: USDOC, BEA, table 4.1, "Services Supplied to Foreign Persons by U.S. MNEs through Their MOFAs, by industry and Affiliate and by Country of Affiliate," October 19, 2021; table 5.1, "Services Supplied to U.S. Persons by Foreign MNEs through Their MOUSA, by Industry of Affiliate and by Country of UBO," October 19, 2021.
Note: Computer services includes data processing, hosting, and related services and computer system design and related services. Data for affiliate sales in 2019 are underreported because data are suppressed for data processing, hosting, and related services. MNEs = multinational enterprises, MOFAs = majority-owned foreign affiliates; MOUSA = majority-owned U.S. affiliate; UBO = ultimate beneficial owner. Underlying data for this figure can be found in appendix table B.22.

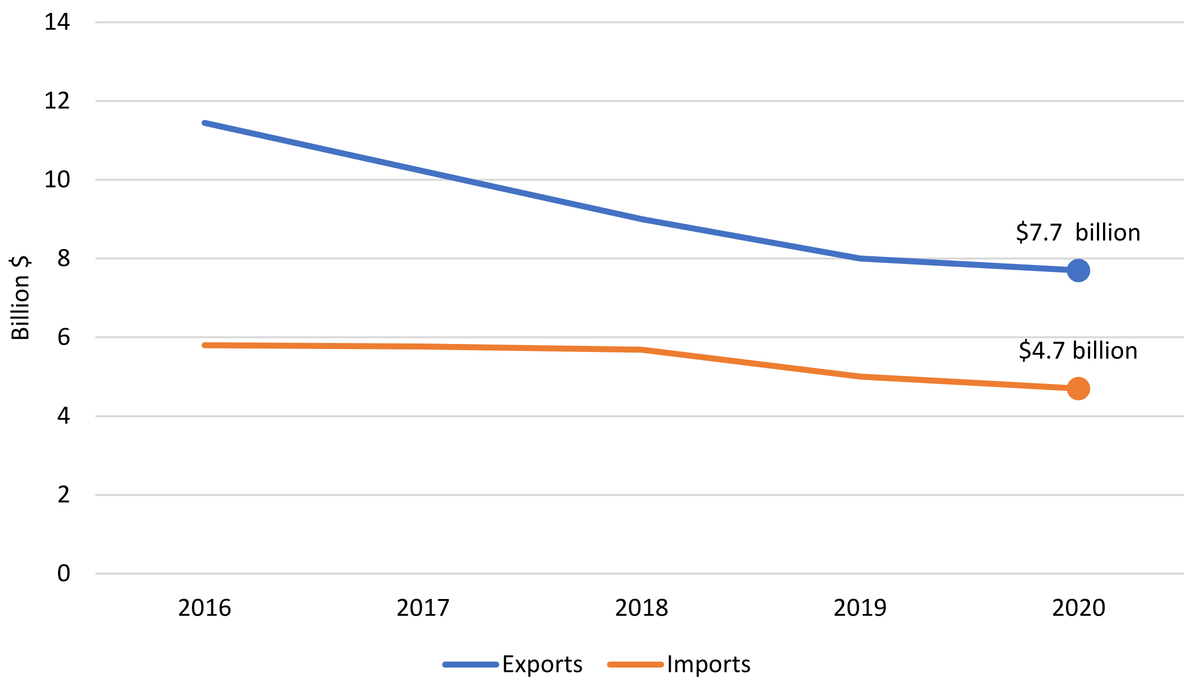
Telecommunications Services

In 2020, both U.S. cross-border exports and imports of telecommunications services continued to decline, with exports falling to $7.7 billion and imports to $4.7 billion, resulting in a surplus of $3.0 billion (figure 2.13).[41] Exports of telecommunications services declined by 3.7 percent during this year, whereas imports declined by 6.1 percent. Since 2016, both cross-border exports and imports of telecommunications services have consistently declined, during 2016-2019 the rate of decline was 11.3 percent and 4.8 percent for exports and imports, respectively.

[41] USDOC, BEA, table 2.1, "U.S. Trade in Services, by Type of Service," July 2, 2021.

Figure 2.13 Telecommunications services: Cross-border exports and imports, 2016–20

In billions of dollars.



Source: USDOC, BEA, table 2.1, "U.S. Trade in Services, by Type of Service," July 2, 2021.
Note: Underlying data for this figure can be found in appendix table B.23.

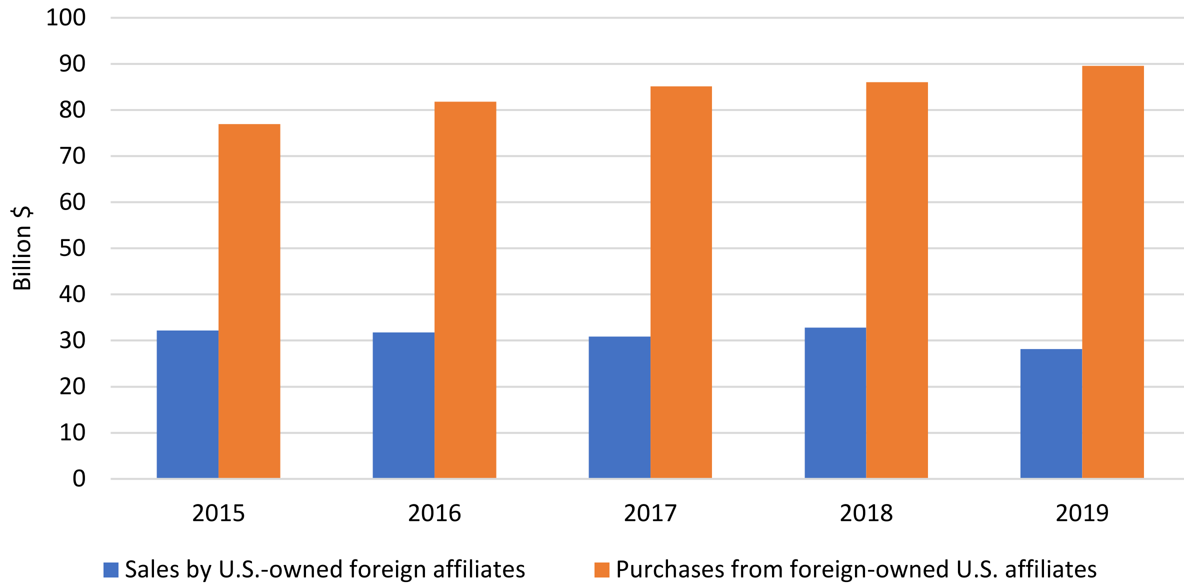
Purchases from U.S. affiliates of foreign-owned telecommunications companies outpaced the sales of U.S. telecommunications companies' affiliates abroad, with purchases totaling $89.6 billion in 2019, compared to sales of $28.2 billion (figure 2.14).[42] In 2019, sales of U.S. affiliates in foreign markets decreased by 14.1 percent, whereas sales by the affiliates of foreign firms in the United States grew by 4.1 percent compared to 2018.

Telecommunications services are discussed in case studies in both chapters 3 and 4. The case study in chapter 3 covers the global mobile services market and the broad differences between the markets of developed and developing countries. In chapter 4, the case study focuses on undersea fiber optic cables—critical network infrastructure supporting the global internet—and the move by cloud and content providers, namely Amazon, Meta, Google, and Microsoft, into the industry.

[42] USDOC, BEA, table 4.1, "Services Supplied to Foreign Persons by U.S. MNEs through Their MOFAs, by Industry and Affiliate and by Country of Affiliate," October 19, 2021. USDOC, BEA, table 5.1, "Services Supplied to U.S. Persons by Foreign MNEs through Their MOUSA, by Industry of Affiliate and by Country of UBO," October 19, 2021.

Figure 2.14 Telecommunications services: affiliate sales and purchases, 2015–19

In billions of dollars.



Source: USDOC, BEA, table 4.1, "Services Supplied to Foreign Persons by U.S. MNEs through Their MOFAs, by industry and Affiliate and by Country of Affiliate," October 19, 2021; table 5.1, "Services Supplied to U.S. Persons by Foreign MNEs through Their MOUSA, by Industry of Affiliate and by Country of UBO," October 19, 2021.

Note: MNEs = multinational enterprises, MOFAs = majority-owned foreign affiliates; MOUSA = majority-owned U.S. affiliate; UBO = ultimate beneficial owner. Underlying data for this figure can be found in appendix table B.24.

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U.S. Department of Commerce (USDOC), Bureau of Economic Analysis (BEA). "Table 2.1 U.S. Trade in Services, by Type of Service," July 2, 2021. https://apps.bea.gov/iTable/iTable.cfm?ReqID=62&step=1.

U.S. Department of Commerce (USDOC), Bureau of Economic Analysis (BEA). "Table 2.2 U.S. Trade in Services, by Type of Service and by Country or Affiliation," July 2, 2021. https://apps.bea.gov/iTable/iTable.cfm?ReqID=62&step=1.

U.S. Department of Commerce (USDOC), Bureau of Economic Analysis (BEA). "Table 4.1 Services Supplied to Foreign Persons by U.S. MNEs through Their MOFAs, by Industry of Affiliate and by Country of Affiliate," October 19, 2021. https://apps.bea.gov/iTable/iTable.cfm?ReqID=62&step=1.

U.S. Department of Commerce (USDOC), Bureau of Economic Analysis (BEA). "Table 5.1 Services Supplied to U.S. Persons by Foreign MNEs Through Their MOUSAs, by Industry of Affiliate and by Country of UBO," October 19, 2021. https://apps.bea.gov/iTable/iTable.cfm?ReqID=62&step=1.

Chapter 3 Digital and Electronic Services Expand Their Global Reach and Adapt to Local Markets

This chapter highlights examples of digital and electronic services from three sectors—audiovisual services, computer services, and mobile services—that are offered worldwide yet are adapting to local market conditions. In the audiovisual services sector, local adaptation is driven by viewer preferences for television (TV) and movie programming in local languages, a factor which is driving video on demand streaming services like Netflix to produce their own content in dozens of countries.[43] In the computer services sector, the placement of data centers is evolving away from traditional geographic locations to include locations that reduce network traffic delays or lower electricity usage. Finally, in the mobile services industry, local specialization is driven to a great degree by a country's level of economic development, which impacts a range of factors including the predominant mobile network technologies used to offer services and the adoption of smartphones by the general populace.

Audiovisual Services: Subscription Video on Demand Services

On-demand streaming of film and TV serials is displacing traditional sources of entertainment, including movie theaters, pay-TV, and over-the-air broadcasting (traditional TV aired on a set time schedule). The COVID-19 pandemic has accelerated this trend, reflecting the broader shift toward viewing video entertainment through online digital media.[44] U.S. streaming platforms continue to be the largest (or only) providers of streaming services in many major markets.[45] One of the most significant industry trends in recent years has been the rapid growth of production and the licensing of locally produced content, including foreign-language content, by subscription video on demand (SVOD) firms.

Market Conditions

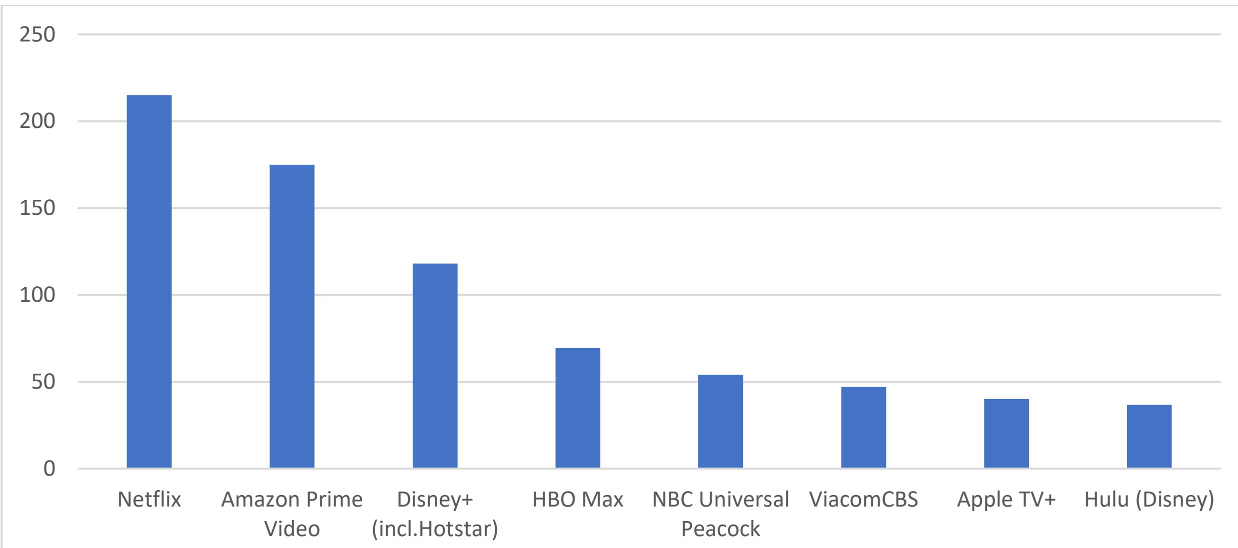
SVOD services are fee-based subscription services that offer unlimited access to a library of video content (e.g., movies, TV shows, and documentaries).[46] Netflix and Amazon Prime were the largest global providers of such services in 2021 (figure 3.1). The global SVOD market is expanding rapidly with many new entrants in recent years, including U.S. companies such as Disney (Disney+), Warner Media

[43] Producing local-language television and movie programming in country markets also captures the cultural context of those countries in terms of both filming locations and plotlines.
[44] Roxborough, "Ready to Watch More Theatrical Releases?," July 3, 2020.
[45] U.S. International Trade Commission, *Foreign Censorship Part 1*, February 2022, 10, 78. The most notable exception is China, where U.S. SVOD providers are prohibited.
[46] Ellis, "What Are SVOD, AVOD, and TVOD?," accessed January 11, 2022.

(HBO Max), and Apple (Apple TV+).[47] From 2017 through 2021, global SVOD revenues soared by 151 percent to $71 billion.[48] In 2021, U.S. SVOD platforms were the global leaders and had the largest number of subscribers. Netflix, for example, had 215 million global subscribers, followed by Amazon Prime Video (175 million) and Disney+ (118 million), which also have large and growing international subscriber bases (figure 3.1). Although U.S. SVOD platforms are market leaders in many countries, they face competition from both domestic and regional streaming services as well as other large, well-financed global providers. For example, in Asia, the region with the strongest subscription growth in recent years, leading Chinese providers Tencent Video and iQIYI recently launched SVOD services in Indonesia, Singapore, Thailand, and the Philippines.[49] In the European Union (EU), U.S. SVOD companies (led by Netflix) are leaders in terms of subscription numbers, although local and regional platforms are moving into the market. In Scandinavia, for example, regional providers such as C More and Viaplay are gaining viewers by offering a growing range of local-language content.[50] In Africa, South Africa-based Showmax offers SVOD services in 50 African countries and, recently, in select European countries.[51]

Figure 3.1 U.S. SVOD companies: Total global subscribers, by firm, 2021

In millions of subscribers.



Sources: Sherman, "Disney Makes the Trend Clear," November 10, 2021; Apple+ estimate, Statista, "Estimated Users of Apple TV Plus in the U.S. 2020," accessed December 16, 2021. Underlying data for this figure can be found in appendix table B.25.

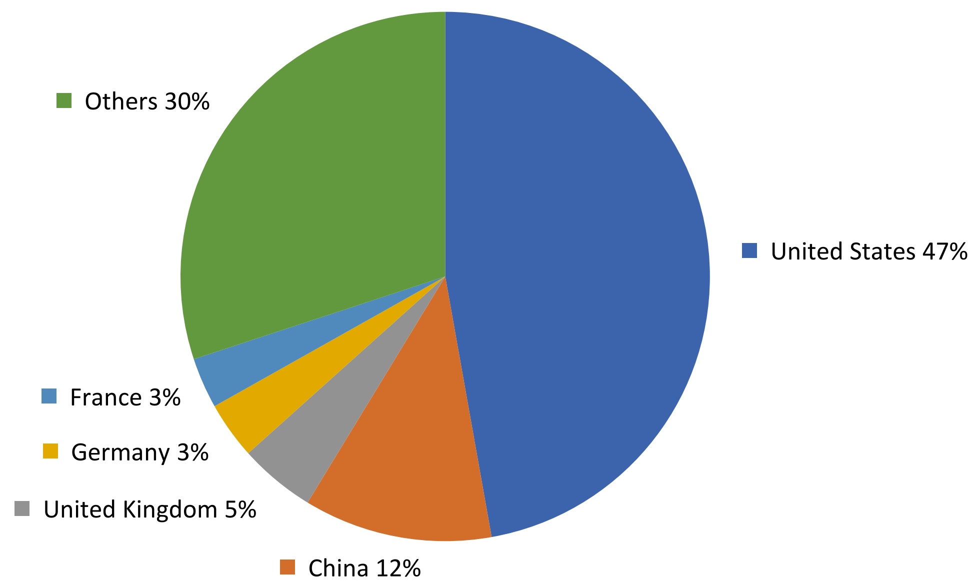
Global SVOD revenues tripled from $17.2 billion in 2016 to $67 billion by the end of 2020.[52] The United States ($29.6 billion) and China ($7.2 billion) together accounted for about 60 percent of revenues by market in 2020 (figure 3.2), followed by the United Kingdom ($2.9 billion) and Germany ($2.2 billion).

[47] Leading U.S. media companies, attracted by the growth in demand for streaming services, have entered the global market in recent years, including Disney, Apple, Comcast, ViacomCBS (renamed Paramount in February 2022), Discovery, and others. Yahoo News, "Netflix Rides on International Content," May 27, 2021.
[48] Statista, "Video Streaming (SVoD) - Worldwide," November 2021.
[49] Shaw, "The Next Streaming Showdown," July 24, 2020.
[50] As a result, Netflix has increased its spending on Nordic languages content. Roxborough, "Nordic Streamers Fight Netflix," November 19, 2019.
[51] Mohammed, "Showmax Invests in African Content," April 27, 2021.
[52] Statista, "SVOD Revenue Worldwide 2016–2026," October 21, 2021.

Other large SVOD markets included France, Canada, Brazil, Japan, Mexico, and Spain.[53] In many global markets, there is strong competition among video streaming providers, including in high growth Asian markets such as India, South Korea, Indonesia, the Philippines, Malaysia, and Vietnam.[54] In 2020, the total number of SVOD subscriptions worldwide was estimated at 904 million, a figure which was forecasted to surpass 1 billion by the end of 2021.[55]

Figure 3.2 SVOD revenue, by market, 2020

In billions of dollars.



Source: Statista, *Subscription Video on Demand (SVOD) Revenue in Selected Countries Worldwide from 2019 to 2025*, November 12, 2021. Underlying data for this figure can be found in appendix table B.26.

The TV and movie content streamed by SVOD companies is displacing traditional sources of entertainment, including movie theaters, pay-TV services, and linear broadcasting services (i.e., traditional TV aired on a set time schedule).[56] Moreover, the COVID-19 pandemic has accelerated the adoption of such services, extending the broader shift toward at-home viewing of video content.[57] Although the United States is the world's largest SVOD market, measured by subscribers, it is also the most saturated.[58] With the entrance of many new streaming services into the U.S. market since 2019, and no current prospect for U.S. providers to legally operate in China, the world's second-leading

[53] Stoll, "Global SVoD Revenue Share by Country 2019," October 21, 2021; PR Newswire, "Global SVOD Forecasts Report 2020-2025," May 14, 2021.
[54] Statista, "Video Streaming - Asia," accessed March 4, 2022.
[55] Stoll, "SVOD Subscriptions and Subscribers Worldwide 2020-2026," November 15, 2021.
[56] Motion Picture Association, *2020 Theme Report*, March 18, 2021.
[57] Motion Picture Association, *2020 Theme Report*, March 18, 2021.
[58] Low, "Inside Netflix's Quest to Become a Global TV Giant," July 30, 2020; Watson, "Streaming Giants Are Spending Billions Overseas," May 12, 2021.

market, U.S. SVOD firms are turning to emerging markets for subscriber and revenue growth.[59] In 2021, for example, 90 percent of Netflix's new subscribers were in foreign markets.[60] In many developing-country markets, SVOD subscriber growth has been driven by the introduction of high-speed mobile services and the adoption of smartphones that, increasingly, are used to stream video content.[61]

U.S. SVOD Companies Produce Television Serials and Movies in Non-U.S. Markets

One of the most significant industry trends in recent years has been the rapid growth of production and licensing of locally produced content in foreign countries, including foreign-language content by U.S. SVOD firms.[62] Investment in local content is occurring in most global regions, including Asia, Eastern Europe, and Latin America. To attract subscribers in the United States and abroad, U.S. SVOD firms are now incorporating a wide (and expanding) range of foreign-language content.[63] In 2020, Netflix, Disney+, Amazon Prime, and Apple TV+, among other U.S. SVOD platforms, spent an estimated $66 billion on video content with a large proportion invested in foreign programming.[64]

Netflix, in particular, has pioneered the production of TV and movie programming in foreign countries.[65] The platform's strategy for producing TV and movie programming in foreign countries is to develop content that simultaneously appeals to country-level markets but also has regional, and even global, appeal. Recent examples of country-level video content that appeal to global viewers are the hit South Korean-language series, Squid Game, and Lupin, a French mystery thriller TV series, which led viewer rankings in Argentina, Germany, Italy, and Spain.[66] In Netflix's U.S. library, 45 percent of content now features foreign-language titles.[67] In 2014, Netflix spent about 7 percent of its budget on original content (both foreign and domestic). By 2020, however, one-half of its budget was spent on original content, with foreign-language content accounting for 38 percent of the total.[68] In 2021, Netflix was estimated to have spent $17 billion on original programming,[69] with one-half of such programming developed outside the United States and more than one-third consisting of non-English TV and movie programing.[70]

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[59] Watercutter, "HBO Max Is Now on Roku," December 18, 202AD; Chris Arkenberg et al., "As the World Churns," December 1, 2021.
[60] Watson, "Netflix, Disney and Amazon's Streaming Wars," April 22, 2021; Williams, "Netflix Searches for Next Growth Opportunity," October 18, 2021.
[61] Epstein, "Why Asia Is Now Netflix's Hottest Market," December 2, 2020.
[62] Walborn, "International TV Booms," April 14, 2021.
[63] Watson, "Netflix, Disney and Amazon's Streaming Wars," April 22, 2021.
[64] Stoll, "Global Content Spend of Streaming Companies 2020 and 2025," November 9, 2021.
[65] De Silva, "NetFlix Banks on Local Language Original Content," April 11, 2021; Skinner, "Developing a Global Content Strategy Like Netflix," *Voices* (blog), October 20, 2020; Choudhury, "Netflix Bets Big on Asia," November 9, 2020; Gruenwedel, "Netflix Becomes Largest Producer," July 1, 2021. For example, in 2021, Netflix was the leading producer of original content in Europe.
[66] Cross, "The 2021 Global Content Wars," February 9, 2021; Brzeski, "Squid Game," October 11, 2021.
[67] Moore, "Does Netflix Have Too Much Foreign Content?," August 5, 2020.
[68] Spangler, "Netflix's Amortized Content Spending to Rise 26%," September 23, 2021; Laburza, "How the Streaming Wars Are Changing What You Watch," July 18, 2021.
[69] Stoll, "Netflix: Content Spend 2021," August 26, 2021.
[70] Watson, "Netflix, Disney and Amazon's Streaming Wars," April 22, 2021.

Other U.S. SVOD firms are similarly making large investments in local content, including local-language content. In 2020, Disney+ reportedly spent $10 billion on original content with about one-quarter invested in foreign programming. Amazon, HBO Max, and Apple TV+ are also reportedly spending heavily on local-language content as they compete for subscribers with Netflix and other global providers, including iQIYI, which is reportedly investing heavily in local-language content in Southeast Asia.[71] Large investments in foreign local content by U.S. and other global SVODs is reportedly leading to increased competition with media firms in destination markets for actors, writers, and crews, putting pressure on content producers in those markets to be more aggressive in bidding for projects and talent.[72]

Localization of programing is reportedly essential for subscription growth in many emerging SVOD markets, but particularly in fast growing Asian markets. As a result, U.S. SVOD platforms are making large investments in local content.[73] Disney+, for example, plans to produce 50 original Asian titles by the end of 2023.[74] Similarly, Netflix announced plans to spend more than $700 million on an estimated 200 programming titles in Asia during 2016-20 and was expected to double annual spending in 2021.[75] About one-half of Netflix's new subscribers were in the Asia-Pacific region in 2020.[76] To boost demand for video streaming services, US SVOD companies are offering tiered, and relatively low-cost, subscriptions, including mobile-only plans, in India, Malaysia, Indonesia, Thailand, and the Philippines.[77]

South Korea and India are key Asian markets for subscription growth and content development. South Korea, in particular, has emerged as a creative hub for TV and movie content, producing a wide variety of high-quality content that is popular with audiences around the world. In 2020, for example, the South Korean film *Parasite* won the Academy Award for Best Picture. As a result, U.S. SVOD companies are spending heavily on South Korean-produced content.[78] Netflix, for example, currently has over 70 South Korean titles in its global library and planned to invest $500 million in original South Korean films and TV shows in 2021.[79] In 2021, Netflix controlled 50 percent of the South Korean SVOD market (7.9 million subscribers), followed by the South Korean SVOD company, Wavve, which had a 20 percent market share.[80] Disney+, which entered South Korea in 2021, is also spending heavily on South Korean video content.[81] In addition to producing TV and movie content in South Korea, U.S. SVOD companies are also purchasing the licensing rights for South Korean programming. For example, Netflix purchased three

[71] Watson, "Netflix, Disney and Amazon's Streaming Wars," April 22, 2021; Meek, "Disney+ Is Mopping the Floor with Netflix," July 10, 2021; O'Farell, "IQiyi Takes Chinese Streaming Regional," December 15, 2021.
[72] Roxborough, "Netflix Dominates Global SVOD Market," November 13, 2019; Watson, "Netflix, Disney and Amazon's Streaming Wars," April 22, 2021.
[73] Shackleton, "How Local Streamers Are Holding Up," October 8, 2021; Epstein, "Why Asia Is Now Netflix's Hottest Market," December 2, 2020.
[74] Announced in October 2021. Toh, "Disney Wants Some of Netflix's Asian Success," October 14, 2021.
[75] Mu-Hyun, "Netflix to Spend $500 Million," February 24, 2021.
[76] Choudhury, "Netflix Bets Big on Asia," November 9, 2020.
[77] Choudhury, "Netflix Bets Big on Asia," November 9, 2020.
[78] Epstein, "Why Asia Is Now Netflix's Hottest Market," December 2, 2020; Merican, "Netflix Will Invest $500 Million," February 26, 2021.
[79] Merican, "Netflix Will Invest $500 Million," February 26, 2021.
[80] Seung-hyun, "Disney+ to Expand Partnership," October 14, 2021.
[81] Seung-hyun, "Disney+ to Expand Partnership," October 14, 2021.

high profile, big-budget South Korean films that were planned for release in domestic Korean theaters in 2020, but instead aired exclusively on Netflix due to the COVID-19 pandemic.[82]

In India, Netflix accounted for 29 percent of the SVOD market in 2020, measured by revenues, followed by Disney+ Hotstar (25 percent) and Amazon Prime (22 percent).[83] In an effort to appeal to local audiences, all three US SVOD companies are investing heavily in original Indian content.[84] Most such investment is directed toward Hindi language programming, which made up about two-thirds of original content production in the country.[85] During 2019–20, Netflix reportedly spent $400 million on the production of original content in India as well as on the licensing rights for programming content produced by domestic Indian companies.[86] Together, all SVOD platforms in India produced about 400 original TV and movie titles in 2021.[87]

Outlook

The shift toward in-home entertainment is expected to continue to boost global demand for SVOD services over the next five years.[88] SVOD services are estimated to increase by 41 percent to 1.5 billion subscriptions by 2026, while revenues are expected to rise 88 percent to $126 billion, up from $67 billion in 2020.[89] Since the United States and Europe are now considered mature markets, U.S. SVOD platforms will likely continue to focus on emerging markets for growth, particularly in Asia and Latin America.[90] In the competition for new customers, U.S. SVOD companies are expected to further increase spending on original and foreign-language content.[91] Netflix, for example, is expected to boost original content spending to $18.9 billion by 2025, with one-half of such expenditures focused on foreign content.[92] Total spending by U.S. SVOD companies is estimated to nearly double from 2020 levels, to $108 billion by 2025 with a large share dedicated to foreign-language content.[93]

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[82] Frater, "Netflix Adds Seven Movies and Series," November 24, 2020.
[83] Shackleton, "India's OTT Revenue to Reach $4.5bn," November 25, 2021; Dager, "Netflix, Disney+ Hotstar Account for Half," April 5, 2021. Although trailing Netflix by revenues, Disney+ Hotstar has more than twice the number of subscribers.
[84] Dager, "Netflix, Disney+ Hotstar Account for Half," April 5, 2021.
[85] Dager, "Netflix, Disney+ Hotstar Account for Half," April 5, 2021.
[86] Choudhury, "Netflix Bets Big on Asia," November 9, 2020.
[87] Dager, "Netflix, Disney+ Hotstar Account for Half," April 5, 2021.
[88] CRFA, *Media and Entertainment*, September 2021, 4.
[89] Stoll, "SVOD Subscriptions and Subscribers Worldwide 2020-2026," November 15, 2021; Stoll, *SVOD Revenue Worldwide 2026*, October 21, 2021.
[90] CRFA, *Media and Entertainment*, September 2021, 4.
[91] Pennington, "Local Content Hits Home for SVODs," May 18, 2021.
[92] Spangler, "Netflix's Amortized Content Spending to Rise 26%," September 23, 2021.
[93] Stoll, "Global Content Spend of Streaming Companies 2020 and 2025," November 9, 2021. In response to the Russian invasion of Ukraine, leading U.S. SVODs including Netflix, Amazon Prime Video, and Disney+ have suspended services in Russia. Lang, "Netflix Suspends Service in Russia," March 6, 2022; Malik, "Amazon Suspends Access to Prime Video in Russia," March 9, 2022; Rubin, "Disney 'Taking Steps to Pause' All Business in Russia," March 10, 2022.

Computer Services: Data Centers

Over the past decade, the exponential growth in social media, gaming, video streaming, and other digital services has created ever stronger demand for computer services, especially cloud computing services. As a result, many of the providers of digital content and services have engaged in the large-scale construction of data centers. Data centers—and the telecommunications networks that connect them—are the physical infrastructure over which all computer services are delivered. Over the past few years, the design and location of such data centers has begun to evolve. In particular, the geography of data centers is becoming more dispersed. While data centers are still being constructed in traditional geographic locations, in response to a variety of factors new data centers are also being built in other locations. These factors include, as discussed below, the low network latency[94] requirements of some computer services and the desire to reduce the electricity consumption and environmental impact of data centers.[95]

Market Conditions

A data center is a facility—typically a building or a group of buildings—that houses computer and networking equipment. In addition to equipment storage space (racks, cabinets, cages, or rooms),[96] data centers offer a suite of services to power, cool, and protect on-site equipment. Such services include uninterruptable power sources (redundant electricity sources, backup generators, and battery banks), environmental control systems (heating, air conditioning, ventilation, and exhaust systems), building security (fencing, video surveillance and biometric access systems, and security guards), and operations staff to monitor data center operations and maintain information technology (IT) equipment and infrastructure.[97] Data centers must also maintain redundant, high-speed, fiber optic cable connections to the broader internet and, in some cases, to proprietary networks used to transfer large amounts of data between data center facilities. Large, complicated networks of servers located in data centers (and the software installed on those servers) facilitate a wide range of cloud computing applications and services.

There are two main types of data centers: private data centers and colocation data centers. Private data centers are owned and operated by a company for its exclusive use, such as those operated by Meta and Google. By contrast, colocation data centers are operated by specialist companies—like Equinix or Digital Realty Trust—that lease space to clients and operate and manage the facility on their behalf. In 2020, the colocation segment of the market was valued at approximately $54 billion; the five largest operators in the market were Equinix (11.1%), Digital Realty Trust (7.6%), China Telecom (6.1%), NTT

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[94] Latency refers to the gap in time between when a data request is made and the point when the requested information is delivered to a user. Latency is impacted by a variety of factors, including the proximity of data centers to users. Computer services vary in terms of the latency requirements necessary for services to function as intended. Basic applications like email, for example, can function with high latency—over 160 milliseconds (ms)—whereas data-intensive applications like streaming video require latency of less than 100 ms to function properly.

[95] Government regulations like data localization requirements could also influence decisions about data center location in some country markets.

[96] Equipment commonly stored in data centers includes servers, routers, switches, modems, multiplexers, firewall devices, and data storage equipment.

[97] Palo Alto Networks, "What is a Data Center?," accessed January 6, 2022.

GDC (4.3 percent), and China Unicom (4.2 percent).[98] As of 2021, the United States was home to the largest number of data centers (2,750), followed by Germany (482), the United Kingdom (458), China (447), and Canada (324).[99] Despite already housing more data centers than any other country, data center construction in the United States rose considerably in 2020. Total capacity under construction in the United States, for example, increased from 171.2 megawatts (MW) in 2019 to 611.8 MW in 2020. In the first half of 2021, capacity under construction was 680.8 MW, with 339 MW alone taking place in Northern Virginia. [100] Other markets, including Europe and India, also saw considerable planned capacity increases.[101]

Demand for digital and electronic services has been the primary driver of data center construction over the past decade. From 2010 to 2020, the volume of data that the world generated and replicated increased from 2 zettabytes (ZB) to 64.2 ZB.[102] As of 2018, over 90 percent of the data that existed worldwide had been generated in the previous two years alone, and the amount of data continues to grow rapidly each year.[103] Since 2020, the COVID-19 pandemic and measures to limit the spread of the virus accelerated digital transformation and service adoption. Remote working (which included increased videoconferencing and file sharing), distance learning, online video streaming, and various other online activities led to a rapid and substantial increase in the generation and use of data. All of these applications and platforms contributed significantly to the surge in generated data, which grew by 56.6 percent worldwide from 2019 to 2020.[104]

In response to forecasts of growing data volumes, IT spending on data center systems in a wide range of geographies and locations is expected to increase by 11.4 percent in 2022, reaching $226 billion.[105] Google, for example, is building new data centers in metropolitan centers such as Berlin, Germany, as well as in smaller urban areas such as Council Bluffs, Iowa.[106] Similarly, Microsoft is planning to build 50 to 100 new data centers a year for the foreseeable future.

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[98] Sverdlik, "These Are the World's Largest Data Center Colocation Providers," January 15, 2021; Structure Research, *2020: Global Data Centre Colocation & Interconnection Report*, December 2020. Companies, like Google, that own and operate private data centers, typically do so for their own use and therefore do not report revenues.
[99] Daigle, "Data Centers Around the World: A Quick Look," May 2021; Cloudscene, "Colocation & Interconnection Industry—Data Centers," accessed January 19, 2022.
[100] Barnett, *H1 2021 Data Center Outlook 2021*, September 8, 2021; Barnett, *Data Center Outlook*, H1 2020.
[101] Barnett, *H1 2021 Data Center Outlook 2021*, September 8, 2021.
[102] Reinsel, Rydning, and Gantz, "Data Creation and Replication Will Grow at a Faster Rate than Installed Capacity," March 24, 2021; Pritchard, "Data Integration Dogged by Complexity," January 31, 2022. From 2014 to 2020, the number of internet-connected people worldwide rose from 2.7 to 4.6 billion. ITU, *Internet Use*, accessed March 4, 2022; Reinsel, Gantz, and Rydning, "The Digitization of the World from Edge to Core," November 2018, 3.
[103] Marr, "How Much Data Do We Create Every Day?," May 21, 2018.
[104] Von See, "Volume of Data/Information Created," June 7, 2021; Cooke, Fitzgerald, and White, *A Blueprint for DX Success*, April 2021; Klosowski, "We Checked 250 iPhone Apps,", May 6, 2021; Reinsel, Rydning, and Gantz, "Data Creation and Replication Will Grow at a Faster Rate," March 24, 2021.
[105] Liu, "Worldwide IT Spending Data Center Systems 2012-2022," October 22, 2021; Gartner, "Gartner Forecasts Worldwide IT Spending to Grow 5.1%," January 18, 2022.
[106] Google Data Centers, "Discover Our Data Center Locations," accessed February 10, 2022.

These range from hyperscale data centers in Malaysia to small, self-contained, modular data centers which can be smaller than a shipping container and, thus, quickly transported and easily deployed to remote and challenging environments such as military missions and disaster-hit areas.[107]

The Push for Latency Reduction is Driving the Geographic Placement of Some Data Centers

The growing prevalence of applications and services that require low latency—like video streaming, telesurgery, unmanned aircraft systems, some cloud computing services, and high-frequency securities trading—is driving the location of some data centers.[108] A growing number of applications, including the surge in Internet of Things (IoT) devices, require near real-time communications between such devices (that are sending and receiving data) and the data centers that are analyzing and processing the data. Historically, data centers were placed near major telecommunications networking hubs and internet exchange points, which explains the cluster of data centers in places like London, England, and Northern Virginia in the United States. Today, while new data centers are still being constructed in established locations like Ashburn, Virginia, and Chicago, Illinois,[109] in an effort to reduce overall network latency, they are also being constructed in an expanding range of locations, including near coastal undersea cable landing stations. For example, the NAP of Virginia (NAP) datacenter is currently being constructed in Virginia Beach, Virginia, due to its proximity to the Telxius Cable Station, which is the landing location for the MAREA, BRUSA, and Dunant undersea cable systems.[110]

Data centers are also being placed at the so-called "edge" of the network to reduce latency.[111] In response to demands for speed and responsiveness, the number of edge data centers and the proportion of data that they process are growing rapidly.[112] Such "edge" data centers are typically smaller than traditional data centers and, increasingly, the size of a standard shipping container. Edge computing—or analysis and processing functions that are performed by computers at the edge of the network, often due to the requirements for near real-time response times (i.e., low latency)—is one factor driving the location of data centers to the edge of the network. Edge computing, and the data

[107] Roach, "Microsoft's Virtual Datacenter Grounds 'the Cloud' in Reality," April 20, 2021; Microsoft Malaysia, "Microsoft Announces Plans to Establish First Datacenter Region in Malaysia," April 19, 2021. IDC defines a hyperscale data center as one that generally exceeds 5,000 servers and 10,000 square feet, although some hyperscale data centers house millions of servers.
[108] Doctors use medical robotics and multimedia image communication to remotely perform telesurgery; unmanned aircraft systems, commonly referred to as drones, are remotely controlled by a human or, in the most advanced cases, fly themselves without human intervention; computerized, algorithmic, trading systems operate on microsecond or nanosecond timetables.
[109] Phillips, "Data Center Construction Market Continues to Boom," November 2, 2020.
[110] Point One, "NAP of Virginia Beach," accessed March 7, 2022; Bruns, "How Undersea Cables Drive Onshore Site Decisions," March 2020.
[111] The term "the edge" refers to the edge of the network, i.e., where the consumer is located. Consumers, using devices like smartphones, computers, and tablets, are the "edge" of the network. In the commercial market, a factory, for example, would be at the "edge."
[112] IDC forecasts that by 2023, over half of new enterprise IT infrastructure will be at the edge. Gartner forecasts that 75% of enterprise-generated data will be created and processed outside a traditional centralized data center or cloud by 2025. McCarthy, "Edge Computing: Not All Edges Are Created Equal," *IDC Blog* (blog), June 1, 2020; Van Der Meulen, "What Edge Computing Means for Infrastructure," October 3, 2018.

centers that support such applications, are increasingly supporting services ranging from traffic management to electricity networks to in-hospital patient monitoring.

Manufacturing, which has become highly digitized, increasingly requires low latency network connections because even slight increases in latency levels can slow production and negatively affect a company's ability to compete effectively. Modern "smart" factories, which integrate technology and data in real-time, contain large numbers of sensors which are connected to the IoT and which create massive amounts of data.[113] To reduce the latency resulting from transferring data to and from distant data centers, manufacturers are placing edge data centers at, or as close as possible to, the origin and use of the data. Some of these—micro-modular data centers—are smaller than a shipping container. Collecting and processing data at or near the source (for example, near an assembly line) provides near real-time findings, allowing manufacturers to increase efficiency and improve operations.[114]

Providers are increasingly adding edge data centers to their catalog of offerings, and they are often doing so collaboratively. For example, Microsoft has partnered with AT&T to bring Microsoft's Azure cloud services closer to customers via a service called Azure Edge Zones. These zones, which are connected via fifth generation (5G) networks in AT&T's data centers, will offer computing, storage, and ultra-low-latency networking services to end users. Microsoft is also reportedly planning to establish Azure Edge Zones with other global telecommunications operators, including Rogers (Canada), Telefonica (Spain), Vodafone Business (UK), SK Telecom(South Korea), Telstra (Australia), Etisalat (United Arab Emirates), and NTT Communications (Japan).[115] Similarly, Verizon and Google will be jointly offering edge computing through Verizon's 5G Edge platform.[116] This partnership aims to deliver computing and storage services to the edge of local networks and provide the capacity and low latency that near real-time applications require.

CrowdVision, a provider of automated pedestrian analytics and insights, is an example of a company that switched from using traditional centralized data centers to edge data centers.[117] Through Verizon 5G Edge and AWS Wavelength, CrowdVision installs edge data centers with the goal of increasing the capacity of its interconnected systems and thus improving safety and efficiency in public spaces. The company uses large numbers of sensors to measure points on the surfaces of people and objects to generate a three-dimensional point cloud—a detailed set of data points–and visualizations to monitor and manage crowds. The edge data centers collect, analyze, and present near real-time information about important safety and comfort factors. These include the level of activity at security checkpoints; the number and engagement of people in venues such as airports, theaters, or sports stadiums; the

[113] While many factories use computers to control manufacturing processes, the systems and data on these computers exist in silos with little or no connectivity. Smart factories, in contrast, connect technologies and contextualize data into "fully-integrated, collaborative manufacturing systems that respond in real time to meet changing demands and conditions in the factory, in the supply network, and in customer needs," often referred to as smart manufacturing. See Shiklo, "Smart Factory: The Future of Manufacturing," *ScienceSoft* (blog), December 15, 2021; Lipman et al., "Product Definitions for Smart Manufacturing," May 3, 2021; Hill, "Simulation Is a Window Into the Future," January 21, 2022.

[114] Early adopters of smart manufacturing processes report average three-year gains of 10 percent or more for factory output, factory capacity utilization, and labor productivity. Wellener et al., *2019 Deloitte and MAPI Smart Factory Study*, 2019; Wellener et al., "Manufacturing Goes Digital," September 16, 2019.

[115] Hardesty, "Microsoft, AT&T Create Edge Compute Zones," April 1, 2020.

[116] Ehrlich, "Verizon and Google Cloud Partnering on 5G Mobile Edge Computing," January 3, 2022.

[117] Miller, "Business Edge Emerges," September 28, 2020; CrowdVision, "Company," September 22, 2020.

length of queues for concessions and restrooms; and, by measuring the space between people, adherence to social-distancing protocols. Utilizing edge computing, CrowdVision reports that is has benefitted from lower latency, greater capacity, and higher quality information. The company also plans to place edge data centers in more locations.[118]

Cool Locations and Energy-efficient Data Centers Lower Electricity Usage and Reduce Emissions

Due to the sheer volume of data that data centers now process and store, data centers are very energy intensive, using large amounts of electricity to power servers and networking equipment and to cool the facility.[119] In general, data center cooling requires significant investments in temperature controls, which are typically needed around the clock and are economically and environmentally costly.[120] One study estimates that cooling IT equipment alone comprises 40 percent of total energy costs for data centers.[121] This energy consumption, when generated by fossil fuels, can create a high volume of carbon emissions.

In response, companies are innovating to make data centers more environmentally friendly. The main strategies are (1) building data centers in cool locations, a practice which requires less electricity to cool the facility, and (2) using renewable energy. For example, Google opened a data center in Hamina, Finland, in 2009, and announced in May 2019 that it would invest 600 million euros more into this facility.[122] Moreover, Microsoft has begun testing and deploying data centers underwater in Scotland. In the spring of 2018, Microsoft's Project Natick deployed its Northern Isles data center in 117 feet of water off the coast of the Orkney Islands, retrieving it in 2019.[123] Going forward, underwater data centers could be used not only to reduce electricity consumption but also to reduce network latency as one-half of the world's population lives within 120 miles of a coast.[124]

The other main strategy to reduce data center emissions is the efficient use of energy, particularly renewable energy.[125] Major data creators and processors like AWS, Apple, and Microsoft have pledged to use 100 percent renewable energy sources in the coming years (or already do so for certain segments of their operations).[126] As part of meeting these pledges, some companies have located data centers

[118] Gibson, "Verizon 5G Edge and AWS Wavelength," September 22, 2020.
[119] The exact amount of energy that data centers use is difficult to determine, and studies often find varying results. Two recent studies estimated that the yearly energy use by data centers was 196 terawatt hours (TWh) in 2010, and that this yearly total had risen to 400 TWh by 2018. For reference, the city of Washington, DC, consumes a total of 11.3 TWh per year. See Masanet et al., "Recalibrating Global Data Center Energy-Use Estimates," February 28, 2020, 984–86; Hintemann, *Data Centers 2018*, May 16, 2020; USDOE, *Washington, D.C. Energy Sector Risk Profile*, accessed February 4, 2022.
[120] Miller, "How Data Center Cooling Works," February 1, 2022; Tylor, "Why Is Data Center Environmental Monitoring Important?," August 28, 2020.
[121] Zhang et al., "Cooling Energy Consumption Investigation of Data Center IT Room," May 2017.
[122] Kauranen and Virki, "Google to Invest 600 Million Euros in Finnish Data Center," May 27, 2019.
[123] Roach, "Microsoft Finds Underwater Datacenters Are Reliable," September 14, 2020.
[124] Roach, "Microsoft Finds Underwater Datacenters Are Reliable," September 14, 2020.
[125] Hölzle, "Data Centers Are More Energy Efficient than Ever," *The Keyword* (blog), February 27, 2020.
[126] Sengupta and Penney, "Big Tech Has a Big Climate Problem," July 21, 2020. Some observers have questioned Amazon's commitment to these pledges. Merchant, "Amazon Is Aggressively Pursuing Big Oil," April 8, 2019.

near sources of renewable energy or have begun to purchase electricity from renewable sources.[127] For example, all of Apple's data centers have, reportedly, been powered by 100 percent renewable energy since 2014.[128] As part of this effort, in 2014, Apple purchased a hydroelectric plant near its data center in Prineville, Oregon, in order to power the then-new data center exclusively by renewable energy sources.[129] Moreover, Microsoft's Project Natick underwater data center in Scotland was able to take advantage of the Orkney Island power grid, which is powered exclusively by wind.[130] Meta's Luleå, Sweden, data center, which was its first non-U.S. data center and began operations in 2013, utilizes the city's power grid which is entirely supplied by hydroelectric power.[131] In 2020, Amazon and Google purchased 6.5 GW and 5.5 GW of electricity, respectively, from renewable energy sources.[132]

In addition to renewable energy, companies are also seeking to reduce total electricity usage associated with their data centers by employing energy efficient technology through upgrading (or optimizing) existing technology.[133] Google, for example, reports that its data centers have consumed 50 percent less energy than the industry average since 2014 by employing highly efficient evaporative cooling solutions, smart temperature and lighting controls, and custom-built servers designed to minimize energy use.[134] Google has also partnered with DeepMind to employ artificial intelligence to analyze resource consumption and to monitor and control humidity and temperature in some of its data centers.[135] Finally, one Nordic data center operator, DigiPlex, uses the waste heat from its facilities in Ulven, Oslo, and Stockholm, Sweden, to warm 5,000 and 10,000 apartments in nearby cities, respectively, which are initiatives aimed at reducing the energy needs of the surrounding community instead of reducing the energy needs of the data center .[136]

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[127] Trueman, "Why Data Centres Are the New Frontier in the Fight Against Climate Change," August 9, 2019.
[128] Apple, "Apple Now Globally Powered by 100 Percent Renewable Energy," April 9, 2018.
[129] O'Grady, "Apple Acquires Hydroelectric Project," April 14, 2014. Apple has since begun construction on a second data center in Prineville and has submitted plans for a third. For more information, see Avangrid Renewables, "Avangrid Renewables Celebrates Renewable Power Partnership," July 21, 2020; DataCenters.com, "Apple Inc.: Prineville Data Center," accessed January 19, 2021.
[130] The Orkney Islands deploys a combination of wind and solar power, as well as experimental green energy technologies under development at the European Marine Energy Centre. For more information, see Roach, "Microsoft Finds Underwater Datacenters Are Reliable," September 14, 2020. Similarly, Microsoft has pledged to have 100 percent of its energy consumption matched by zero carbon energy purchases by 2030, and has taken various actions already to facilitate this pledge including their new "sustainable data center" region in Arizona and partnerships with Water.org to produce various consumer products from recycled products. For more information, see Sverdlik, "Microsoft Pledges to Emit 'Zero Carbon' By 2030," July 15, 2021; Joppa, "Made to Measure," July 14, 2021.
[131] Danko, "Facebook Does Hydro," June 14, 2013; Euronews, "Facebook Boasts Green Data Centre in Luleå, Sweden," November 24, 2015.
[132] Amazon recently purchased more than 3.4 GW of power from 26 wind and solar-power projects in eight countries. Lee, "Amazon Topples Google as World's Largest Corporate Renewable Energy Buyer," December 10, 2020.
[133] Trueman, "Why Data Centres Are the New Frontier in the Fight Against Climate Change," August 9, 2019.
[134] Google, "Machine Learning Finds New Ways for Our Data Centers to Save Energy," December 2016.
[135] Gamble and Gao, "Safety-First AI for Autonomous Data Centre Cooling," *DeepMind* (blog), August 17, 2018.
[136] DigiPlex, "Oslo Data Centre to Heat Homes," August 14, 2018; Smolaks, "DigiPlex Data Center Will Help Keep Oslo Warm," August 18, 2018; Young, "Swedish Data Centre Uses Waste Heat," April 7, 2018.

Outlook

The growth of data generation and replication, increasing requirements for low-latency networks, and demands to improve energy efficiency are expected to not only continue to increase the demand for data centers, but also continue to change the composition and locations of data centers and data processing.[137] One source estimates that the global data center market will grow at a compound annual growth rate of 4.5 percent from 2021 through 2026.[138] Relatedly, edge computing and greater numbers of strategically distributed data centers of all types are expected to increasingly capture and replicate exponentially growing volumes of data in real time.[139] Industry experts foresee an expanded, more complex network architecture with rising numbers of participants and partnerships. They also foresee an "ecosystem" that will enable more data to be more economically and sustainably processed and acted upon at or near source and use.[140]

Telecommunications Services: Mobile Networks

Over the past 25 years, mobile telecommunications services have expanded from a niche service offered only in a few high-income countries to one that is now offered in nearly every corner of the world. Over time, mobile services expanded from the simple voice telephone call to services ranging from text messaging and email to telephone-based internet access, a development which has enabled a host of smartphone-based applications and tools. Although mobile services are nearly ubiquitous around the world, country-level markets exhibit noticeable differences based largely upon the level of economic development. Such differences range from the network technologies used to offer such services to the adoption of smartphones by the local populace.

Market Conditions

In this report, mobile telecommunications services are defined as communications services offered to individual retail consumers, with the mobile telephone being the primary means of access. Common mobile services include standard telephone calls and text messaging services as well as internet access and broadband data services supporting a wide range of applications (apps) and tools installed on smartphones. In 2020, the global market for mobile telecommunications services, measured by revenues, was estimated to be $1.0 trillion.[141] Overall, the global market grew by 1.8 percent during

[137] Van Der Meulen, "What Edge Computing Means for Infrastructure," October 3, 2018.
[138] Research and Markets, "Data Center Market," February 2021.
[139] Research and Markets, *Global Edge Computing Market 2021-2026*, October 2021.
[140] Equinix, *The Future of Digital Leadership*, 2021.
[141] Koronios, *Global Wireless Telecommunications Carriers*, February 2021, 13. The global market is defined as revenues derived from cellular voice services, messaging services, broadband data services, and mobile backhaul services (i.e., transferring data from a small subnetwork to a core network) as well as sales of mobile telephones and other devices. This definition does not include revenues from so-called mobile virtual network operators (MVNO). An MVNO is a telecommunications company that does not own the network over which it offers services but, instead, purchases network services from a network operator at wholesale rates.

2020, after experiencing an average annual decline of 1.3 percent during 2016–19.[142] The decline of revenues during 2016–19 is largely attributed to price cuts driven by intense competition among industry participants, whereas revenue growth in 2020 resulted from subscriber growth and the introduction of higher-priced data services.[143]

At the global level, the mobile services market is characterized by a relatively low level of industry concentration, with large telecommunications companies sometimes maintaining a leading position in a particular country—or, in some cases, region—but typically not establishing a global presence. Measured by revenues, the top five companies make up about 40 percent of the market: China Mobile accounts for 9.1 percent of global revenues, followed by Verizon (9.0 percent), Deutsche Telekom (8.9 percent), AT&T (7.6 percent), and Vodafone (5.0 percent).[144] In terms of mobile subscribers, about 10 mobile companies account for 40 percent of the global market: China Mobile (987 million subscribers in 7 countries), Bharti Airtel (414 million in 18 countries), China Telecom (344 million subscribers in 3 countries), Vodafone (265 million subscribers in 26 countries), America Movil (251 million subscribers in 27 countries), Telefonica (247 million subscribers in 15 countries), MTN (217 million subscribers in 22 countries), VEON (193 million subscribers in 10 countries), Telenor (173 million in 10 countries), and Deutsche Telekom (171 million subscribers in 21 countries).[145] According to industry research, in 2020, the mobile services industry contributed $4.4 trillion, or 5.1 percent, to global gross domestic product and directly supported more than 12 million jobs and, indirectly, another 13 million jobs.[146]

Level of Economic Development Determines Local Market Conditions

Over the past 25 years, mobile services, which emerged as a broad-based, commercially viable product in the mid-1990s, have experienced rapid worldwide adoption, growing from a niche service offered only in select developed countries to one that is now widely available including in the least-developed countries. During 1995–2020, for example, the number of mobile subscriptions worldwide grew from 91 million to 8.3 billion, representing an average annual growth rate of 19.8 percent.[147] At the global level, additional subscriber growth is becoming increasingly difficult to achieve due not only to market saturation in most developed countries but also to the high cost and difficult logistics associated with expanding mobile networks ever deeper into rural areas of the developing world.[148] In many developing countries, too, ongoing issues related to affordability of both services and mobile devices as well as a lack of literacy and technical skills continue to impede the adoption of mobile services. Currently, the largest under-penetrated markets are located in sub-Saharan Africa (SSA) and Asia.[149]

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[142] Koronios, *Global Wireless Telecommunications Carriers*, February 2021, 13.
[143] Koronios, *Global Wireless Telecommunications Carriers*, February 2021, 13.
[144] Koronios, *Global Wireless Telecommunications Carriers*, February 2021, 29–33. Revenue numbers represent total global revenues from all sources.
[145] Bell, “Ten Groups Control 40% of Global Wireless Subscribers,” *TeleGeography BLOG* (blog), September 10, 2020.
[146] GSMA, *The Mobile Economy 2021*, 2021, 7.
[147] Statista, *Mobile Communications*, 2020, 2.
[148] GSMA, *The Mobile Economy 2021*, 2021, 3.
[149] GSMA, *The Mobile Economy 2021*, 2021, 43–44.

Since the launch of the Apple iPhone in 2007, smartphones have become ubiquitous in developed countries and are widely used in many developing countries, although nearly half of the world's population is still not connected to the internet by mobile phone.[150] By the end of 2020, there were an estimated 4.0 billion mobile internet subscribers worldwide, accounting for about 51 percent of the global population.[151]

Although mobile services have grown into a truly global market, with nearly identical services being available in a wide range of developed and developing countries, there are important differences at both the country and regional levels. A country's stage of economic development is often an important differentiating factor. In terms of network infrastructure, mobile services are predominantly delivered to customers in developed countries over 4G networks, with 3G and 5G technologies making up only a small share of network connections (box 3.1). In Europe, for example, 69 percent of users access mobile services via 4G networks, with an even larger share (85 percent) using 4G services in North America. Similarly, 82 percent of mobile connections in China are via 4G technologies.[152] By contrast, 4G networks made up only 12 percent of total connections in the SSA region. Instead, networks in SSA are characterized by lower-bandwidth, older generation 2G and 3G networks which represent 36 percent and 52 percent of total network connections, respectively.[153] Globally, 4G connections represent nearly 60 percent of mobile internet connections, although that number will likely decline over time as a growing number of users migrate to 5G services.[154]

Box 3.1 The Evolution of Mobile Network Technologies

Over the past 15 years, telecommunications carriers have continuously upgraded their wireless networks from relatively low-bandwidth second-generation (2G) technologies, capable of handling little more than telephone calls and text messaging, to third-generation (3G) network technologies. 3G technologies—and upgrades referred to as 3.5G—offered greater data transmission capacity (i.e., bandwidth), allowing the faster delivery of multimedia services like multimedia emails and text messages as well as internet access and audio/video downloads. Shortly after the commercialization of 3G and 3.5G services, carriers began to shift their focus to the fourth generation (4G) of wireless technologies. The main 4G technology (4G LTE) offers even greater data-transmission capacity than 3G technologies, alleviating network congestion and enabling the delivery of bandwidth-intensive services like video streaming. In 2019, telecommunications carriers started deploying 5G network technologies which, ultimately, have the potential for both dramatically higher bandwidth (and therefore download speeds) and significantly lower latency than current 4G networks.

Source: USITC, *Recent Trends in U.S. Services Trade, Annual Report 2018*, 2018.

[150] GSMA, *The Mobile Economy 2021*, 2021, 15.
[151] GSMA, *The Mobile Economy 2021*, 2021, 6.
[152] GSMA, *The Mobile Economy 2021*, 2021, 8–9. In Europe, 2G and 3G networks made up 10 percent and 20 percent of network connections, respectively, and in North America, 2 percent and 10 percent, respectively. In both Europe and North America, 5G connections made up only 1 percent of network connections.
[153] GSMA, *The Mobile Economy 2021*, 2021, 9.
[154] GSMA, *The Mobile Economy 2021*, 2021, 12.

Although 5G connections represent a very small share of the market in most countries, such services are now available in more than 60 country markets.[155] In 2020, 5G connections represented about 1 percent of total subscriber connections in Asia and Europe, and 3 percent in North America. In terms of 5G technology adoption, China is an outlier, with 12 percent of the subscriber base using 5G services. In Latin America, the Middle East and North Africa (MENA), and SSA, 5G services are available in select countries but represent a miniscule share of the market.[156]

Smartphone adoption also varies significantly by region and is correlated to per-capita income and the predominant network technologies available to a country's population. Countries in which 3G and 4G technologies are the dominant network technologies tend to have higher smartphone penetration rates. Smartphone users, for example, made up more than 70 percent of the subscriber base in Asia Pacific, North America, Europe, and Latin America in 2020. By contrast, penetration rates in the MENA region and SSA were only 66 percent and 48 percent, respectively.[157]

Mobile money services—i.e., mobile telephone-based financial services offered by telecommunications companies—have spread from Kenya, where they were launched via a pilot project in 2007,[158] to a large number of low- and middle-income countries, although such services are virtually nonexistent in most developed countries. Such services, predominantly cash deposits, cash transfers, payments and, to a lesser extent, microloans, are typically offered to low-income people in developing countries who do not have access to the traditional banking system. These services are marketed as a safe and convenient way to save and transfer money. By the end of 2020, for example, there were more than 1.3 billion registered accounts worldwide, offered by more than 310 service providers in 96 countries. Despite growing mobile money coverage in recent years, many services failed to gain a critical mass of customers. In 2020, however, the COVID-19 pandemic acted as a catalyst to wider service adoption due to lockdowns and other restrictions on physical movement in many countries. Mobile money was also viewed as a safer option to handling physical cash in many countries. A further impetus to mobile money adoption has been the growing use of mobile money services to distribute financial aid by many humanitarian agencies, including the World Food Programme and the United Nations Refugee Agency. In 2020, there were more than 41.4 billion separate mobile money transactions worldwide, totaling more than $767 billion. Although mobile money services have spread around the world, SSA is still the global epicenter, with more than two-thirds of the global market value occurring in SSA. Overall, more than half of mobile money service providers worldwide are operating in SSA, where most countries have at least three providers and some have five or more. Other areas characterized by a substantial service provider presence include Russia and the Commonwealth of Independent States, the Indian subcontinent, and Southeast Asia.[159]

As high-bandwidth 3G and 4G services and smartphone usage has spread around the world over the past 15 years, the use of smartphone-based tools, known as applications (apps) have become ubiquitous. In 2020, for example, 218 billion apps were downloaded worldwide, up from 141 billion

[155] "Distribution of 5G in Cities and Countries Worldwide," *Faist* (blog), October 7, 2021.
[156] GSMA, *The Mobile Economy 2021*, 2021, 8–9.
[157] GSMA, *The Mobile Economy 2021*, 2021, 9.
[158] Forden, *Mobile Money in Kenya*, June 2015.
[159] GSMA, *The Mobile Economy 2021*, 2021, 47–48.

downloads in 2016.[160] In 2021, the most downloaded apps worldwide were TikTok (656 million downloads), Instagram (545 million downloads), Facebook (416 million downloads), WhatsApp (395 million downloads), Telegram (329 million downloads), Snapchat (327 million downloads), Zoom (300 million downloads), Messenger (268 million downloads), CapCut (255 million downloads), and Spotify (203 million downloads).[161] Although these apps feature prominently in the most-downloaded and most-used apps in many, perhaps most, countries, the most popular apps tend to vary significantly between countries, which may be influenced by both the level of economic development as well as other policies in the local market. Whereas the most popular apps in the United States, measured by downloads, were TikTok, Zoom, Instagram, Messenger, and Facebook, the same list in China was: WeChat, Taobao, Alipay, QQ, and Douyin.[162] In Brazil, the most popular apps were Caixa Tem, TikTok, WhatsApp, and Auxilio Emergencial, whereas the top-five list in India included Aarogya Setu, TikTok, WhatsApp, and Facebook.[163]

Outlook

Revenue in the global mobile services industry is expected to continue to grow over the next five years, rising at an average annual rate of 2.8 percent through 2025.[164] Such revenue growth is expected to be driven not only by an expanding subscriber base, which is expected to grow at an average annual rate of 3.2 percent through 2025, but also by the adoption of higher-margin data services. Indeed, developing countries are expected to drive revenue growth over the next few years as employment and incomes recover from the COVID-19 pandemic, allowing consumers to upgrade to smartphones and higher-value-added 4G data services. In addition, the bulk of subscriber growth through 2025 is expected to originate in developing countries. In developed countries, the ongoing rollout of 5G networks and the adoption of high-margin 5G data services is expected to drive revenue growth over the next five years.[165] The expense of constructing 5G networks and high cost of 5G smartphones and services are expected to act as a drag on the adoption of 5G services in many developing countries.

3G networks, which spearheaded the adoption of smartphones and mobile internet/data services starting in 2007, are expected to be decommissioned in the United States and most European countries over the next few years as 4G and, increasingly 5G, technologies deliver the bulk of such services at dramatically higher download speeds.[166] By contrast, 3G services are expected to be the main method of access to broadband services in many developing countries, particularly in SSA. Between 2021 and 2025, telecommunications companies worldwide are expected to spend $900 million on network construction, of which more than 80 percent will be spent on 5G networks.[167] Over this same period, the number of 5G subscribers is estimated to grow from 234 million (4 percent of total connections) in 2021 to 1.8

[160] Ceci, *Mobile App Usage*, October 14, 2021.
[161] Koetsier, “Top 10 Most Downloaded Apps and Games of 2021,” December 27, 2021.
[162] In China, TikTok is referred to as Douyin.
[163] Curry, “Most Popular Apps,” September 14, 2021.
[164] Koronios, *Global Wireless Telecommunications Carriers*, February 2021, 36.
[165] Koronios, *Global Wireless Telecommunications Carriers*, February 2021, 36.
[166] Bell, “3G’s Sun Is Setting in Europe,” *TeleGeography BLOG* (blog), August 12, 2021; Molina, “Remember 3G? It’s Going Away,” October 25, 2021.
[167] GSMA, *The Mobile Economy 2021*, 2021.

billion by the end of 2025, or 21 percent of total connections.[168] By 2024, China alone is estimated to account for 44 percent of 5G subscribers worldwide, while adoption of 5G services, as a share of the subscriber base, is expected to be highest in the developed Asia-Pacific region and North America.[169]

[168] GSMA, *The Mobile Economy 2021*, 2021.
[169] GSMA, *The Mobile Economy 2021*, 2021. The term “developed Asia-Pacific” is defined as including Australia, Japan, Singapore, and South Korea.

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Chapter 4 New Internet Technologies Change the Delivery of Digital and Electronic Services

Over the past several years, rapidly evolving internet and computing technologies have changed the way some services are delivered to and experienced by customers. These changes can be attributed to a number of factors, including the COVID-19 pandemic, improved advertising techniques, and the increasing need to reduce network latency. This chapter reviews developments in three subsectors of the digital and electronic services category—audiovisual services, computer services, and telecommunications services. In the audiovisual services segment, user-generated video platforms like YouTube have developed increasingly sophisticated algorithms[170] that customize the viewing experience for platform users, efforts that are designed, ultimately, to increase advertising revenues. On the consumer side, the COVID-19 pandemic caused millions of people to suddenly work (and play) from home, a process facilitated not only by widespread broadband access but also by the widespread adoption of cloud computing platforms and software. In the telecommunications services industry, over the past five to six years, leading U.S. cloud and content companies like Google and Meta have sharply increased their investments in undersea cables in an effort to gain management control of critical infrastructure and reduce overall network latency.

Audiovisual Services: User-generated Video Content

An important and growing segment of audiovisual services production is user-generated video content delivered over online platforms. The broader category of online video content can be divided into categories based on the revenue model used by the service and the type of content it provides. The two major revenue models are subscription video on demand services, like Netflix (as discussed in chapter 3), and advertising-supported services such as YouTube.[171] The most popular advertising-supported video services focus on user-generated content; that is, content created voluntarily by users of a

[170] An algorithm is a set of mathematical instructions for performing calculations. These algorithms are often paired with machine learning, a process which uses large amounts of data to recognize patterns. Many types of online platforms use algorithms to build recommendation engines, which attempt to identify what types of content or videos a user prefers to watch and generate content or video recommendations based on these patterns. A platform's recommendation engine may use many different interrelated algorithms to perform different functions. DeAngelis, "Artificial Intelligence: How Algorithms Make Systems Smart," September 2014; Newton, "How YouTube Perfected the Feed," August 30, 2017.

[171] Subscription-based services are covered separately in this report. Some services, like YouTube, combine both revenue models, with an advertising-supported tier that is free for users and a subscription-supported tier. YouTube, "YouTube Premium-YouTube," accessed February 9, 2022.

particular platform for viewing by other users.[172] This is in contrast to content created or licensed by the platform itself, which is how subscription services typically source their content. Because of its user-generated nature, many leading platforms for this type of content are also classified as social media sites (for example, Instagram or TikTok).[173] The algorithms that control these user-generated video platforms increase user engagement with the platforms and drive revenue growth by targeting individual user preferences.

Market Conditions

The user-generated video content market has grown significantly in popularity in recent years, with three large firms accounting for the majority of global users: two U.S. firms, YouTube (owned by Alphabet, the parent company of Google) and Instagram (owned by Meta, the parent company of Facebook), and the Chinese firm TikTok (owned by ByteDance).[174] Differences in measurement provide a range of estimates of these platforms' active users worldwide: industry sources estimate that in 2021 YouTube had between 2.0 billion and 2.3 billion active users, while Instagram had between 1.4 billion and 2.0 billion users, and TikTok had between 1.0 billion and 1.9 billion users.[175] Other smaller platforms compete with YouTube, TikTok, or Instagram, but they typically have a more regional focus. For example, three domestic Chinese firms have over 300 million users in the country but little presence outside of it.[176] Daily Motion, a French video-sharing platform, had 300–350 million users worldwide in 2020, but reportedly pivoted to focus on premium content rather than user-generated videos.[177]

TikTok's recent growth has overshadowed that of its more established competitors. While estimates of total active users vary, by one estimate, the number of TikTok users grew by an average annual rate of 121 percent per year from 2017 to 2020, much faster than either YouTube (15 percent) or Instagram (23

[172] Krum, Davies, and Narayanaswami, "User-Generated Content," 2008.
[173] This section excludes more general-purpose social media sites such as Facebook, which also host text and photo content. While these may host user-generated video content, such video content is not their primary focus.
[174] ByteDance also operates a user-generated video platform similar to TikTok in mainland China called Douyin. In this section, references to TikTok do not include Douyin unless otherwise noted. Yang, "TikTok's Secret Sauce," December 7, 2021.
[175] The most commonly used measurement of "active" users, reported here, are so-called "monthly active users" which tracks the number of unique users who log into a platform each month. Some sources appear to provide user totals for both TikTok and Douyin combined but do not specify this; the lower bound of these estimates likely refers only to TikTok users and excludes Douyin users while the upper bound estimate likely includes both. Statista, "Number of Global Social Network Users 2017—2025," September 10, 2021; Lin, "TikTok Owner ByteDance's Annual Revenue Jumps to $34.3 Billion," June 17, 2021; Rodriguez, "Instagram Surpasses 2 Billion Users," December 14, 2021; Iqbal, "TikTok Revenue and Usage Statistics (2022)," January 25, 2022.
[176] As of September 2021, Tencent video had 393 million monthly active users, while Youkou (owned by Alibaba) had 367 million monthly active users and iQiyi had 351 million monthly active users. Thomala, "China," accessed February 9, 2022.
[177] Spangler, "Dailymotion Plans Major Relaunch," April 10, 2017; Dailymotion, "Dailymotion for Advertisers," accessed February 9, 2022. Another example of a smaller platform is Twitch, a video-game focused user-generated video platform that had 140 million monthly active users worldwide in 2021, while another video platform, Vimeo, had around 1.7 million active users globally. Twitch allows users to "live-stream" their content (e.g., broadcast live over the internet), while YouTube and Instagram both also have livestreaming capabilities in addition to hosting prerecorded content. Ceci, *Number of Vimeo Subscribers Worldwide*, January 28, 2022; Vimeo, *Vimeo Quarterly Report Form 10Q*, November 5, 2021; MediaKix, "10 Twitch Gaming Statistics Marketers Should Know," *MediaKix* (blog), February 18, 2017.

percent).[178] Based on the number of visitors to all websites, TikTok was estimated to be the second-most-visited website worldwide in March 2022, while YouTube and Instagram were 7th and 12th, respectively.[179]

The market presence of each firm varies by country as shown below (table 4.1). In China, where both YouTube and Instagram are blocked by the government, Douyin has the most users of any user-generated video platform, while Instagram predominates in Indonesia. By number of users, the United States is the second or third largest market for each platform.[180]

Table 4.1 Monthly active YouTube, Instagram, and TikTok users, by country, 2020 and 2021
In millions of users, n.a. = not available (user-generated content is banned).

Country	YouTube	Instagram	TikTok (Douyin in China)
China	n.a.	n.a.	578.9
India	372.9	201.1	167.0
United States	205.9	157.1	65.9
Brazil	145.4	114.9	4.4
Russia	89.4	60.1	16.4
Indonesia	77.6	94.2	22.2
Japan	72.7	48.7	12.6
Vietnam	65.9	8.0	12.9
Mexico	61.2	36.3	15.0
Turkey	57.9	49.0	19.2

Sources: Hayakawa, “TikTok Gives up on India, Months after Government Ban,” February 3, 2021; Thomala, “China,” accessed February 9, 2022; Statista Research Department, “Instagram: Users by Country,” October 2021; Degenhard, “YouTube User Worldwide 2020, by Country,” May 2021; Ceci, “Number of TikTok Users in Selected Countries in 2020,” January 28, 2022; Degenhard, “Instagram Users in Vietnam 2025,” July 20, 2021; Dolan, “Mexico’s TikTok User Base More than Tripled in 2020,” July 13, 2021; İnce, “‘I Felt I Existed in This World,’” July 24, 2021; Iris, “Social Media Report in Vietnam 2020,” accessed February 9, 2022.
Notes: YouTube user data are for 2020. Instagram user data are for 2021. TikTok user data are for 2020 except for Turkey, which are for 2021. TikTok User counts in China are for Douyin, a separate platform operated there by TikTok’s parent company ByteDance. Both YouTube and Instagram are blocked in mainland China. Access to TikTok was blocked in India beginning in January 2021. As of March 2022, the operations of YouTube, Instagram, and TikTok in Russia have changed. See Outlook section for more information. Users may have accounts or view content on multiple platforms, so these numbers are not cumulative by country.

By revenue, the United States accounted for about 70 percent of Instagram’s estimated global revenue ($17 billion of $24 billion) in 2021,[181] but only 20 percent of YouTube’s global revenue ($4 billion of

[178] This calculation uses the lower bound of estimates of TikTok users. Iqbal, “TikTok Revenue and Usage Statistics (2022),” January 25, 2022. Iqbal, “YouTube Revenue and Usage Statistics (2022),” January 11, 2022; Iqbal, “Instagram Revenue and Usage Statistics (2022),” January 19, 2022.
[179] Cloudflare, “Cloudflare Radar,” accessed March 3, 2022; Tomé and Cardita, “In 2021, the Internet Went for TikTok, Space and Beyond,” *Cloudflare Blog* (blog), December 20, 2021. At several points in late 2021 and early 2022, TikTok was ranked the most visited site on the internet.
[180] For both YouTube and Instagram, the United States is the second largest market in terms of users (behind India), while it is the third largest market for TikTok (behind both China and India when Douyin users are included). Access to TikTok was blocked in India beginning in January 2021, reportedly for national security reasons. Nikkei Asia, “India Permanently Bans TikTok,” January 26, 2021.
[181] Iqbal, “Instagram Revenue and Usage Statistics (2022),” January 19, 2022; Statista Research Department, “U.S. Instagram Ad Revenues 2023,” November 2021. Based on USITC calculations.

$19.8 billion),[182] and about 25 percent of TikTok’s global revenue ($500 million of $1.9 billion).[183] Growth in users and revenue also coincided with growth in spending on digital video advertising: total spending on digital video advertising in the United States alone increased from $31.9 billion in 2019 to $41.4 billion in 2020, and is projected to rise to 78.5 billion by 2023.[184]

Algorithms Provide a Competitive Advantage for User-generated Content Platforms

Algorithms have provided a competitive advantage for many types of platforms. Online video sites like YouTube (along with Instagram, TikTok, and Netflix) recommend or select videos for users to watch, while e-commerce sites like Amazon recommend products to shoppers, and social media sites like Facebook recommend content to view or people to “friend.”[185] The algorithms behind these recommendation engines have been described as the single most important factor driving the growth of user-generated content platforms, such as YouTube and TikTok, in terms of both user viewing hours and advertising revenue.[186] YouTube uses artificial intelligence (AI) techniques from Google Brain, its parent company’s AI division, which reportedly decreased the amount of time the algorithm took to learn a user’s preferences and make more tailored video recommendations.[187] Several sources also identified TikTok’s algorithms as a key factor behind its recent growth.[188] TikTok’s algorithm reportedly learns users’ preferences more quickly and in a much more detailed way than the algorithms used by other

[182] Based on USITC calculations. YouTube does derive a portion of its revenue from subscriptions to its premium services, and both Instagram and TikTok also generate revenue from in-app purchases, but advertising is the primary source of revenue for all three firms. When a U.S. firm sells ads in a foreign market, it corresponds to U.S. exports of advertising services as captured by the BEA. Conversely, a foreign firm selling ads in the United States would correspond to an import of advertising services. Advertising revenues may also be booked by foreign affiliates of these firms (or their parent companies) and these would be captured under professional services in foreign affiliate statistics. One government representative noted that these sales are reported in official data as a mix of cross-border exports and foreign affiliate sales. Pichai and Porat, “Alphabet Announces Third Quarter 2021 Results,” October 26, 2021, 10; Ceci, “YouTube Global Advertising Revenues 2021,” accessed February 9, 2022; Statista Research Department, “U.S. Instagram Ad Revenues 2023,” November 2021; Ceci, “YouTube Global Advertising Revenues 2021,” accessed February 9, 2022; government representative, interview by USITC staff, January 31, 2021.

[183] Based on USITC calculations. This statistic does not include revenue from Douyin, but one source estimated Douyin’s advertising revenue at $16 billion in 2020. Iqbal, “TikTok Revenue and Usage Statistics (2022),” January 25, 2022; Lin, “TikTok Owner ByteDance’s Annual Revenue Jumps to $34.3 Billion,” June 17, 2021; Zhu and Yang, “ByteDance to Rake in $27 Billion Ad Revenue,” November 11, 2020; Zhang and Dotan, “TikTok’s U.S. Revenues Expected to Hit $500 Million,” June 17, 2020.

[184] Statista Research Department, *Digital Video Advertising Spending in the United States*, October 15, 2021.

[185] Krysik, “How Does Recommendation Systems of Netflix, Amazon, Spotify, Tik Tok and YouTube Work?,” January 20, 2021; Pandey, “The Remarkable World of Recommender Systems,” September 11, 2020.

[186] Lewis, “‘Fiction Is Outperforming Reality,’” February 2, 2018; Newton, “How YouTube Perfected the Feed,” August 30, 2017; Alexander, “TikTok Reveals Some of the Secrets, and Blind Spots, of Its Recommendation Algorithm,” June 18, 2020; Smith, “How TikTok Reads Your Mind,” December 5, 2021.

[187] Newton, “How YouTube Perfected the Feed,” August 30, 2017.

[188] Taulli, “TikTok: Why The Enormous Success?,” January 31, 2020; Newton, “How YouTube Perfected the Feed,” August 30, 2017; TikTok For Business, “Nielsen Study Shows TikTok Ideal Place for ‘Discovery,’ Content More ‘Authentic,’” October 20, 2021.

platforms.[189] For example, about 70 percent of videos viewed on YouTube are those recommended by the algorithm (rather than popular videos or those searched for by users), while 90 to 95 percent of videos viewed on TikTok result from the recommendation algorithm.[190]

While the exact mathematical formulas in these algorithms are proprietary and constantly changing,[191] a simplified version of these algorithms works in the following way. When a new user logs into user-generated video platform such as TikTok, YouTube, or Instagram, the platform first shows them a collection of popular videos. The platform collects data on how long a user watches each video, as well as whether a user "liked" or commented on the video, and then identifies attributes about the videos[192] which are input into mathematical formulas that generate a score. The algorithms then attempt to show the user similar videos to those that previously scored highly while collecting more data on watch time and user interactions. If users continue to watch these similar videos for longer amounts of time compared to other videos in the feed, the platform progressively recommends more of these types of videos.[193] These algorithms rely on large amounts of data to fine tune their recommendations. This creates a feedback loop when the algorithm prioritizes increasing video watch time: more videos watched by the user generates more data, which in turn generates better recommendations, which leads to more videos being watched. While the basic aspects of the different platforms' algorithms are similar, the way in which the algorithms are designed (i.e., the attributes of a video they prioritize) and how the platforms combine machine learning with user data and engaging content are strategic decisions that provide a key competitive advantage for firms.[194] An increase in viewing time and user retention drives advertising revenue, as users who spend more time on the platform view more advertisements.

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[189] Taulli, "TikTok: Why The Enormous Success?," January 31, 2020; Chen, "A Leaked Excerpt of TikTok Moderation Rules," November 25, 2019; Hu, "A Look Inside TikTok's Seemingly All-Knowing Algorithm," December 7, 2021.
[190] Wall Street Journal, "Investigation," July 21, 2021; Cummins, "The Creepy TikTok Algorithm Doesn't Know You," January 3, 2021.
[191] Smith, "How TikTok Reads Your Mind," December 5, 2021; Lewis, "'Fiction Is Outperforming Reality,'" February 2, 2018.
[192] These attributes include titles, captions, descriptions, and hashtags which may describe the video's content as well as information about video length, image quality, and music.
[193] For example, if a viewer spends time watching videos about French bulldogs, the platform will suggest more videos of such dogs. Wall Street Journal, "Investigation," July 21, 2021; Matsakis, "TikTok Finally Explains How the 'For You' Algorithm Works," June 18, 2020; Smith, "How TikTok Reads Your Mind," December 5, 2021; Yang, "TikTok's Secret Sauce," December 7, 2021; Cooper, "The 2021 Instagram Algorithm Breakdown," *Social Media Marketing & Management Dashboard* (blog), March 30, 2021; Mosseri, "Shedding More Light on How Instagram Works," June 8, 2021; Newton, "How YouTube Perfected the Feed," August 30, 2017; Cooper, "How Does the YouTube Algorithm Work in 2021?," *Social Media Marketing & Management Dashboard* (blog), June 21, 2021; Lewis, "Fiction Is Outperforming Reality," February 2, 2018.
[194] For example, Instagram's algorithm reportedly weight information about a user's history of interaction with the person who posted the content, including whether both users have followed each other, tagged each other in posts, or exchanged messages, while YouTube also incorporates user surveys. Smith, "How TikTok Reads Your Mind," December 5, 2021; Newton, "How YouTube Perfected the Feed," August 30, 2017; Cooper, "How Does the YouTube Algorithm Work in 2021?," *Social Media Marketing & Management Dashboard* (blog), June 21, 2021; Cooper, "The 2021 Instagram Algorithm Breakdown," *Social Media Marketing & Management Dashboard* (blog), March 30, 2021; Mosseri, "Shedding More Light on How Instagram Works," June 8, 2021.

The way these algorithms work may have negative consequences for users.[195] A *Wall Street Journal* investigation created 100 computer programs (called bots) which were trained to use TikTok like a human and given a variety of simulated interests. The bots programmed to be interested in "sad" content (such as videos about relationship breakups) eventually ended up viewing large amounts of "sad" content, to the exclusion of most other types of content (with the exception of advertisements).[196] Several sources have noted the potential consequences this strategy may have for users' mental and physical health.[197] The algorithms for other platforms such as YouTube and Instagram have been similarly criticized for recommending content to users which may affect their mental or physical health or suggest illegal activity.[198] A recent article in the British newspaper, *The Guardian*, described a similar bot programmed to watch YouTube videos which ended up viewing large numbers of extreme and conspiratorial videos recommended by the algorithm.[199] Video creators also add new content based on users' viewing habits, which is, in turn, affected by recommendation algorithms. One YouTube video creator stated that the strange content of his videos was driven by the types of videos made popular by Google's algorithm and noted that creators like himself sought to respond to this perceived demand.[200]

YouTube, Instagram, and TikTok have all recently stated that they are taking additional steps to detect and remove certain content on their platforms. YouTube noted in its annual transparency report that it had developed automated systems to detect content that violated its policies and reportedly changed its algorithm in 2019 to recommend more family-friendly content.[201] Similarly, Instagram stated that it adjusted its recommendation engine to put "potentially upsetting posts" lower in a user's feed if a user has previously reported similar posts as problematic. In addition, Instagram stated that the recommendation engine will prompt users to view posts on different topics if they repeatedly view certain types of content.[202] TikTok has also begun developing new methods to "interrupt repetitive patterns" of viewing (i.e., to steer users towards more diverse content) and avoid recommending large amounts of "problematic" content in a short period of time.[203]

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[195] For more on issues with algorithms beyond user-generated video platforms, see O'Neil, *Weapons of Math Destruction* (2016).
[196] Lin, "TikTok Owner ByteDance's Annual Revenue Jumps to $34.3 Billion," June 17, 2021.
[197] Lin, "TikTok Owner ByteDance's Annual Revenue Jumps to $34.3 Billion," June 17, 2021; Jargon, "TikTok Diagnosis Videos Leave Some Teens Thinking They Have Rare Mental Disorders," December 26, 2021; Hobbs, "'The Corpse Bride Diet,'" December 17, 2021; Paul, "It Spreads like a Disease," October 16, 2021.
[198] Internal research by Facebook, widely reported by the media, suggest that Instagram's algorithm was recommending content that promoted eating disorders to users, particularly teenage girls. Gilbert, "YouTube's Secret Algorithm Continues to Push Misinformation," July 7, 2021; De Vynck and Lerman, "Facebook and YouTube Spent a Year Fighting Covid Misinformation," July 22, 2021; Sims, Hendrix, and Sims, "How Tech Platforms Fuel U.S. Political Polarization," September 27, 2021; Bond, "Instagram Suggest Posts to Users," March 9, 2021; Lewis, "Fiction Is Outperforming Reality," February 2, 2018. Seetharaman, "Facebook Knows Instagram Is Toxic for Teen Girls," September 14, 2021.
[199] Lewis, "Fiction Is Outperforming Reality," February 2, 2018.
[200] Lewis, "Fiction Is Outperforming Reality," February 2, 2018.
[201] YouTube, "YouTube Community Guidelines Enforcement – Child Safety," accessed February 10, 2022; Alexander, "YouTube's Recent Algorithm Change," August 1, 2019.
[202] "How We Address Potentially Harmful Content," *Instagram* (blog), January 20, 2022; Newton, "Using Research to Improve Your Experience," *Instagram* (blog), September 14, 2021.
[203] TikTok, "An Update on Our Work to Safeguard and Diversify Recommendations," August 16, 2019.

Outlook

According to industry observers, the three largest user-generated video platforms are all expected to continue to increase their worldwide user base in the next several years.[204] However, the platforms have also come under increased scrutiny by governments for a variety of reasons including concerns about data privacy and competition. Since 2019, the United States and Europe have launched investigations into these areas. Access to TikTok was blocked in India beginning in January 2021, reportedly for national security reasons following a border clash involving the Indian and Chinese militaries.[205] Access to YouTube and Instagram also remains blocked in mainland China by the country's "Great Firewall."[206] Russia's invasion of Ukraine has also affected user-generated content platforms in Russia. As of mid-March 2022, access to Instagram was blocked in Russia, as part of Russia's wider efforts to curtail access to foreign social media platforms intensified following the invasion of Ukraine.[207] Similarly, TikTok has limited the content its users in Russia can view (Russian users were restricted from posting any new content, and all content posted by users outside Russia was blocked).[208] YouTube remains available in Russia, but its parent company suspended all advertising sales in Russia.[209]

Additionally, several investigations are ongoing in both the United States and Europe into various aspects of the business models of TikTok, YouTube, and Instagram. In August 2020, President Trump issued an executive order banning new downloads of TikTok in the United States, although a series of legal challenges meant the ban was never implemented, and President Biden subsequently rescinded the order. As of February 2022, the U.S. Department of Commerce is reviewing comments on proposed rules that could expand government oversight of apps that could be used "by foreign adversaries to steal or otherwise obtain data."[210]

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[204] For more on this issue, see USITC, Foreign Censorship Part 1: Policies and Practices Affecting U.S. Businesses, January 2021. Degenhard, *Forecast of the Number of Instagram Users*, July 20, 2021; Degenhard, "YouTube User Worldwide 2020, by Country," May 2021; Ceci, "U.S. TikTok User Growth 2024," October 2020; Goldman, "TikTok to Reach 1.5 Billion Users," November 16, 2021.

[205] After India banned TikTok, several similar India-based apps were launched to serve the market. However, one source noted that Instagram has largely replaced TikTok in India, although it attracted a slightly different user base. Nikkei Asia, "India Permanently Bans TikTok," January 26, 2021; Aronczyk, "A Look At The Fallout Of TikTok Ban In India," January 15, 2021; Sharma, "Instagram Has Largely Replaced TikTok in India," October 6, 2021; Bansal, "Indian Developers Are Racing to Replace TikTok," November 27, 2020.

[206] These services are reportedly accessible in Hong Kong and Macau, and some Chinese users are reportedly able to view content on these platforms through virtual private networks or other methods. Freedom House, "China," accessed February 10, 2022.

[207] Sonne and Ilyushina, "'I'm Writing This Post Now and Crying,'" accessed March 14, 2022; Reuters, "Instagram Users in Russia Are Told Service Will Cease from Midnight," March 13, 2022.

[208] Historical content posted by Russian users is still able to be viewed in Russia. Milmo, "TikTok Users in Russia Can See Only Old Russian-Made Content," March 10, 2022.

[209] Dave, "Google Suspends All Ad Sales in Russia as Censorship Demands Grow," March 4, 2022; "GlobalCheck - Availability Check Network," accessed March 14, 2022.

[210] BBC, "Donald Trump-Era Ban on TikTok Dropped," June 9, 2021; Smith, "How TikTok Reads Your Mind," December 5, 2021; Shepardson, "U.S. Commerce Department Rescinds TikTok, WeChat Prohibited Transactions List," June 22, 2021; Federal Register, "Rescission of Identification of Prohibited Transactions With Respect to TikTok and WeChat," June 23, 2021; Federal Register, *Protecting American's Sensitive Data*, June 11, 2021; Zakrzewski and Harwell, "Biden Administration Weighing New Rules to Limit TikTok," February 2, 2022.

The U.S. Congress has also held multiple recent hearings regarding the safety of online platforms, including platforms for user-generated video, and their effects on children's wellbeing.[211] In addition, Ireland's data protection regulator submitted a draft decision in December 2021 (a part of the investigation process) after complaints were submitted regarding Instagram's collection and handling of children's personal data.[212] In June 2021, the European Commission also announced an investigation into whether firms are unfairly obligated to purchase ads through Google's advertising services to display on YouTube (which is owned by Google's parent company).[213]

Computer Services: Cloud-based Infrastructure and Software

Over the past several years, the provision of computer services has moved increasingly to the cloud. Cloud computing is a shared network of computing resources, including servers and other data center infrastructure, that is accessed via the internet.[214] The COVID-19 pandemic accelerated demand for cloud computing services in both the business and consumer markets, and cloud services providers have greatly increased their cloud infrastructure investment in response. For many types of businesses, the sudden shift toward remote working has increased adoption of cloud software, such as videoconferencing, document sharing, and other collaboration software. On the consumer side, demand for in-home entertainment such as video games increased sales and led to video game developers expanding their cloud-based offerings for gaming based on both a console and a personal computer (PC).[215]

Market Conditions

From 2015 to 2020, revenue in the global cloud computing market grew from $109 billion to $344 billion.[216] The cloud computing market is divided broadly into two segments: infrastructure and

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[211] U.S. House of Representatives, Committee on Energy and Commerce, "Kids Online During COVID: Child Safety in an Increasingly Digital Age," March 11, 2021; U.S. Senate, Committee on Commerce, Science, and Transportation, "Protecting Kids Online: Facebook, Instagram, and Mental Health Harms," October 26, 2021; U.S. Senate, Committee on Commerce, Science, and Transportation, "Protecting Kids Online: Snapchat, TikTok, and YouTube," October 26, 2021.

[212] YouTube was also fined $170 million by the U.S. Federal Trade Commission (FTC) in 2019 for allegedly collecting personal data on children who used the site in violation of U.S. law. Data Protection Commission, "Irish DPC Submits Article 60 Draft Decision," December 7, 2021; Lomas, "Ireland-Led GDPR Inquiry into Instagram's Use of Kids' Data Inches On," *TechCrunch* (blog), December 7, 2021; FTC, "Google and YouTube Will Pay Record $170 Million for Alleged Violations of Children's Privacy Law," September 3, 2019.

[213] Meta's acquisitions of Instagram and WhatsApp are also currently being investigated by the FTC for monopolistic behavior. Schechner and Olson, "Google Faces EU Antitrust Probe of Alleged Ad-Tech Abuses," June 22, 2021; FTC, "FTC Alleges Facebook Resorted to Illegal Buy-or-Bury Scheme," August 19, 2021.

[214] USITC, *Recent Trends in U.S Services Trade,* 2018 Annual Report, 73.

[215] As noted in the Audiovisual Services section of chapter 3, the COVID-19 pandemic also accelerated growth in streaming services.

[216] ITCandor, "Global Cloud Computing Revenue," accessed November 12, 2021. Estimates of the total size of the cloud computing market vary by source. Gartner estimates that cloud computing market size was $270 billion in 2020, while MarketLine estimates a market size of $261.9 in 2019. Gartner, "Gartner Forecasts Worldwide Public Cloud End-User Spending to Grow 23%," April 21, 2021; MarketLine, *Global Cloud Computing*, October 2020, 2.

software. In addition to access to remote servers for data storage (Infrastructure as a Service), cloud infrastructure also includes more user-friendly access that includes a built-in operating system (Platform as a Service).[217] Together, these infrastructure segments accounted for 52.0 percent of total cloud computing revenue in 2020.[218] The leading provider of cloud infrastructure services in 2020 was Amazon Web Services, which made up 24.1 percent of the global market. Other leading cloud infrastructure providers include Microsoft (16.6 percent), Google (4.2 percent), Alibaba (3.7 percent), and IBM (2.8 percent).[219]

Cloud software (also known as "software as a service") is hosted on cloud servers and accessed by consumers and firms via the internet.[220] Cloud software, which ranges from basic applications like cloud-hosted email, such as Microsoft Outlook, to AI applications, like IBM's Watson, is typically subscription based, which increases the stability of revenue for software providers and gives consumers automatic access to the most up-to-date versions of software.[221] Top providers of cloud software in the first half of 2021 included Microsoft (16.8 percent of the market), followed by Salesforce (10.5 percent) and IBM (4.4 percent).[222]

Remote Work: Cloud Infrastructure and Communication Software

The COVID-19 pandemic forced a shift toward remote working in early 2020 that accelerated cloud adoption. From Q32019 to Q32020, enterprise spending on cloud services increased by 28 percent, and cloud workloads (the amount of computer processes completed in the cloud) increased by 20 percent.[223] In particular, legacy applications were either replaced by cloud software solutions (such as a move from Microsoft Office to Microsoft 360), or whole computer systems shifted from local hosting to hosting on cloud infrastructure.[224]

Figure 4.1 shows total sales in cloud computing services for top U.S. cloud infrastructure providers Amazon, Microsoft, and Google starting in the third quarter of 2019. To account for spikes in sales for all three companies, which likely were driven by a concentration in contract renewal dates, the figure also plots linear trendlines for each of the three companies. Overall, these trendlines suggest that Microsoft and Google experienced larger increases in cloud computing-related sales than Amazon over this period.

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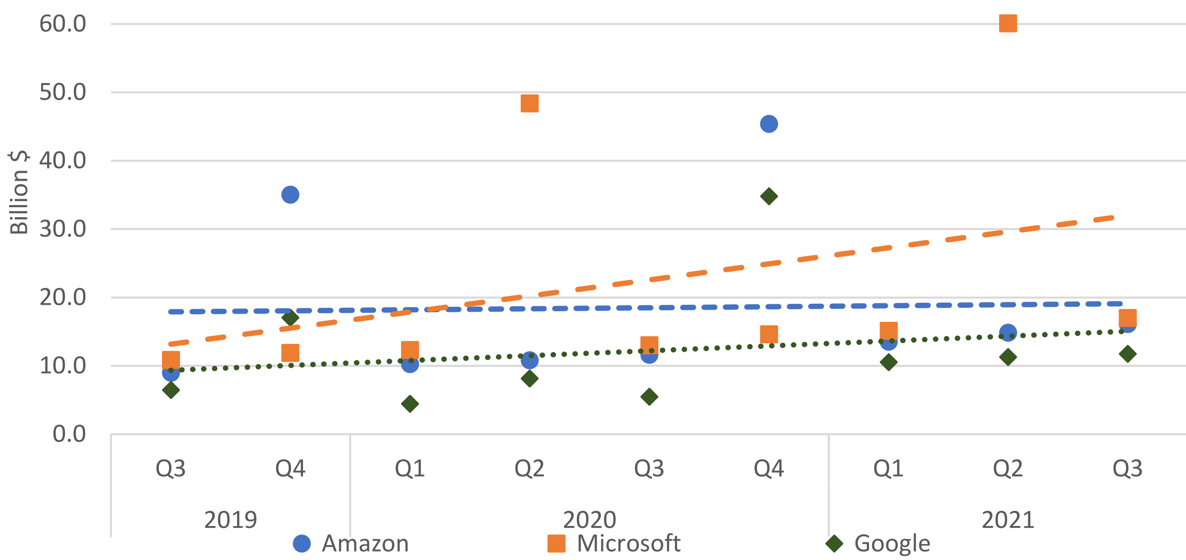
[217] While many industry publications describing cloud services report Infrastructure as a Service and Platform as a Service as separate segments of the market, in practice, the same firms that provide these services and data on revenue and trade frequently combine these two categories into a single segment.
[218] ITCandor, "Global Cloud Computing Revenue," accessed November 12, 2021.
[219] IDC, "Public Cloud IaaS/PaaS Market Share Worldwide 2020," May 2021.
[220] MarketLine, *Global Cloud Computing*, October 2020, 8.
[221] Cook, *Software Publishing in the US*, March 2021, 17.
[222] ITCandor, "Global Cloud Software Market Vendor Share 2021," September 2021; Palo Alto Networks, *Cloud Threat Report*, 2021.
[223] Synergy Research Group, "COVID-19 Boosts Cloud Service Spending," December 5, 2020.
[224] Freeman, *Industry Surveys: Software*, July 2020, 7; Palo Alto Networks, *Cloud Threat Report*, 2021.

One potential explanation for this trend is that during the move to remote work, Microsoft and Google, which provide a suite of cloud-based services, such as remote videoconferencing, email, and document production software, may have had an advantage over Amazon Web Services in attracting new cloud users, as Amazon Web Services does not provide similar services.[225]

Figure 4.1 Cloud computing sales, by top U.S. cloud infrastructure providers, by quarter, June 2019 through August 2021

In billions of dollars.



Source: Data from quarterly reports for Amazon, Google, and Microsoft, downloaded from Bureau van Dijk, Orbis database, accessed December 8, 2021.
Note: Sales for Amazon are the business line "Amazon Web Services," for Google the business line is "Google Cloud," and for Microsoft the business line is "Intelligent Cloud." Lines are linear trends of point data. Underlying data for this figure can be found in appendix table B.27.

One key type of cloud computing software that expanded rapidly during the pandemic in response to increased teleworking and remote learning is cloud-based videoconferencing software. In 2020, the global market for collaboration applications, including both videoconferencing software like Zoom and collaboration software like Slack, totaled $22.6 billion.[226] Zoom, in particular, benefitted from the increased adoption of cloud-based videoconferencing software. Between fiscal year (FY) 2019 and FY 2021, Zoom's worldwide revenue increased from $330 million to $2.65 billion, a 700 percent growth rate over the two-year period.[227] As with cloud infrastructure, U.S. firms are the primary providers of cloud videoconferencing software. Customers often used more than one type of software, with 54 percent of videoconferencing users reporting that they used Microsoft's Teams and Skype platforms, 46 percent reported using Zoom, 14 percent used Google Meet, and 7 percent used Cisco's Webex.[228]

[225] Chan, "Amazon Web Services Generated Over $10 Billion in Quarterly Revenue," April 30, 2020.
[226] IDC, "Collaborations Applications Revenue," August 2021.
[227] Vailshery, "Zoom's Revenue Worldwide in 2019-2021," May 2021.
[228] Totals do not sum to 100 percent since individuals can use multiple platforms. YouGov, "Most Used Online Communication Services Worldwide 2021," April 2021.

Home Entertainment: Video Games also Drive an Increase in Cloud Computing

In the consumer market, demand for at-home entertainment options has driven strong growth in the video game market during the COVID-19 pandemic. In particular, between 2019 and 2020, revenue from digital video games in the United States (including games downloaded from the internet, mobile, and internet-hosted games) increased by 18.4 percent.[229] In the United States, from 2019 to 2020, the number of individuals playing video games also increased by 50 million, representing a 31 percent increase in users during the pandemic, compared to a 7 percent increase in users per year in the previous two years.[230] The recent surge in demand for online gaming has sharply accelerated the development of cloud-based video game infrastructure and software.[231] While these developments seem to mirror shifts of other entertainment segments, such as the shift of movies and TV to cloud-hosted platforms like Netflix, shifting to a cloud-based model for video games presents additional challenges due to the complexity of the interactions between gamers and games compared to other forms of video entertainment, as explained below.[232]

In 2020, global revenue from digital games (excluding physical copies of games and console sales) totaled $133.1 billion, up from $108.0 billion in 2019. This 23.2 percent annual increase in revenue represents stronger growth than in previous years; year-on-year revenue growth was 11.8 percent in 2018 and 14.0 percent in 2019. There are three main segments of digital games: download games (12.6 percent of digital games revenue in 2020), which include full versions of games that are downloaded on a PC or console; mobile games (71.5 percent of revenue) which are played on smartphones or tablets; and online games, which are played directly on the internet or via installed clients (15.9 percent of revenue). While not explicitly branded as cloud games, this third category meets the requirement of a product that is remotely hosted and accessed via the internet, and thus could represent the upper bound of what could be considered current cloud video gaming.[233] In 2020, global revenue from games that were played entirely online totaled $21.1 billion, up from $17.3 billion in 2019, representing 21.9 percent growth rate.[234] The subsegment of the online video games market explicitly branded as cloud gaming is considerably smaller, capturing only 0.5 percent ($669 million) of the total digital game market in 2020.[235]

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[229] Statista, "U.S. Video Game Segment Revenue," November 2021.
[230] Morgan Stanley, "Into the Metaverse: Why Gaming Could Level Up in 2022," November 12, 2021.
[231] Mulholland, "Gamers Prepare for Cloud Computing," March 8, 2021.
[232] Singer and D'Angelo, "The Netflix of Gaming?," July 8, 2020.
[233] Remote hosting of video games began as early as 1980. At that time, some text-based fantasy adventure games were hosted in a single location, allowing users worldwide to connect via an early form of the internet known as the Advanced Research Projects Agency Network (ARPANET). Starting in the 2000s, massive multiplayer online games, like World of Warcraft (first released in 2004) have been hosted worldwide on centralized servers that individuals log into. Ray, "Online Gaming," October 29, 2021.
[234] The remaining two categories of digital games, download and mobile games, also rely on cloud computing to some extent. For example, mobile games may push updates to their games via the phone's internet connection. Statista, "Forecast of Video Games Revenue by Segment in the World from 2017 to 2025," June 2021.
[235] VentureBeat, "Global Cloud Gaming Market Size 2019 to 2024," August 2021.

One of the challenges for attracting new users to the video game market is the cost—of gaming consoles and of computers with sufficient memory and processing power—and cloud-based video games have the potential to shift this. Recently launched video game consoles—such as the Nintendo Switch, PlayStation 5, and Xbox One S—retail for $300-$500, while a retail gaming PC in 2021 cost $1,000–$4,000.[236] In contrast, recent cloud offerings provide remote access to cloud computing infrastructure via a PC, smart TV, or mobile device to play video games without investing in local computing power by shifting resource-intensive gaming tasks from local machines to cloud-based processing.[237] Like other cloud software services, these new services are run on a subscription model, ranging from $4.99 to $14.99 per month.[238]

In recent years, cloud providers and video game companies have launched a range of new services for accessing cloud video games. Services such as Nvidia's GeForce Now, launched in 2020, provide access to dedicated server space (cloud infrastructure) to play video games from online game libraries (including Steam, Epic, and Uplay libraries). As well as cloud gaming services launched by cloud providers, such as Amazon Luna (launched 2020) and Google Stadia (launched 2019), can be played via PCs or directly on a Smart TV, and have some compatibility with gaming hardware from other companies (such as controllers).[239] For example, in January 2022, Samsung announced a partnership with GeForce, Stadia, and Utomik cloud game services, allowing users to access cloud games directly from Samsung Smart TVs.[240] Finally, existing game systems have introduced new cloud-based services, such as Microsoft's Game Pass (launched in 2017) and PlayStation Now (launched 2014), which can be accessed via PCs or mobile apps in addition to the console systems, and include cloud-hosted versions of hundreds of Xbox and PlayStation titles. [241]

While most companies working on cloud video game services are either cloud providers or video game publishers hoping to develop additional cloud or video game capacity, Microsoft is unique in that it has both an existing cloud computing segment (Azure) and an existing game console and library (Xbox). This positioning gives Microsoft an advantage over other providers because it has employed both its existing cloud computing infrastructure and existing Xbox game library to create a video-game specific cloud platform. Rather than focusing exclusively on Xbox games, this Game Pass platform focuses on providing seamless access to Microsoft games from Xbox, PC, and mobile devices and a place for other game developers to publish games and access consumers on the Xbox network.[242] From 2020 to 2021, Game Pass grew 30 percent, to 25 million subscriptions. In January 2022, Microsoft announced plans to purchase video game publisher Activision Blizzard, which includes 30 game-development studios and a network of 400 million monthly players to include as part of its Game Pass library.[243]

While these cloud-based distribution systems may have lower barriers to entry for new gamers, they are also dependent on upload and download speed, latency, and reliability of the users' internet

[236] Sirani and Dornbush, "Comparing Price of Every Game Console," September 18, 2020; Buzzi, "Best Gaming Desktops," November 24, 2021.
[237] Morgan Stanley, "Video Gaming's Epic Battle in the Cloud," November 19, 2018.
[238] Greenwald, "The Best Game Streaming Services for 2021," June 15, 2021.
[239] Greenwald, "The Best Game Streaming Services for 2021," June 15, 2021.
[240] Samsung, "Samsung Electronics Unveils Its 2022 MICRO LED, Neo QLED and Lifestyle TVs," January 3, 2022.
[241] Greenwald, "The Best Game Streaming Services for 2021," June 15, 2021.
[242] Davison, "Game On," January 6, 2022.
[243] Waters, "Microsoft's $75bn Bet on Activision," January 19, 2022.

connection. A unique feature of video games compared to other online entertainment services is the bilateral transfer of data: both the game system and the gamer send data (in the form of commands in the game) across the connection. For a cloud-based video game, this means that an internet connection must have both fast upload (user to cloud) and download (cloud to user) speeds. [244] Minimizing latency (the time between when a user makes a data request and when the data is provided to the users) is particularly important in video games, where lags between commands and system responses can render games unplayable. In particular, cloud games require 20–30 milliseconds (ms) of latency to operate, which is faster than the average U.S. mobile connection in 2021 (40 ms), but within the range of the average U.S. fixed broadband network (24 ms).[245] While the average user will likely be able to play cloud-based games via a 5G Wi-Fi or cable connection, some cloud-based games, particularly multiplayer shooter/fighting games, may still have too much lag for competitive gamers.[246] Given the complexity of the cloud workloads associated with gaming, a reliable internet connection is critical for the success of cloud games. Unlike other types of cloud-hosted content, like videos, which can be restarted when a connection is lost, loss of internet connection in a game can result in a loss of progress for the game player.[247]

Subscription-based cloud gaming services may also face limits on how much of the market they can capture as users of existing systems may have limited reasons to switch to cloud-based systems. The higher computational power of cloud based systems has the potential to create high quality content, such as games with more user-customized AI, and shift users to these platforms.[248] However, as developing new games is costly ($50-100 million for major publishers) and time-consuming (three to six years for major publishers), firms may instead focus on developing a centralized platform for existing games from different game companies.[249] For example, in February 2021, Google shut down its Stadia game development division to focus on creating a platform that brings together games from different producers that can be seamlessly accessed across PCs, mobile phones, and TVs.[250] Subscription-based platforms also may struggle to gain traction in this market due to the success of non-subscription-based models, particularly free-to-play games with in-game purchases like Fortnite, and the user preference to own games that are stored locally.[251]

Outlook

The market for cloud computing services is forecast to continue to grow in coming years. Industry predictions suggest global spending on cloud computing will continue to experience strong growth of about 20 percent per year in 2021 and 2022, driven primarily by increased revenue in the cloud infrastructure market.[252] On the cloud software side, industry predictions also suggest cloud

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[244] Davison, "Game On," January 6, 2022; Ericsson, *Mobile Cloud Gaming*, November 2020, 4.
[245] Ericsson, *Mobile Cloud Gaming*, November 2020; Speedtest, "United States' Mobile and Broadband Internet Speeds," accessed January 19, 2022.
[246] Greenwald, "The Best Game Streaming Services for 2021," June 15, 2021.
[247] Davison, "Game On," January 6, 2022.
[248] Mulholland, "Gamers Prepare for Cloud Computing," March 8, 2021.
[249] Davison, "Game On," January 6, 2022; Singer and D'Angelo, "The Netflix of Gaming?," July 8, 2020.
[250] Gartenberg, "Google Is Shutting Down Its In-House Stadia Game Development Studios," February 1, 2021.
[251] Singer and D'Angelo, "The Netflix of Gaming?," July 8, 2020; Futter, "Why Video Game Industry Pushes Cloud-Based Gaming," April 23, 2019.
[252] Gartner, "Gartner Forecasts Worldwide Public Cloud End-User Spending to Grow 23%," April 21, 2021.

subscription revenue will exceed legacy software purchases starting in 2022.[253] One of the challenges in the business market going forward will be the expected shift to hybrid work environments with both in-person and remote workers. In particular, hybrid videoconferencing meetings can be difficult to conduct because of echoes from multiple in-person participants on different devices, poor audio quality in conference rooms, and a lack of interaction between in-person and remote participants. To address these issues, software providers have announced several software updates to minimize background noise, differentiate individuals grouped together in a conference room, and introduce virtual whiteboards and other collaborative tools to meetings.[254]

The recent Russian invasion of Ukraine may slightly depress sales of cloud computing services in the coming year. As of March 16, 2022, U.S. cloud services providers Microsoft, Google, Amazon and IBM have all released statements indicating they are not accepting new customers for their cloud services in Russia.[255] However, as Russia represents less than 1 percent of global spending on Information and Communications Technology overall, industry reports suggest this disruption will be minimal for global cloud services sales.[256]

In the video game market, revenue from cloud subscriptions is expected to grow to $11 billion by 2025. However, this growth still represents a small share of the total video games market, as cloud subscription revenue share is still only expected to capture 5.1 percent of the total digital video game market by 2025.[257]

Telecommunications Services: Undersea Cables

Over the past five to six years, a handful of U.S. cloud and content providers, mainly Google, Microsoft, Meta, and Amazon, have become leading investors in undersea fiber optic cable systems. Seeking to support data flows between proprietary data centers, these cloud/content providers initially leased or purchased data transmission capacity on existing undersea cable systems. As their demand for transmission capacity grew due to soaring data volumes, these companies began to commission the construction of proprietary cables. During the past ten years, the cloud/content providers have invested in roughly 30 cables, including those that are operational, under construction, or planned.

Market Conditions

Undersea cables, which consist of up to two dozen strands of ultra-pure glass fibers that are surrounded by several layers of insulation and protective covering, are used to connect the land-based telecommunications networks of countries that are separated by oceans and other large bodies of water.

[253] Freeman, *Industry Surveys: Software*, July 2020, 6.
[254] Abril, "Workers Frustrated with Current Video Tools," December 2, 2021.
[255] Miller, "Amazon, Microsoft and Google Have Suspended Cloud Sales in Russia," March 10, 2022.
[256] IDC, "A New Report from IDC Looks at the Initial Impact of the Russia-Ukraine War," March 7, 2022.
[257] Waters, "Microsoft's $75bn Bet on Activision," January 19, 2022; Statista, "Forecast of Video Games Revenue by Segment in the World from 2017 to 2025," June 2021.

These cables, which are laid on the seabed and stretch between coastal landing stations in different countries, transmit data using fiber optic technologies: lasers on one end of the cable shoot bursts of light down thin glass fibers the entire length of the cable—which can be thousands of miles long—to receptors at the other end of the cable.[258] By the end of 2021, there were approximately 808,000 miles of undersea cables in service around the world. The lengths of such cables range from the 81-mile CeltixConnect-1 cable that runs between Ireland and the United Kingdom to the 12,400-mile Asia America Gateway cable, which connects the United States across the Pacific Ocean with eight countries in Southeast Asia.[259] Many undersea cables are owned and operated by groups of telecommunications companies, including government-owned (or controlled) companies. The consortium that owns the Bay of Bengal Gateway Cable System, for example, which covers more than 5,000 miles connecting India with the Middle East and Southeast Asia, includes private companies like AT&T (U.S.), Vodafone (UK), and Telstra (Australia) as well as government-owned (or controlled) entities like China Telecom (China), Omantel (Oman), and Telekom Malaysia (Malaysia).[260]

At the end of 2021, there were an estimated 436 separate undersea cable systems[261] in service around the world.[262] Such cables form the backbone of the global internet and transport more than 95 percent of international telecommunications and data traffic.[263] The undersea cable market—measured by revenues attributable to companies that build undersea cables - was valued at $13.3 billion in 2020, and is expected to increase to $30.8 billion by the end of 2026.[264] Undersea cable systems are built by a relatively small group of specialized companies, including Alcatel-Lucent Submarine Cable Networks; Ciena Corporation; Fujitsu; Huawei Marine Networks; NEC Corporation; NTT World Engineering Marine Corporation; Orange Marine; Seaborn Networks; and TE SubCom.[265]

Overall, total international internet bandwidth derived from undersea cable systems increased by 29 percent in 2021, to 786 terabits per second (Tbps) by the end of 2021.[266] Peak international internet traffic data over these cables in 2021 was estimated at 353.6 Tbps, while average traffic was less than 206.0 Tbps.[267] In addition to undersea cables, global data transmission capacity is augmented by broadband satellite systems recently launched by Starlink, OneWeb, and other companies (box 4.1).

Box 4.1 Low-Earth Orbit Satellite Systems

Starlink, a division of Elon Musk's SpaceX, is currently in the process of building a network of low-earth orbit (LEO) satellites that, if fully deployed, will offer internet access virtually anywhere on earth. Starlink's goal is to offer high-speed internet access to individual customers, with a focus on rural and remote areas, via a small satellite dish. Starlink started launching satellites in 2018, with about 1,850 satellites in orbit by the end of 2021. Currently, the company has received approval from the U.S.

[258] TeleGeography, "Submarine Cable 101," accessed February 25, 2022.
[259] TeleGeography, "Submarine Cable 101," accessed February 25, 2022.
[260] TeleGeography, "Submarine Cable Map," accessed November 5, 2021.
[261] To see a map depicting the global undersea cable network, see TeleGeography's online submarine cable map at https://www.submarinecablemap.com/.
[262] TeleGeography, "Submarine Cable 101," accessed February 25, 2022.
[263] Morcos and Wall, "Invisible and Vital," June 11, 2021.
[264] Global Newswire, "Global Submarine Optical Fiber Cables Market to Reach $30.8 Billion," October 29, 2021.
[265] Global Newswire, "Global Submarine Optical Fiber Cables Market to Reach $30.8 Billion," October 29, 2021.
[266] TeleGeography, *Global Internet Geography*, September 28, 2021, 1.
[267] TeleGeography, *Global Internet Geography*, September 28, 2021, 2.

Federal Communications Commission to launch 12,000 satellites with plans, ultimately, to blanket the earth with as many as 42,000 satellites. By the end of 2021, Starlink reported about 140,000 customers worldwide paying $99 per month for satellite internet service.[a] UK-based OneWeb, which has launched 650 LEO satellites, offers satellite internet access to enterprise customers like government agencies and private companies.[b] Other companies planning to construct LEO satellite networks over the next few years include Amazon, Astra, Boeing, and Telesat, among others.[c]

Recent media attention on these satellite projects has led some commentators to ask whether LEO satellite systems will compete with undersea cable networks—or eventually supplant them—for the purpose of transmitting international data traffic.[d] An examination of the two systems, however, indicates that satellites and undersea cables are not alternate technologies for two main reasons: available transmission capacity and construction costs. First, in terms of sheer data transmission capacity, current-generation undersea cable systems far outstrip the bandwidth available from even the highest-capacity satellite network. For example, Google's Dunant subsea cable has a design capacity of more than 250 terabits per second (Tbps). By contrast, the total transmission capacity available from Starlink tops out at 10.3 Tbps, and OneWeb is capable of only 1.4 Tbps.[e] The disparity in available transmission capacity between satellite systems and undersea cable networks becomes even more apparent when considering the fact that there are an estimated 436 undersea cables currently in service across the world.

Second, satellite systems are much more expensive to build than undersea cables. Starlink, for example, estimates that an investment of at least $10 billion will be required to make the company cashflow positive, with total investment requirements of $20–$30 billion to complete the network.[f] By contrast, undersea cables require investments of several hundred million dollars, depending on system length. Google's Dunant cable, for example, cost $163 million[g] to build and delivers dramatically more transmission capacity than a satellite network, resulting in substantially lower unit costs.

Satellites excel for certain applications. For example, they are able to effectively reach areas of the globe that are not connected by fiberoptic networks, typically remote, rural areas. Satellites can also effectively distribute content from one source to multiple locations like, for example, broadcasting international sporting events.[h] Ultimately, the satellite networks operated by Starlink and OneWeb are designed to offer internet access services, mostly to remote areas, whereas submarine cable networks are designed to carry large-volume, intercontinental data traffic.

[a] Callaham, "What is Starlink?," November 14, 2021; Crist, "Starlink Explained," November 11, 2021; Maidenburg, "SpaceX's Future," December 28, 2021.
[b] One Web, "Company," accessed February 7, 2022.
[c] Sheetz, "Companies Ask FCC for about 38,000 New Broadband Satellites," November 5, 2021; Leins, "International Satellite Broadband Battle Intensifies," October 25, 2021.
[d] Lavallée, "Satellite vs. Submarine Cables: Myth vs. Reality," January 13, 2022.
[e] Mauldin, "Satellites and Submarine Cables: Friends or Enemies," January 13, 2022.
[f] Mukherjee and Laudette, "Musk Says May Need $30 bln to Keep Starlink in Orbit," June 29, 2021.
[g] Kim, "Telxius Joins Trans-Atlantic Dunant and Marea Subsea Cables," January 29, 2021.
[h] TeleGeography, "Submarine Cable 101," accessed February 25, 2022.

U.S. Cloud/Content Providers Move into the Undersea Cable Industry

For much of the 20th century, undersea cables were commissioned and operated by consortia of large, incumbent telecommunications carriers like AT&T (United States), British Telecom (United Kingdom), Deutsche Telekom (Germany), and NTT (Japan). Under such arrangements, which could include as many as 30 carriers, consortia members would build cables to accommodate the fairly predictable growth rates of international voice traffic, sharing the costs of cable construction and allocating transmission capacity among themselves based upon ownership share. This system existed more or less undisturbed until the 1990s, when telecom deregulation in many countries and growing internet traffic led telecom companies (like WorldCom) and specialty companies (like Global Crossing) to construct private (i.e., non-consortium) undersea cable systems. Both construction models (consortia and private) have existed side-by-side since the late 1990s.[268]

Over the past five to six years, a small group of cloud and content providers—mainly Google, Meta, Amazon, and Microsoft—have moved into the undersea cable industry. Seeking to support high volumes of data traffic between their proprietary data centers, these cloud/content providers initially leased capacity on existing undersea cables, but eventually began commissioning the construction of proprietary cables.[269] With their largest data centers in North America, Europe, and Asia, they have focused on core routes in the Atlantic and Pacific oceans. By contrast, these companies represent only a small share of capacity on routes connecting Africa and the Middle East.[270] Cloud/content providers' investment in undersea cables over the past few years has been mirrored by decreasing investment by the traditional builders of such cables. Prior to 2012, cloud/content providers made up less than 10 percent of undersea cable capacity. By 2020, however, their investments accounted for 66 percent of global undersea capacity.[271] Of the cloud/content providers, Google and Meta are by far the most active investors in the undersea cable industry. Google, which started investing in undersea infrastructure with the Unity/EAC-Pacific cable, launched in 2010, now has an ownership position in about 16 current (or planned) cables and is reportedly the sole owner of 5 of those cables, and a co-owner of the remainder. Meta, on the other hand, is a partial owner of 13 cables, although it frequently takes a leadership role among the other owners. Microsoft is a partial owner of three cables (and a majority capacity purchaser in at least two others) and Amazon is a partial owner of two cables (and a major capacity purchaser in at least three others). Overall, during the past ten years, the cloud/content providers have invested in roughly 30 cables, including those that are operational, under construction, or planned.[272] Over the next two to three years, cloud/content providers are expected to account for about 30–50 percent of total investment in new undersea cable systems.[273]

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[268] TeleGeography, "The Rise of Private Cables," 1999; TeleGeography, "Infrastructure: 20,000 Leagues Under the Sea," January 1, 1999; Sverdlik, "How Hyperscale Cloud Platforms Are Reshaping the Submarine Cable Industry," February 17, 2021.
[269] Naik, "Content Delivery Networks Under the Sea," *Thousand Eyes* (blog), July 24, 2018; Sverdlik, "How Hyperscale Cloud Platforms Are Reshaping the Submarine Cable Industry," February 17, 2021.
[270] TeleGeography, *The State of the Network*, January 31, 2019.
[271] Mims, "Google, Amazon, Meta and Microsoft Weave a Fiber-Optic Web of Power," January 15, 2022.
[272] Swinhoe, "Submarine Cables Find New Impetus," November 23, 2021.
[273] Sverdlik, "How Hyperscale Cloud Platforms Are Reshaping the Submarine Cable Industry," February 17, 2021.

Table 4.2 Select undersea cables owned or co-owned by U.S. cloud/content providers, by year
Tbps = terabits per second; n.a. = not available.

Cable name	Year	Length (miles)	Design capacity (Tbps)	Owners	Regions
Junior	2018	242	n.a.	Google	South America
MAREA	2018	4,104	200	Meta, Microsoft, Telxius	North America, Europe
New Cross Pacific (NCP) Cable System	2018	8,462	80	Microsoft, China Mobile, China Telecom, China Unicom, Chunghwa Telecom, KT, Softbank Corp	Asia, North America
Tannat	2018	1,243	90	Google, Antel Uruguay	South America
INDIGO-Central	2019	3,014	36	Google, Australia's Academic and Research Network (AARNET), Indosat Ooredoo, Singtel Optus, Superloop	Australia
INDIGO-West	2019	2,858	36	Google, Australia's Academic and Research Network (AARNET), Indosat Ooredoo, Singtel Optus, Superloop, Telstra (incl. Belong)	Australia, Asia
Curie	2020	6,509	72	Google	North America, South America
Havfrue/AEC-2	2020	4,759	108	Meta, Google, Aqua Comms, Bulk	North America, Europe
Japan-Guam-Australia (JGAS)	2020	4,400	36	Google, Australia's Academic and Research Network (AARNET), RTI	Australia, Asia
Jupiter	2020	9,045	60	AWS, Meta, NTT, PCCW, PLDT, Softbank Corp	North America, Asia
Pacific Light Cable Network (PLCN)	2020	7,336	144	Meta, Google	North America, Asia
Dunant	2021	3,977	250	Google	North America, Europe
Malbec	2021	1,616	108	Meta, GlobeNet	South America

Source: TeleGeography, "Submarine Cable Map," accessed November 5, 2021; Submarine Telecom Forums, "Submarine Cable Almanac," November 2021; GlobeNet, "ISPs, Carriers, and OTTs," June 7, 2021; Lardinois, "Google's Indigo Subsea Cable is Now Online," May 30, 2019, author calculations.

As mentioned above, cloud/content providers invest in undersea cable systems largely for the purpose of transporting massive volumes of data traffic between their proprietary data centers located around the world. The networks that directly connect proprietary data centers are referred to as content delivery networks, with the inter-data center traffic flowing over them typically driven by activities related to database mirroring, search-index synchronization, and cloud computing services and applications.[274] These high-capacity, inter-data center connections increase the performance of consumer-facing services, particularly cloud services.[275]

[274] TeleGeography, *The State of the Network*, January 31, 2019; Naik, "Content Delivery Networks Under the Sea," July 24, 2018.
[275] Finley, "How Google Is Cramming More Data Into Its New Atlantic Cable," April 5, 2019; Ward, "Ask a Techspert," January 28, 2022.

In 2015, for example, Microsoft invested in two transatlantic cables—Hibernia Express and AEconnect—with the stated purpose of connecting its data center infrastructure in North America with Ireland and the UK, mainly to offer cloud services, including Azure, to its customers.[276] Google's Firmina cable—which will run from the United States to South America lands near its Google Cloud regions in Northern Virginia in the United States and Sao Paulo, Brazil—and will be used to bolster low-latency access to its products and services in Latin America, including Google Cloud.[277] Similarly, Google announced that its planned Grace Hopper cable is being constructed between the United States (New York), Spain, and the UK to support services like Google Meet (videoconferencing) and Google Cloud.[278]

Due to the overriding imperative of connecting proprietary data centers, the routing of cables commissioned by the cloud/content providers is increasingly determined by data center locations and the cables that they commission are often laid along nontraditional seabed routes. New transatlantic cables, for example, are increasingly landing in areas that historically would not have hosted undersea cable landings, like Denmark, Virginia Beach, Virginia (United States), or the west coast of Ireland, where data centers have been constructed over the past few years.[279] Until fairly recently, nearly all transatlantic cables from the United States were routed from Long Island, New York, to either the UK or, less frequently, France.

Cloud/content providers are also reshaping the industry by dramatically increasing the data transmission capacity of newly constructed undersea cables. Historically, undersea cables contained between four and eight pairs of fiber optic cable. Google's Dunant cable, however, which is laid on the Atlantic Ocean seabed between Saint-Hilaire-de-Riez (France) and Virginia Beach, Virginia (United States), was constructed with 12 fiber pairs, delivering an unprecedented data transmission capacity of 250 Tbps. For comparison, the design capacity of undersea cables in 2013 was about 9 Tbps and as recently as 2019 or 2020 the design capacity was 60 Tbps. Upcoming cables are being designed with 16 fiber pairs and, going forward, industry analysts predict that cables will be constructed with 20 or more fiber optic pairs.[280]

Cloud/content providers have also been changing the way that undersea cables terminate on land. Historically, undersea cables would come ashore at a coastal cable landing station, with network facilities referred to as "backhaul" providing fiber-optic connections further inland to internet exchange points, colocation facilities, and data centers.[281] Increasingly, however, submarine cables are bypassing cable landing stations and terminating directly in data centers,[282] which are increasingly being built near the coast to facilitate such connectivity. Currently, at least 20 undersea cables worldwide terminate directly in data centers or metro-area colocation facilities.

[276] TechCrunch, "Microsoft Invests In 3 Undersea Cable Projects To Improve Its Data Center Connectivity," accessed January 10, 2022.
[277] Goovaerts, "Google Gets to Work on Its Sixth Private Subsea Cable," June 9, 2021.
[278] Shead, "Google Is Building a Huge Undersea Fiber-Optic Cable to Connect the U.S. to Britain and Spain," July 28, 2020.
[279] Sverdlik, "How Hyperscale Cloud Platforms Are Reshaping the Submarine Cable Industry," February 17, 2021.
[280] Sverdlik, "How Hyperscale Cloud Platforms Are Reshaping the Submarine Cable Industry," February 17, 2021.
[281] Poole, "Submarine Cable Boom Fueled by New Tech," March 6, 2018.
[282] Sverdlik, "How Hyperscale Cloud Platforms Are Reshaping the Submarine Cable Industry," February 17, 2021; Bruns, "How Undersea Cables Drive Onshore Site Decisions," March 2020.

Over the past decade, for example, several cables have landed directly at colocation facilities or central interconnection points in London, New York, and Hong Kong.[283] More recently, Google selected colocation data center company Equinix to terminate its Curie cable system, with the system's fiber optic cabling coming directly out of the ocean and terminating at Equinix's LA4 International Business Exchange data center in El Segundo, California.[284] Terminating undersea cables directly in data centers or colocation facilities not only eliminates the need to operate and manage a cable landing station but also reduces network latency by bypassing terrestrial backhaul facilities. Direct connections with customers located in data centers and colocation facilities also reduces latency.[285]

Establishing an ownership position in an undersea cable system is attractive to cloud/content providers because it ensures access to a crucial service input (i.e., data transmission capacity) and eliminates the need to pay maintenance fees to cable owners. Equity ownership also allows cloud/content providers to fully define a cable's technical specifications and confers control over equipment upgrade schedules and data traffic management.[286] Maintaining control of cables on diverse sea-bed routes also increases network diversity—allowing owners to re-route data and internet traffic over other cables—in the event of a network outage.[287] For example, the Blue and Raman cables, which are co-owned by Google, Omantel, and Telecom Italia Sparkle, will improve route diversity between Europe, India, and the Middle East; they are the first cables to connect these regions without relying on landing stations in Egypt.[288] In addition to increasing route resiliency, cloud/content providers have also commissioned the construction of undersea cables to connect underserved regions, notably sub-Saharan Africa and South America.[289] Google's Firmina cable, for example, will improve access to Google services to users in South America.[290]

Outlook

Over the next three years, cloud/content providers will likely become the primary financiers and owners of undersea cable systems in the Atlantic and Pacific oceans.[291] Over this period, an additional $8 billion is projected to be invested in new undersea cables, with demand for data transmission capacity by U.S. cloud/content providers driving most of this investment.[292] On the core Atlantic and Pacific routes, most new cables will likely be built by one or a few cloud/content providers, with little to no participation by traditional telecommunications operators or wholesale players.[293] Instead, some analysts predict that

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283 Bruns, "How Undersea Cables Drive Onshore Site Decisions," March 2020.
284 Bruns, "How Undersea Cables Drive Onshore Site Decisions," March 2020.
285 Poole, "Submarine Cable Boom Fueled by New Tech," March 6, 2018.
286 Economist, "Tech Giants Are Building Their Own Undersea Fibre-Optic Networks," October 17, 2017; Sverdlik, "Three New Submarine Cables to Link Cloud Data Centers," January 17, 2018.
287 Finley, "How Google Is Cramming More Data Into Its New Atlantic Cable," April 5, 2019; Ward, "Ask a Techspert," January 28, 2022.
288 Brodsky, "The Blue and Raman Cable Systems Stand Out," July 30, 2021; Arthur, "Undersea Internet Cables off Egypt Disrupted as Navy Arrests Three," March 28, 2013. In recent years, undersea cables in Egyptian waters have been subject to cuts by ship anchors as well as sabotage.
289 Ward, "Ask a Techspert," January 28, 2022.
290 Koley, "Hola, South America! Announcing the Firmina Subsea Cable," June 9, 2021.
291 Mims, "Google, Amazon, Meta and Microsoft Weave a Fiber-Optic Web of Power," January 15, 2022.
292 Miller, "$8 Billion in Subsea Cable Investment," June 16, 2021.
293 Swinhoe, "Submarine Cables Find New Impetus," November 23, 2021.

carriers and specialty cable companies will evolve to specialize in underserved geographic areas, like Africa, regional systems, or even domestic routes. The Confluence-1 cable, for example, built by Confluence Networks, will run the down the east coast of the United States from New Jersey to Florida, with branches to Virginia and South Carolina. In terms of regional systems, Reliance Jio Infocomm is building a cable called India Asia Xpress that will connect India with Malaysia, Maldives, Singapore, and Sri Lanka.[294]

[294] Swinhoe, "Submarine Cables Find New Impetus," November 23, 2021.

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Chapter 5
Services Roundtable Summary

The Commission hosts an annual roundtable to encourage dialogue among individuals from government, industry, and academia on issues that impact services trade. The 15th Annual Services Roundtable was held on Thursday, October 28, 2021. This year's roundtable focused on two themes: (1) the evolving concept of worker-centric services trade, including the connection between labor markets, employment, and services trade; and (2) the potential climate effects of services sector operations, and the contribution of services industries toward mitigating adverse climate impacts. Following introductory remarks by Chair Jason E. Kearns, Vice Chair Randolph J. Stayin moderated the first half of the discussion, and Commissioner Rhonda K. Schmidtlein moderated the second half.

Worker-centric Services Trade: The Impact of Services Trade on Labor

The first discussion topic of the roundtable was worker-centric services trade. In general, a worker-centric trade policy focuses on labor-specific outcomes of trade, including its impact on employment, wages, and working conditions. One participant noted that services trade contributes to rising living standards but that there is little evidence of the connection between services trade and labor market impacts. This participant mentioned that studies on the effects of cross-border trade on workers most commonly focus on the manufacturing sector, although some research examines the effects of services offshoring on domestic labor markets. In particular, this participant noted a 2011 paper by Liu and Trefler that discussed the differential impacts of services trade on labor and found both gains and losses for blue- and white-collar workers.[295] Another participant noted that services are embedded in manufacturing and that one has to look not only at the direct effect on workers, but also on the indirect effect of services trade on the agriculture and manufacturing sectors to determine overall service sector impacts. Separately, a representative from the telecommunications industry noted that factory closures resulting from trade and offshoring, as well as workers' subsequent transition from high wage manufacturing jobs to the services sector, lessens service workers' ability to advocate for wage increases.

Labor Mobility and Worker Retraining

Participants also discussed the impact of geographic mobility on employment. Lack of mobility means that workers in towns where jobs are lost are often forced to take lower paying jobs. This, in turn, leads to a downward pressure on wages as the number of jobseekers exceeds the number of available jobs. One participant commented that regional mobility and mobility across industries are key to mitigating the negative effects of trade and the structural transformations from trade, so workers need to move

[295] For more information see Runjuan Liu and Daniel Trefler. *A Sorted Tale of Globalization: White Collar Jobs and the Rise of Service Offshoring*. Working Paper Number 17559. National Bureau of Economic Research, November 2011. https://www.nber.org/papers/w17559.

across sectors, across regions, and across occupations. When workers are offered retraining, they tend to choose jobs in similar occupations, which limits their reemployment options and post-displacement wages.

Another participant said that while geographic mobility may be the solution for some workers, barriers to mobility pose difficulties for others. As an example, a participant noted that in the call center industry, companies have moved operations to the Philippines to take advantage of the English-speaking workforce in that country, along with lower wages and labor standards. The offshoring of call center operations to a less costly market puts U.S. workers at a disadvantage, as they are unable to follow their jobs overseas. In the motion picture industry, labor mobility is key, and work is high skilled and high paying—creating a pathway to the middle class. However, travel restrictions under the COVID-19 pandemic have affected the movement of people in the motion picture industry. This, in turn, has had a large impact on film and television production, especially productions that involve the use of foreign talent. Another participant noted that licensing, education, and training requirements serve as barriers to entry in certain services industries and affect cross-state mobility for U.S. workers. Further, a recent study by the Organisation for Economic Co-operation and Development found that strict and extensive licensing requirements in the services sector are associated with lower job mobility.[296]

The discussion then turned to the issue of worker retraining. One participant noted that nearly two-thirds of the 13 million U.S. jobs created since 2010 require medium to advanced digital skills. Such jobs are growing 2.5 times faster and pay wages that are on average 18 percent higher than other types of services jobs. Prominent computer software companies are training employees in basic IT support and certifying them in company-based computer programs, filling in-house employment gaps. These companies also have a need for non-technical personnel, including administrative and support staff, and provide vocational training to prospective employees. Another participant stated that it is important to consider both retraining and reskilling of the blue-collar work force—not just preparing traditional manufacturing workers to gain employment in the digital services industry, but to provide more skills-based training for those who remain in traditional blue-collar jobs. Yet another participant suggested continuing to expand the role of the U.S. Trade Adjustment Assistance Act in providing training and support for displaced services workers.

Services Workers and Labor Provisions in Trade Agreements

Next, participants discussed the efficacy of labor provisions in trade agreements. One participant commented that trade agreements typically target unionized workers and exclude the informal workforce (including "gig" workers). She indicated that gig workers do not have the ability to collectively bargain, so including provisions in trade agreements that address this segment of the workforce is important. Another participant stated that while labor provisions generally focus on unionized workers, these provisions are also broad enough to include non-unionized workers as well. Specifically, labor

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[296] For more information see Indre Bambalaite, Giuseppe Nicoletti, and Christina von Rueden. *Occupational Entry Regulations and Their Effects on Productivity in Services: Firm Level Evidence*. Economics Department Working Papers No. 1605, ECO/WKP(2020)13. Organisation for Economic Co-operation and Development, 2020. https://www.oecd.org/economy/growth/occupational-licensing-and-productivity/.

provisions in agreements on digital trade and telecommunications investment cover a wide range of industries, many of which do not have labor unions.

Another participant emphasized the need to look more broadly at the distributional impacts on labor, specifically who benefits from trade agreements and who does not. U.S. companies and the trade community are examining how to be more inclusive of different labor groups. He stated that, in general, U.S. trade policy should extend beyond the narrow objective of opening market access and commercial opportunities for U.S. firms. Rather, such policy should seek to advance U.S. workers and create better working conditions in countries that are parties to an agreement, not pit workers against one other. Other participants confirmed the need for trade agreements to include provisions on labor standards and mechanisms to enforce these standards both domestically and abroad.

Climate Impacts from Services Sector Operations

The second half of the roundtable focused on the climate effects of services trade. In general, participants discussed how certain services, such as cloud computing and transportation services, have contributed to the rise of greenhouse gas (GHG) emissions. Participants also examined the roles of government, the private sector, and technology in helping mitigate the climate impacts of services trade.

The Impact of Climate Change on Service Industries, Including Insurance, Computer, and Transportation Services

A participant from the insurance industry commented on the impact of climate change on the insurance and reinsurance industries. The participant noted that the insurance industry uses modeling to predict climate risks and is also engaged in efforts to build climate resilience. The former effort informs where insurers provide service, the rates that they offer, and the level of risk that they are willing to undertake. This participant also indicated that the growing threat of climate impacts, combined with intervention by governments in rate setting, have caused some insurance providers to exit markets. For example, this participant claimed that in California, the risk of wildfires is extremely high, yet the state government will not permit U.S. insurers to raise rates to reflect the heightened risk level. The participant further offered that, in India, insurers are encouraged to purchase reinsurance services from a government-owned entity; as a result, the Indian government has significant influence over the interrelated prices of insurance and reinsurance services. According to this participant, in markets where governments mandate insurance rates that overestimate or underestimate the level of risk, it is difficult for reinsurers to operate and for consumers to access insurance and reinsurance services.

A computer software industry representative acknowledged that cloud computing contributes to GHG emissions. However, this participant’s company has established targets to become carbon negative by 2030 and to eliminate its historical emissions by 2050. These carbon reduction efforts will be achieved in part by using new technologies to monitor and track the company’s emissions. Another participant commented that electricity use by cloud computing firms has remained flat over the past decade despite a ten-fold increase in internet traffic and a 25 percent increase in data storage capacity. As such, the participant suggested that there is a public misconception regarding the climate role played by data centers, which account for one percent of total electricity consumption. Further, according to the participant, while private sector efforts are important, government commitments towards carbon reduction are also critical, including the advancement of policies like a carbon border adjustment mechanism.

A third participant from a computer hardware firm stated that her company is pursuing a multifaceted plan to reduce its carbon emissions. The plan includes increasing the cooling efficiency of its data centers by 20 percent (from 2019 levels), as well as procuring 75 percent of its electricity needs from renewable energy and implementing an additional 3,000 in-house conservation projects by 2025. The company is also using cloud computing and artificial intelligence to achieve carbon capture and other environmentally beneficial outcomes. The participant commented that the company is not waiting for government mandates to reduce carbon emissions but is instead addressing climate change impacts in advance of policymaking.

Separately, a U.S. government representative discussed the role played by the U.S. transportation sector (including air, maritime, rail, and trucking services) in contributing to GHG emissions. This participant reported that the sector accounts for 29 percent of U.S. GHG emissions, primarily from the use of fossil fuels. Auxiliary supply chain services that rely on cloud computing also contribute to the sector’s environmental footprint. Both public and private entities are engaged in efforts to reduce or eliminate carbon emissions by the transportation sector. Broadly, these efforts focus on developing alternative fuels, reducing fuel consumption, and improving operational efficiency. Developing fuels that emit less carbon, transitioning to hybrid and electric-powered engines, and improving the aerodynamic efficiency of vehicles are some of the ways that stakeholders are aiming to reduce the use of fossil fuels. For air transport, these efforts include optimizing flight routes to reduce fuel use and reducing average taxi time for aircraft. For trucking, they include training truck drivers in driving habits that help reduce their fuel consumption.

A participant from a large internet firm discussed how information, communications, and technology services are used to reduce the environmental impacts of transportation. For example, the company uses data analytics and machine learning to help trucks and express delivery vehicles find the most fuel-efficient routes, and similar applications are available for commercial airlines. Data analytics are also being used to reduce the time that vehicles idle at traffic lights. To this end, the company is engaged in a pilot project in Israel to assist with more fuel-efficient traffic routing, which has led to a 10–20 percent reduction in fuel consumption by drivers in that country. Further, a participant from a consulting firm stated that climate considerations, alongside the effects of the COVID-19 pandemic, have led companies to conclude that they should undertake only 25 percent of pre-pandemic airline travel in the future.

The Role of Trade Policy in Mitigating Services Firms’ Climate Change Impacts

Finally, participants discussed how government-led efforts may assist services firms in addressing climate change. An industry representative suggested that trade agreements on environmental goods should also incorporate environmentally related services (e.g., construction and engineering services), a subject that has been discussed at the World Trade Organization. The representative also suggested that trade agreements could provide an incentive for countries to develop and adhere to environmental standards for data centers or other services sector activities. A U.S. government representative confirmed that climate-related commitments in international trade agreements generally cover environmental goods, but not services. In addition, because there is little data on environmental services trade, it is challenging for policymakers to assess whether and to what extent barriers to such trade exist. Nevertheless, U.S. trade negotiators are examining environmental services provisions in the Asia-Pacific Economic Cooperation forum and other fora to consider how such provisions might help the United States and its trading partners advance climate mitigation efforts in the context of services trade.

Appendix A
Selected Services-related Commission Publications and Staff Research

This appendix provides summaries of and links to recent U.S. International Trade Commission publications—reports and shorter papers—that feature topics in services trade. Reports are prepared under section 332(g) of the Tariff Act of 1930 (19 U.S.C § 1332 (g)) in response to requests from the U.S. Trade Representative, the U.S. House of Representative's Committee on Ways and Means, and/or the U.S. Senate's Committee on Finance. The shorter papers are the results of research by the Commission's Services Division staff, sometimes in collaboration with staff members from other divisions of the Commission. These papers include articles in the Commission's Journal of International Commerce and Economics and working papers.

The shorter papers summarized in this appendix are solely meant to represent the opinions and professional research of their authors. They are not meant to represent in any way the views of the U.S. International Trade Commission, of any of its individual Commissioners, or of the United States government.

332 Investigations

Economic Impact of Trade Agreements Implemented Under Trade Authorities Procedures, 2021 Report

Tamara Gurevich (Office of Economics, Research Division) and David Guberman (Office of Industries, Natural Resources and Energy Division)

Investigation Number: TPA-105-008

https://usitc.gov/sites/default/files/publications/332/pub5199.pdf

This report looks at the economic impact of U.S. Trade Agreements that were negotiated with trade promotion authority procedures. Several sections of the report consider the role of services trade in U.S. trade agreements, including:

- Chapter 2: Provisions related to services trade in the Uruguay Round and in U.S. Free Trade Agreements.
- Chapter 3: Estimates of the impact of trade agreements on barriers to services trade, and the overall impact on the economy. Chapter 3 also includes standalone estimates of the effects of specific services provisions on services trade, such as liberalization approach and market access provisions, and the impact of digital trade provisions such as electronic commerce tariff moratoriums and free data flow provisions on services trade.
- Chapter 4, case study 5: Prohibitions on Customs Duties on Electronic Transmissions: Describes the relationship between these types of provisions in U.S. FTAs and non-FTA agreements like the World Trade Organization Moratorium on Customs Duties for building international consensus.

Foreign Censorship, Part 1: Policies and Practices Affecting U.S. Businesses

Isaac Wohl (Office of Industries, Services Division) and Martha Lawless (Chief, Office of Industries, Services Division), December 2021

Investigation Number: 332-585

https://www.usitc.gov/publications/332/pub5244.pdf

This report identifies and describes various foreign government censorship policies and practices, including examples that U.S. businesses consider impediments to trade and investment, in six key markets: China, Russia, Turkey, Vietnam, India, and Indonesia.

- Foreign government censorship policies and practices include laws, regulations, and other measures that directly target the suppression of speech (such as premarket review of content, internet shutdowns, and internet blocking, filtering, and throttling) or that may be used to enable or facilitate its suppression (such as internet intermediary rules, data localization and local presence requirements, and market access and FDI restrictions), as well as examples of extraterritorial censorship and self-censorship.
- China is consistently rated as having one of the highest levels of censorship, across all sectors. In addition, five other key markets (Russia, Turkey, Vietnam, India, and Indonesia) use a wide variety of policies and practices to operationalize censorship and suppress speech and, since 2016, their policies have become more restrictive.
- The report focuses on digital and media services sectors in selected markets, as these are the sectors most impacted by censorship. The broad trend toward online publication and communication in the global media and audiovisual services sectors and the heavy reliance on digital distribution for the cross-border provision of news, information, and audiovisual content imply that foreign censorship of the flow of information over digital platforms is having a significant impact on U.S. digital and media services firms operating in the six key markets and on the digital economy in general.

Working Papers

The Role of "Mode Switching" in Services Trade

Sarah Oliver and Tamar Khachaturian (Office of Industries, Services Division), February 2021

https://usitc.gov/sites/default/files/publications/332/working_papers/id_20_71_wp_the_role_of_mode_switching_in_services_trade_final_022421-compliant.pdf

Since the 1995 General Agreement on Trade in Services (GATS), international trade in services has been categorized into four "modes of supply." This paper uses a detailed sector level cross-border services structural gravity model to shed light on the question of whether mode 3 trade (trade via foreign affiliates) is a complement or substitute for cross-border trade (modes 1, 2 and 4) in 14 services sectors. Due to data limitations, previous work on this topic has been unable to disaggregate services trade data at this level, and as a result has not found a consistent answer to this question. In this paper, we find a negative and significant impact of mode 3 barriers on cross-border trade, suggesting an inter-modal complementary relationship between cross border-trade and foreign affiliate sales. This result holds for majority of the sector-specific estimations. These results suggest that within individual services sectors, firms use multiple modes of supply to provide services to foreign customers. For example, while architecture services can, in principle, be provided entirely via cross-border means by email or travel abroad, architecture firms may nevertheless benefit from commercial presence in foreign markets, since this enables them to interact more effectively with clients and monitor construction progress.

Appendix B
Data Tables for Figures

Table B.1 Real value-added by U.S. industry, 2016–20

This corresponds to figure 1.1. Value in trillions of dollars.

Type of industry	2016	2017	2018	2019	2020
Private goods-producing industries	3,338	3,440	3,553	3,628	3,523
Private services-producing industries	12,127	12,411	12,803	13,142	12,620

Source: USDOC, BEA, "Real Value Added by Industry," Sept 30, 2021.

Note: Estimates are chained 2012 dollars. Private goods-producing industries include agriculture, forestry, fishing, and hunting; mining; construction; and manufacturing. Private service-producing industries include utilities; wholesale trade; retail trade; transportation and warehousing; information; finance, insurance, real estate, rental, and leasing; professional and business services; educational services, health care, and social assistance; arts, entertainment, recreation, accommodation, and food services; and other services, except government.

Table B.2 Global services: Cross-border exports of commercial services, by country, 2020

This corresponds to figure 1.2. Value in billions of dollars (billion $), shares in percent (%).

Country	Billion $	Share of total (%)
United States	684	13.9
United Kingdom	339	6.9
Germany	305	6.2
China	278	5.7
Ireland	262	5.3
France	245	5.0
India	203	4.1
Singapore	187	3.8
Netherlands	186	3.8
Japan	156	3.2
All other countries	2,068	42.1
Total	4,914	100.0

Source: WTO, Statistics Database, Time Series on International Trade, "Trade in Commercial Services." Note: Exports of commercial services exclude public-sector transactions. Due to difficulty measuring and reporting services trade data, total services exports do not equal total services imports. Due to rounding, figures may not add to 100 percent.

Table B.3 Global services: Cross-border imports of commercial services, 2020

This corresponds to figure 1.3. Value in billions of dollars (billion $), shares in percent (%).

Country	Billion $	Share of total (%)
United States	436	9.5
China	378	8.2
Germany	307	6.7
Ireland	296	6.4
France	232	5.0
United Kingdom	201	4.4
Japan	183	4.0
Singapore	172	3.8
Netherlands	169	3.7
India	153	3.3
All other countries	2,070	45.0
Total	4,596	100.0

Source: WTO, Statistics Database, Time Series on International Trade, "Trade in Commercial Services." Note: Imports of commercial services exclude public-sector transactions. Due to difficulty measuring and reporting services trade data, total services exports do not equal total services imports. Due to rounding, figures may not add to 100 percent.

Table B.4 U.S. services: Cross-border exports and imports, 2016–20
This corresponds to figure 1.4. Value in millions of dollars.

Year	U.S. cross-border exports of private services	U.S. cross-border imports of private services
2016	762,167	491,114
2017	813,851	525,125
2018	839,594	540,951
2019	853,842	567,121
2020	684,001	435,748

Source: USDOC, BEA, table 2.1, "U.S. Trade in Services, by Type of Service," July 2, 2021.

Table B.5 U.S. services: Affiliate sales and purchases, 2015–19
This corresponds to figure 1.5. Value in millions of dollars.

Year	Sales by U.S.-owned foreign affiliates	Purchases from foreign-owned U.S. affiliates
2015	1,462,788	957,849
2016	1,476,980	999,362
2017	1,549,858	1,123,825
2018	1,679,254	1,192,047
2019	1,765,329	1,231,592

Source: USDOC, BEA, table 4.1, "Services Supplied to Foreign Persons by U.S. MNEs through Their MOFAs, by Industry and Affiliate and by Country of Affiliate," October 19, 2021; and table 5.1, "Services Supplied to U.S. Persons by Foreign MNEs through Their MOUSA, by Industry of Affiliate and by Country of UBO," October 19, 2021.
Note: MNEs = multinational enterprises; MOFAs = majority-owned foreign affiliates; MOUSAs = majority-owned U.S. affiliates; UBO = ultimate beneficial owner.

Table B.6 U.S. services: Cross-border exports, by category, 2020
This corresponds to figure 1.6. Value in millions of dollars (million $), shares in percent (%).

Type of industry	Million $	Share of total (%)
Professional services	237,543	34.7
Travel services	84,205	12.3
Financial services	164,774	24.1
Digital and electronic services	110,217	16.1
Distribution services	47,099	6.9
All other services	40,163	2.4
Total	684,001	100.0

Source: USDOC, BEA, table 2.1, "U.S. Trade in Services, by Type of Service," July 2, 2021.
Note: Due to rounding, figures may not add to 100 percent.

Table B.7 U.S. services: Cross-border imports, by category, 2020
This corresponds to figure 1.7. Value in millions of dollars (million $), shares in percent (%).

Type of industry	Million $	Share of total (%)
Professional services	146,102	33.5
Travel services	48,839	11.2
Financial services	97,873	22.5
Digital and electronic services	71,344	16.4
Distribution services	61,836	14.2
All other services	9,754	1.1
Total	435,748	100.0

Source: USDOC, BEA, table 2.1, "U.S. Trade in Services, by Type of Service," July 2, 2021.
Note: Due to rounding, figures may not add to 100 percent.

Table B.8 U.S. services: Cross-border exports, by country, 2020 (percent)
This corresponds to figure 1.8. Value in millions of dollars (million $), shares in percent (%).

Country	Million $	Share of total (%)
United Kingdom	62,691	9.2
Ireland	61,935	9.1
Canada	53,241	7.8
UK Islands	44,498	6.5
Switzerland	41,970	6.1
China	40,394	5.9
Japan	37,817	5.5
Germany	29,594	4.3
Singapore	24,520	3.6
All other countries	287,341	42.0
Total	684,001	100.0

Source: USDOC, BEA, table 2.2, "U.S. Trade in Services, by Type of Service and by Country or Affiliation," July 2, 2021.
Note: The BEA category "United Kingdom Islands (Caribbean)" includes the following four U.K. overseas territories: the British Virgin Islands, the Cayman Islands, Montserrat, and the Turks and Caicos Islands. Due to rounding, figures may not add to 100 percent.

Table B.9 U.S. services: Cross-border imports, by country, 2020
This corresponds to figure 1.9. Value in millions of dollars (million $), shares in percent (%).

Country	Million $	Share of total (%)
United Kingdom	51,717	11.9
Japan	30,855	7.1
Bermuda	29,163	6.7
Canada	29,049	6.7
Germany	27,475	6.3
India	25,880	5.9
Switzerland	24,681	5.7
Ireland	18,876	4.3
Mexico	17,083	3.9
China	15,610	3.6
All other countries	165,359	37.9
Total	435,748	100.0

Source: USDOC, BEA, table 2.2, "U.S. Trade in Services, by Type of Service and by Country or Affiliation," July 2, 2021.
Note: Due to rounding, figures may not add to 100 percent.

Table B.10 U.S. services: Affiliate sales by U.S.-owned foreign affiliates, by industry, 2019
This corresponds to figure 1.10. Value in billions of dollars (million $), shares in percent (%).

Type of industry	Billion $	Share of total (%)
Distribution services	482.7	27.3
Digital and electronic services	421.1	23.9
Financial services	328.5	18.6
Professional services	89.9	5.1
Mining	38.9	2.2
Manufacturing	33.8	1.9
All other services	370.5	21.0
Total	1,765.3	100.0

Source: USDOC, BEA, table 4.1, "Services Supplied to Foreign Persons by U.S. MNEs through Their MOFAs, by Industry of Affiliate and by Country of Affiliate," October 19, 2021.
Note: "Manufacturing" includes ancillary services provided by goods manufacturers. "Other services" include goods and services supplied by majority-owned foreign affiliates of U.S. parent firms. MNEs = multinational enterprises; MOFAs = majority-owned foreign affiliates. Due to rounding, figures may not add to 100 percent.

Table B.11 U.S. services: Purchases from foreign-owned U.S. affiliates

This corresponds to figure 1.11. Value in billions of dollars (million $), shares in percent (%).

Type of industry	Billion $	Share of total (%)
Distribution services	355.9	28.9
Financial services	222.9	18.1
Digital and electronic services	196.4	15.9
Professional services	130.1	10.6
Manufacturing	95.0	7.7
Mining	42.7	3.5
All other services	188.7	15.3
Total	1,231.6	100.0

Source: USDOC, BEA, table 5.1, “Services Supplied to U.S. Persons by Foreign MNEs though Their MOUSAs, by Industry of Affiliate and by Country of UBO,” October 19, 2021.

Notes: “Manufacturing” includes ancillary services provided by goods manufacturers. “Other” includes ancillary services provided in the mining, agriculture, and other sectors, as well as suppressed data. MNEs = multinational enterprises; MOUSAs = majority-owned U.S. affiliates; UBO = ultimate beneficial owner. Beginning with the 2018 *Recent Trends in U.S. Services Trade* report, software publishing was reallocated from “Other Services” to “Digital and electronic Services” to better reflect the industry composition. Therefore, digital and electronic services data in this report and the 2018 report cannot be directly compared with such data in USITC reports published before 2018. Due to rounding, figures may not add to 100 percent.

Table B.12 Digital and electronic services: U.S. cross-border exports, by country, 2020

This corresponds to figure 2.1. Value in millions of dollars (million $), shares in percent (%).

Country	Million $	Share of total (%)
United Kingdom	11,487	10.4
Canada	10,301	9.3
Ireland	9,886	9.0
Japan	7,474	6.8
Germany	6,049	5.5
Switzerland	4,532	4.1
China	4,266	3.9
Australia	4,099	3.7
France	3,090	2.8
Mexico	2,906	2.6
All other countries	46,127	41.9
Total	110,217	100.0

Source: USDOC, BEA, table 2.2, “U.S. Trade in Services, by Type of Service and by Country or Affiliation,” July 2, 2021.

Note: Digital and electronic services include audiovisual, computer, information, and telecommunications services and computer software. Due to rounding, figures may not add to 100 percent.

Table B.13 Digital and electronic services: U.S. cross-border imports, by country, 2020
This corresponds to figure 2.2. Value in millions of dollars (million $), shares in percent (%).

Country	Million $	Share of total (%)
India	12,768	17.9
Canada	8,334	11.7
United Kingdom	6,745	9.5
Ireland	6,180	8.7
Japan	2,705	3.8
Netherlands	2,364	3.3
Germany	1,500	2.1
Mexico	1,132	1.6
France	908	1.3
South Korea	718	1.0
All other countries	27,990	39.2
Total	71,344	100.0

Source: USDOC, BEA, table 2.2, "U.S. Trade in Services, by Type of Service and by Country or Affiliation," July 2, 2021.
Note: Digital and electronic services include audiovisual, computer, information, and telecommunications services and computer software. Due to rounding, figures may not add to 100 percent.

Table B.14 Digital and electronic services: U.S. cross-border exports, by industry, 2020
This corresponds to figure 2.3. Value in millions of dollars (million $), shares in percent (%).

Type of industry	Million $	Share of total (%)
Telecommunications services	7,680	7.0
Computer services	15,118	13.7
Computer software	66,341	60.2
Information services	6,865	6.2
Audiovisual services	14,213	12.9
Total	110,217	100.0

Source: USDOC, BEA, table 2.1, "U.S. Trade in Services, by Type of Service," July 2, 2021.
Note: Due to rounding, figures may not add to 100 percent.

Table B.15 Digital and electronic services: U.S. cross-border imports, by industry, 2020
This corresponds to figure 2.4. Value in millions of dollars (million $), shares in percent (%).

Type of industry	Million $	Share of total (%)
Telecommunications services	4,659	6.5
Computer services	19,044	26.7
Computer software	24,493	34.3
Information services	3,006	4.2
Audiovisual services	20,142	28.2
Total	71,344	100.0

Source: USDOC, BEA, table 2.1, "U.S. Trade in Services, by Type of Service," July 2, 2021. Note: Due to rounding, figures may not add to 100 percent.

Table B.16 Digital and electronic services: Sales by U.S.-owned foreign affiliates, by industry, 2019
This corresponds to figure 2.5. Value in millions of dollars (million $), shares in percent (%).

Type of industry	Million $	Share of total (%)
Computer systems design and related services	127,180	30.2
Software publishers	77,834	18.5
Telecommunications services	28,186	6.7
Motion picture and video industries	14,283	3.4
All other	173,583	41.2
Total	421,066	100.0

Source: USDOC, BEA, table 5.12, "Services Supplied to U.S. Persons by Foreign MNEs through Their MOUSAs, by Industry of Affiliate and by Country of UBO," October 19, 2021.
Note: Data were suppressed for Motion picture and sound recording industries, Broadcasting, Data processing, hosting, and related services, and other information services. MNEs = multinational enterprises; MOUSAs = majority-owned U.S. affiliates; UBO = ultimate beneficial owner. Due to rounding, figures may not add to 100 percent.

Table B.17 Digital and electronic services: Purchases from foreign-owned U.S. affiliates, 2019
This corresponds to figure 2.6. Value in millions of dollars (million $), shares in percent (%).

Type of industry	Million $	Share of total (%)
Telecommunications services	89,569	45.6
Computer systems design and related services	36,642	18.7
Motion picture and sound recording industries	19,938	10.2
Software publishing	10,611	5.4
Data processing, hosting, and related services	3,293	1.7
All other	36,315	18.5
Total	196,368	100

Source: USDOC, BEA, table 5.12, "Services Supplied to U.S. Persons by Foreign MNEs through Their MOUSAs, by Industry of Affiliate and by Country of UBO," October 19, 2021.
Note: Data were suppressed for Motion picture and sound recording industries, Broadcasting, and Other information services. MNEs = multinational enterprises; MOUSAs = majority-owned U.S. affiliates; UBO = ultimate beneficial owner. Due to rounding, figures may not add to 100 percent.

Table B.18 Previous and current presentation structure for audiovisual and computer services trade data

This corresponds to figures 2.7 and 2.8. n.i.e = not included elsewhere.

Version	Structure
Previous structure for audiovisual services	Charges for the use of intellectual property n.i.e Audiovisual and related products Movies and television programming Books and sounds recordings Broadcast and recordings of live events
Current structure for audiovisual services	Charges for the use of intellectual property n.i.e. Licenses to reproduce and/or distribute audiovisual products Movies and television programming Books and sounds recordings Broadcast and recordings of live events Personal, cultural, and recreational services Audiovisual services Audiovisual production services Rights to use audiovisual products Movies and television programming Books and sound recordings Audiovisual originals Movies and television programming Books and sound recordings
Previous structure for computer services	Charges for the use of intellectual property n.i.e. Computer software Telecommunications, computer, and information services Computer services
Current structure for computer services	Charges for the use of intellectual property n.i.e. Licenses to reproduce and/or distribute computer software Telecommunications, information, and computer services Computer services Computer software, including end-user licenses and customization Cloud computing and data storage services

Source: USDOC, BEA, “Annual Update of the U.S. International Transactions Accounts,” July 2020.

Table B.19 Audiovisual services: Cross-border exports and imports, 2016–20

This corresponds to figure 2.9. Value in millions of dollars.

Year	U.S. cross-border exports	U.S. cross-border imports
2016	19,025	9,368
2017	21,500	14,328
2018	19,160	16,015
2019	17,871	17,408
2020	14,213	20,142

Source: USDOC, BEA, table 2.1, "U.S. Trade in Services, by Type of Service," July 2, 2021.

Table B.20 Audiovisual services: Affiliate sales and purchases, 2015–19

This corresponds to figure 2.10. Value in millions of dollars.

Year	Services supplied by U.S. firms' foreign affiliates	Services supplied by U.S. affiliates of foreign firms
2015	10,051	5,425
2016	10,075	5,274
2017	13,354	5,587
2018	13,831	18,970
2019	14,283	19,938

Source: USDOC, BEA, table 4.1, "Services Supplied to Foreign Persons by U.S. MNEs through Their MOFAs, by Industry of Affiliate and by Country of Affiliate," October 19, 2021; USDOC, BEA, table 5.12, "Services Supplied to U.S. Persons by Foreign MNEs through Their MOUSAs, by Industry of Affiliate and by Country of UBO," October 19, 2021.

Note: Audiovisual services includes motion picture and sound recording industries. Data for 2017–19 were suppressed to avoid the disclosure of confidential information of business enterprises. MNEs = multinational enterprises; MOFAs = majority-owned foreign affiliates; MOUSAs = majority-owned U.S. affiliates; UBO = ultimate beneficial owner.

Table B.21 Computer services: Cross-border exports and imports, 2016–20

This corresponds to figure 2.11. Value in millions of dollars.

Year	U.S. cross-border exports	U.S. cross-border imports
2016	8,730	19,884
2017	9,881	21,316
2018	10,568	21,657
2019	12,391	23,618
2020	15,118	19,044

Source: USDOC, BEA, table 2.1, "U.S. Trade in Services, by Type of Service," July 2, 2021.

Note: Computer services include Cloud computing and data storage services and other computer services.

Table B.22 Computer services: Affiliate sales and purchases, 2015–19

This corresponds to figure 2.12. Value in millions of dollars.

Year	Services supplied by U.S. firms' foreign affiliates	Services supplied by U.S. affiliates of foreign firms
2015	115,738	31,296
2016	124,150	35,193
2017	133,925	41,519
2018	123,517	45,210
2019	127,180	39,935

Source: USDOC, BEA, table 4.1, “Services Supplied to Foreign Persons by U.S. MNEs through Their MOFAs, by Industry of Affiliate and by Country of Affiliate,” October 19, 2021; USDOC, BEA, table 5.12, “Services Supplied to U.S. Persons by Foreign MNEs through Their MOUSAs, by Industry of Affiliate and by Country of UBO,” October 19, 2021.

Note: Computer services includes data processing, hosting, and related services and computer system design and related services. MNEs = multinational enterprises; MOFAs = majority-owned foreign affiliates; MOUSAs = majority-owned U.S. affiliates; UBO = ultimate beneficial owner. Data for affiliate sales in 2019 is under reported due to the data for data processing, hosting, and related services is suppressed.

Table B.23 Telecommunications services: Cross-border exports and imports, 2016–20

This corresponds to figure 2.13. Value in millions of dollars.

Year	U.S. cross-border exports	U.S. cross-border imports
2016	11,446	5,800
2017	10,220	5,766
2018	8,998	5,686
2019	7,999	5,007
2020	7,680	4,659

Source: USDOC, BEA, table 2.1, “U.S. Trade in Services, by Type of Service,” July 2, 2021.

Table B.24 Telecommunications services: Affiliate sales and purchases, 2015–20

This corresponds to figure 2.14. Value in millions of dollars.

Year	Services supplied by U.S. firms' foreign affiliates	Services supplied by U.S. affiliates of foreign firms
2015	32,177	76,939
2016	31,746	81,777
2017	30,833	85,159
2018	32,831	86,033
2019	28,186	89,569

Source: USDOC, BEA, table 4.1, “Services Supplied to Foreign Persons by U.S. MNEs through Their MOFAs, by Industry of Affiliate and by Country of Affiliate,” October 19, 2021; USDOC, BEA, table 5.12, “Services Supplied to U.S. Persons by Foreign MNEs through Their MOUSAs, by Industry of Affiliate and by Country of UBO,” October 19, 2021.

Note: Includes Telecommunications and Broadcasting services. However, the data for broadcasting were suppressed for all periods for sales as well as for 2016–19 for purchases. MNEs = multinational enterprises; MOFAs = majority-owned foreign affiliates; MOUSAs = majority-owned U.S. affiliates; UBO = ultimate beneficial owner.

Table B.25 U.S. SVOD companies: Total global subscribers, by firm, 2021
This corresponds to figure 3.1. In millions of subscribers.

Year	Subscribers (millions)
Netflix	215
Amazon Prime Video	175
Disney+ (including Hotstar)	118
HBO Max	69
NBC Universal Peacock	54
Viacom	47
Apple TV+	40
Hulu	37

Sources: Sherman, "Disney Makes the Trend Clear," November 10, 2021; Apple+ estimate, Statista, "Estimated Users of Apple TV Plus in the U.S. 2020," accessed December 16, 2021.

Table B.26 SVOD revenue, by market, 2020
This corresponds to figure 3.2. In billions of dollars (billion $).

Country	Billion $
United States	29.6
China	7.2
United Kingdom	2.9
Germany	2.2
France	1.9
Other	18.8

Source: Statista, Subscription Video on Demand (SVOD) Revenue in Selected Countries Worldwide from 2019 to 2025, November 12, 2021.

Table B.27 Cloud computing sales, by top U.S. cloud infrastructure providers, by quarter, June 2019 through August 2021
This corresponds to figure 4.1. In billions of dollars.

Year	Quarter	Amazon	Microsoft	Google
2019	Q3	8.995	10.845	6.428
2019	Q4	35.026	11.869	17.014
2020	Q1	10.219	12.281	4.435
2020	Q2	10.808	48.366	8.131
2020	Q3	11.601	12.986	5.478
2020	Q4	45.370	14.601	34.77
2021	Q1	13.503	15.118	10.541
2021	Q2	14.809	60.080	11.251
2021	Q3	16.110	16.964	11.744

Source: Data from quarterly reports for Amazon, Google, and Microsoft, downloaded from Bureau van Dijk, Orbis Database, accessed December 8, 2021.
Note: Sales for Amazon are the business line "Amazon Web Services," for Google the business line is "Google Cloud," and for Microsoft the business line is "Intelligent Cloud."