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The Evolution of Taiwan's Trade Linkages With the U.S. and Global Economies

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Economic, trade, innovation, and global value chain (GVC) linkages between the United States and Taiwan are vitally important to both nations' advanced technology industries and broader economies. Policymakers should work to deepen them.

KEY TAKEAWAYS

- In sectors from semiconductors and electrical vehicles to pharmaceuticals, Taiwanese suppliers play key roles in helping make the business models of U.S. advanced-technology enterprises, like fabless semiconductors, tenable.
- The United States has deeper inter-industry trade linkages with Taiwan than virtually any other East Asian trade partner. Taiwan supplies more exports for U.S. GVCs than Indonesia, the Philippines, and Thailand combined.
- Seventy percent of Taiwan's GDP relies on exports, which makes it the seventh-most trade-dependent economy participating in global value chains.
- The United States should move beyond the Trade & Investment Framework Agreement (TIFA) with Taiwan and pursue a comprehensive free trade agreement that would produce economic and employment benefits for both nations.
- The United States should join the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP) and in doing so bring along both South Korea and Taiwan.
- The United States and Taiwan should build on the Economic Prosperity Partnership Dialogue (EPPD) by launching an innovation experts' working group to deepen collaboration in AI, IoT, semiconductors, and biotechnology, among other fields.

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INTRODUCTION

Economic, trade, innovation, and supply chain linkages between the United States and Taiwan are vitally important to the health of both nations' advanced technology industries, enterprises, and broader economies. Taiwanese companies represent key suppliers to many "Tier 1" U.S. original equipment manufacturing (OEM) firms, meaning that the success of those U.S. OEMs, particularly in the information and communications technology (ICT) industry, depends on the vibrancy and innovation capacity of key Taiwanese suppliers. Especially in the semiconductor, related ICT, and electric vehicle (EV) industries, Taiwanese enterprises have become vital players in global supply chains for the manufacture of sophisticated advanced-technology products. Building off the Information Technology and Innovation Foundation's (ITIF) prior report "Global Trade Interdependence: U.S. Trade Linkages With Korea, Mexico, and Taiwan," this report examines the continually evolving Taiwanese trade, economic, innovation, and supply chain linkages with the United States and other global economies.[1] The report further examines how countries are implementing strategies to promote reshoring and supply chain resiliency, and provides policy recommendations on a variety of issues such as how to advance supply chain resiliency, foster greater levels of technology and innovation collaboration and cooperation, and more broadly deepen trade and economic linkages between both Taiwan and the United States and Taiwan and the broader global innovation economy.

TAIWAN-U.S. TRADE AND ECONOMIC LINKAGES

The Taiwan-U.S. trade relationship is highly complementary, interdependent, and increasingly characterized by trade in advanced-technology industries. Taiwan has become America's 10th-largest goods trading partner and 13th-largest goods export destination, with U.S. goods and services trade with Taiwan totaling $103.9 billion in 2019.[2] In fact, the United States now trades more with Taiwan than it does with France, India, or Italy.[3] In 2019, the United States exported $42.3 billion worth of goods and services to Taiwan, while importing $61.6 billion, producing a trade deficit of $19.3 billion. Conversely, the United States represents Taiwan's second-largest trading partner, accounting for 13.2 percent of Taiwan's total trade and receiving about one-third of Taiwan's exports of ICT goods. Foreign direct investment (FDI) also represents an important facet of the relationship, with the total stock of FDI from Taiwanese companies in the United States at $47 billion, per the latest data available from the American Institute in Taiwan at the end 2019. Taiwanese companies currently operating in the United States support 19,100 U.S. jobs, invest almost $159 million annually in research and development (R&D), and contribute $1.6 billion to U.S. goods exports.[4] Despite the fact that global FDI flows fell 49 percent worldwide in the first half of 2020 compared with 2019, Taiwan actually remained a quite attractive location for investment, attracting 1,220 FDI projects worth a total value of $2.96 billion from January to April 2020, which represents an increase of 8.9 percent in the number of cases and 48.7 percent in FDI value compared with the same period in 2019.[5]

In 2020, chip maker Taiwan Semiconductor Manufacturing Company (TSMC) announced it would invest up to $12 billion to build a new 5 nanometer (nm) capable foundry near Phoenix, Arizona, and in May 2021, TSMC officials confirmed that they were considering doubling the company's initially planned investment by constructing a $25 billion second factory capable of building 3 nm chips.[6] (TSMC indicated that it may build as many as seven total facilities in Arizona.)[7] Importantly, TSMC will also be bringing its own key suppliers, with as many as 12 TSMC suppliers indicating that they will also open facilities in the United States. For instance,

LCY Chemical, one of the world's biggest producers of chemicals for semiconductor plants (producing isopropyl alcohol, which is essential for cleaning wafers and equipment in the chip manufacturing process) announced in February 2021 it would build a new chemical-purifying factory in Arizona that will represent its largest-ever overseas investment.[8] These investments are helping deepen U.S. supply chains in the critical semiconductor industry. This type of FDI also explains why, once again, Taiwan sent the largest delegation to the June 2021 Select USA Summit (America's annual FDI attraction conference), with 220 delegates representing 153 companies from across Taiwan.[9]

The percentage of Taiwan's exports feeding into the U.S. global supply chain is greater than those of Indonesia, the Philippines, and Thailand combined.

However, as the Congressional Research Service (CRS) has written, "U.S. data on trade with Taiwan may understate the importance of Taiwan to the U.S. economy because of the role of global supply chains."[10] For instance, 86 percent of Taiwan's exports to the United States comprise intermediate goods, such as semifinished products, parts, and capital goods U.S. companies use to make final products in the United States.[11] Indeed, Taiwanese inputs play a critical role in U.S.-manufactured final products in a wide range of industries, and not just for ICT goods but also others including medical devices and pharmaceuticals, automobiles (especially EVs), heavy machinery, and transportation equipment.[12] In fact, the United States has deeper inter-industry trade linkages with Taiwan than with almost any other East Asian trade partner, with the percentage of Taiwan's exports feeding into the U.S. global supply chain greater than those of Indonesia, the Philippines, and Thailand combined.[13]

As noted previously, Taiwan ran a slight trade surplus with the United States in 2019 of $19.3 billion. This represents a slight fraction of the U.S. global trade deficit and is in many ways far outweighed by the value Taiwanese exports produce in the U.S. economy. On a trade-in value added (TiVA) basis in 2020 for six high-tech industries—automobiles, chemicals, computers and electronics, machinery, pharmaceuticals, and other transportation (including aerospace)—Taiwan ran a trade surplus of more than $17 billion, including $8.9 billion in computers and electronics and $8.4 billion in machinery. Conversely, the United States ran a trade surplus in value-added terms in the automobiles, chemicals, pharmaceuticals, and other transportation sectors. (See table 1.) However, as noted earlier, it's vital to recognize that the value produced by America's Taiwanese suppliers—especially in ICT-based sectors such as semiconductors—far outstrip any minor sector-specific trade deficits, as evidenced alone by the fact that a global shortfall in semiconductor production (which would have been far worse in the absence of Taiwanese production) may cause a 1.28 million-vehicle shortfall in U.S. automotive production in 2021 at a cost of $110 billion.[14] In short, U.S.-Taiwan trade flows overall are mutually productive and beneficial to both nations.

Table 1: U.S. trade with Taiwan, select industries, 2018–2020 (millions)[15]

Taiwan	Value Added of Exports to the United States			Value Added of Imports From the United States			Taiwan-U.S. Trade Balance		
Industry	**2018**	**2019**	**2020**	**2018**	**2019**	**2020**	**2018**	**2019**	**2020**
Total	$39,610	$46,351	$50,828	$33,456	$35,151	$33,025	$6,153	$11,200	$17,803
Machinery	$9,117	$13,125	$15,075	$5,860	$6,994	$6,691	$3,257	$6,131	$8,384
Computers & Electronics	$10,488	$12,594	$14,316	$5,151	$5,023	$5,382	$5,337	$7,571	$8,934
Automobiles	$3,063	$3,213	$3,218	$4,202	$5,255	$3,578	-$1,139	-$2,042	-$360
Chemicals	$960	$753	$832	$1,350	$1,095	$1,184	-$390	-$342	-$352
Pharmaceuticals	$138	$186	$214	$298	$284	$288	-$160	-$99	-$74
Other Transportation (Including Aerospace)	$372	$362	$310	$329	$326	$319	$44	$37	-$9

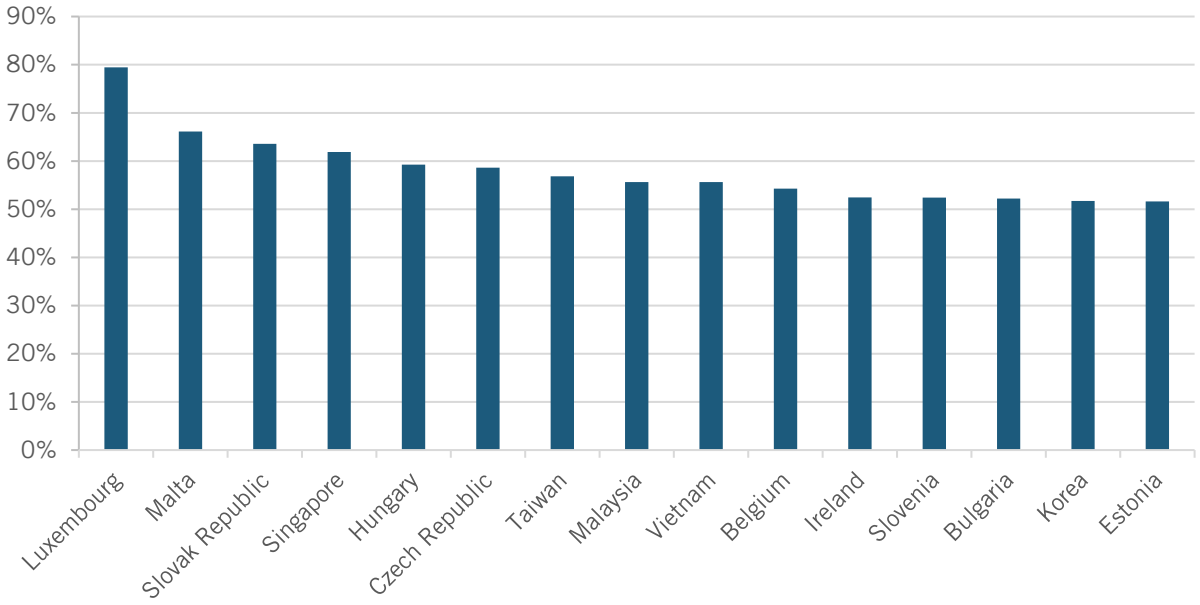
TAIWAN-GLOBAL TRADE AND ECONOMIC LINKAGES

Taiwan represents a key link in global supply chains for the production of advanced-technology goods. Taiwan's strength in these value chains is a reflection of the country's decision, made as early as the 1950s, to adapt its economic development strategy, shelving the then-fashionable import substitution industrialization strategy of the day for a focus on exports and integration into global markets.[16] Manufacturing today accounts for just under 30 percent of Taiwan's gross domestic product (GDP) and a roughly equivalent share of job creation. However, when downstream effects are considered (i.e., the economic and employment multiplier effects of Taiwan's manufacturing and export sectors), the U.S. Congressional Research Service found that Taiwan's economy is highly export dependent, with exports accounting for almost 70 percent of the country's GDP.[17]

Taiwan is heavily dependent on global trade, with 70 percent of its GDP relying on exports and ranking as the seventh-most dependent economy in participation in global value chains.

In fact, Taiwan ranks among the world's most global value chain (GVC)-dependent countries, ranking seventh in terms of Organization for Economic Cooperation and Development (OECD) countries' GVC participation rates as a share of total exports (which is slightly down from being the second-most GVC-dependent country for exports in 2013).[18] (See figure 1.) Taiwan mainly exports semifinished products, with finished products accounting for only a relatively small share of Taiwan's total exports.[19]

Figure 1: Countries' global value chain participation rate, as share of total exports (2018)[20]



Taiwan's position within the global trade system continues to evolve. Its share of total global trade has fallen over the first two decades of this century, and its share of exports accounted for 2.3 percent of the global total in 2000, which declined to represent 1.8 percent of the global total in 2019 (as its global export ranking fell from 14th to 17th). Likewise, Taiwan's share of total global imports fell from 2.1 to 1.5 percent over that time period (as its global import ranking fell from 15th to 17th place). Factors broadly accounting for these decreases include the difficulty Taiwan has experienced in completing free trade agreements (FTAs) with other nations and, as a trade-oriented economy with a small domestic market, being more exposed to recent systemic global economic shocks, such as the Great Recession and COVID-19 pandemic.

Table 2: Taiwan's evolving position within world trade[21]

	2000	2005	2010	2015	2019
Taiwan's Exports (Billions)	$148	$198	$275	$285	$331
Taiwan's Share of Total Global Exports (%)	2.3	1.9	1.8	1.7	1.8
Taiwan's Export Ranking	14	16	16	17	17
Taiwan's Imports (Billions)	$140	$183	$251	$238	$287
Taiwan's Share of Total Global Imports (%)	2.1	1.7	1.6	1.4	1.5
Taiwan's Import Ranking	15	16	17	18	17

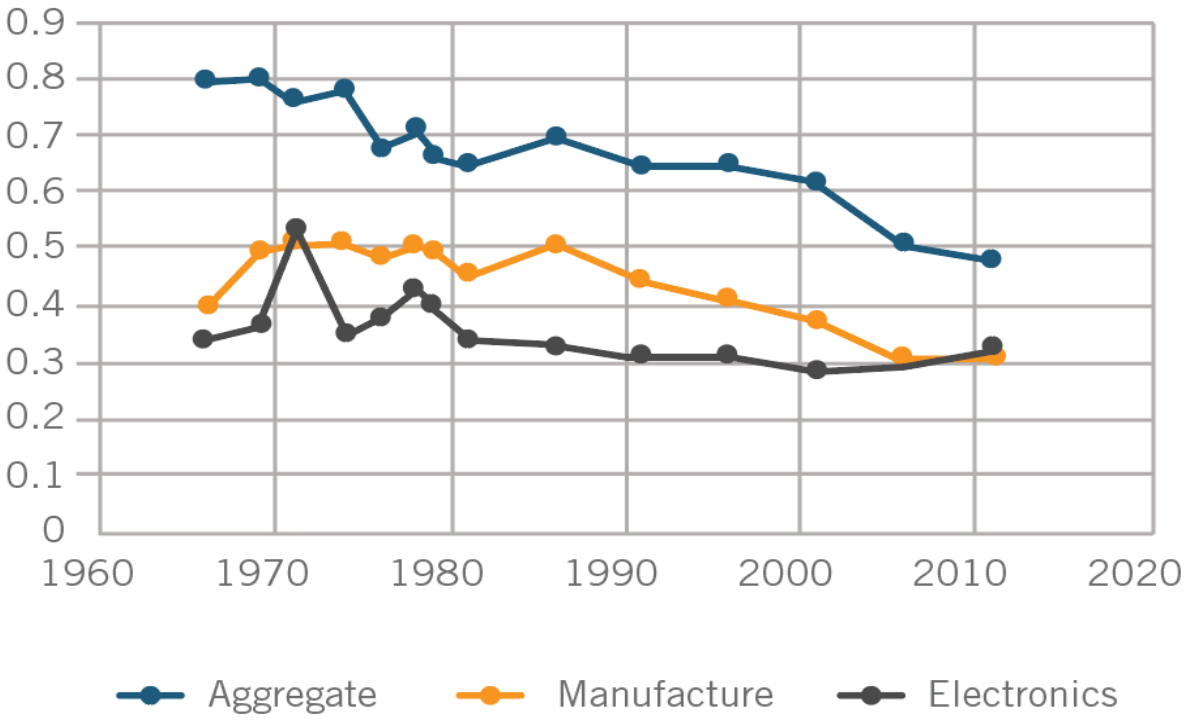
From 2005 to 2015, Taiwan's real manufacturing value added increased from $105 billion to $163 billion, as its share of world manufacturing value added stayed roughly consistent, slipping only from 1.30 to 1.24 percent. (See table 3.) By contrast, the U.S. share of world manufacturing value added fell by almost a quarter between 2005 and 2015, from 21.0 to 16.8 percent; and Japan's was nearly halved, shrinking from 12.6 percent to 6.9 percent, while China's share increased nearly threefold, from 9 to 24.5 percent.

Table 3: Manufacturing output among select nations[22]

	Real Manufacturers' Value Added (in Millions of US$)			Share of World Manufacturing Value Added		
	2005	**2010**	**2015**	**2005**	**2010**	**2015**
China	738,696	1,980,291	3,224,340	9.03%	17.67%	24.53%
Germany	636,467	733,238	794766	7.78%	6.54%	6.05%
India	74,812	167,026	181,466	1.84%	1.49%	1.38%
Indonesia	150,385	289,083	359,069	0.91%	2.58%	2.73%
Japan	1,031,548	1,190,979	911,209	12.61%	10.62%	6.93%
Korea	255,867	329,018	416,290	3.13%	2.93%	3.17%
Taiwan	105,951	126,077	163,210	1.30%	1.12%	1.24%
United States	1,719,671	1,840,720	2,202,461	21.02%	16.42%	16.75%

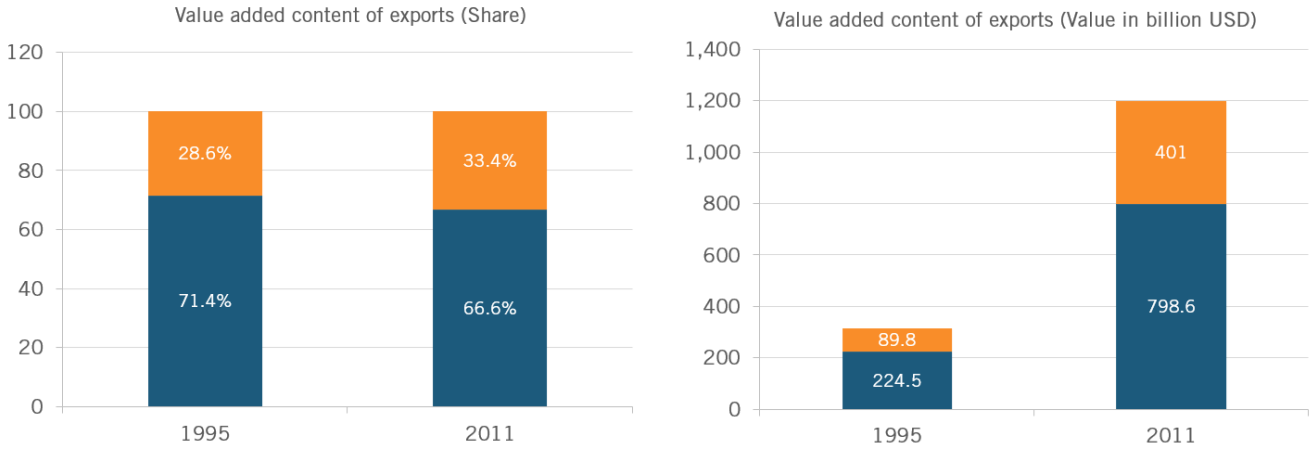
The domestic value added of Taiwan's exports has fallen over time. In fact, whereas the domestic content in Taiwan's exports peaked in 1969 at 79 percent, domestic content fell to 48 percent by 2011 (a 30 percentage-point decline, a period during which the world average ratio of domestic value added declined by about 10 percentage points).[23] (See figure 2.) However, this is not an unfortunate story, as it illustrates Taiwan effectively integrating into GVCs. In its report, "Technological Innovation, Supply Chain Trade, and Workers in a Globalized World," the World Trade Organization (WTO) wrote, "Given the growth of international production fragmentation, along with Chinese Taipei's steady trade liberalization, it is expected that the ratio of domestic content to exports would see a sharp decline. As a strategy for the developing regions to integrate into the world economy, joining global production is one of the shortcuts."[24]

Figure 2: Domestic value added of Taiwan's exports, 1965–2010[25]



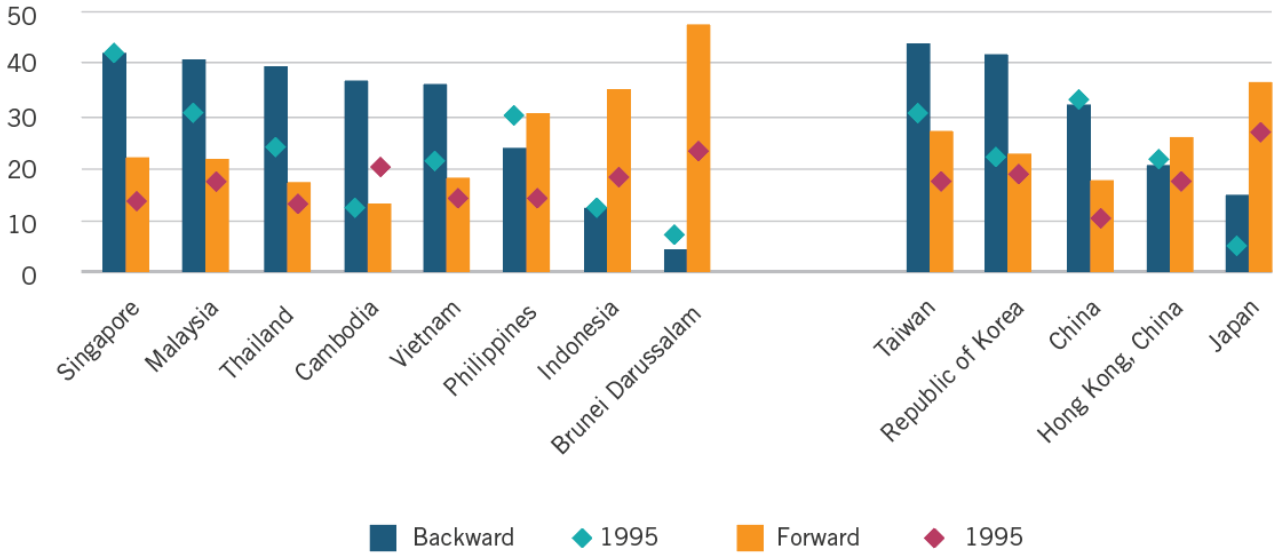
Across Association of Southeast Asian Nations (ASEAN) countries from 1995 to 2011, the domestic value-added share of exports fell from 71 to 67 percent; however, the region's absolute exports grew nearly fourfold, with "much of this increase attributed to an increase in intermediate exports (i.e., exports related to global value chains)." (See figure 3.) Lopez-Gonzalez concluded that the foreign value added, in the form of intermediate imports as well as services, has played a significantly positive role in enhancing both employment and productivity (value added per worker) in the ASEAN countries.[26]

Figure 3: Value added content of ASEAN exports, 1995 and 2011[27]



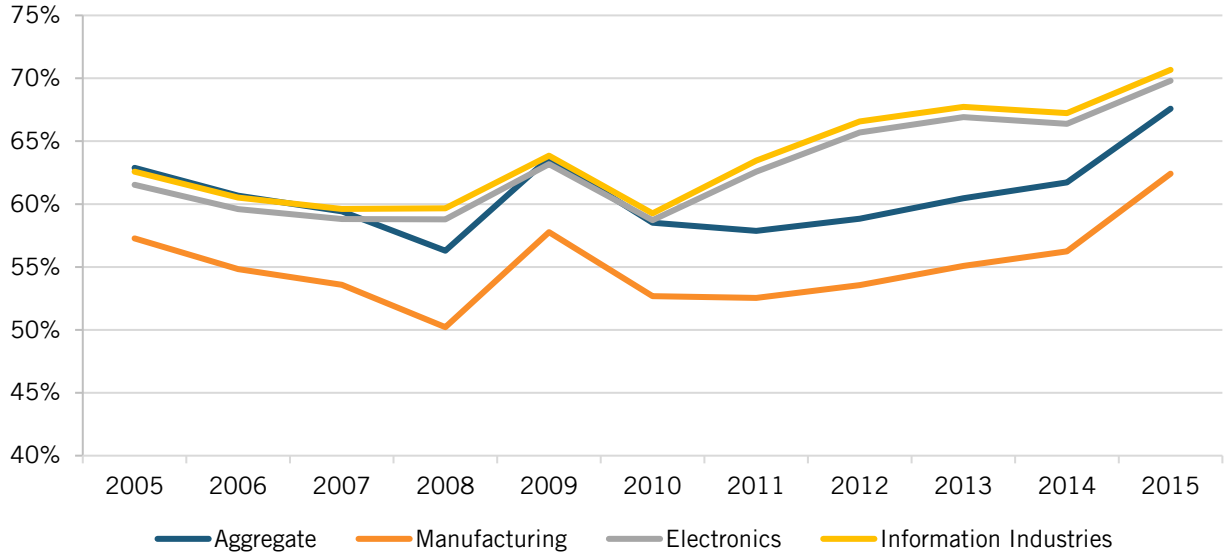
This matters because Taiwan has been among the most-effective nations at integrating itself into GVCs, in terms of both backward and forward linkages. (Backward linkages refer to the use of imported goods and services in the production of exports, while forward linkages refers to the use of a country's exports in the production of other goods and services.) By 2011, Taiwan had achieved the deepest backward GVC trade linkages among any ASEAN country, and achieved some of the strongest forward trade linkages, which have undoubtedly deepened in the decade since, given the country's increasing strength in semiconductor exports, which have become a critical input to a wide variety of downstream industries. (See figure 4.)

Figure 4: Selected ASEAN nations' GVC participation in factory Asia, 1995–2011[28]



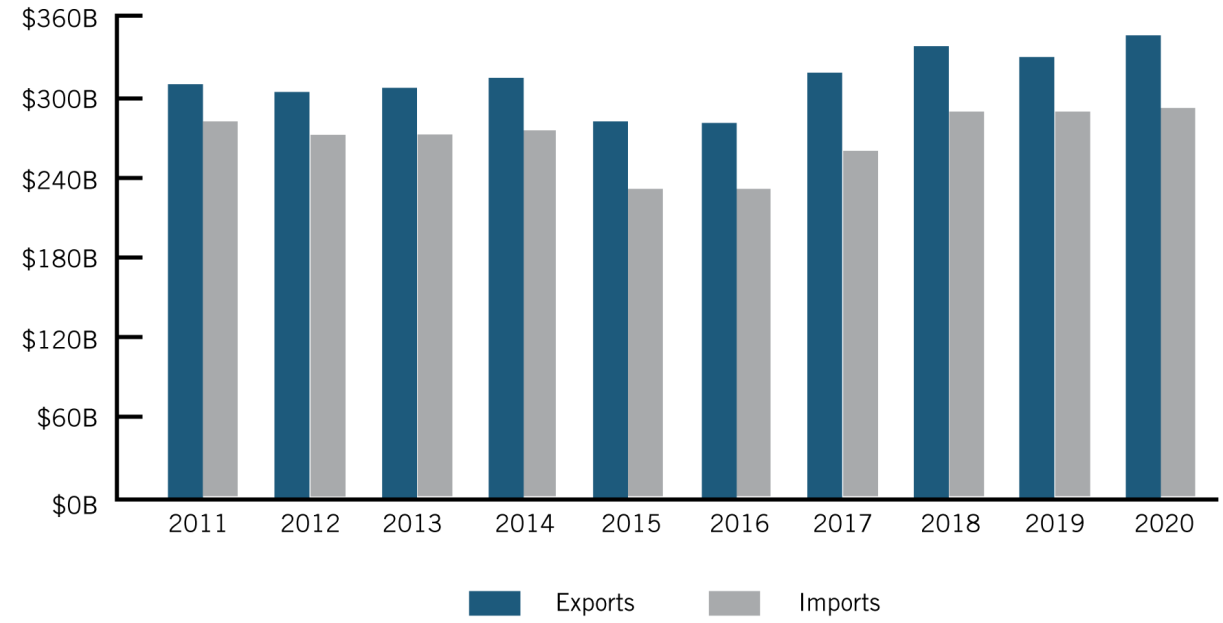
Moreover, updating this data to 2015 shows that Taiwan's domestic value added in manufacturing, electronics, and information industries began to rise considerably over the last half of the prior decade. Starting in 2010, the domestic value added produced in Taiwanese electronics and information industries, and even across its broader manufacturing economy, rose approximately 10 percentage points. By 2015, Taiwanese domestic value added accounted for about 70 percent of the value of Taiwan's gross exports from both the electronics and information industry sectors, and about 62 percent of all manufactured exports. (See figure 5.)

Figure 5: Share of domestic value added in Taiwanese gross exports, 2005–2015[29]



Taiwan has consistently run positive in terms of trade in the global economy over the past decade; and in 2020, its total exports of approximately $350 billion outstripped its $300 billion imports by approximately $50 billion. (See figure 6.)

Figure 6: Taiwan total foreign trade, 2011–2020[30]



Over the past two decades, and notably since China joined the WTO in December 2001, China has come to play a greater role in Taiwan's trade flows. In 2001, the share of Taiwanese exports flowing to China and the United States were almost identical (25.8 and 22.6 percent, respectively), but since then, the share of Taiwan's exports going to China have increased by 18.1 percentage points (to 43.9 percent), while those going to the United States have fallen to 14.6 percent. (See figure 7.) Likewise, China has supplanted Japan as the leading source of

Taiwanese imports, with Japan's share falling from 24 to 16 percent, while China's share increased threefold from 7.2 percent to 22.7 percent. Likewise, the U.S. share of Taiwan's imports fell from 17 to 11.5 percent over this time period. (See figure 8.)

Figure 7: Share of Taiwan's total exports deriving from selected partners, 2001–2020[31]

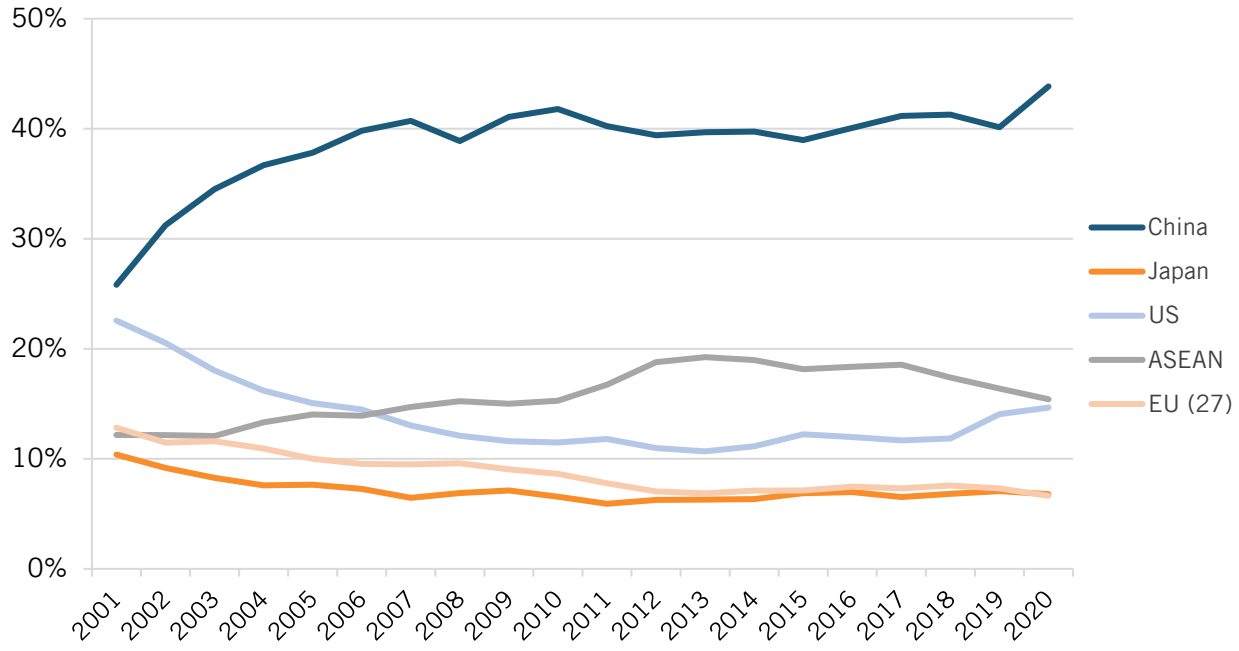
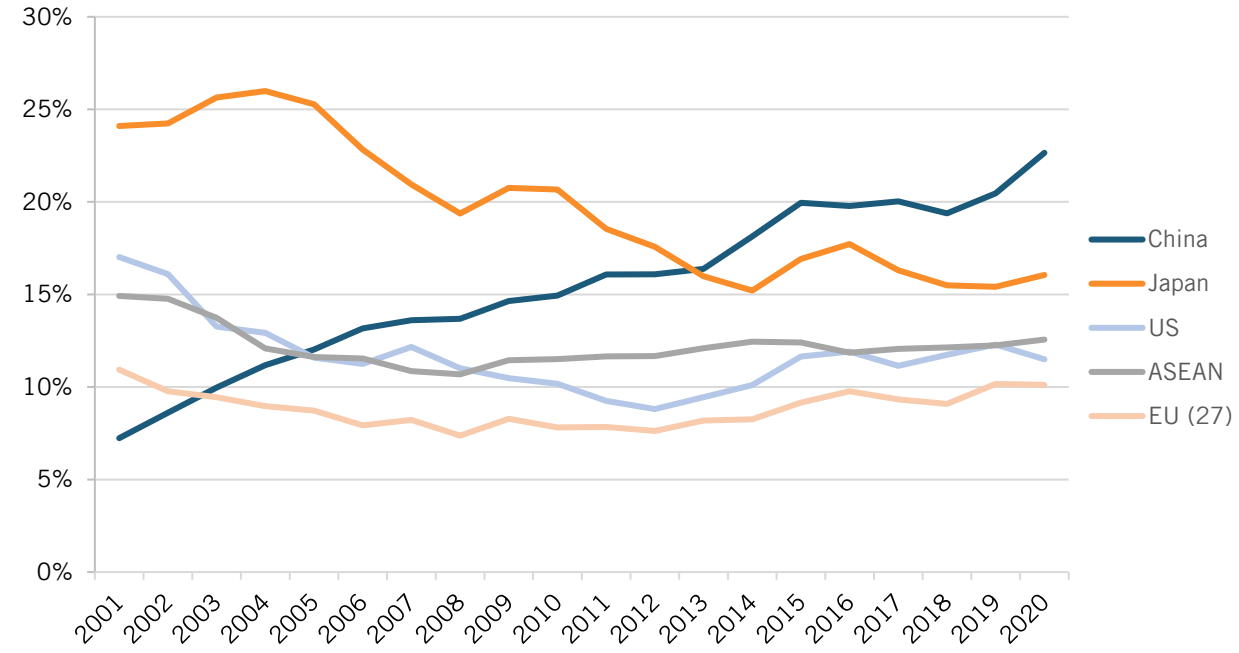


Figure 8: Share of Taiwan's total imports deriving from selected partners, 2001–2020[32]



The notion that a U.S.-Taiwan FTA would simply make Taiwan a conduit for exports of Chinese products to the United States simply isn't borne out by the data.

However, while China's share of Taiwan's total imports has increased, what has not changed substantively over the past decade is the share of value added China contributes to Taiwanese exports. For instance, the value added contributed by Taiwanese enterprises to Taiwanese exports was virtually unchanged from 2005 to 2015 at 73.4 percent, while at best the increased value added contributed to Taiwanese exports by Chinese enterprises rose 1.2 percentage points over that decade. (See table 4.) Some have contended that "an American FTA with Taiwan will just be a pass-through for Chinese content."[33] This simply isn't the case, and fears that Taiwan would simply become a conduit for Chinese exports to the United States aren't a valid reason for the United States not to pursue an FTA with Taiwan.

Table 4: Value added of Taiwan exports, as a share of total gross exports[34]

Exporting Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Taiwan	73.4%	71.9%	71.4%	72.3%	74.5%	74.1%	73.8%	73.7%	73.4%	73.7%	73.5%
China	10.4%	11.6%	12.2%	11.6%	10.0%	10.2%	10.5%	11.4%	12.3%	11.8%	11.7%
EU28	3.7%	3.8%	4.1%	3.9%	3.3%	3.4%	3.3%	3.0%	2.9%	3.2%	3.1%
South Korea	1.9%	1.9%	1.9%	2.0%	2.4%	2.3%	2.7%	2.5%	2.2%	2.2%	2.3%
United States	1.3%	1.2%	1.1%	1.2%	0.9%	1.0%	1.0%	1.0%	1.0%	1.0%	1.1%
Mexico	1.1%	1.2%	1.0%	1.2%	1.1%	1.1%	1.0%	1.0%	0.9%	0.9%	1.0%
Japan	1.1%	1.2%	1.1%	1.1%	0.9%	0.9%	0.9%	0.8%	0.7%	0.8%	0.8%

TAIWAN'S CONTRIBUTION TO ADVANCED TECHNOLOGY INDUSTRIES

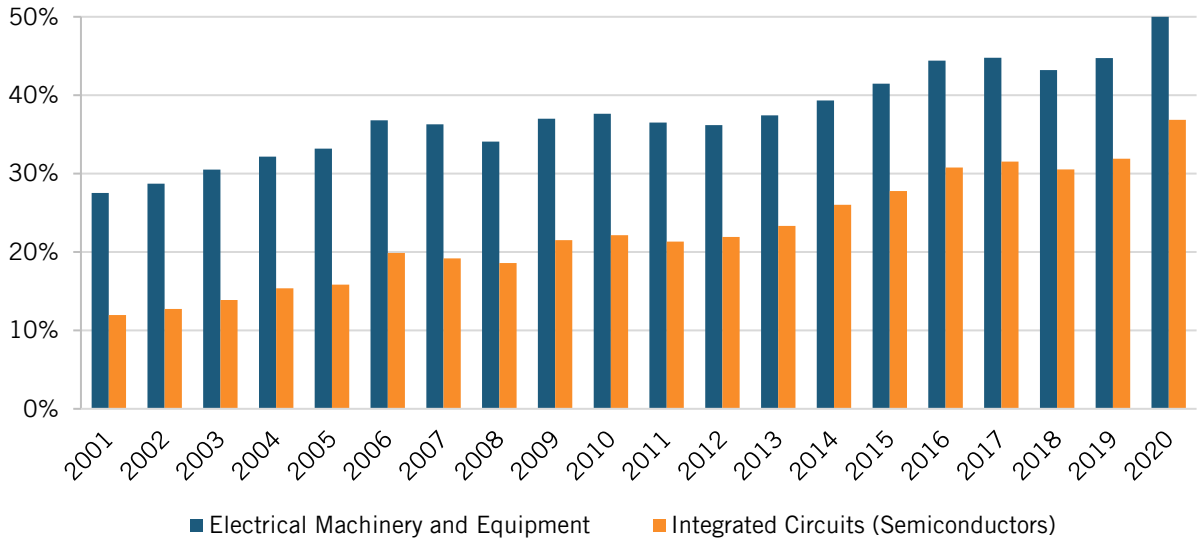
Taiwan has become an increasingly important global player in a number of advanced technology industries, and exhibits particular strengths in hardware-oriented ICT industries—especially semiconductors, personal computers, desktops, tablets, and other electronic equipment—as well as in emerging advanced transportation systems such as EVs. The following sections provide an overview of U.S.-Taiwan and global economic, trade, and supply chain linkages in these sectors.

Semiconductors

Over the past two decades especially, Taiwan has become one of the world's most important players in the global semiconductor industry—and, equally, the sector has become one of the most critically important for Taiwan's economy. The McKinsey Global Institute (MGI) found that the "high-tech" sector contributes 18 percent of Taiwan's GDP, with electronic manufacturing companies making up the bulk of the sector.[35] Indeed, electrical machinery and equipment has become Taiwan's most essential export, with its share of Taiwan's total exports increasing from 39.5 percent of the total in 2012 to 40.8 percent in 2013, 41.9 percent in 2014, 43.5 percent

in 2015, 46 percent in 2017, and 50 percent in 2020. (See figure 9.) And within the electrical machinery and equipment segment, there's no more important sector than semiconductors, which from 2003 to 2018 more than doubled as a share of Taiwan's total exports, from 14 to 29 percent.

Figure 9: Hardware as a percentage of Taiwan's total exports, 2001–2020[36]



Indeed, from 2005 to 2019, Taiwan's exports of semiconductors increased from $35.9 billion to $111 billion, making it the world's second-leading semiconductor exporter, up from fourth in 2005. (See figure 10.) In terms of percentage change, Taiwan's semiconductor exports grew 209 percent from 2005 to 2019, second only to China, which saw its semiconductor exports grow nearly fourfold over that period. (See figure 11.)

Figure 10: Nations' semiconductor exports, 2005 and 2019 (billions)[37]

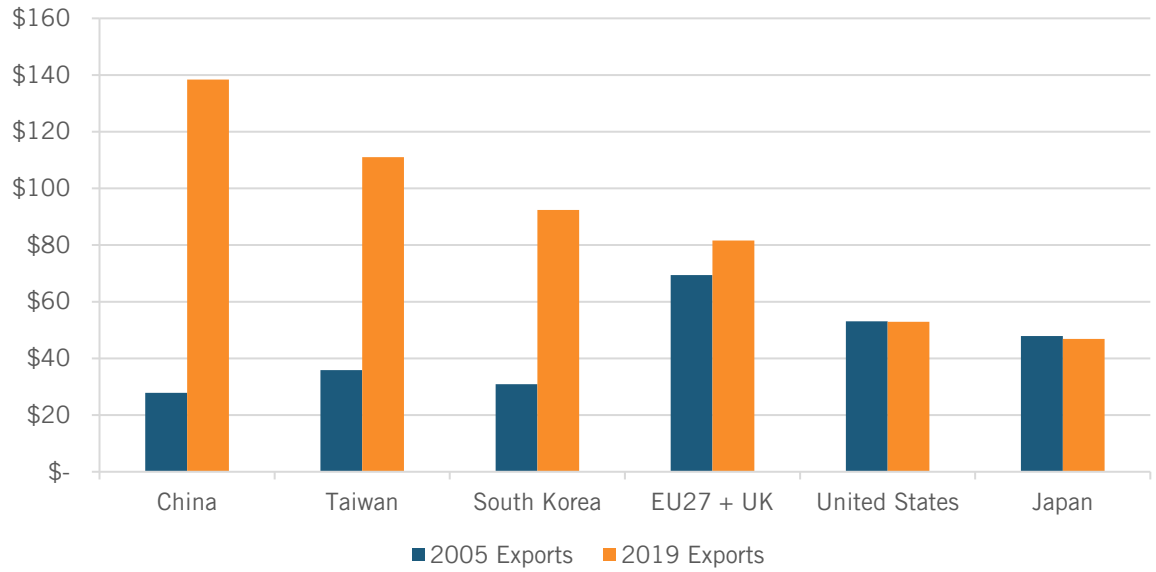
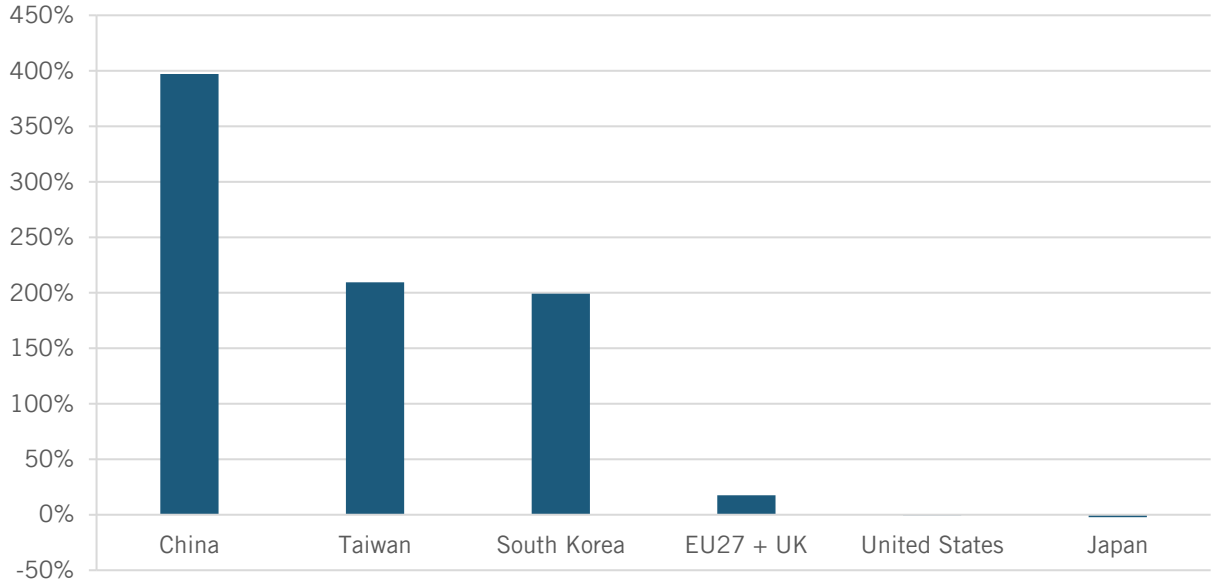


Figure 11: Percentage change in nations' semiconductor exports from 2005 to 2019[38]



And just as Taiwan's share of global semiconductor exports has significantly increased over the past two decades, so has its share of global value added in the sector. Indeed, Taiwan's value added in the semiconductor industry increased fourfold between 2001 and 2016, from $13.96 billion to $55.64 billion. (See figure 12.) In terms of global total value added in the semiconductor industry, Taiwan's share nearly doubled from 8 to 15 percent over that period. (See figure 13.) Likewise, Taiwan's share of global manufacturing capacity in the semiconductor industry has grown from a miniscule amount in 1990 to 22 percent today. (See figure 14.)

Figure 12: Value added of semiconductor industry by economy, 2001–2016 (billions)[39]

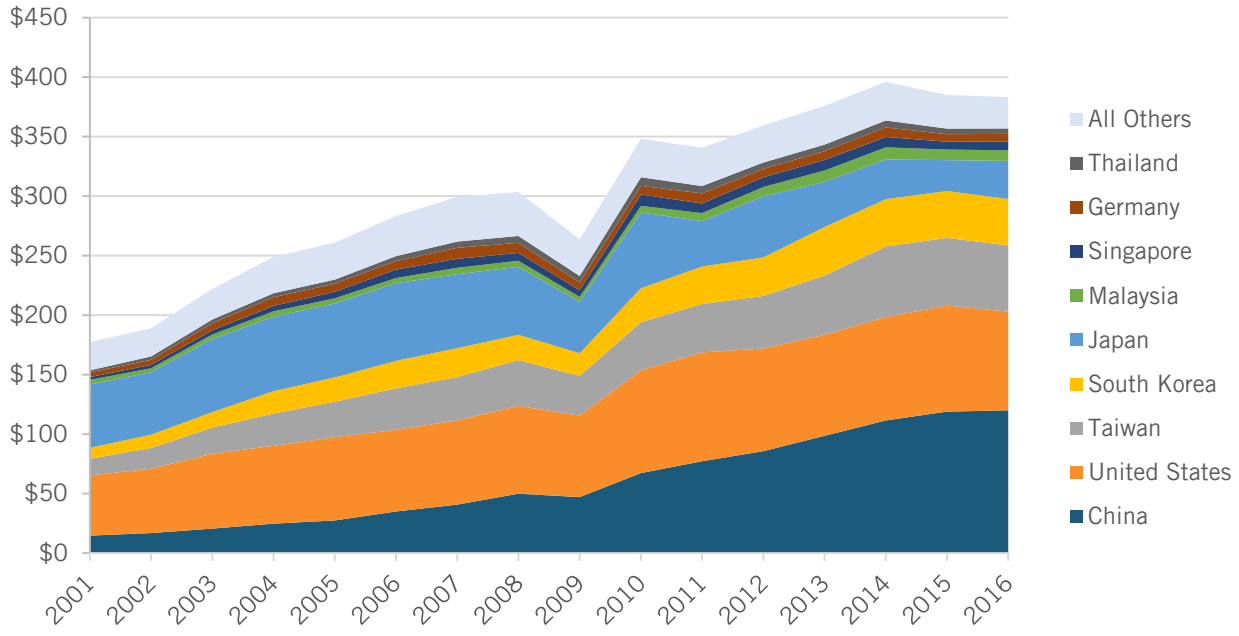
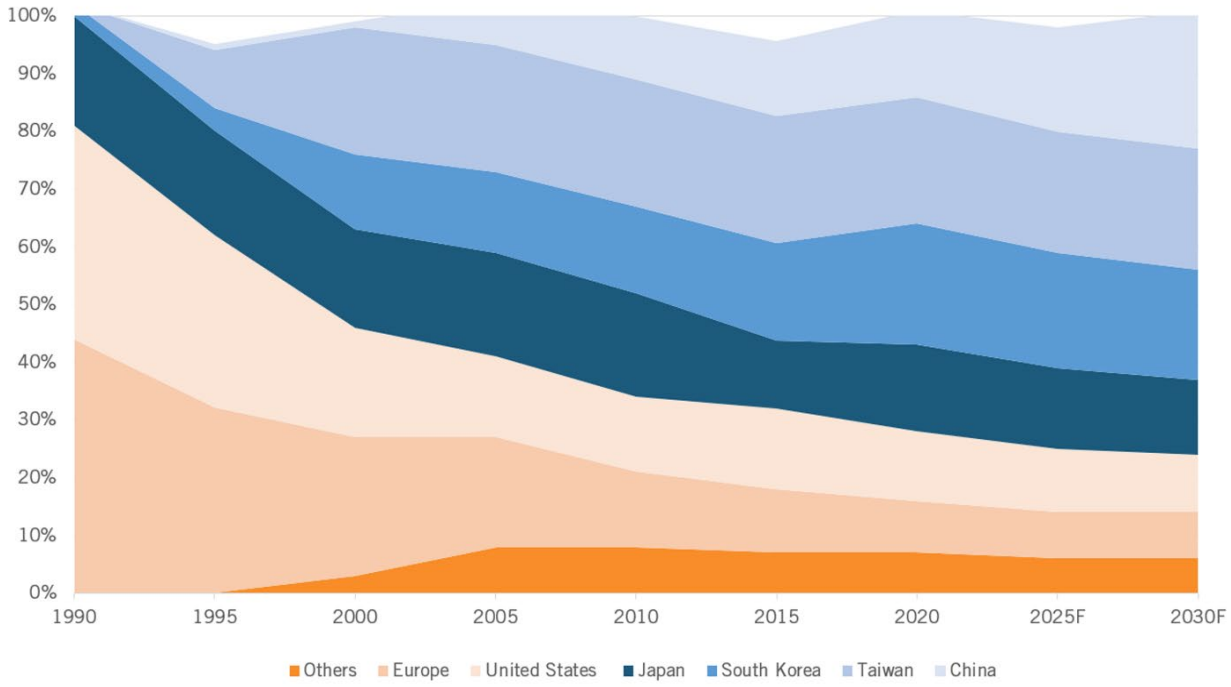


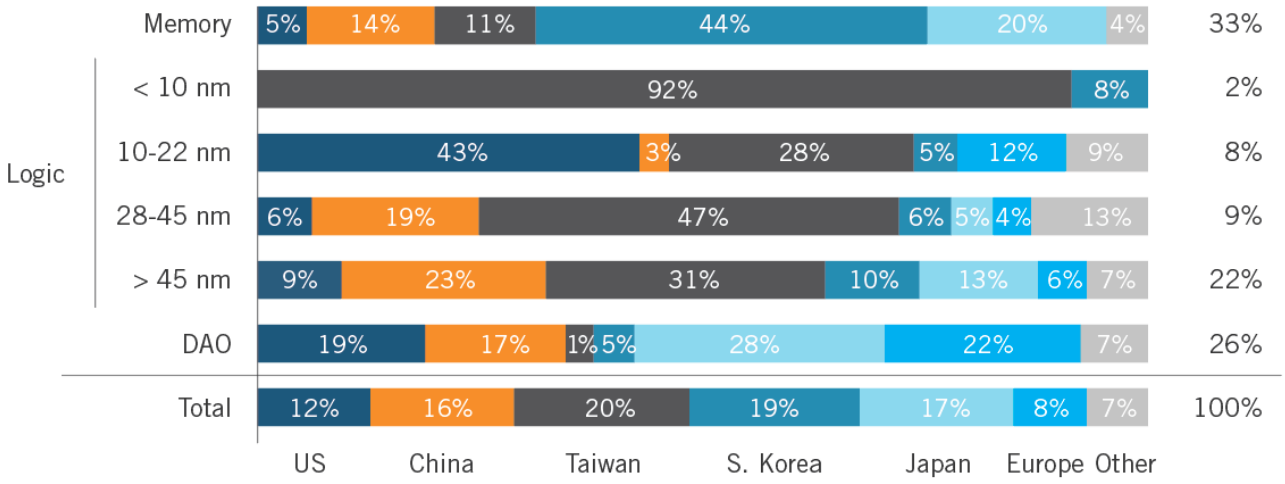
Figure 13: Country share of value added in global semiconductor industry, 2001 and 2016[40]

Figure 14: Global semiconductor manufacturing capacity by location[41]



While the statistic that Taiwan now accounts for 20–22 percent of global semiconductor manufacturing capacity might not necessarily catch one's eye, what will is that Taiwan now accounts for 92 percent of all semiconductor production for logic chips at process nodes of less than 10 nm—that is, the world's most sophisticated and most important chips.[42] (See figure 15.)

Figure 15: Share of global semiconductor wafer manufacturing capacity by region (2019, %)



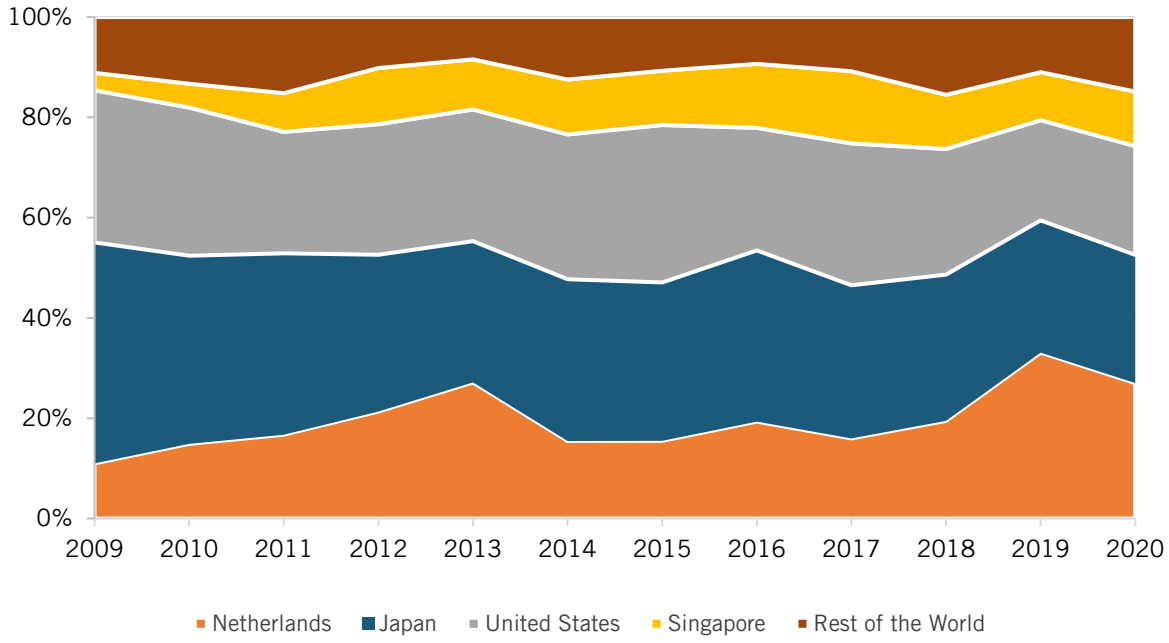
Taiwan's great semiconductor success story is in part a result of effective government planning, but most of the credit goes to Morris Chang, founder of the Taiwan Semiconductor Manufacturing Company. TSMC pioneered the foundry business model, concentrating on contract manufacturing for other "fabless" (i.e., those without semiconductor fabrication factories of their own) semiconductor companies. Fabless companies concentrate on semiconductor chip research and design, with examples including Advanced Micro Devices (AMD) (chips for artificial intelligence (AI), high-performance computing, and graphics), NVIDIA (graphics chips), and Qualcomm (5G and other wireless chips). Such has been TSMC's success that it now accounts for over half the world's market for made-to-order chips, commands 90 percent of global market share for the most advanced semiconductor (sub 7 nm) production, and will soon open the most advanced (3 nm) semiconductor fab in the world.[43] TSMC also arguably now leads the world in private-sector capital expenditures, announcing in April 2021 that it would invest $100 billion over the next three years to help meet growing global semiconductor demand.[44] In 2020, Taiwanese firms accounted for over 60 percent of revenues generated in the global foundry market.[45]

Over the past two decades especially, Taiwan has become one of the world's most important players in the semiconductor industry—and, equally, the sector has become one of the most critically important for Taiwan's economy.

Not only are TSMC and other Taiwanese foundry players key suppliers to many U.S. enterprises, but in many cases the business models of American chip makers would be fundamentally impossible without these Taiwanese suppliers. In fact, U.S. companies—whether fabless players such as AMD, NVIDIA, or Qualcomm, or manufacturers of consumer electronics goods such as Apple—account for 64 percent of global demand for fabless semiconductor manufacturing.[46] In turn, Taiwanese companies now account for 78 percent of value-added output (in terms of revenues generated) from the global foundry-based semiconductor sector.[47] Apple alone accounts for one-quarter of TSMC's revenues.[48]

However, conversely, it should be noted that Taiwan accounts for 45 percent of U.S. exports of semiconductor manufacturing equipment (i.e., the tools that run the fabs). In fact, Taiwan's total imports of semiconductor manufacturing equipment and other materials reached $28.8 billion in 2020.[49] Along with the United States, the Netherlands and Japan are leading sources of Taiwanese imports of such equipment. (See figure 16.)

Figure 16: Share of Taiwanese imports for semiconductor-producing machinery, by exporting country[50]



Taiwan's semiconductor industry—with over 247 listed companies—generated revenues in excess of $108 billion in 2020 (a 20.7 percent growth rate over the prior year), after having accounted for fully 30 percent of Taiwan's exports and 14 percent of its GDP in 2019.[51] The semiconductor industry represents the leading locus of U.S. FDI into Taiwan. U.S. memory semiconductor chip manufacturer Micron is the largest U.S foreign investor in Taiwan, investing over $2 billion annually and employing 8,000 Taiwanese workers. Similarly, Corning has invested over $5 billion in Taiwan, operating two manufacturing facilities and two research and technology labs, and supporting over 4,000 employees, while the U.S. semiconductor manufacturing equipment maker Applied Materials employs over 2,700 Taiwanese employees and operates a Global Technical Learning Center and Display Manufacturing Center & Lab in Taiwan.[52]

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Electric Vehicles

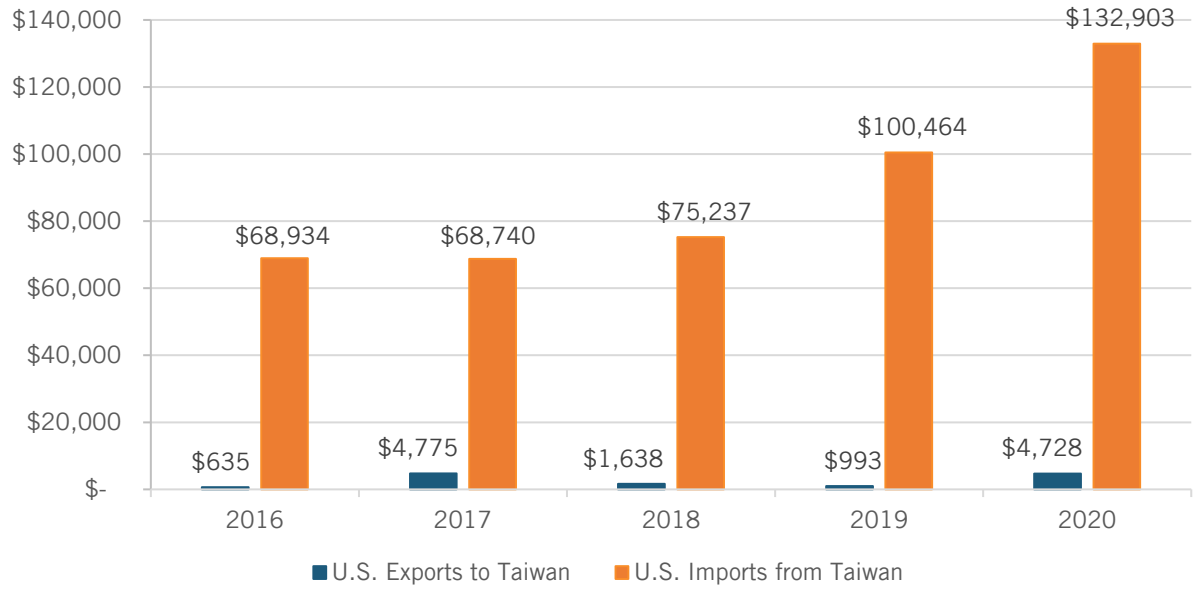
The global market for EVs is expected to expand rapidly in the near term, driven by an increase in policy support, infrastructure investment, and component affordability.[53] Global EV sales are predicted to grow from 2.5 million in 2020 to 31.1 million by 2030.[54] Likewise, global demand

for EV batteries is projected to grow from approximately 747 gigawatt hours (GWh) in 2020 to 2,492 GWh by 2025.[55] Accordingly, it's worth considering the impact of escalated EV and EV-battery adoption on global supply chains.

EVs run on electric motors powered by large traction battery packs that must be recharged by being plugged into a wall outlet or charging equipment.[56] In a recent supply chain review, the Biden administration identified high-capacity batteries, critical minerals and materials (e.g., lithium and graphite), and semiconductors as crucial to EV production.[57] Since traditional auto manufacturers lack the experience to vertically integrate their EV supply chains, joint ventures with specialist suppliers are often required, especially for the acquisition of the most expensive EV component: batteries.[58]

Today, most EVs use lithium-ion batteries due to their high energy-per-unit mass, power-to-weight ratio, energy efficiency, good high-temperature performance, low self-discharge, and reusable elements.[59] In 2020, the overall value of lithium-ion storage batteries imported by the United States from Taiwan was over 28 times the value of those exported from the United States to Taiwan.[60] (See figure 17.) When zeroing in on trade of lithium-ion storage batteries that are specifically used as the primary source of power for electrically powered passenger vehicles, the United States' trade deficit with Taiwan was valued at $2.13 million in 2020; however, this represents a decline, as the deficit stood at $6.32 million in 2019.[61]

Figure 17: Trade flow of lithium-ion batteries between Taiwan and the United States ($ Thousands)[62]



Taiwanese suppliers contribute in various ways to EV production, and include companies such as the Chang Chun Group, a petrochemical conglomerate producing copper foils for lithium-ion batteries, and Hota Industrial Manufacturing Co., the sole supplier of reduction gears to Tesla.[63] Delta Electronics, the nation's leading power and thermal management solutions provider, aims to maintain 10 percent of the global market share for power and traction components.[64]

Finally, several Taiwanese companies have planned to establish EV production plants in the United States. In May 2021, Hota Industrial Manufacturing announced plans for its first U.S.

factory to be based in Texas, with an estimated total investment of $285 million.[65] Tech giant Hon Hai Precision Industry Co. (Foxconn) has also committed to building an EV production site in the United States by teaming up with U.S. EV start-up Fisker.[66]

IMPACT OF RESHORING INITIATIVES ON GLOBAL TRADE FLOWS

A growing number of nations—including Australia, Japan, South Korea, Taiwan, the United States, and the United Kingdom—in recent years have become more focused on policies to promote manufacturing and supply chain reshoring. The trend, though certainly accelerated by the COVID-19 pandemic, actually began well before it, in part spurred by the Trump administration's sanctions on China's unfair trade practices (especially with regard to the 25 percent tariffs imposed on billions in Chinese exports).[67] Reshoring efforts were also a reaction to many nations' concerns about how China's growing concentration of manufacturing activity would affect manufacturing employment in other countries. Additionally, pushes to reshore came from the recognition of a broader need to diversify supply chains to enhance national redundancy and resiliency. Other factors contributing to nations' reshoring efforts include growing manufacturing labor and operational production costs in China, concerns regarding protecting proprietary intellectual property and technologies in China, and increasing regulatory costs and uncertainty. This has led to an increased recognition among companies that the total cost of ownership (TCO), when considering all these factors, significantly raises the true costs of producing in China and substantially narrows the difference with the costs of manufacturing in domestic markets. In other words, many companies are realizing that today's "China price" isn't nearly what it once was.[68]

A growing number of nations—including Australia, Japan, South Korea, Taiwan, the United States, and the United Kingdom—in recent years have grown more focused on policies to promote manufacturing and supply chain reshoring.

Countries' Reshoring Strategies, and Their Impact

A number of countries have established reshoring initiatives designed either to bolster domestic production and supply chains generally or to induce the movement of production out of China specifically. For instance, as part of its April 2020 COVID-19 economic stimulus package, Japan allocated 220 billion yen ($2.2 billion) to assist manufacturers in moving production back to Japan, as well as a separate 23.5 billion yen ($215 million) package for Japanese companies seeking to move production out of China to other countries.[69] The strategy also sought to help Japanese manufacturers identify alternatives to Chinese suppliers, with one study by Tokyo Shoko Research Ltd. finding that 37 percent of the 2,600 survey-responding companies were seeking to diversify procurement away from Chinese providers.[70] Likewise, in May 2020, the United Kingdom announced "Project Defend," an effort seeking "to diversify the UK's imports of critical goods, including pharmaceuticals and personal protective equipment (PPE), as it plans to end the country's reliance on supply from China."[71] British officials noted that Project Defend's dual goals include "reducing the UK's reliance on China for key imported goods" while simultaneously "building up trade links with other Asian countries."[72] As Japan and the United Kingdom were launching these initiatives in Spring 2020, the Trump administration mulled creating a $25 billion "reshoring fund," including subsidies and incentives, to lure U.S. manufacturers out of China.[73] While the Biden administration hasn't announced any specific

reshoring fund, promoting reshoring was certainly a significant campaign theme for the incoming president, who quickly announced an executive order modifying the rules of the Buy American program in order to encourage greater domestic production and, in February 2021, through Executive Order (EO) #14017 directed an immediate 100-day review of supply chains in four critical industries: active pharmaceutical ingredients (APIs), critical minerals, semiconductors, and large capacity batteries, such as those used in EVs.[74] That EO also directs one-year supply chain reviews (to be delivered by February 24, 2022) of six critical industrial base sectors underpinning America's economic and national security: the defense industrial base, public health and biological preparedness industrial base, ICT industrial base, energy sector industrial base, transportation industrial base, and supply chains for production of agricultural commodities and food products.

U.S. Supply Chain and Reshoring Initiatives

In June 2021, the Biden administration released findings from its 100-day review of the four initial sectors, finding "long-standing vulnerabilities in U.S. supply chains." The report identifies five key vulnerabilities: 1) insufficient U.S. manufacturing capacity; 2) misaligned incentives and short-termism in private markets; 3) industrial policies introduced by partner and competitor nations alike; 4) geographic concentration in global sourcing; and 5) limited international coordination in addressing supply chain challenges.[75] To address these challenges, the review offers six categories of recommendations: 1) rebuilding U.S. production and innovation capabilities; 2) supporting the development of markets with high road production models, labor standards, and product quality; 3) leveraging the government's role as a market actor; 4) strengthening international trade rules, including trade enforcement mechanisms; 5) working with allies and partners to decrease vulnerabilities in the global supply chains; and 6) partnering with industry to take immediate action to address existing shortages.[76]

Some of the most significant specific proposals in the review include the following:

- Proposing that Congress invest $50 billion to create a new Supply Chain Resilience Program at the Department of Commerce that would monitor, analyze, and forecast supply chain vulnerabilities and partner with industry, labor, and other stakeholders to strengthen resilience in supply chains across a range of critical products.
- Leveraging the Defense Production Act (DPA) to expand production capacity in critical industries, in part by establishing a new interagency DPA Action Group to recommend ways to leverage the authorities of the DPA to strengthen U.S. supply chain resilience.
- Recommending that Congress invest at least $50 billion to advance domestic U.S. manufacturing of leading-edge semiconductors; expand capacity in mature node and memory production to support critical manufacturing, industrial, and defense applications; and promote R&D to ensure the next generation of semiconductors is developed and produced in the United States.
- Providing up to $17 billion to support EV battery and cell-pack manufacturing in the United States along with a suite of consumer rebates and tax incentives to spur consumer adoption of EVs, including asking Congress to provide $5 billion to electrify the federal fleet with U.S.-made EVs and approve $15 billion in infrastructure investment to build a national charging infrastructure to facilitate the nationwide adoption of EVs.

- Expanding the U.S. Export-Import Bank's ability to use existing authorities to further support domestic manufacturing, including by implementing a new Domestic Financing Program to support the establishment, expansion, or both of U.S. manufacturing facilities and infrastructure projects in the United States that would support U.S. exports.
- Using federal procurement activity as a stronger force for reshoring and building manufacturing supply chain capacity, including by establishing a list of designated critical products that should receive additional preferences under the Buy American Act and Federal Acquisition Regulations (FAR) Council guidelines and by strengthening domestic production requirements in federal grants for science and climate R&D.
- Establishing a U.S. Trade Representative (USTR)-led trade strike force to identify unfair foreign trade practices that have eroded critical U.S. supply chains and recommend trade actions to address such practices.
- Working more closely with allies to decrease vulnerabilities across global supply chains, including by hosting a new Presidential Forum with like-minded nations on supply chain resilience and leveraging the U.S. Development Finance Corporation to support supply chain resilience and build up supply chains of critical products within like-minded nations.
- Establishing a new Supply Chain Disruptions Task Force to provide an all-of-government response to address near-term supply chain challenges, supported by a Department of Commerce-led data hub to monitor near-term supply chain vulnerabilities.[77]

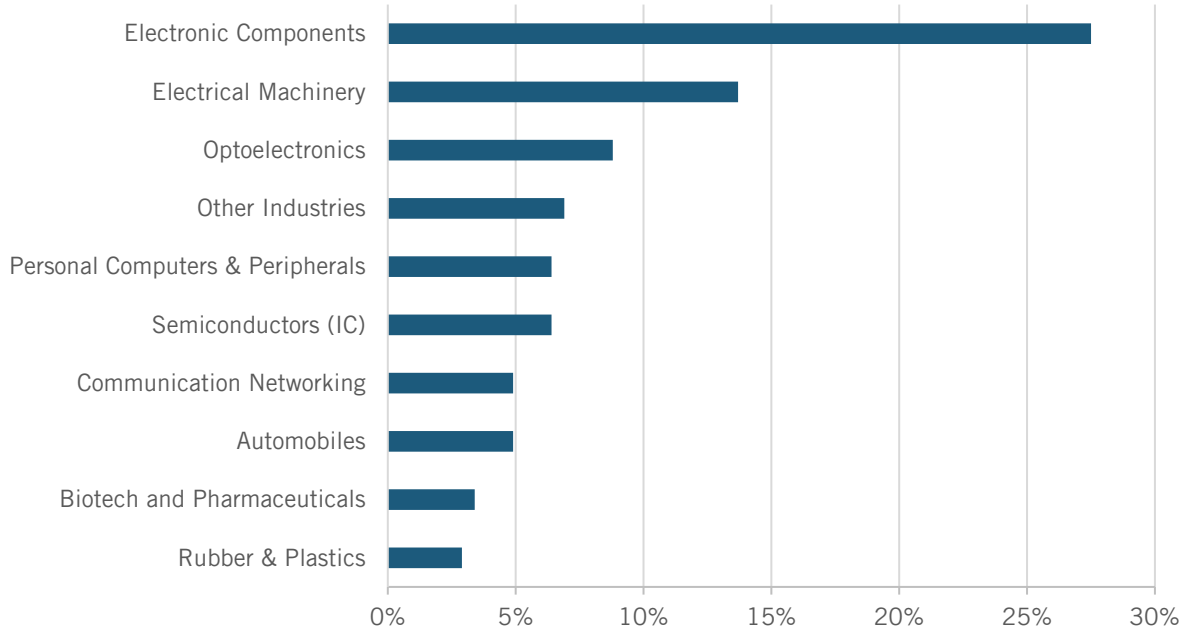
Taiwanese Supply Chain and Reshoring Initiatives

Since the 1980s, over 100,000 Taiwanese firms have moved at least some production to China in setting up manufacturing facilities there, in part attracted by cheap labor and China's large domestic market.[78] Taiwan has historically had a high overseas production ratio in the ICT industry, with over 90 percent of electronics industry-related products, including ICT, optical equipment, and electronic (components) products being manufactured offshore, and over 60 percent of Taiwanese-listed companies having factories in China.[79] U.S. firms have been the same, investing seven times as much in China (and four times as much in Hong Kong) as they have in Taiwan.[80]

To address this, and to stimulate manufacturing reshoring from China to Taiwan, in July 2019, the Taiwanese government launched the "Action Plan for Welcoming Overseas Taiwanese Businesses to Return to Invest in Taiwan," which from its launch through April 2021 had approved 213 enterprises' reinvestment projects.[81] The program—which is only available to companies that have invested in China for at least two years and which commits them to incorporate smart manufacturing technologies into their new or expanded production lines in Taiwan—offers preferential loan terms, land concessions, and land breaks, and covers considerations such as financing, water, electricity, and manpower in a single service window.[82] Taiwan's reshoring initiative especially targets innovative industrial sectors such as ICTs, electronics, smart machinery, biomedicine, and green energy.[83] The vast majority of the enterprises taking advantage of the plan hail from various ICT subsectors, led by the electrical components, electrical machinery, optoelectronics, personal computer, and semiconductor industries. (See figure 18.) As of September 2020, a little more than a year after Taiwan's reshoring program began, Taiwanese companies had reinvested $38 billion in Taiwan under the

government program. As one report notes, "Taiwan's strengths in high-value-added contract manufacturing, particularly in the ICT industry, make it an ideal supply chain partner for tech companies from the U.S. and elsewhere seeking to diversify their production processes away from China."[84]

Figure 18: Industry share of enterprises reshoring to Taiwan since 2019[85]



Alongside the "Action Plan," two other incentive programs exist for local manufacturers that have never invested in China: one for large corporations and another for small- and medium-sized enterprises. Together, the three programs have generated NT$1.18 trillion ($42 billion) in investment from 783 companies since their 2019 launch, with more than two-thirds of that total, NT$792.5 billion ($28 billion) attributable to Taiwanese firms returning from China.[86] Perhaps the most prominent reshorer has been Quanta Computer, the assembler of MacBooks and Apple Watches and a supplier of data center servers to Facebook and Google, which is investing NT$15 billion ($542 million) to build a new factory in Taoyuan.[87]

While it is only early days for many nations' reshoring strategies, they are beginning to show some evidence of having an effective impact. MGI found that 16 to 26 percent of global goods exports ($2.9 trillion to $4.6 trillion) could conceivably move to new countries over the next five years.[88] Taiwan's direct U.S. exports rose by 21 percent in 2018 (over 2017) and by 19 percent in 2019 (over 2018) as some China-based production shifted to Taiwan to avoid U.S. tariffs and in response to Taiwan's government incentives.[89] Further, U.S. manufactured goods imports from China fell 17 percent from 2018 to 2019, a total drop of roughly $90 billion.[90] America's manufacturing import ratio—that is, total manufactured goods imports as a percentage of domestic manufacturing gross output—fell from 13.1 in 2018 to 12.1 in 2019.

There is also some evidence of a near-shoring shift to Mexico. A.T. Kearney calculated a near-to-far trade ratio (NFTR) that tracks the movement of U.S. imports toward nearer-shore production from locations such as Mexico; the ratio calculates the value of Mexican-manufactured imports to the United States, divided by the value of manufactured imports from 14 Asian low-cost

countries. Typically, the ratio hovers from 36 to 38 percent, but in 2019, it increased 400 basis points. On a dollar-value basis, total manufacturing imports from Mexico to the United States increased 10 percent from 2017 to 2018, from $278 billion to $307 billion, and by another 4 percent the following year, to $320 billion.[91]

Reshoring Best Practices and Lessons Learned

Whether it comes to the U.S.-China trade conflict; the COVID-19 pandemic; natural disasters or challenges including earthquakes, floods, freezes, droughts, and climate change; geopolitical risk and instability; or emerging threats such as cybertheft or terrorism, enterprises have learned over the past several years that the risk, severity, and expense from supply chain disruptions have all increased. A recent study by MGI estimated that companies today should expect supply chain disruptions of one to two weeks occurring at least once every two years; two to four weeks occurring once every 2.8 years; one to two months every 3.7 years; and two months or more every 4.9 years, and that companies should expect to lose 42 percent of one year's worth of EBITDA (earnings before interest, taxes, depreciation, and amortization) every decade.[92]

As the report explains, "Changes in the environment and in the global economy are increasing the frequency and magnitude of shocks. Forty weather disasters in 2019 caused damages exceeding $1 billion each—and in recent years, the economic toll caused by the most extreme events has been escalating."[93] Moreover, geopolitical risk is increasing, with the share of global trade conducted with countries ranked in the bottom half of the world for political stability rising from 16 percent in 2000 to 29 percent in 2018. Moreover, 80 percent of global trade involves nations experiencing declining political stability scores.[94]

At the same time, as GVCs have produced tremendous value for the global economy in terms of facilitating division of labor, specialization, and the efficiencies that have enabled innovations and reduced production costs for many products, the flip side of this is increasing geographic concentration of production of certain goods. For instance, MGI has identified 180 products across value chains for which one country accounts for 70 percent or more of exports.[95] As a Biden supply chain review report notes, "Such concentration leaves companies vulnerable to disruption, whether caused by a natural disaster, a geopolitical event or indeed, a global pandemic."[96] And a report by the Boston Consulting Group finds that "there are more than 50 points across the supply chain where one region holds more than 65% of the global market share."[97] Likewise, China commands over 75 percent of global cell fabrication capacity for advanced batteries and refines 60 percent of the world's lithium and 80 percent of the world's cobalt—two core inputs to high-capacity batteries.[98]

For companies, becoming more resilient doesn't have to come at the expense of efficiency.

MGI (in an August 2020 survey of 605 global business executives) found that 93 percent of global business leaders are seeking to bolster their firms' supply chain resiliency, and 44 percent would be willing to do so even at the expense of short-term savings.[99] According to the study, in terms of the leading strategies companies are deploying to achieve supply chain resiliency, 53 percent of companies are dual-sourcing raw materials, 47 percent are increasing their inventory of critical products, 40 percent are nearshoring or expanding their supplier base, 38 percent are seeking to regionalize their supply chains, and 30 percent are seeking to reduce the number of

SKUs (i.e., product lines) in their product portfolios. For its part, the Biden administration's supply chain review "recommend[s] that industries that have faced shortages of critical goods evaluate mechanisms to strengthen corporate stockpiles of select critical products to ensure greater resilience in times of disruption."[100]

Likewise, a study by the Digital Supply Chain Institute (DSCI) and Bain & Company of 200 Fortune 500 companies finds that companies' supply chain priorities have shifted markedly during the COVID-19 pandemic. Comparing these companies' investment goals over the last three years with the next three years, the study found that companies identifying flexibility as the leading priority have nearly doubled (from 35 to 60 percent, and now becoming the leading priority), and those most valuing resilience increased threefold (from 14 to 41 percent), while the share most valuing reducing costs fell by nearly half (from 63 to 36 percent).[101]

The DSCI and Bain & Company study emphasizes that manufacturers are increasingly learning that "becoming more resilient doesn't have to come at the expense of efficiency."[102] It notes that the best companies are increasingly managing customer demand, using short-term planning horizons, and creating scenarios for a range of possible changes in demand—and doing all this while increasing their focus on customer satisfaction, even as they retool operations. Both the DSCI/Bain and MGI studies note that an increasing number of companies are leveraging modern digital technologies—notably AI, the Internet of Things (IoT), 3D printing, robotics, and blockchain tools—to better manage their supply chains. For instance, Procter & Gamble deployed an AI/IoT solution to automate warehouses and distribution centers, including the customized automation of product deliveries to 7,000 different stock-keeping units, helping the company reach its goal of cutting supply chain costs by $1 billion annually.[103] Likewise, Nike provides another example of a company effectively using AI to better manage its supply chains. As MGI wrote:

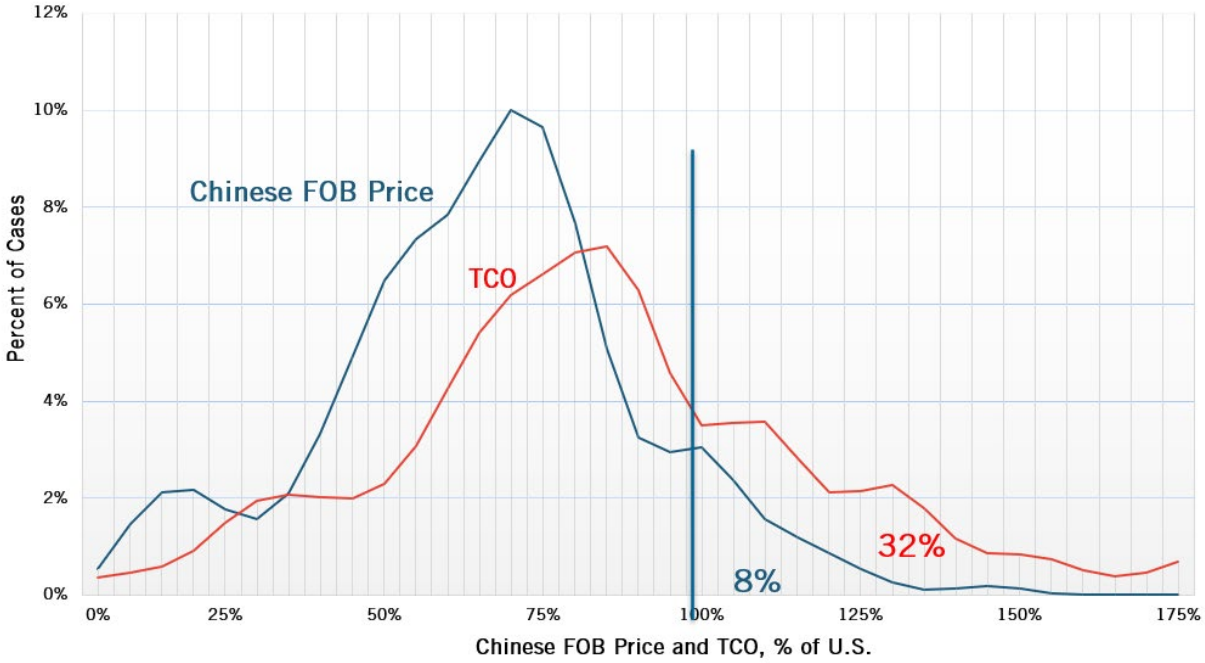
> When the COVID pandemic hit, Nike used predictive analytics to selectively mark down goods and reduce production early on to minimize impact. The company was also able to reroute products from brick-and-mortar stores to e-commerce sales, driven in part by direct-to-consumer online sales through its own training app. As a result, Nike sustained a smaller drop in sales than some of its competitors.[104]

Companies are also increasingly applying a China+1 strategy to their supply chain management strategies. Certainly, many manufacturers aren't departing China entirely—often because they want to use Chinese production facilities as a base to supply local, or regional, markets—but they are seeking at least one alternative production environment to diversity and mitigate risk. Moreover, as noted previously, companies are starting to realize that when they calculate the true TCO of manufacturing in China versus other locations (e.g., Taiwan or the United States), the true cost of doing so in China is higher than recognized, and manufacturing domestically is more competitive.

The U.S.-based Reshoring Institute has developed a TCO Estimator that was used by more than 200 companies from 2010 to 2017, factoring in 29 variables—such as duties, freight, carrying cost of inventory, travel costs, IP risks, etc.—beyond the out-of-the-factory (i.e., free on board or "FOB") price. As these 200+ companies entered data into the TCO Estimator, the facility revealed that when TCO is considered (and the true "landed" cost of products manufactured in China accounted for) 32 percent of companies experienced a Chinese price that was higher than

the U.S. price (and for 8 percent of companies, the China manufacturing price was higher than the U.S. price even without factoring in TCO). (See figure 19.) This data suggests that using TCO has a considerable impact on recognizing the overall feasibility of reshoring and identifying the best-suited products therefore, and that 10 to 30 percent of U.S. imports of Chinese products would likely be reshored if companies consistently used TCO.[105]

Figure 19: Chinse free onboard price and total cost of ownership[106]



Similarly, professor Suzanne de Treville of the University of Lausanne has developed supply chain analytics tools that help companies quantify and price the advantages they have in manufacturing locally, thereby making it easier to show that the apparent cost reduction offered by a competitor in a low-wage country might not be as compelling as it seems.[107] By applying quantitative finance tools to demand dynamics, Treville's freely available Cost-Differential Frontier (CDF) price calculator allows manufacturers to price the increase in exposure to demand volatility that comes from increases in lead time.[108] The tool is available at OpLab | Cost Differential Frontier at http://cdf-oplab.unil.ch/.[109]

It's also important to recognize that the advent of smart manufacturing—the application of ICT to every facet of modern manufacturing processes—will change the nature of manufacturing itself, and increasingly make manufacturing competitive in what has historically been higher-cost labor environments (in part by increasing the share of capital and technology as a key manufacturing input). First, smart manufacturing will enable shorter production runs (mass customization) to become more economical. Flexible factories and ICT-optimized supply chains will change manufacturing processes to allow manufacturers to customize more products to individual needs, such as medications with specific dosages.

Second, smart manufacturing, in part by boosting labor productivity and reducing efficient production lot sizes, will likely enable more localized manufacturing (i.e., "on-shoring"). In previous manufacturing technology transitions, technology worked to enable geographically

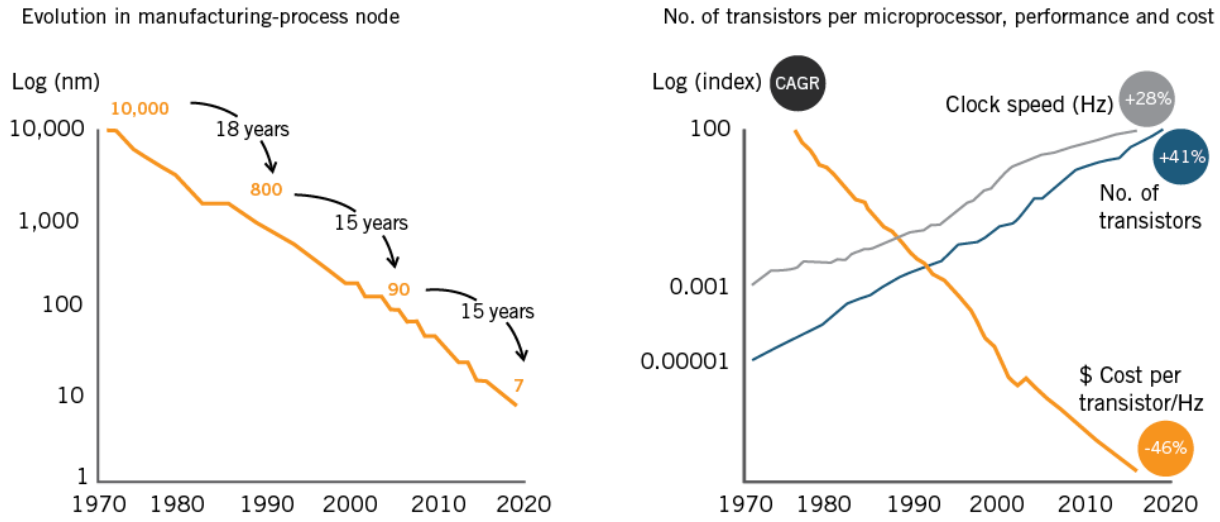
dispersed production (e.g., the shift to Asian production starting in the 1970s with mass production runs of lot sizes greater than 1,000,000). Mass production meant long production runs and a focus on reducing labor costs by seeking low-wage locations. But as smart manufacturing boosts productivity, labor costs relative to total costs will diminish, making at-the-margin manufacturing easier to locate in higher-cost areas. At the same time, smart manufacturing will increase needed skill levels on the shop floor, making traditional locations in low-wage nations whose workers have limited skills more problematic. Finally, by reducing efficient minimum production scale, in part through customized manufacturing, smart manufacturing will make it more economically feasible to locate certain work closer to the customer base, and that will often mean in higher-income nations, such as Taiwan or the United States.[110] In short, the use of modern digital manufacturing technologies can represent a powerful tool making the economics of reshoring more attractive to what had previously been much higher manufacturing cost environments.

However, to take advantage of this opportunity, Taiwan will need to more strongly promote the digitalization of its industries, for as a 2017 MGI report, "Taiwan's Digital Imperative," finds, "The adoption of digital technologies in Taiwan has been inconsistent."[111] It added, "Manufacturing industries in Taiwan have been slow to digitize," and "Taiwan's high-tech sector lags the US significantly," with the extent of digitalization in U.S. manufacturing industries as of 2017 almost twice the level of Taiwan's.[112]

Lastly, it should be noted that, while countries increasingly compete to attract as much high-value-added manufacturing as possible to their shores, globalization has produced tremendous value for the world economy. And that's true nowhere more so than in the global semiconductor industry, which represents the world's fourth-most traded product and where a global division of labor based on specialization, competitive advantage, and economies of scale have enabled tremendous innovation and value production. The innovation process captured by Moore's Law has delivered tremendous improvements in semiconductor performance and cost. In fact, the number of transistors per wafer has increased by a factor of almost 10 million (since Intel's Gordon Moore articulated the "law" in 1975, which states that the number of transistors in a dense integrated circuit doubles about every two years), yielding a 100,000-fold gain in processor speed and a cost reduction of more than 45 percent per year for comparable performance.[113] (See figure 20.) Moore's Law has also offered somewhat of a guiding innovation pathway for the industry, providing an orientation for the efforts of precompetitive research consortia and their development of long-term industry roadmaps. However, while some have come to take Moore's Law for granted, one study finds that the number of researchers required to achieve Moore's Law today is more than 18 times larger than the number required in the early 1970s.[114]

But these dynamics explain why the Boston Consulting Group report finds that an effort to create "self-sufficient" local supply chains in each region to meet their current levels of semiconductor consumption would require at least $1 trillion in incremental upfront investment, resulting in a 35 to 65 percent overall increase in semiconductor prices and ultimately higher costs of electronic devices for end users.[115] In short, global policymakers will need to find the right balance between embracing the benefits of globalization while seeking reshoring and greater levels of manufacturing activity across a range of high-tech industries.

Figure 20: Increasing performance, decreasing relative costs of semiconductors over the past half-century[116]



POLICY RECOMMENDATIONS

The following section provides policy recommendations designed to deepen U.S.-Taiwan and global-Taiwan economic, trade, innovation, and supply chain linkages.

Complete a U.S.-Taiwan Free Trade Agreement

Taiwan is a democratic, free-market economy that embraces market-based, private-enterprise-led, rules-based economic exchange. Moreover, Taiwan is not just a key trade and economic partner of the United States but also a key strategic ally of the United States. As this report shows, Taiwanese enterprises play a pivotal role in supporting U.S. supply chains across a range of industries including ICT, aerospace, automotive, EVs, medical devices, and many others. It is time for the United States to conclude a comprehensive trade deal with Taiwan, as a group of 161 members of Congress called for in December 2020 in sending a letter to USTR calling on the agency to "work toward beginning negotiations for a bilateral trade agreement with Taiwan."[117] At the very least, after a five-year hiatus, the United States should restart bilateral Trade & Investment Framework Agreement (TIFA) negotiations with Taiwan, which would provide a practical and symbolic foundation for commercial ties, covering areas such as IP protection, pharmaceuticals, medical devices, and agriculture.[118] In this regard, it was heartening that on June 30, 2021, the United States and Taiwan held trade talks for the first time since 2016.[119] In the productive talks, the two countries agreed to work together to strengthen supply chains and address a number of other concerns including workers' rights, climate change, and wildlife trafficking.

While those conversations are certainly a positive step in the right direction, the Biden administration really should move beyond the TIFA framework with Taiwan (originally signed in 1984) and pursue negotiation of a true U.S.-Taiwan bilateral trade agreement (BTA), which would further enhance trade linkages between, and improve the competitiveness of, both nations.

Such a negotiation could build on House Resolution 271 in the U.S. House of Representatives, which expresses the sense of the U.S. House of Representatives that USTR should commence negotiations to enter into a bilateral trade agreement with Taiwan.[120] A U.S.-Taiwan FTA would make the nation a more attractive location for sourcing advanced-technology production as an alternative to China in global supply chains. Moreover, a U.S.-Taiwan FTA would help Taiwan ensure stable commercial access to the U.S. market, help increase its growth rate, and promote political stability in the country.[121]

Analysts have found that a U.S.-Taiwan FTA would generate positive economic impacts for the United States. Assuming zero tariffs on commodity trade, a 25 percent liberalization of service trade, and a 10 percent improvement in trade facilitation, a computable general equilibrium model simulation (based on the Global Trade Analysis Project data bank 9A version) estimates that a U.S.-Taiwan FTA would result in a welfare increase in the United States of $3.6 billion, an increase in real GDP of $3.5 billion, a decrease of the U.S. trade deficit with Taiwan by 75 percent, and the generation of an additional 27,000 U.S. jobs.[122] Taiwan's average trade-weighted tariff is 2 percent, similar to the United States'.[123] A 2004 study finds that, in dollar-value terms, the positive economic benefits of a U.S.-Taiwan FTA would be more significant for the United States under a trade deal with Taiwan than under most of the other 12 bilateral deals examined.

In August 2020, Taiwan's President Tsai removed long-standing barriers to U.S. beef and pork imports by executive order, and the following month, Taiwan's Council on Agriculture announced it would remove restrictions on ractopamine as a feed additive for pork (a contentious issue with Taiwanese farmers and ranchers), moving to address a critical and long-standing sticking point in the U.S.-Taiwan trade relationship.[124] These actions indicate a serious commitment from the Taiwanese to address issues that had long been roadblocks with U.S. domestic political constituencies regarding pursuing a U.S.-Taiwan FTA. Hopefully these moves will be met with an equally serious commitment from Washington to pursue a trade agreement that would benefit both nations at a critical juncture.

Both the United States and Taiwan Should Join the CPTPP

The Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP) represents a high-standard trade agreement signed by 11 nations in Santiago, Chile, in March 2018. The CPTPP features 21st-century trade rules and norms, including higher standards for digital trade, protection of intellectual property, services-market access, labor and environmental standards, disciplines on state-owned enterprises, and rules facilitating many others facets of modern trade. Over the past several years, Taiwan has begun the process of reviewing and revising its laws and regulations to bring itself into compliance with CPTPP provisions, a process that will help bring Taiwan's regulatory regime more closely in line with international standards and practices.[125] The United States needs to join the CPTPP, and in so doing bring along like-minded nations such as Taiwan and South Korea. On September 22, 2021, Taiwan formally applied for application to the CPTPP, one week after China itself did so.[126]

One reason doing so is especially important is that in November 2020, China, along with 14 other nations, concluded the Regional Comprehensive Economic Partnership agreement (RCEP), creating the world's largest regional trade block and representing the first trade agreement between China, Japan, and South Korea while excluding both the United States and Taiwan.

Robert Ward of the geopolitical risk consultancy IISS wrote that this represents a "significant geopolitical win for China."[127] In the meantime, the United States has lamentably retreated from such trade-deepening efforts, with the Trump administration withdrawing from the now-11-naton CPTPP and the Biden administration evincing no signals of reengaging. It was a grave strategic error of the Trump administration to withdraw the United States from the CPTPP, thus ceding leadership of regional economic integration to China; it will constitute an equally grave geostrategic error should the Biden administration fail to redress this misstep by not having the United States join the CPTPP.

The United States needs to join the CPTPP, and in so doing bring along like-minded nations such as Taiwan and South Korea.

Embrace the Taiwan Commercial Initiative

On June 23, 2021, the American Chamber of Commerce in Taiwan (AmCham Taiwan) introduced plans for a Taiwan Commercial Initiative (TCI) designed to bring Taiwan-U.S. economic relations to an ever-deepening level, culminating in completion of a U.S.-Taiwan BTA.[128] The six-track TCI framework urges expansion of the Economic Prosperity Partnership Dialogue (EPPD) initiated by the U.S. State Department in November 2020, in part by encompassing greater business participation. In addition, it calls for the U.S. Department of Commerce and Taiwan's Ministry of Economic Affairs to develop transaction-oriented, public-private platforms to promote two-way trade and investment, in order to facilitate Taiwan's inclusion in new and existing plurilateral economic agreements, and to conclude a U.S.-Taiwan double-taxation pact. AmCham Taiwan views these overlapping workstreams as reinforcing one another and paving the way for the sixth and final goal: a U.S.-Taiwan BTA.[129]

Promote Taiwanese Participation in International Forums

Ever since a 1994 trade policy review, U.S. policy has been to support Taiwan's membership in international organizations for which statehood is not a requirement, and to encourage "meaningful participation in organizations for which it is."[130] Despite being excluded from some important international organizations, Taiwan contributes in important ways to global governance through functionally based multilateral agreements and voluntary compliance with agreements it has been barred from joining.[131] Nevertheless, one challenge for Taiwan's integration into the global economy has been roadblocks against its participation in various international forums, such as the International Civil Aviation Organization, Interpol, and the World Health Organization.[132] Despite a quite-effective COVID-19 response from which the world has much to learn, Taiwan was prevented from even attending the World Health Assembly as an observer this May, the fifth consecutive year it has been turned away. As Alex Wong, head of the U.S. State Department's Indo-Pacific strategy, has noted, "[Taiwan] can no longer be excluded unjustly from international fora. [It] has much to share with the world."[133] The United States should continue to facilitate Taiwan's engagement in these types of international forums.

Advocate That International Economic Institutions Produce More Taiwanese Research

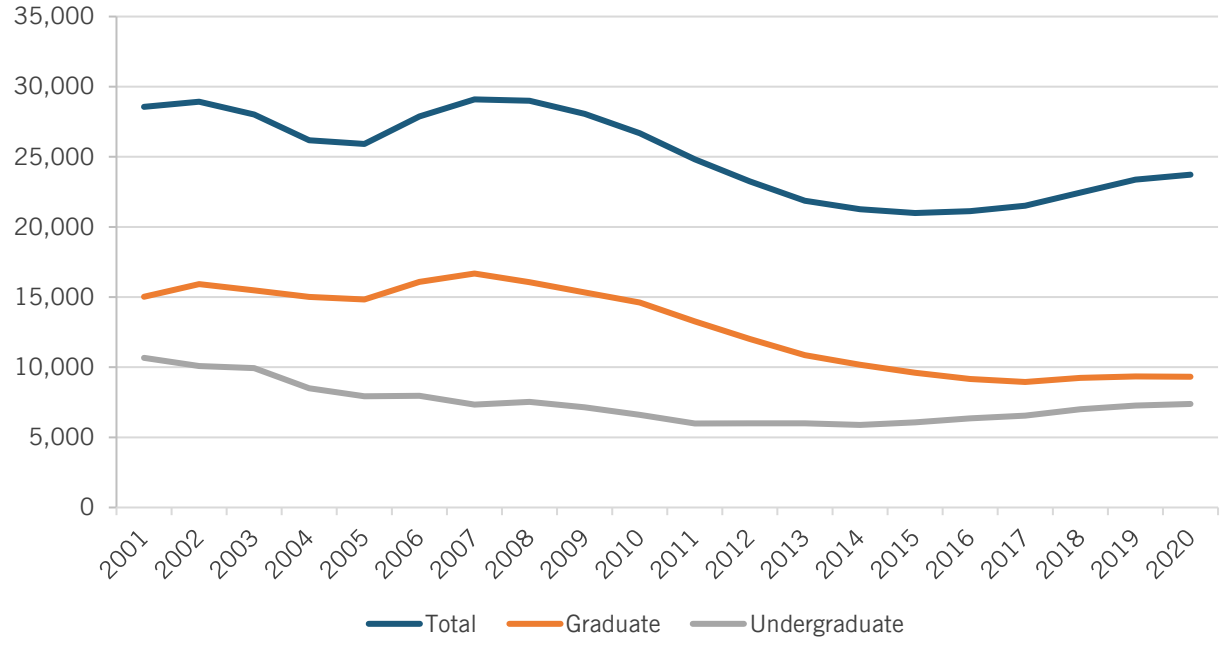
Compared with other similarly developed nations, there exists a dearth of globally available economic and financial data regarding Taiwan. The United States should advocate that international economic institutions such as the International Monetary Fund and the World Bank

produce more economic research pertaining to Taiwan. One step that could enhance this is for the United States to advocate that Taiwan be elevated from an observer to a full member of OECD.

Increase STEM Education Exchange

The number of Taiwanese students going to the United States for study has trended downward over the last 20 years at every educational level, although most notably with graduate students. U.S.-bound undergraduates from Taiwan declined from 10,668 in 2001 to 7,385 in 2020, while U.S.-bound graduate students declined from 15,022 to 9,236 over that same timeframe, a decline of approximately 40 percent.[134] (See figure 21.) It's imperative that policymakers from both nations recognize the importance of circulation of high-skill talent between the two countries and prioritize greater levels of science, technology, engineering, and mathematics (STEM) education exchange. Another step that could help in this regard is to continue progress toward the goal of making Taiwan bilingual (Mandarin and English) by 2030. Here, Taiwan should be more open to English-language multimedia content and encourage its use in teaching and learning.[135]

Figure 21: Number of Taiwanese STEM students studying in the United States[136]



Increase Investment in Publicly Funded Research

Policymakers in both Taiwan and the United States need to invest more in publicly funded R&D.[137] The Taiwanese government's share of the country's R&D expenditures has declined from 51 percent in 1991 to just 19 percent today, a decline of almost two-thirds. (See figure 22.) Likewise, the U.S. government's investment in R&D has been on a steady downward trajectory for decades, to the point now where it's even below pre-Sputnik-era levels. Indeed, in 22 of the 28 years following 1990, federal R&D spending has made up a smaller share of GDP than the year before, sinking to just 0.61 percent of GDP in 2018, the lowest level since 1955, according to the latest data from the National Science Foundation. (See figure 23.) Meanwhile, "China continued its years-long run of double-digit percentage increases in spending on R&D in 2019,"

with total public and private Chinese science and technology expenditures in 2019 rising by 12.5 percent over the previous year to 2.21 trillion Chinese yuan ($322 billion).[138] Notably, unlike the United States, where the vast majority of federally funded R&D goes toward knowledge-expanding basic scientific research that's freely appropriable to humanity, in China, investment in basic research accounts for just 6 percent of the total; applied research, 11.3 percent; and development, 82.7 percent, meaning that Chinese R&D investments are specifically designed to confer a competitive advantage for its companies.[139] Both the United States and Taiwan need to invest more in publicly funded R&D to meet the China challenge.

Figure 22: Taiwan's government R&D expenditure as a percentage of total R&D expenditure, 1991–2018[140]

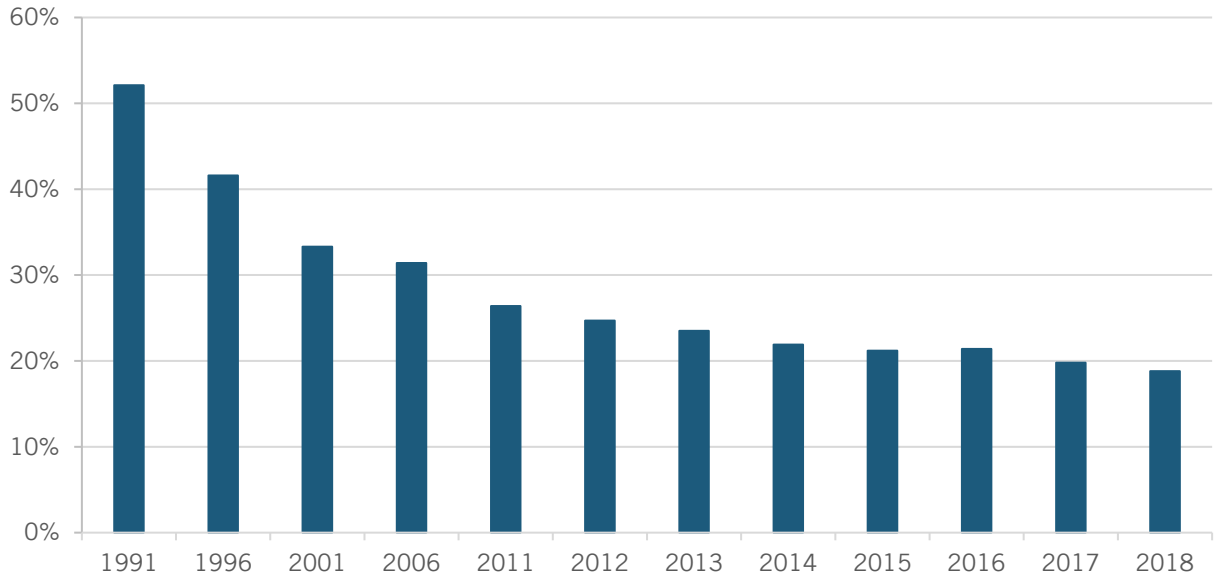
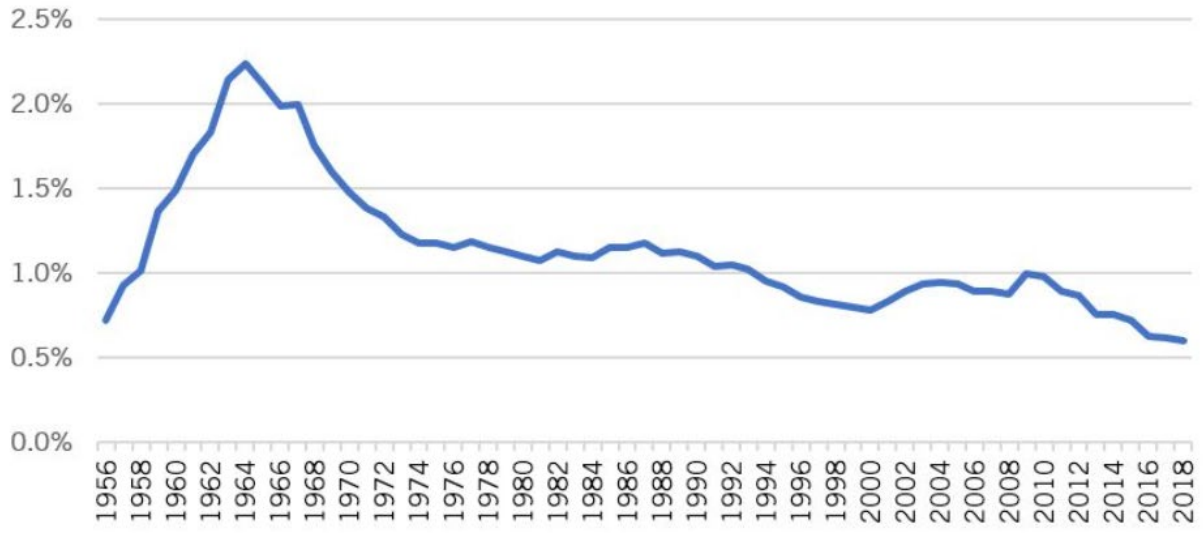


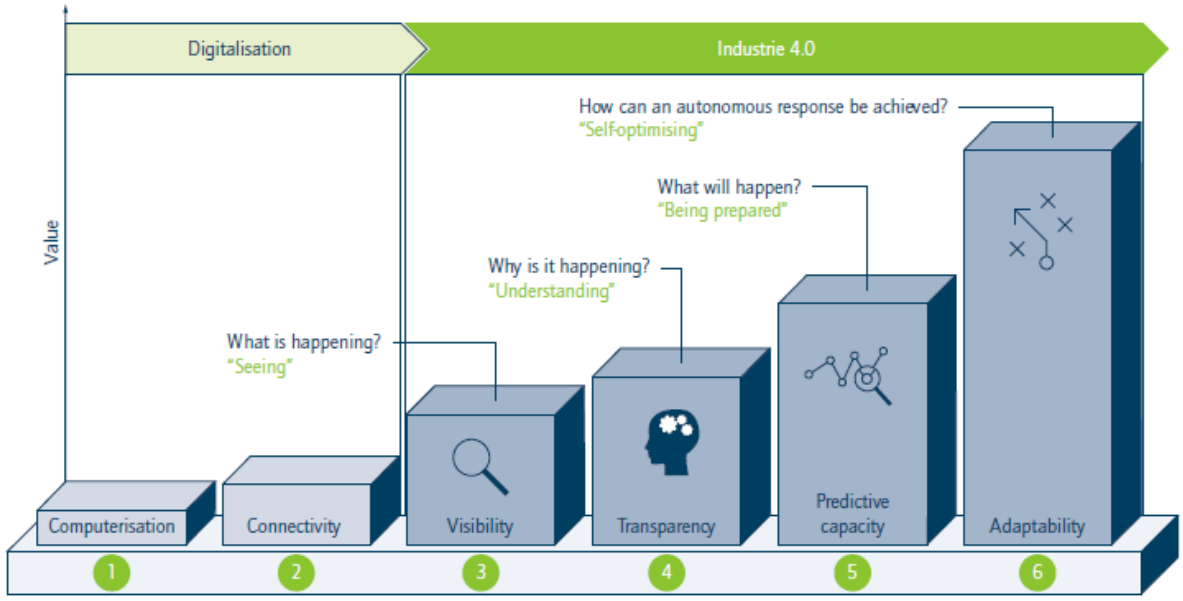
Figure 23: Federal R&D investment as a share of U.S. GDP[141]



Turbocharge Taiwanese Digitalization, Especially in Manufacturing

As noted, Taiwan continues to lag behind in digitalization, including in manufacturing industries. To address this, Taiwan has declared its intent to establish a Ministry of Digital Development (MODD) to coordinate and expedite the development of Taiwan's digital economy.[142] This is needed across all sectors of the economy—as too large a portion of the operations of industry and government in Taiwan is still conducted manually or on paper—such as in the financial services sector, where hard copies of documents for Know Your Customer (KYC) processes and physical signatures for verification or the execution of contracts are still required in many cases.[143] As ITIF wrote in "Why Manufacturing Digitalization Matters and How Countries Are Supporting It," one of the most important steps countries are taking to stimulate digital manufacturing deployment is by developing "Digital Manufacturing Maturity Indices" and providing "Self-Benchmarking Assessment Tools" (including cybersecurity) for semiconductor manufacturing equipment manufacturers.[144] These help companies understand where they are along the various stages of the digital manufacturing journey. (See figure 24.) Another step is inventorying and describing discrete, specific manufacturing digitalization use cases and processes (e.g., Germany has documented over 300 specific use cases/sample instances of semiconductor manufacturing equipment digitalization). Other steps countries can take to promote manufacturing digitalization include launching "pilot fabs" that demonstrate smart manufacturing techniques on active production lines, providing financial support (including financial loans, grants, or tax credits) for manufacturing digitalization, and helping industry address manufacturing workforce challenges.[145]

Figure 24: Stages in the digital manufacturing development journey[146]



Complement Taiwan's Strengths in Hardware With Greater Strengths in Software

As the Carnegie Endowment for International Peace's Evan Feigenbaum has compellingly written, "Taiwan faces headwinds because of the concentration of so much of its comparative advantage into hardware manufacturing, just as next-generation industries are moving toward an emphasis on integration of software and hardware."[147] He elaborated that Taiwan hasn't effectively

transitioned from a hardware-dominant ecosystem to one with a greater emphasis not just on software but especially on hardware-software integration.[148] As Feigenbaum explained, "Taiwan should prioritize carving out a specialized niche in the newly emerging, rapidly evolving global value chains for knowledge industries like AI and IoT … There is considerable opportunity to integrate software, AI, and data science into established industries ranging from healthcare to education to information security."[149]

To achieve this, Taiwan will need to catch up in global user-centric ecosystems and business models and build its STEM talent base in these fields.[150] It's also an area of greater potential U.S.-Taiwan collaboration. As Feigenbaum noted, one of the challenges Taiwan will confront in the AI field is a lack of scale in its economy disadvantaging its ability to collect the large datasets that are so important to training AI systems—particularly in comparison with China, which not only has access to large datasets but is restricted by little compunction regarding citizens' privacy rights. If Taiwanese firms were to partner more with American ones, they could both not only have access to the larger datasets needed to train AI algorithms, but also responsibly use that data in a framework that protects data owners' rights more effectively.

Collaborate on Supply Chain Security, Especially in the Semiconductor Sector

The United States and Taiwan, and their respective enterprises, have an opportunity to collaborate even more extensively on achieving supply chain security, especially in the semiconductor industry, where effective collaborations have already begun. For instance, TSMC is collaborating with Purdue University to open a Center for Secured Microelectronics Ecosystems, which aims to ensure a secure supply of semiconductor chips and related tools all the way from the foundry to the packaged system in order to develop advanced chips that could be detected or traced if security concerns arise.[151]

Deepening such collaborations was a key goal of the recent Senate-passed U.S. Innovation and Competition Act (USICA), which evolved from the original Endless Frontiers Act, and includes legislation originally envisioned in the CHIPS (Creating Helpful Incentives to Produce Semiconductors) Act to support the U.S. semiconductor manufacturing ecosystem.[152] The USICA legislation recently passed by the U.S. Senate appropriates upfront $500 million (allocated at $100 million annually over five years) to the Department of State, in coordination with the U.S. Agency for International Development, the Export-Import Bank, and the U.S. International Development Finance Corporation, for the purposes of coordinating with foreign government partners to support international ICT security and semiconductor supply chain activities, including supporting the development and adoption of secure and trusted telecommunications technologies, semiconductors, and other emerging technologies.

Collaborate on Semiconductor Export Controls

The United States needs to eschew the application of unilateral export controls and instead seek to develop a more ambitious and effective plurilateral approach to promulgate export controls among like-minded nations that have indigenous semiconductor production capacity, such as Germany, Japan, South Korea, Taiwan, the Netherlands, and the United Kingdom.[153] These nations should work together to establish a common understanding of both what threats are posed to the global semiconductor industry by enterprises from nonmarket economies not fundamentally competing on market-based terms as well as the pace and evolution of semiconductor technology. Then, among themselves, these nations should establish working

groups, outside the Wassenaar structure, to develop descriptions of both the semiconductor technologies and related items that warrant controls (beyond what already exists), as well as establish common licensing policies. However, to accomplish this, several peer nations—including Japan, South Korea, Taiwan, the Netherlands, and the United Kingdom—would have to adjust their domestic laws, which were both designed around the 1990s structure of regime-based controls and don't have the authority for unilateral or plurilateral controls or end-use/end-user controls. In other words, to develop a semiconductor export-controls regime in this way would require very close collaboration among allied countries, in terms of capacity building, information sharing, intelligence sharing, and developing a common understanding of what threats exist and to what extent they should be addressed through the use of export controls.

Establish an Innovation Experts Working Group

The U.S. and Taiwanese governments should establish an integrated platform for collaboration and cooperation in the development of new technologies and industries.[154] For instance, Taiwan's National Development Council and the U.S. State Department hold an annual forum on the digital economy to discuss their respective policy initiatives and development strategies in the digital economy, including discussions on promoting innovation and entrepreneurship, further developing smart-city applications, and applying digital technologies to other sectors of the economy.[155] An innovation experts working group could make comparative assessments of innovation strengths and weaknesses between the United States and Taiwan in sectors such as AI, the Internet of Things, smart cities, data analytics, biotechnology, and GVC integration best practices. As Feigenbaum suggests, to further expand partnerships with American interests and institutions, "a transpacific advisory panel could be established encompassing domestic technology leaders in Taiwan, representatives of U.S. firms doing R&D in Taiwan, the VC industries on both sides of the Pacific, and university leaders."[156]

Develop a Strategic Sovereign Wealth Fund

Unlike many other leading global economies, Taiwan lacks an internationally focused sovereign wealth fund that could help it meet key strategic domestic objectives as well elevate its influence in the international business community. As AmCham Taiwan wrote, "At over US$500 billion, Taiwan's reserves are among the largest in the world. But they are currently managed in a way that cannot meet Taiwan's most pressing needs, including its looming pension shortages, the burden of a rapidly aging population, and unforeseen events like another pandemic."[157] Indeed, a Sovereign Wealth Fund that invests in Fortune 500 companies would give Taiwan direct access to global business leaders and a voice in how these leaders shape their business strategies.[158] A Sovereign Wealth Fund could also represent a strategic fund supporting investments in Taiwan's economic competitiveness and broader innovation economy, such as the afore-mentioned needed investments in manufacturing digitalization. Taiwan should seriously consider how to leverage strategic resources to better empower its innovation economy.

Collaborate to Support the Competitiveness of Allied High-Tech Enterprises

The United States needs to work with like-minded nations to develop initiatives to address the changing global trade and economic landscape. Since an inaugural Indo-Pacific Business Forum in July 2018, U.S. government engagement has catalyzed private-sector investment in Indo-Pacific infrastructure, supported by $2.9 billion through the Department of State and the U.S. Agency for International Development, as well as hundreds of millions more through other

agencies, including the U.S. Millennium Challenge Corporation (MCC) and the Overseas Private Investment Corporation (OPIC).[159] Meanwhile, the U.S. International Development Finance Corporation, created by the Better Utilization of Investments Leading to Development (BUILD) Act in 2018, will be providing $60 billion in development financing to attract more private-sector investment into global emerging markets. In May 2020, the U.S. Export-Import Bank launched a "Strengthening American Competitiveness Initiative" that seeks "to advance U.S. comparative leadership in the world with respect to China and supporting America's innovation, employment, and technological standards through supporting U.S. exports."[160]

Similarly, "The New Southbound Policy," launched in May 2016 by President Tsai Ing-wen aims to expand Taiwan's trade, investment, and diplomatic relations with countries in South and Southeast Asia.[161] Likewise, South Korean President Moon Jae-in has articulated a New Southern Policy that seeks to deepen trade and economic relationships with ASEAN (Association of Southeast Nations) countries, and Japan has expressed its own Free and Open Indo-Pacific Vision (FOIP).[162]

Here, the United States should build on language in Section 3213, "Enhancing the United States-Taiwan Partnership," in the recently Senate-passed USICA, which articulates:

> It is the policy of the United States to recognize Taiwan as a vital part of the United States' Indo-Pacific strategy; to advocate and actively advance Taiwan's meaningful participation in the United Nations, the World Health Assembly, the International Civil Aviation Organization, the International Criminal Police Organization, and other international bodies as appropriate; to advocate for information sharing with Taiwan in the International Agency for Research on Cancer; and to support United States educational and exchange programs with Taiwan, including by promoting the study of Chinese language, culture, history, and politics in Taiwan, including the Taiwan Fellowship Act and its People-to-People exchanges.[163]

Indeed, the United States should continue to work with these nations on collaborative international development aid/assistance, development of finance support, and export credit initiatives to encourage nations in the Indo-Pacific region to select digital technologies, solutions, and platforms from vendors from like-minded nations. Further, as noted previously with regard to the Biden administration's 100-day supply chain review, the United States should actively include Taiwan in the newly proposed Presidential Forum with like-minded nations on supply chain resilience.[164]

CONCLUSION

Taiwan and the United States represent free, like-minded, democratic societies that constitute key economic and national security partners for one another. The competitiveness and innovation capacity of a wide range of U.S. high-tech enterprises and industries depends on the vitality of the key Taiwanese suppliers they depend on. This report has endeavored to showcase the depth and importance of U.S. economic, trade, innovation, and supply chain linkages with Taiwan and offer a broad range of policy recommendations that, if undertaken, would strengthen the depth and strength of those relationships to the mutual benefit of both nations.

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About ITIF

The Information Technology and Innovation Foundation (ITIF) is an independent, nonprofit, nonpartisan research and educational institute focusing on the intersection of technological innovation and public policy. Recognized by its peers in the think tank community as the global center of excellence for science and technology policy, ITIF's mission is to formulate and promote policy solutions that accelerate innovation and boost productivity to spur growth, opportunity, and progress.

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