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Global Trade Interdependence: U.S. Trade Linkages With Korea, Mexico, and Taiwan

BY STEPHEN J. EZELL AND CALEB FOOTE | JUNE 2019

Korea, Mexico, and Taiwan represent vital trade partners for the United States, not only as destinations for U.S. exports, but more importantly as key partners whose firms supply critical intermediate goods on which the health of America's advanced-technology industries depend.

The global economy has become increasingly interlinked, as nations—and enterprises therein—specialize in productive activities wherein they enjoy the greatest levels of comparative advantage. This phenomenon has become especially pronounced in the globalization of value chains for sectors such as information and communications technologies (ICT), electronics, aerospace, and automotive, with Asia becoming a central player in many of these supply chains, especially for ICT products. This internationalization of supply chains means that the success of original equipment manufacturers (OEMs) depends greatly on the health and vitality of suppliers in other nations and the ability to pursue trade, ideally on mostly unimpeded terms, with them. This report examines trade linkages between the United States and three key partner nations—Mexico, Korea, and Taiwan—analyzing the extent of inter- and intra-industry trade across six key sectors: automobiles, chemicals, computers and electronics, machinery, other transportation equipment (including aerospace), and pharmaceuticals. The report demonstrates both that U.S. industries in these sectors depend greatly on trade with suppliers in study partner nations and that these nations are key importers of U.S. goods in these industries.

The report begins by analyzing the evolution of trade in the 21st century, characterized especially by the rise of global supply chains. It next provides an in-depth analysis of U.S. trade with the three partner nations, including analyzing value added and inter- and intra-industry trade linkages and flows in the six industries across the three countries. In order to illustrate the nature of global value chains in concrete terms, it then provides a case study assessing the nature of U.S.-Taiwan trade and economic linkages. The report concludes by offering policy recommendations.

TRADE IN THE 21ST CENTURY: GLOBAL VALUE CHAINS

Trade optimally represents a willing and market-based exchange between two parties for something one party can produce more efficiently than the other. This formula has not changed much over human history—only its scale. Economies have evolved from the trading of simple products between farmers and craftsmen to the current 21st-century global trading system structured around global value chains (GVCs) that connect end users to complex goods and services, both physical and digital. GVCs, as described by the Organization for Economic Cooperation and Development (OECD), represent a system "where different stages of the production process are located across different countries."[1] To generalize, firms in multiple countries (or a single multinational firm with operations across multiple countries) work together by splitting up the production process into "specialized tasks" (e.g., product design, testing, material sourcing, manufacturing, distribution, marketing, retail, and other activities) that eventually lead to the lowest production costs and highest quality for consumers. The term GVCs serves as a useful metaphor to visualize the concept that to produce a final product, value is added step-by-step by different establishments (and often different enterprises), often from different nations across the globe, performing specific tasks across multiple countries. To be sure, not all traded goods are produced through GVCs. Some are produced in one country by one firm and then exported. But a significant share of exports now are produced through GVCs, with the amount of foreign-produced value in U.S. exports growing from 11 percent in 2002 to 15 percent in 2011.

Global Value Chains or Global Supply Chains?

Many use the terms "global value chains" and "global supply chains" interchangeably.[2] In terms of what they describe, these two concepts have no major differences. Each emerged out of two separate academic disciplines; yet, at their core, both seek to analyze and understand the linkages between the various key stages of goods and services production systems. To oversimplify the main difference, "global supply chains" is a supply-side concept, wherein producers are the key drivers of value in the economy; in contrast, "global value chains" is a demand-side concept, wherein consumers are the key drivers of value in the economy.

Discussions in the trade policy space in recent years have shifted to using the term "global value chains." For example, OECD uses this term, rather than "global supply chains," to describe its research in this area.[3] Another term that has emerged is "global innovation networks" (GINs), which represent how companies transfer intangible and immaterial assets between countries. World Bank modeling shows a strong and positive correlation between bilateral trade and co-invention, suggesting interdependence between GVCs and GINs at the country level.[4] In fact, evidence shows that countries with many firms that engage with foreign firms in close-knit production processes have much higher productivity than countries whose firms do not.[5]

Understanding trade and economic linkages through the lens of GVCs intrinsically places consumer benefit at the focal point of trade discussions, a major advantage given that many have become wary of or even hostile toward supporting deeper trade linkages. The term "value," insofar as being defined in economics as a consumer's willingness to pay for goods or services, places the consumer front and center. Economists calculate the value a firm adds to an economy—a firm's value added—by deducting the cost of its intermediate inputs from its total revenue (wages plus capitalized costs).

Competitiveness and GVCs

The advent of GVCs means that a significant share of global trade involves trade in inputs—countries adding a tiny bit of value to a certain input, then exporting that input to another country for even further refinement and increases to value.

Just as the formula for trade has not changed over time, neither has the formula for competitiveness. As the Information Technology and Innovation Foundation (ITIF) defines it, competitiveness represents "the ability of a nation's non-mineral-based traded sectors to effectively compete in global markets in the absence of subsidies and government protections, while receiving a strong price premium that enables strong terms of trade."[6] A nation, for instance, is globally competitive when it has a trade surplus, a strong currency, and doesn't use market-distorting trade policies. Using this framework, the world's most competitive economies include Austria, Germany, the Netherlands, and Sweden. Even though China runs a trade surplus, one could argue its competitiveness is due to both the raft of domestic policies that subsidize its production of goods and its many import restrictions. Because of its large trade deficit, the United States is not truly competitive, even after accounting for other countries' mercantilist trade practices.[7]

At the global level, GVCs do not impact the basic methodology used to calculate a country's trade balance: exports minus imports. But when factoring in GVCs at the bilateral level, this formula becomes tricky for estimating a country's relative competitiveness with a trading partner. This stems from trade-accounting methodologies not being able to capture the realities of modern trade. In the past, most countries only traded in final products; therefore, when, for example, Country A exported $1,000 in products to Country B without importing anything in return, Country A had a $1,000 trade surplus with Country B. But the advent of GVCs means a significant share of global trade involves trade in inputs—countries adding a bit of value to a certain input, then exporting that input to another country for even further refinement and increases to its value. To illustrate, from 2004 to 2014, trade in intermediate goods increased from one-quarter of global trade to two-fifths of global trade.[8]

Turning back to our example, for the modern-day equivalent, that $1,000 in exports to Country B may not in fact be entirely produced in Country A. Country A could be using $500 in inputs from Country C and $300 in inputs from Country D, and generating only

$200 of that final $1,000 value exported to Country B. Country A's "true" trade surplus with Country B should therefore be $200. But instead, Country B would actually have "true" deficits of $500 with Country C and $300 with Country D. In reality, Country A's "true" trade surplus with Country B would be much smaller than what standard trade surplus reporting would indicate, and Country A's competitiveness relative to Country B would be overstated through standard means. But bear in mind that factoring in GVCs only readjusts a country's bilateral trade balances to better account for the flow of inputs across multiple countries, and does nothing to affect a country's overall trade balance with the world. This weakness in methodology has often been cited as one major factor why the U.S.-China trade deficit appears larger than it "truly" is.[9] Indeed, a significant portion of China's exports to the United States consist of final products assembled from components imported from various other countries. Thus, within the bilateral trade balance equation, the overall value of its exports should not be directly attributed to China.

This method of analyzing bilateral trade deficits refers to the value-added (VA) trade balance. This method attempts to factor in GVCs by tracking how the bits of value added from one input to another flow from the source country all the way to their final destination, rather than just calculating trade flows as static border-to-border exchanges. In summary, for $1,000 in imports to Country B from Country A (using our above example), a value-added trade balance separates that value into $200 imported from Country A, $500 imported from Country C, and $300 imported from Country D.

However, value-added trade balances contain certain major assumptions and limitations about the way firms operate, because real VA trade data simply does not exist.[10] VA trade data is synthetic—assembled through merging global gross trade data with countries' input-output tables and various statistical techniques. To date, only a handful of VA trade datasets exist: Notable ones include OECD's Trade in Value-Added (TIVA) accounts and the University of Groningen's global input-output database. Although the methods to construct VA trade data differ from organization to organization, these assembled datasets tend to present similar findings.[11] But until countries start developing and implementing statistical methodologies that take into account the modern realities of GVCs in trade, these synthetic VA trade datasets will remain a key tool in revealing countries' true trade balances with one another.

Factors That Propagated GVCs

A dearth of data accurately capturing how GVCs have spread across trade belies what is qualitatively known about GVC propagation. Reduced trade barriers, decreasing transportation costs, and increasing adoption of digital tools have all complemented each other in facilitating the emergence of GVCs.[12]

Transportation Costs

Geographical distance has long served, effectively, as a barrier to trade. Transportation costs limit both firms' willingness to source for inputs from regions further from them, and retailers' willingness to import products with high shipping costs. But technological progress and increasing returns to scale have massively lowered these barriers.[13] This has been the case across all forms of transportation.

In the latter half of the 20th century, the average air-freight cost to transport 1 ton of goods 1 kilometer (0.62 miles) decreased thirteenfold, from $3.87 to $0.30.[14] Increased demand will continue to put downward pressure on air transportation costs, but likely at a slower rate due to decreasing returns to scale. In 2013, cargo airplanes accounted for 10 percent of all aircraft globally, with their number expected to grow from approximately 1,700 to 3,200 vehicles by 2031, or about 80 percent, to meet an estimated threefold increase in air freight demand.[15] Ocean transportation costs decreased sharply from 1950 to the mid-1970s (the implementation period for international standards for shipping-container dimensions) but have remained stagnant since.[16] Although average shipping costs have not decreased significantly, quality and scale improvements have increased. Container ships have become much larger and faster, and spend less time idle at ports, while improvements to port infrastructure have reduced the time it takes to transfer containers to their next mode of transportation.[17] As one example, the number of containers the average container ship can transport in one trip increased fifteenfold from 1970 to 2014.[18] Over-ground transportation such as trucking and rail have also experienced significant decreases to cost, by almost 40 percent over the past 30 years.[19] Because over-ground freight transports up to 90 percent of U.S. goods, further reductions to trucking and rail costs, likely in the form of autonomous technologies, will enable firms currently located further away from seaports to more cheaply integrate into GVCs.[20]

ICT Adoption

The Internet and new developments in ICT have created an added dimension of value generation for GVCs: the digital economy. The impact of the digital economy on GVCs has only recently received recognition, and is limited by a lack of data collected on economic activities pertaining to the digital economy. Yet, ICT's methods of expanding GVCs can be broken down into two main components: digital economy and digital/physical economy overlap.

Regarding how the digital and physical economies overlap, ICT products reduce communication costs within GVCs, thereby raising efficiencies.[21] Supply-chain management computer software allows managers to coordinate just-in-time production systems spread out across the globe; email enables businesses to communicate seamlessly across time zones; and e-commerce allows consumers to easily make purchases from a global network of suppliers. This overlap also brings forth new forms of value creation, integrating physical goods and services provision with, for example, advanced manufacturing, robotics and factory automation, platform-based industries, cloud computing, big data analytics, and artificial intelligence.[22] Each of these technologies offers firms new business models and creates opportunities for innovation in "trade in tasks." Such technologies open up new ways for businesses to capture value within the global economy, but create challenges for statistical agencies to accurately capture and measure this flow of value. For example, a "smart manufacturing" enterprise may partner with an artificial intelligence company to develop the "brains" for a piece of manufacturing equipment; a cloud computing company to store the data gathered by the device; and a big data analytics company to analyze the data collected Each of these activities, while capturing a unique slice of the value chain, is likely to end up aggregated—if included at all—as simply trade in computer services. This prevents a deeper assessment of the "specialized tasks" through which economies compete in the digital era. Clearly, new ways of measuring value chains within the global digital economy will be needed to assess how competitive countries truly are in the digital economy.

Trade Liberalization

Increasing trade liberalization, including reducing tariffs and integrating more nations into the global trading system, has also spurred the expansion of GVCs. In fact, there are now well over 400 regional free trade agreements in place across the world, helping to reduce tariff rates and eliminate other trade barriers.[23] In part because of this, the global mean tariff rate applied to all products fell to 2.59 percent in 2017 from 6.82 percent in 1990, a decline of over 60 percent.[24] Moreover, a much larger share of global trade now occurs within the World Trade Organization's (WTO) rules-based framework, with 98 percent of world merchandise trade in 2017 taking place under WTO rules.[25]

"Real" trade balances are often different than they appear on a gross-value basis, inflating the size of some trading partners' surpluses and deflating the size of others.

TRADE LINKAGES WITH PARTNER COUNTRIES

This section explores U.S. bilateral trade linkages with three key trading partners—Mexico, Taiwan, and Korea—in depth. Many firms in these countries manage key "specialized tasks" within broader U.S. enterprise-driven ICT and automotive GVCs. There is no one single metric that evaluates the bilateral trade linkages and bilateral competitive position of two economies. Therefore, the following section will examine U.S. trade with the three partner countries through the following lenses (note that the reference years provided in these tables vary according to data availability, with the most recently available data being used wherever possible):

- Value-added trade balances
- Intra-industry trade in value added
- Composition of product trade in terms of capital, intermediate, or final goods
- Domestic value added as a share of countries' gross exports and imports
- Industry-level trade in value added with each partner country across six industries: automobiles, chemicals, computers and electronics, machinery, other transportation equipment (including aerospace), and pharmaceuticals
- Domestic value added as a share of gross exports and imports, by industry
- Intermediate and final goods trade linkages among countries, by industry

Value-Added Trade Balance

Value-added (VA) trade balance reflects the "real" trade balance the United States has with its bilateral trading partners. It is calculated as the value generated by the United States exported to another country that remains there, minus the "real" value generated by a foreign economy imported by the United States that remains here. Table 1 reflects the VA trade balance estimates in 2002 and 2014 for the three countries (2014 data was used because it was the most recent year value-added trade data was available for all three countries). The table contains three main categories:

- **Gross trade:** The gross trade balance between the country pair. This is simply total exports minus total imports.
- **VA-adjusted trade:** This is the estimate of the "real" trade balance. This is defined as the value directly exported to the trading partner that remains abroad plus value indirectly exported to the trading partner through an intermediary country that remains there, minus value imported from the trading partner that remains here plus value indirectly imported from the trading partner through intermediary countries that remains here. "Real" trade balances are often different than they appear on a gross-value basis, inflating the size of some trading partners' surpluses and deflating the size of others.
- **Intra-industry trade (VA-adjusted):** This is similar to the second category, but only counts intermediate goods trade from industry to industry (e.g., Taiwanese ICT firms purchasing components from U.S. ICT firms).

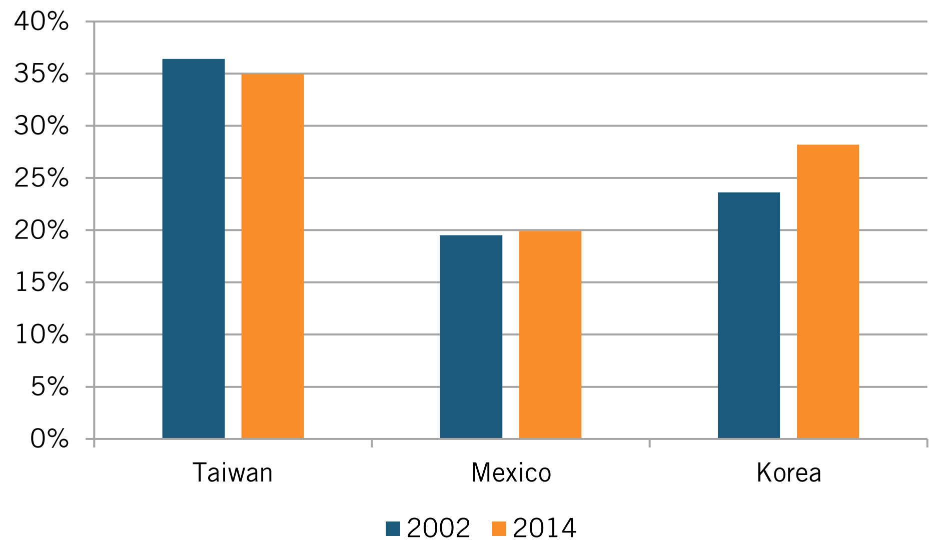
Table 1: U.S. Trade With Partner Nations, Adjusted by Value Added, 2002 and 2014 (Millions, 2014)[26]

		Gross			Value Added			Intra-industry		
Country	**Year**	**Exports**	**Imports**	**Balance**	**Exports**	**Imports**	**Balance**	**Exports**	**Imports**	**Balance**
Taiwan	2014	$24,088	$40,584	**-$16,496**	$16,415	$34,050	**-$17,635**	$5,304	$4,951	**$352**
Mexico	2014	$193,345	$293,916	**-$100,571**	$178,587	$267,366	**-$88,778**	$42,200	$29,078	**$13,123**
Korea	2014	$42,138	$68,679	**-$26,541**	$43,887	$78,341	**-$34,454**	$7,867	$9,300	**-$1,434**
Taiwan	2002	$21,457	$40,935	**-$19,478**	$17,052	$36,584	**-$19,532**	$6,249	$4,400	**$1,849**
Mexico	2002	$110,024	$171,362	**-$61,338**	$113,839	$169,043	**-$55,203**	$29,563	$16,534	**$13,029**
Korea	2002	$27,029	$45,123	**-$18,094**	$29,319	$47,452	**-$18,133**	$7,421	$4,421	**$3,000**

As table 1 shows, U.S. trade deficits in both gross terms and VA-trade terms widened from 2002 to 2014 with Mexico and Korea, while shrinking with Taiwan. The gross U.S. trade deficit with Taiwan fell from $19.5 billion in 2002 to $16.5 billion in 2014, while increasing with Korea from $18.1 billion to $26.5 billion, and with Mexico from $61.3 billion to $100.6 billion over this period. Comparing the gross trade balances with the respective VA trade-balance value for 2014, the United States had a slightly wider VA-adjusted trade deficit with Taiwan ($16.5 billion versus $17.6 billion) and Korea ($26.5 billion versus $34.5 billion), and a narrower VA-adjusted trade deficit with Mexico ($100.6 billion versus $88.8 billion). The VA figures reveal the United States is slightly less competitive against Taiwan and Korea, but somewhat more competitive against Mexico, than gross trade figures would suggest.

Examining the VA trade balance share of total trade provides context for the magnitude of the trade balance (it calculates the absolute value of the trade balance, and then divides it by the sum of imports and exports), as seen in figure 1. In 2002, the Taiwanese trade balance made up 36.4 percent of total Taiwan-U.S. trade, decreasing to 34.9 percent in 2014. The Mexican share increased from 19.5 percent to 19.9 percent; while the Korean share increased from 23.6 percent to 28.2 percent. These figures suggest the United States gained competitiveness against Taiwan because the trade balance relative to the volume of trade decreased. Meanwhile, the United States lost competitiveness against Mexico and Korea, but the losses were significantly smaller than the raw trade-balance data would suggest.

Figure 1: Value-Added Trade Balance as Percentage of Total Value-Added Trade[27]



Another aspect is the extent to which VA-adjusted imports and exports differ from their gross values. In 2014, Taiwan's VA exports were 68 percent of gross exports, and VA imports were 84 percent of gross imports; for Mexico, these shares were 92 percent and 91 percent, respectively; and for Korea, 104 percent and 114 percent, respectively. These figures suggest 32 percent of the value of gross U.S. exports to Taiwan come from imports to the U.S. or are ultimately sold in another nation. Just under 20 percent of gross imports to the United States from Taiwan constitute value from other countries that pass through Taiwanese products that make it to U.S. shores. For Mexico, the percentages are balanced at approximately 90 percent, meaning bilateral gross trade flows with Mexico closely reflect the true trade relationship. Korea presents an interesting case, wherein both VA exports and imports are higher than their respective gross values.

Conversely to Mexico's and Taiwan's, the VA data for Korea shows that it is consuming U.S. production indirectly through U.S.-value-laden imports from other countries. This could be ICT products designed and developed in the United States, but assembled in a third-party country and then exported to Korea. The United States, too, consumes 14 percent more value generated by Korea than what gross-trade figures reveal. These divergences present an interesting insight into ICT global value chains, which are centered around East Asia and the United States. In terms of VA trade data between Korea and

Taiwan, Korea appears as more of a hub for value creation and value demand, as expressed by its VA export and import data with the United States being much larger than the gross values. On the contrary, Taiwan serves as a "linking" country that focuses on slightly lower value-added activities to inputs and exchanging them in the global marketplace and within value chains.

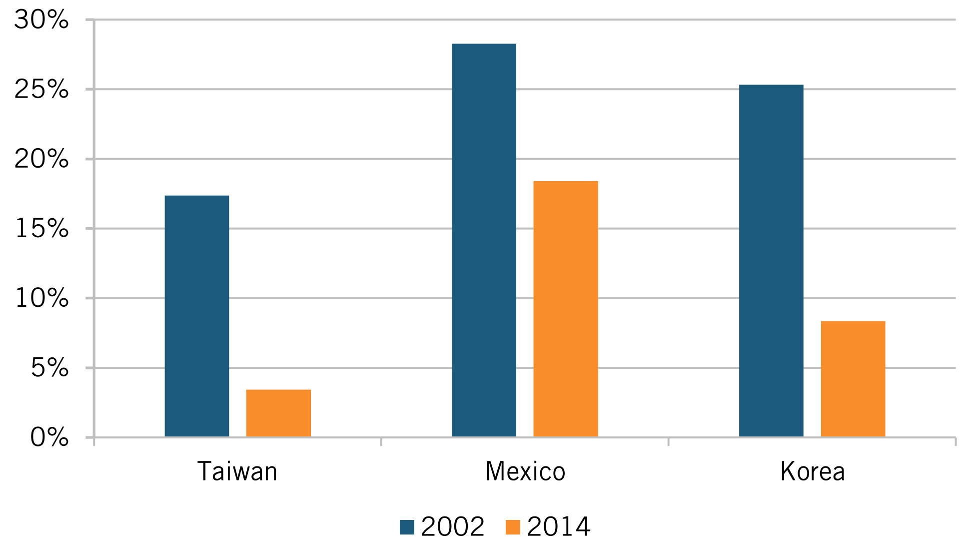
The third category provides yet another level of understanding VA-adjusted trade. This examines trade at the industry-to-industry level. In other words, what is the trading relationship between a U.S. industry and its foreign counterpart? (Put differently, what is the value in trade, for example, between the U.S. ICT industry buying Korean ICT parts, and the Korean ICT industry buying U.S. ICT parts?). This metric provides key details on industrial linkages between the partner countries. At the industry-to-industry level, the United States maintained a trade surplus in intermediate goods with Taiwan and Mexico from 2002 to 2014, and went from a surplus to a deficit with Korea over the same time period. (In 2002, U.S. firms exported more inputs to Korean firms than they imported; but by 2011, U.S. firms imported more inputs from Korean firms than they exported.) Taiwan's surplus with the United States narrowed from $1.4 billion in 2002 to $0.3 billion in 2014. A surplus means industries in partner countries are more reliant on key parts and components for production than the United States; the larger the surplus, the more dependent the partner country is on the United States for key inputs. As seen in figure 2, in 2002, the intra-industry trade balance accounted for 17 percent of intra-industry trade with Taiwan, 28 percent with Mexico, and 25 percent with Korea. By 2014, these values had decreased to 3.4 percent for Taiwan, 18 percent for Mexico, and 8.4 percent for Korea (a 34-point swing because the Korean intra-industry trade balance went from surplus to deficit).

At the industry-to-industry level, the United States maintained a trade surplus in intermediate goods with Taiwan and Mexico from 2002 to 2014.

Expressing intra-industry trade as a share of total value-added trade provides some sense of how closely linked the United States and its trading partners are. A greater share of total trade bundled up in critical components for industrial production suggests closer economic ties. In 2002, intra-industry trade accounted for 20 percent of U.S.-Taiwan VA trade, 16 percent for Mexico, and 15 percent for Korea. By 2014, this figure increased by 0.4 percent for Taiwan and decreased by 0.3 percent and 1.4 percent for Mexico and Korea, respectively. These statistics show U.S.-Taiwan industries are most closely linked, followed by Mexico and Korea, and that the U.S.-Taiwan and U.S.-Mexico relationships have been more stable than the U.S.-Korea relationship.

In summary, of the three partner countries, the United States has the closest industrial linkages with Taiwan, with a sizable share of bilateral trade occurring between firms within the same industry. Moreover, Taiwan and Mexico depend on the United States for critical inputs into their production processes; actually more so than the United States depends on them reciprocally, albeit less so than in 2002. Finally, the United States depends more on these partner countries for final products (although intermediate-goods imports remain vital, of course), while these partner countries (especially Taiwan and Mexico) depend more on the United States for key inputs to their production processes (e.g., U.S. exports of semiconductor manufacturing equipment to Taiwan).

Figure 2: Intra-industry Trade Balance as Percentage of Total Intra-industry Trade[28]



Examining intra-industry trade linkages reveals U.S.-Taiwan industries are most closely linked, followed by U.S. linkages with Mexican and Korean industries.

Trade in Intermediate Products

In general, products fall into one of three categories—capital goods such as machinery, consumption (final) goods such as smartphones, and production inputs (intermediate goods) such as steel plates. Deeper integration into GVCs means trade in inputs will increase much more than capital and consumption goods because countries are sourcing from a wider network of global suppliers, and production processes are becoming more complex, churning out products with more complicated features.

By this metric, the United States has not integrated itself more deeply into GVCs with the world as a whole from 2002 to 2017, with its exports becoming somewhat more focused on intermediate goods, and its imports becoming somewhat less focused on intermediate goods, increasing by 3 percent and decreasing by 5 percent, respectively, as table 2 shows. This suggests manufacturing in the United States has shifted toward the production of intermediate goods, which the United States is both exporting and using domestically, relying slightly less on intermediate imports.

Trade with Mexico has moved in the same direction as the United States' global trade, but the changes have been more pronounced. From 2002 to 2017, U.S. exports of intermediate goods to Mexico grew from 76 percent to 81 percent (of the total amount of exports). In absolute terms, the United States also exports 13 percent more intermediate goods to Mexico than its global average. Similarly, the proportion of intermediate goods in Mexican imports has decreased by 8 percent, such that U.S. imports from Mexico have slightly fewer intermediate goods than average. This indicates an increasingly one-sided relationship with Mexico, with Mexico relying more on U.S. inputs for its products than the United States relies less on Mexican inputs.

Table 2: U.S. Product Trade According to Broad Economic Categories, 2002 and 2017[29]

	World		Korea		Mexico		Taiwan	
	2002	2017	2002	2017	2002	2017	2002	2017
Exports								
Capital Goods	26%	21%	32%	28%	15%	14%	33%	28%
Intermediate Goods	65%	68%	63%	66%	76%	81%	63%	67%
Consumption Goods	9%	11%	5%	6%	9%	5%	4%	5%
Imports								
Capital Goods	21%	26%	28%	28%	28%	39%	39%	29%
Intermediate Goods	55%	50%	48%	62%	57%	49%	41%	55%
Consumption Goods	24%	24%	24%	10%	15%	12%	20%	16%

However, the metric demonstrates that the United States has become more integrated with Korea and Taiwan. U.S. exports to Korea and Taiwan have followed this overall trend, with intermediate goods accounting for 3 percent more exports to Korea and 4 percent more to Taiwan. Unlike the overall trend, though, Korea and Taiwan send much larger proportions of intermediate goods to the United States than they did in 2002, each increasing by 14 percentage points (48 percent to 62 percent and 41 percent to 55 percent, respectively), indicating GVCs with these two partners have grown much stronger over this period. Notably, the shift toward intermediate goods has come almost exclusively at the expense of consumption-goods imports in Korea, while most of the decline in Taiwan has been in capital goods. American enterprises' participation in global value chains with Korean and Taiwanese enterprises grew much stronger from 2002 to 2017.

Domestic Value Generated Found in Exports and Imports

The previous three metrics examined overall U.S. bilateral trade linkages with the three partner countries. This metric takes one step back to examine a country's economic linkage back to itself within the context of GVCs. As established in previous metrics, only a portion of a country's exports contain value generated by that country itself, with the rest consisting of inputs imported from foreign economies. Likewise, when a country imports goods, a certain share of gross imports consist of that country's intermediate goods once exported now returning to the country in the form of finished products or more-complicated production inputs. An example of this is smartphones: Semiconductors produced in the United States end up on smartphone assembly lines in Asia. Then these finished products are imported back to the United States.

This metric looks at one feature of trade linkages that is rarely examined: how a country's exports eventually flow back to itself to benefit its own consumers. ITIF has found that U.S. exports reflect less reliance on foreign inputs than do the exports of Mexico, Taiwan, and Korea. In other words, U.S. exports operate relatively independently of GVCs (compared with the three study countries, that is), utilizing higher levels of domestic inputs. In addition, goods imported by the United States contain a high share of value originally generated in the United States, relative to what Korea, Mexico, and Taiwan import. This suggests the more conventional measures of bilateral trade balances understate U.S. competitiveness, because U.S. exports have especially high levels of domestic value added, and U.S. imports often use inputs that were produced domestically.

Table 3: Domestic Value Added as a Share of Gross Exports and Imports[30]

	United States			Mexico			Taiwan			Korea		
Domestic VA as Share of Gross Exports	**2002**	**2011**	**Change**	**2002**	**2011**	**Change**	**2002**	**2011**	**Change**	**2002**	**2011**	**Change**
Economy Wide	89%	85%	-4%	67%	68%	2%	70%	57%	-14%	73%	58%	-14%
Manufacturing	84%	81%	-3%	56%	57%	0%	63%	49%	-14%	68%	53%	-15%
Domestic VA as Share of Gross Imports	**2002**	**2011**	**Change**	**2002**	**2011**	**Change**	**2002**	**2011**	**Change**	**2002**	**2011**	**Change**
Economy Wide	6.5%	4.6%	-1.9%	0.8%	1.1%	0.4%	0.8%	0.7%	-0.1%	0.8%	0.8%	0.0%
Manufacturing	9.1%	6.4%	-2.6%	0.9%	1.3%	0.4%	1.2%	1.0%	-0.2%	1.3%	1.4%	0.1%

As table 3 shows, from 2002 to 2011, the United States increased its participation in GVCs, with U.S. value added as a share of gross exports and gross imports both decreasing. Domestically generated value comprised a large share (85 percent) of U.S. gross exports in 2011, although it was down 4 percentage points from 2002. This suggests a greater reliance on foreign inputs used to produce exports. In 2011, U.S. gross imports derived 4.6 percent of their value from domestic value added, a decrease of approximately 2 percentage points since 2002, meaning the domestically created value of imports coming back into the United States fell by nearly one-third from 2002 to 2011. These trends coincide with what we know about greater GVC integration in the past decade: U.S.-exporting firms make use of more-competitive foreign inputs, and foreign firms exporting to the United States have a greater diversity of suppliers to import from and thus rely less on U.S. imports. The U.S. manufacturing sector does not differ much from the U.S. economy as a whole: 81 percent of gross U.S. manufacturing exports comprised value generated in the United States in 2011, while 6.4 percent of manufactured goods imports contain value that originated in the United States (down from 9.1 percent in 2002). Imported manufactured goods having a higher share of U.S.-value added than overall U.S. imports reveals the key importance of U.S. inputs within GVCs for manufactured products.

Because competitiveness is relative to other economies, ITIF examines how partner countries stack up against the United States. In general, exports from the three partner countries contain a much smaller share of domestically generated value added than exports from the United States. Only 68 percent of Mexican gross exports contain value generated by Mexican firms; 57 percent of Taiwanese gross export value is generated by Taiwanese firms; and 58 percent of Korean gross export value is generated by Korean firms. Likewise, a minimal share of goods these countries import contain components that originated from them. Returning Mexican value added in Mexican imports accounts for only 1.1 percent of total imports; returning Taiwanese value added accounts for 0.7 percent of total Taiwanese imports; and returning Korean value added accounts for 0.8 percent of Korean imports.

The data from these partner countries shows that their own linkages differ quite a bit from those of the United States.

Mexico's lower domestic value-added content share in gross exports than the United States did not change much from 2002 to 2011, much like the United States. This could be attributed to the economic linkages the North American Free Trade Agreement (NAFTA) precipitated in the 1990s and were solidified by the 2000s; thus, Mexico, already being integrated into the North American economy, did not expand its GVCs by as much.

Taiwan and Korea display similar trends in this metric, which would be expected from smaller economies that are less able to produce in a self-contained manner. In terms of their gross exports, in 2011, barely 60 percent of that value originated from their domestic firms. For both countries, this represents a substantial decrease of 14 percentage points from 2002, which coincides with the rise of deepening East Asian value chains during the 2000s. On the import front, these two countries' imports contain little value that originated from their own countries. This suggests Taiwan and Korea are producing input components for use within GVCs that are not as much meant for final goods production in Taiwan or Korea. In terms of manufacturing, Taiwanese and Korean participation in GVCs reveals only one-half of their gross exports contain value generated in their own country.

Chemical and ICT manufacturing exhibit the most-tightly linked industries in the U.S.-Taiwan bilateral trade relationship.

The United States is highly exposed to global economies, but the key thing is that a large percentage of its exports contain a substantial amount of U.S. value added And what America imports contains a relatively large proportion of U.S. value generated coming back into the country, more than four times higher than for any of the three trading partners. This typically reflects the value of U.S. design, R&D, etc. bundled up in imported goods.

Industry-Level Analysis

For advanced economies such as the United States', competitiveness depends in significant part on how well their technology-based industries perform. These industries are also key drivers of innovation and productivity growth. In this analysis, these industries include chemical manufacturing, pharmaceutical manufacturing, computer and electronics manufacturing, electrical equipment manufacturing, machinery manufacturing, automobile manufacturing, other transportation manufacturing (including aerospace), telecommunication services, computer programming and information services (also labeled as ICT services), and R&D services.[31] In the following metrics, analysis across all 10 industries depends on data availability.

Industry Value-Added Trade Balances

Similar to the analysis at the economy-wide level, an analysis of VA trade balances at the industry level provides insight as to the actual dollar value of goods and services for each of these industries that originates from the United States and remains here.

U.S.-Taiwan

Chemical and ICT manufacturing exhibit the most-tightly linked industries in the U.S.-Taiwan bilateral trade relationship. These two industries account for approximately one-third of two-way goods trade, and approximately one-half of industry-to-industry trade in inputs. In value-added terms, United States' goods imports from Taiwan in 2014 totaled $34 billion, and goods exports totaled $16 billion. Three industries account for approximately 40 percent of U.S. value-added goods exports to Taiwan: chemical manufacturing, ICT manufacturing, and machinery manufacturing. Four industries account for approximately 50 percent of U.S. value-added goods imports from Taiwan: chemical manufacturing, ICT manufacturing, machinery manufacturing, and automobile manufacturing. In terms of intra-industry trade, U.S. industries maintain a trade surplus of $352 million with Taiwanese industries, as table 4 shows.

Table 4: U.S. Trade With Taiwan, Adjusted by Value Added, 2014 (Millions)[32]

Taiwan	Gross			Value Added			Intra-industry		
Industry	Exports	Imports	Balance	Exports	Imports	Balance	Exports	Imports	Balance
TOTAL	$24,088	$40,584	-$16,496	$16,415	$34,050	-$17,635	$5,304	$4,951	$352
Chemicals	$3,346	$1,302	$2,044	$3,068	$2,891	$176	$1,875	$822	$1,053
Pharmaceuticals	$420	$202	$218	$267	$135	$132	$41	$3	$38
Computers and Electronics	$3,213	$15,554	-$12,341	$2,563	$8,274	-$5,711	$1,675	$1,015	$660
Machinery	$4,133	$3,628	$505	$985	$2,676	-$1,691	$264	$242	$22
Automobiles	$154	$2,345	-$2,191	$195	$2,558	-$2,363	$23	$1,353	-$1,329
Other Transportation (Including Aerospace)	$3,365	$1,333	$2,032	$812	$903	-$91	$488	$289	$199

Comparing gross trade flows against value-added flows, tech-based industries account for 63 percent of gross trade as compared with 54 percent when adjusted for value added. The composition of tech-based imports and exports in gross or value-added terms is similar (60 percent of both gross imports and exports are tech-based, while 48 percent of value-added exports and 51 percent of value-added imports are tech-based), which suggests tech-based products have equal importance in both export and import flows. This indicates Taiwan serves as a sort of a transition hub with some portion of traded goods intended to go to a third-party country, or Taiwanese firms add a small value component to a U.S. input before exporting it to another country. This is especially the case when comparing gross trade flows with value-added flows by industry.

As noted, ICT manufacturing plays a significant role in the Taiwanese economy and constitutes the main bulk of Taiwanese exports. In the U.S.-Taiwan bilateral relationship, the United States imported $15.5 billion and exported $3.2 billion of ICT in gross terms in 2014, while it imported $8.3 billion and exported $2.6 billion of ICT in value-added terms. This means about 20 percent of U.S. ICT exports to Taiwan transition through to another country, while half of the value of U.S. ICT imports from Taiwan are produced by another country and funneled through Taiwan to the United States; and America's ICT trade balance with Taiwan is not nearly in as much of a deficit as gross numbers suggest—a gross deficit of $12 billion compared with a value-added deficit of $5.7 billion. And although the United States runs a trade deficit with Taiwan in ICT manufacturing, Taiwanese ICT firms rely significantly on U.S. ICT firms for components, expressed as an intra-industry trade surplus of $660 million. Two-thirds of ICT exports to Taiwan are U.S. ICT firms producing components for Taiwanese ICT firms, whereas seven-eighths of ICT imports are geared toward U.S. end users rather than as components for U.S. ICT manufacturers. In other words, U.S. ICT firms produce key tech components for various ICT products, whereas Taiwanese ICT firms produce more end-use products for U.S. consumers.

America's ICT trade balance with Taiwan is not nearly in as much of a deficit as gross numbers suggest—a gross deficit of $12 billion compared with a value-added deficit of $5.7 billion.

Chemical, machinery, and automobile manufacturing form the second-tier of bilateral trade between the United States and Taiwan, with the chemical industry in particular closely linked. In 2014, U.S. gross chemical exports to Taiwan totaled $3.3 billion and gross imports totaled $1.3 billion; comparatively, U.S. value-added chemical exports totaled $3 billion and value-added imports totaled $2.9 billion. That value-added chemical import value more than doubles gross chemical import value means the chemical industry's involvement in bilateral trade is much larger than gross trade values suggest—as a large portion of U.S. chemical imports from other countries depend significantly on Taiwanese-made chemical inputs in their production. This also means the United States does not have as much of a trade surplus with Taiwan in chemicals as the gross trade values suggest: a gross chemical trade surplus of $2 billion, as compared with a value-added surplus of $176 million. Intra-industry chemical trade, at a $1 billion trade surplus, has the largest surplus among all intra-industry trade balances. This is more than five times the overall chemical value-added trade surplus. In other words, Taiwanese chemical manufacturers are much more dependent on sourcing for U.S. chemical inputs than the U.S. chemical firms sourcing inputs from Taiwan. Taiwan's machinery sector is more competitive than would be suggested by simply looking at the country's $500 million gross trade deficit with the United States in the sector.

At first glance, the United States holds a machinery trade surplus of $500 million based on gross trade flows; but in fact, there is a machinery trade deficit of $1.7 billion based on value-added flows. In terms of gross trade, the United States exports $4.1 billion in machinery to Taiwan and imports $3.6 billion, but most of these machinery exports do not remain in Taiwan. Examining the value-added trade flows, less than one-quarter of gross U.S. machinery exports to Taiwan remain there, with the value-added export value totaling less than $1 billion. Value-added imports totaled $2.6 billion, approximately two-thirds of the gross import value. In other words, the U.S. machinery manufacturing industry is in reality not as competitive against the Taiwanese machinery manufacturing industry as gross data would suggest. Although the United States and Taiwan conduct a sizable machinery trade, an intra-industry trade surplus of $22 million shows Taiwanese machinery firms are more dependent on U.S.-sourced inputs than U.S. firms sourcing inputs from Taiwanese machinery companies.

Automobile trade skews heavily in Taiwan's favor, regardless of gross trade flows or value-added trade flows. Value-added trade numbers show a slightly larger trade deficit of $2.4 billion compared with a gross deficit of $2.2 billion. Trade is largely one-way, with automobile imports totaling $2.5 billion and exports of only $200 million. Taiwanese automobile companies supply a significant number of inputs for U.S. automobile manufacturers, with U.S. imports for automobiles less concentrated in final products. This is evident from the intra-industry trade flows, wherein U.S. automakers source up to $1.3 billion in inputs from Taiwanese automobile manufacturers.

In summary, most Taiwanese firms occupy the upper-middle segment of GVCs, wherein production costs are low enough yet technological capabilities are sufficient enough to produce advanced products and intermediate components for other developed and more-advanced economies. Yet Taiwan still relies greatly on advanced economies such as the that of the United States to supply key sophisticated components for use within Taiwanese production processes, again showing the deep and complimentary nature of Taiwan-U.S. trade flows.

U.S.-Korea

Table 5 depicts U.S. trade with Korea, adjusted by value added, in 2014. Chemical, ICT, and machinery manufacturing represent the most-tightly linked industries in the U.S.-Korea bilateral relationship.

These three industries account for approximately one-third of two-way value-added goods trade, and approximately half of industry-to-industry trade in inputs. In value-added terms, in 2014, the United States' goods imports from Korea totaled $78 billion and goods exports totaled $44 billion. Korean automobile imports, valued at $21 billion, account for the largest category of imported products by the United States, or one-quarter of total value-added imports. The automobile industry is very one-sided, with U.S. automobile exports, valued at $1.1 billion, coming in next-to-last among exports of the six tech-based industries. Comparing gross trade flows against value-added flows, tech-based industries account for 63 percent of gross trade, and 54 percent once adjusted for value added.

But, within the composition of trade flows, tech-based trade is skewed more toward imports than exports. Tech-based industries account for 55 percent of gross exports and 68 percent of gross imports, and 39 percent of value-added exports and 62 percent of value-added imports. The value-added figures suggest a startling finding: The United States has rather weak tech-sector competitiveness relative to Korea. Yet, intra-industry trade shows Korea is very dependent on the United States for key inputs into its technology production (excluding the automobile industry). The data suggests Korea depends significantly on the United States for high-quality tech inputs to produce even better-quality products for sale to U.S. (and global) consumers.

Automobile trade comprises the largest component of U.S.-Korean bilateral trade, but is mainly one-sided, with U.S. consumers purchasing a significant number of Korean automobiles—approximately 20 times more in automobile value than the United States exports to Korea ($21 billion versus $1.1 billion). In addition, U.S. automakers import $3.2 billion in inputs from Korean automobile parts supply firms, which is approximately 10 times more than what they export in inputs to these same manufacturing firms. In comparing gross trade and value-added trade, the United States actually exports less and imports more in Korean automobile value added. This is likely due to automakers in other countries using Korean components for products shipped to the United States. This is an important sector wherein the United States could increase its competitiveness vis-à-vis Korea.

Table 5: U.S. Trade With Korea, Adjusted by Value Added, 2014 (Millions)[33]

Korea	Gross			Value Added			Intra-industry		
Industry	**Exports**	**Imports**	**Balance**	**Exports**	**Imports**	**Balance**	**Exports**	**Imports**	**Balance**
TOTAL	$42,138	$68,679	-$26,541	$43,887	$78,341	-$34,454	$7,867	$9,300	-$1,434
Chemicals	$5,542	$2,653	$2,889	$5,143	$6,439	-$1,296	$1,974	$1,662	$312
Pharmaceuticals	$1,217	$119	$1,098	$858	$92	$766	$184	$3	$181
Computers and Electronics	$5,645	$16,363	-$10,717	$4,005	$14,652	-$10,647	$2,236	$1,411	$825
Machinery	$6,019	$5,901	$118	$3,851	$5,065	-$1,214	$500	$378	$121
Automobiles	$1,587	$20,866	-$19,280	$1,106	$21,246	-$20,140	$297	$3,217	-$2,920
Other Transportation (Including Aerospace)	$3,374	$970	$2,405	$2,273	$1,606	$666	$1,112	$314	$797

Second to the automotive industry, ICT manufacturing drives the next-largest portion of bilateral trade. Measured in either gross terms or value-added terms, the U.S.-Korea ICT trade deficit totaled approximately $11 billion in 2014. In value-added terms, the United States imports $14.6 billion in ICT and exports $4 billion in ICT each year. The lack of U.S. competitiveness compared with the Korean ICT industry presents various interesting dynamics about U.S. ICT competitiveness vis-à-vis Korea, wherein Korea's ICT companies—such as Samsung—occupy a similar position in GVCs when compared with large U.S. ICT firms, wherein large ICT firms capture the largest share of GVCs by specializing in R&D, some crucial elements of the production process, retail, and distribution. But with U.S. ICT brands popular in Korea, why is there such a large deficit? Examining intra-industry trade, it is clear that when considering inputs, Korean ICT firms are more dependent on U.S. ICT firms for components and inputs than vice versa. U.S. ICT firms export $2.2 billion and import $1.4 billion annually from Korean ICT firms, resulting in an intra-industry surplus. Therefore, the main driver of the overall ICT deficit with Korea can be chalked up to capital and final products purchased by end users in the United States. After factoring out intra-industry trade (i.e., inputs traded between ICT firms), the United States exports approximately $2 billion in end-use goods to Korea and imports $13 billion—a difference of a factor of six. Given that the United States has a population six times greater than that of Korea, this deficit in ICT could be interpreted as Korean ICT final products in the United States being just as popular as U.S. ICT products in Korea.

The chemical manufacturing and machinery manufacturing industries display similar trends. Measured in gross terms, the United States holds a trade surplus in both of these industries, but when measured in value-added terms, the United States holds a trade deficit. This occurs because, in reality, the United States imports substantially more chemicals from Korea (with these chemicals used in the production of other products that eventually land in the United States); further, the United States exports significantly fewer machines to Korea, with these machines ultimately ending up in a country other than Korea. In value-added terms, the United States exports $5.1 billion in chemicals and imports $6.4 billion, resulting in a chemical deficit of $1.3 billion; it exports $3.8 billion in machinery and imports $5 billion, resulting in a machinery deficit of $1.2 billion.

Korea depends significantly on high-quality tech inputs from the United States to produce even better-quality products for sale to U.S. (and global) consumers.

In summary, the United States has a mixed competitive picture with regard to Korea. It holds a surplus in pharmaceuticals and other transportation goods. Korea, as a leading advanced economy similar to that of the United States, has countless firms that operate in similar positions within GVCs and compete with U.S. firms in similar technological products and markets. Such global competition is key to driving innovation further ahead. However, on an intra-industry basis, U.S.-Korea bilateral trade linkages show that Korean firms depend heavily on U.S. inputs within their own production processes. Across the six tech-based industries studied, the United States holds a surplus in five.

U.S.-Mexico

Signed in 1994, NAFTA deepened trade linkages across North America. In particular, the machinery, ICT, and automobile industries are deeply linked and account for approximately 40 percent of two-way value-added goods trade and more than one-half of industry-to-industry input trade. In value-added terms, the United States' goods imports from Mexico totaled $267 billion and goods exports totaled $178 billion in 2014, as table 6 shows. Weak relative competitiveness in machinery, ICT, and automobiles mainly stem from U.S. firms locating their manufacturing processes in Mexico due to lower labor-unit costs which results in cheaper U.S.-branded tech products for U.S. consumers.

Comparing gross trade flows against value-added flows, tech-based industries make up 50 percent of gross trade and 48 percent once adjusted for value added. But, within the composition of trade flows, tech-based trade is skewed more toward imports than exports. Tech-based industries account for 42 percent of gross exports and 56 percent of gross imports, and 45 percent of value-added exports and 49 percent of value-added imports. These figures show exports to Mexico are more tech-based and imports less tech-based than gross values suggest. In general, trade with Mexico is less tech-based, but the United States depends on Mexican production facilities in large part to supply cheap tech-based products for consumers.

Table 6: U.S. Trade With Mexico, Adjusted by Value Added, 2014 (Millions)[34]

Mexico	Gross			Value Added			Intra-industry		
Industry	**Exports**	**Imports**	**Balance**	**Exports**	**Imports**	**Balance**	**Exports**	**Imports**	**Balance**
TOTAL	$193,345	$293,916	-$100,571	$178,587	$267,366	-$88,778	$42,200	$29,078	$13,123
Chemicals	$22,208	$5,499	$16,709	$23,099	$7,019	$16,080	$6,113	$1,559	$4,554
Pharmaceuticals	$1,628	$327	$1,301	$1,646	$277	$1,369	$70	$5	$65
Computers and Electronics	$14,504	$51,281	-$36,777	$16,867	$44,530	-$27,662	$8,858	$1,995	$6,863
Machinery	$18,231	$17,217	$1,014	$17,306	$18,931	-$1,625	$1,151	$2,132	-$981
Automobiles	$21,697	$86,986	-$65,289	$18,739	$56,295	-$37,556	$10,126	$12,514	-$2,389
Other Transportation (Including Aerospace)	$4,218	$2,700	$1,518	$3,367	$5,364	-$1,998	$812	$1,931	-$1,119

U.S.-Mexico trade linkages hinge on the ICT and automobile industries. These two industries account for one-third of imports. In value-added terms, the United States exports $16.8 billion and imports $44.5 billion in ICT, and exports $18.7 billion and imports $56.3 billion in automobiles. This results in an ICT deficit of $27.7 billion and an automobile deficit of $37.6 billion. It is important to note that value-added imports for ICT and automobiles have much smaller values than gross imports. This is mainly due to Mexico's position in GVCs as a production hub, similar to China's. In other words, a significant portion of Mexico's tech-based exports contain the value of inputs that come from other countries.

There is a slight difference when comparing gross and value-added U.S. exports with those from Mexico. The United States exports more in ICT to Mexico when measured by value added. This results in GVCs and U.S. ICT components contained in the ICT products being exported to Mexico from the rest of the world. Meanwhile, U.S. automobile exports to Mexico are much smaller in value-added terms than gross terms. This is due to the North American automobile value chain, wherein U.S. automobile exports to Mexico contain a fair number of components from Canada. Most of Mexico's automobile and ICT exports are final goods meant for end users. Examining intra-industry trade, U.S. ICT firms maintain a healthy surplus of $6.8 billion with Mexican ICT firms, while U.S. automobile firms hold a deficit of $2.4 billion against Mexican automobile firms. The importance of Mexico within North American value chains is quite clear when examining intra-industry trade. More than half of U.S. ICT and automobile exports come from ICT firms selling inputs to their Mexican counterparts. On the import side, Mexican ICT and automobile firms sell few inputs to their U.S. counterparts (although the automobile industry maintains a small intra-industry deficit). Overall, however, this illustrates the reality of North American automobile value chains, wherein automobile components move between North American countries multiple times before being assembled into a final product. In fact, automobile parts and inputs may cross the U.S-Mexico border as many as eight times as they are being refined and produced.[35]

Machinery trade is another closely linked industry, with the United States exporting $17.3 billion and importing $18.9 billion. Although machinery trade leans toward a value-added deficit of $1.6 billion, the similar machinery export and import values suggest that both the United States and Mexico produce very specific types of machines the other partly relies upon. Intra-industry trade in the machinery industry accounts for a small share of bilateral machinery trade, which further supports the suggestion that the United States and Mexico are trading finished machinery that either country specializes in producing.

In summary, Mexico plays a vital role in North American value chains, especially in ICT, automobiles, and other transportation industries. The trade deficit the United States maintains with Mexico can partially be attributed to the United States taking advantage of lower labor-unit costs in Mexico to produce more competitive products for the American market. While the United States depends on Mexico for a lower-cost production environment, Mexican firms source a large number of inputs from U.S. firms, as established by robust intra-industry trade surplus levels.

Examining intra-industry trade, U.S. ICT firms maintain a healthy surplus of $6.8 billion with Mexican ICT firms.

Domestic Value Generated Found in Exports and Imports, by Industry

Deepening GVCs lead to countries' exports containing value from a more diverse range of sources. Some industries may be more plugged into GVCs than others. As highlighted in the previous section, these industry differences also differ by country. Domestic value added as a share of gross exports highlights the extent of foreign inputs used in exported goods, and domestic value added as a share of gross imports highlights inputs made in the domestic country, exported for further refinement or for use as an input, and imported back to the domestic country. Many factors influence how firms located in different countries establish themselves along GVCs, such as transportation networks, the presence of supporting industries, and market access, among many others.

As table 7—which shows domestic value added as a share of gross exports, by industry, from 2002 and 2011—illustrates, most industries in the study countries have integrated themselves more deeply into GVCs. In general, services industries contain a much larger share of domestic value added than goods industries. This is due to services industries historically being labor-intensive rather than capital-intensive (and also because barriers such as licensing have historically made services trade more difficult). Many countries experienced dramatic economic growth during this period, leading to more competitive global industries. This is evident in the decrease in U.S. value added returning to the United States in imports from other countries. Simply put, as industries in other economies developed, their products became more competitive and, as such, foreign firms did not need to rely on U.S. inputs as much as before.

Focusing on the ICT and automobile manufacturing industries reveals interesting trends. Over that same 10-year period, U.S. ICT manufacturing firms relied slightly less on foreign inputs for production. This is not indicative of U.S. firms pulling out of GVCs, but rather them concentrating their activities on higher-value-added activities such as R&D; producing key inputs such as semiconductors; or distributing while outsourcing lower-value-added manufacturing activities to either their affiliates in other countries or contracting that work out. From 2002 to 2011, the share of domestic value added embodied in gross U.S. ICT exports increased 7 percentage points, from 80 percent to 87 percent. In addition, the value of U.S.-made ICT content returning to the United States as a share of gross imports decreased from 11.5 percent to 6.7 percent.

The automobile industry played a central role in establishing value chains across North America. This is evident in the U.S. automobile industry having the smallest share of U.S.-generated value across the industries (due to these exports containing significant Mexican and Canadian automobile inputs). In 2002, three-quarters of gross automobile exports consisted of U.S.-generated value, with this share decreasing to 65 percent by 2011—the lowest share among the tech-industries. This indicates that ever-deeper North American automobile trade linkages developed. The share of domestic value-added content in other transportation (including aerospace) fell by 5 percent over this period, which, although a slight decline, likely reflects the increasing globalization of aerospace supply chains. For instance, 70 percent of the parts for Boeing's 787 Dreamliner are now manufactured in the United States, while 30 percent are contributed by international partners.[36]

Table 7: Domestic Value Added as a Share of Gross Exports, by Industry, 2002 and 2011[37]

Domestic VA as Share of Gross Exports	United States			Mexico			Taiwan			Korea		
	2002	2011	Change	2002	2011	Change	2002	2011	Change	2002	2011	Change
Economy Wide	89%	85%	-4%	67%	68%	2%	70%	57%	-14%	73%	58%	-14%
Manufacturing	84%	81%	-3%	56%	57%	0%	63%	49%	-14%	68%	53%	-15%
Chemical Manufacturing (Including Pharmaceuticals)	88%	82%	-6%	83%	74%	-9%	63%	41%	-21%	66%	47%	-19%
ICT Manufacturing	80%	87%	7%	37%	36%	-1%	59%	55%	-3%	66%	58%	-8%
Electrical Machinery	85%	78%	-8%	56%	52%	-4%	61%	50%	-11%	74%	62%	-13%
Automobiles	76%	65%	-12%	54%	50%	-3%	72%	52%	-20%	73%	62%	-10%
Other Transportation (Including Aerospace)	83%	78%	-5%	68%	67%	-1%	69%	53%	-16%	72%	62%	-11%
ICT Services	96%	95%	-2%	97%	97%	0%	86%	84%	-3%	88%	83%	-5%
R&D Services	97%	96%	-2%	95%	97%	2%	87%	84%	-2%	92%	86%	-6%

Table 7 contains some other interesting insights. Manufacturing exemplifies below-average levels of economy-wide domestic VA for all four countries, though most significantly so for Taiwan and Mexico. Further, while the share of domestic value added in manufacturing exports did not undergo significant changes in the United States and Mexico between 2002 and 2011, Taiwan and Korea experienced large declines, falling below Mexico. In Taiwan, domestic value added as a share of manufacturing gross exports fell 14 percentage points from 2002 to 2011 (63 percent to 49 percent) while Korea's fell by a similar level of 15 percentage points (from 68 percent to 53 percent). That this decline was considerably steeper than the United States', while Mexico's remained even, may indicate some loss of competitiveness of Taiwanese and Korean manufacturing industries over this period, perhaps suggesting that in some cases key manufacturing inputs which were previously produced in these countries may have been displaced by foreign competitors (China being the most likely culprit).

ICT manufacturing is the only sector in which the United States increased its domestic VA share from 2002 to 2011, while Mexico's level of domestic value added in ICT manufacturing remained constant. However, its extent of domestic value added as a share of gross exports in ICT manufacturing, at 37 percent, was about half its economy-wide level for domestic value contribution in exports. Korea experienced an 8 percentage point decline in domestic value added in ICT manufacturing from 2002 to 2011, while Taiwan experienced a 3 percentage point decline, although these declines were less than economy-wide losses.

Automobile manufacturing experienced very large declines in all countries except for Mexico, especially in the United States and Taiwan. From 2002 to 2011, domestic value added as a share of gross automotive exports declined by 20 percentage points in Taiwan, 10 in Korea, and 3 in Mexico. Chemical manufacturing declined relative to the economy-wide average in every country, with the largest declines in Taiwan and Korea. Electrical machinery manufacturing's share of domestic value added experienced declines in all countries, with Taiwan and Korea again experiencing the largest declines. Other transportation manufacturing did not deviate significantly from economy-wide trends, with the United States and Taiwan being somewhat less domestic-focused than average and Korea being somewhat more domestic-focused. ICT and R&D services saw much higher rates of domestic value added than other industries (over 90 percent in the United States and Mexico and almost 90 percent in Taiwan), in part due to the reality of less-developed services in global value chains.

Table 8 shows domestic value added as a share of gross imports, by industry, in 2002 and 2011. On an economy-wide level, this decreased 1.9 percent for the United States, increased 0.4 percent for Mexico, and was virtually unchanged for Korea and Taiwan. The share of domestic value added for incoming manufactured goods declined by 2.6 percentage points for the United States, a decrease of 30 percent since 2002. However, America's share of domestic value added for incoming manufactured goods still remained over four times as high as that of the study countries.

Table 8: Domestic Value Added as a Share of Gross Imports by Industry, 2002 and 2011[38]

Domestic VA as Share of Gross Imports	United States			Mexico			Taiwan			Korea		
	2002	2011	Change	2002	2011	Change	2002	2011	Change	2002	2011	Change
Economy Wide	6.5%	4.6%	-1.9%	0.8%	1.1%	0.4%	0.8%	0.7%	-0.1%	0.8%	0.8%	0.0%
Manufacturing	9.1%	6.4%	-2.6%	0.9%	1.3%	0.4%	1.2%	1.0%	-0.2%	1.3%	1.4%	0.1%
Chemical Manufacturing (Including Pharmaceuticals)	5.6%	6.7%	1.1%	0.5%	0.7%	0.2%	0.6%	0.6%	0.0%	0.8%	1.0%	0.2%
ICT Manufacturing	11.5%	6.7%	-4.8%	0.9%	0.4%	-0.5%	1.9%	2.5%	0.6%	2.3%	3.4%	1.1%
Electrical Machinery	11.6%	7.4%	-4.2%	1.0%	1.1%	0.1%	1.9%	1.3%	-0.7%	2.0%	2.6%	0.6%
Automobiles	15.0%	11.7%	-3.3%	1.6%	2.4%	0.8%	0.5%	0.4%	-0.1%	0.7%	1.0%	0.4%
Other Transportation (Including Aerospace)	8.7%	6.1%	-2.5%	0.7%	0.9%	0.2%	0.7%	0.7%	0.0%	1.0%	1.7%	0.7%
ICT Services	2.4%	3.5%	1.1%	0.2%	0.2%	0.0%	0.2%	0.3%	0.0%	0.2%	0.4%	0.2%
R&D Services	2.2%	2.2%	0.0%	0.2%	0.2%	0.0%	0.3%	0.2%	-0.1%	0.3%	0.4%	0.1%

America's domestic value-added share of incoming ICT manufacturing goods fell by 4.8 percentage points (from 11.5 percent to 6.7 percent, a decline of just under half), while Mexico experienced a decline of roughly half. Conversely, Korea's levels of domestic value added of ICT manufactured goods imports grew by 1.1 percent while Taiwan's grew by 0.6 percent. Taiwan's largest decline in terms of domestic value added as a share of gross imports came in electrical machinery manufacturing (a 0.7 percent decline) whereas its largest increase came in the aforementioned ICT manufactured goods. Value added in automotive imports fell significantly for the United States (a 3.3 percentage point decline from 15.0 to 11.7 percent), whereas Mexico experienced a 0.8 percent increase on this indicator, and Taiwan was mostly flat. Other transportation manufacturing grew significantly in Korea, was stable in Mexico and Taiwan, and fell significantly in the United States. Original domestic contributions in ICT and R&D services imports were vastly below average across the board, bordering on nonexistent, except in the United States, although ICT services in the United States grew by 1.1 percent.

Relative Importance of Traded Value

A good bilateral trading relationship is one in which trade between the two countries mutually supports each other's production, competitiveness, and consumption. This metric is split into two. One is for production, one is for consumption. This is a key delineator, as the United States benefits from trade in part to stimulate competition that drives low-price consumption, whereas the partner country depends on trade, especially for export-led growth.

This indicator analyzes whether trade in a given industry's inputs leans more heavily toward the United States or one of its partner nations. In other words, it evaluates how dependent a U.S. tech-based industry is on a partner country for inputs. Across 10 tech-based industries, and with each partner country, ITIF examined three metrics:

1. **Imports as a share of imported intermediate goods:** This refers to U.S. intermediate imports from a partner country in a given tech-based industry as a share of total intermediate imports from that country. In other words, how important a partner country is as a source of components and inputs for production in a given tech-based industry.
2. **Exports as a share of exported intermediate goods:** This refers to U.S. intermediate exports to a partner country in a given tech-based industry as a share of total intermediate exports to that country. In other words, how important the United States is as a source of components and inputs for a partner nation's production in a given tech-based industry.
3. **Linkage factor:** Metric 2 divided by metric 1, which describes whether trade in intermediate components within a given industry is more critical for the United State or the partner country. A value of 1 means the relationship is even—the United States depends just as much on its partner for sourcing components and inputs as does the partner country on the United States. A value closer to 0 means the U.S. industry is more dependent on its partner nation's industry for inputs, and a value much greater than 0 means a partner nation's industry is more dependent on the United States for its inputs.

Table 9 analyzes intermediate goods trade linkages between the United States and partner countries, by industry, in 2014. Using the Taiwan-United States pair as an example, the first column means intermediate goods imports from each Taiwanese industry for U.S. production as a share of total intermediate goods imported from Taiwan; the second column means intermediate goods exported from the U.S. industry to Taiwan for their production as a share of total intermediate goods exports to Taiwan; the third column is the linkage factor, wherein the higher the value above 1, Taiwan's industry is more dependent on U.S. inputs than the U.S. industry is dependent on Taiwanese inputs. The closer the number is to 0, the more dependent the U.S. industry is on Taiwanese inputs within the trade relationship.

Table 9 reveals that Mexican, Korean, and Taiwanese pharmaceutical and chemical manufacturing industries depend greatly on American counterpart industries for key intermediate goods inputs, showing the highest linkage factors of all studied goods industries. One-quarter of U.S. intermediate goods exports to Taiwan are in chemical manufacturing, followed by 16 percent in ICT manufacturing. This again reiterates the findings from this report revealing the strong intra-industry trade linkages between the United States and Taiwan.

Table 9: Intermediate Goods Trade Linkages Between U.S. and Partner Countries, by Industry, 2014[39]

	Taiwan			Mexico			Korea		
U.S. Trade Relation With Partner Country	Imports as a Share of Imported Intermediate Goods	Exports as a Share of Exported Intermediate Goods	**Linkage Factor**	Imports as a Share of Imported Intermediate Goods	Exports as a Share of Exported Intermediate Goods	**Linkage Factor**	Imports as a Share of Imported Intermediate Goods	Exports as a Share of Exported Intermediate Goods	**Linkage Factor**
Chemical Manufacturing	11.30%	24.67%	2.18	3.97%	15.95%	4.02	13.50%	14.79%	1.10
Pharmaceutical Manufacturing	0.13%	1.42%	10.91	0.04%	0.44%	11.92	0.09%	2.47%	26.39
ICT Manufacturing	25.64%	16.36%	0.64	10.35%	10.13%	0.98	19.78%	10.58%	0.53
Electrical Equipment Manufacturing	3.68%	1.76%	0.48	8.25%	4.86%	0.59	2.35%	1.19%	0.51
Machinery Manufacturing	4.48%	4.71%	1.05	7.33%	6.45%	0.88	4.06%	5.38%	1.33
Automobile Manufacturing	9.56%	0.33%	0.03	16.39%	11.22%	0.68	12.56%	1.42%	0.11
Other Transportation Manufacturing (Including Aerospace)	2.05%	5.33%	2.60	2.55%	1.64%	0.65	2.07%	6.05%	2.92
Telecommuni-cation Services	0.00%	0.06%	-	0.00%	0.02%	-	0.00%	2.72%	-
ICT Services	0.01%	0.09%	14.65	0.00%	0.00%	-	0.00%	0.65%	-
Research and Development Services	0.00%	0.00%	-	0.00%	0.00%	-	2.39%	0.84%	0.35

Conversely, over one-quarter of the intermediate goods the United States imports from Taiwan are in ICT manufacturing—the highest share for any industry—followed by U.S. imports of Taiwanese-produced chemical manufacturing intermediate goods. As with Taiwan, ICT manufacturing accounts for the largest industrial share of Korean imports coming into the United States, followed by chemical manufacturing and automotive intermediate goods. ICT manufacturing comprises a large portion of trade for each partner. Mexico and Korea import comparable proportions of ICT products, but Korea exports nearly twice as much as Mexico, with Mexico near parity, but Korea's ICT trade significantly skewed in its favor. Taiwan imports and exports about 6 percentage points more than Korea, leading to a less skewed linkage factor.

Chemical manufacturing represents a substantial U.S. export to all three trade partners and is a large import from Taiwan and Korea. Here, Korea is near parity with a linkage factor of 1.10, while Taiwan's gap is larger, as it imports significantly more chemicals from the

United States, and Mexico does not export a significant amount. Electrical equipment manufacturing is a fairly small source of trade with Taiwan and Korea, with each exporting twice as much to the United States as the United States does to them. Here, Mexico has a similar linkage factor but engages in three times as much trade as Taiwan and Korea.

Table 10 depicts where intermediate goods trade linkages stood in 2002, revealing the ways in which trade changed in this regard from 2002 to 2014.

Table 10: Intermediate Goods Trade Linkage Between United States and Partner Countries, by Industry, 2002[40]

	Taiwan			Mexico			Korea		
U.S. Trade Relation With Partner Country	Imports as a Share of Imported Intermediate Goods	Exports as a Share of Exported Intermediate Goods	**Linkage Factor**	Imports as a Share of Imported Intermediate Goods	Exports as a Share of Exported Intermediate Goods	**Linkage Factor**	Imports as a Share of Imported Intermediate Goods	Exports as a Share of Exported Intermediate Goods	**Linkage Factor**
Chemical Manufacturing	5.22%	19.03%	3.64	3.76%	11.41%	3.04	9.59%	15.26%	1.59
Pharmaceutical Manufacturing	0.09%	1.23%	13.07	0.07%	0.37%	5.15	0.19%	0.56%	2.96
ICT Manufacturing	33.96%	40.70%	1.20	8.64%	17.90%	2.07	31.56%	23.82%	0.75
Electrical Equipment Manufacturing	4.13%	1.16%	0.28	8.83%	8.83%	1.00	1.72%	0.94%	0.54
Machinery Manufacturing	5.69%	5.45%	0.96	3.81%	4.82%	1.27	3.62%	4.48%	1.24
Automobile Manufacturing	7.08%	0.86%	0.12	20.97%	13.83%	0.66	4.96%	1.52%	0.31
Other Transportation Manufacturing (Including Aerospace)	1.28%	0.85%	0.67	1.40%	0.61%	0.43	0.89%	6.97%	7.81
Telecommunication Services	0.00%	0.04%	-	0.01%	0.09%	-	0.01%	1.85%	211.27
ICT Services	0.00%	0.04%	-	0.00%	0.00%	-	0.00%	0.19%	-
Research and Development Services	0.00%	0.00%	-	0.01%	0.11%	7.68	2.33%	5.35%	2.30

In 2002, ICT manufacturing constituted a much larger portion of U.S. trade in both directions, with imports from Korea and both imports from and exports to Taiwan representing a higher proportion of trade than any other industry. Imports from Mexico were the only field in which ICT manufacturing grew proportionate to total trade from 2002 to 2014. Linkage factors decreased with all partners, falling by nearly one-third with Korea and by half with Taiwan and Mexico, causing U.S. ICT manufacturing to become more reliant on each nation than it was on the United States by 2014.

U.S. chemical manufacturing exports to Taiwan and Mexico grew significantly over this period, from 19 percent to 25 percent, and 11 percent to 16 percent of intermediate goods exports, respectively, while exports to Korea held steady at 15 percent. Imports from Taiwan and Korea also grew dramatically, as chemical manufacturing's proportion of imports increased by 41 percent in Korea and 116 percent in Taiwan. Thus, while each nation's chemical manufacturing sector is still more reliant on U.S. chemical manufacturing than the United States is on each trade partner, trade in the sector has become more balanced.

The opposite has occurred in automotive manufacturing, wherein linkage factors already skewed toward U.S. dependence have moved further in that direction. Relative imports from and exports to Mexico have both fallen by about one-quarter over the last decade, leaving the linkage factor relatively unchanged. However, while automotive exports to Taiwan and Korea have fallen marginally, Taiwanese exports increased by 35 percent and Korean exports by 153 percent.

Table 11 assesses final goods (as opposed to intermediate goods) trade linkages between the United States and partner countries in 2014. Again, the very strong linkages between the United States and the partner countries are apparent especially in the pharmaceutical and chemical manufacturing industries. These industries are heavily in America's favor, meaning partner countries depend much more on the United States for these final products than the United States depends on them. The deep linkages between these nations in ICT manufacturing are, again, also readily apparent. As a share of all U.S. final goods imports, nearly 23 percent from Mexico, 21 percent from Taiwan, and 17.2 percent from Korea are in ICT manufacturing.

Automobile manufacturing constitutes Korea's greatest final goods exports to America, with nearly half, 46.4 percent, of Korean exports of final goods coming to the United States consisting of automobiles (or related automotive products). This figure is also very high for Mexico, for which automotive goods account for over one-quarter of exports to America.

Table 11: Final Goods Trade Linkage Between U.S. and Partner Countries, by Industry, 2014[41]

	Taiwan			Mexico			Korea		
U.S. Trade Relation With Partner Country	Imports as a Share of Imported Intermediate Goods	Exports as a Share of Exported Intermediate Goods	**Linkage Factor**	Imports as a Share of Imported Intermediate Goods	Exports as a Share of Exported Intermediate Goods	**Linkage Factor**	Imports as a Share of Imported Intermediate Goods	Exports as a Share of Exported Intermediate Goods	**Linkage Factor**
Chemical Manufacturing	1.31%	3.18%	2.43	1.31%	3.26%	2.49	1.23%	4.94%	4.01
Pharmaceutical Manufacturing	1.08%	2.15%	1.99	0.17%	2.46%	14.58	0.15%	0.81%	5.50
ICT Manufacturing	20.88%	13.69%	0.66	22.82%	7.24%	0.32	17.27%	5.91%	0.34
Electrical Equipment Manufacturing	7.24%	2.29%	0.32	7.34%	2.64%	0.36	5.20%	1.58%	0.30
Machinery Manufacturing	16.48%	9.35%	0.57	6.84%	20.08%	2.94	9.65%	16.25%	1.68
Automobile Manufacturing	2.28%	3.40%	1.49	25.62%	8.15%	0.32	46.39%	4.95%	0.11
Other Transportation Manufacturing (Including Aerospace)	4.18%	3.94%	0.94	1.48%	2.66%	1.80	2.02%	3.25%	1.61
Telecommuni-cation Services	0.00%	0.10%	-	0.00%	0.03%	-	0.00%	3.60%	-
ICT Services	0.01%	0.33%	43.04	0.00%	0.00%	-	0.00%	0.98%	-
Research and Development Services	0.00%	0.00%	-	0.00%	0.00%	-	1.59%	20.83%	13.13

Table 12 provides historical context for the data in table 11, in a manner analogous to table 10, providing insight into how each economy has evolved in terms of final goods trade linkages since 2002.

Table 12: Final Goods Trade Linkage Between U.S. and Partner Countries, by Industry, 2002[42]

	Taiwan			Mexico			Korea		
U.S. Trade Relation With Partner Country	Imports as a Share of Imported Intermediate Goods	Exports as a Share of Exported Intermediate Goods	**Linkage Factor**	Imports as a Share of Imported Intermediate Goods	Exports as a Share of Exported Intermediate Goods	**Linkage Factor**	Imports as a Share of Imported Intermediate Goods	Exports as a Share of Exported Intermediate Goods	**Linkage Factor**
Chemical Manufacturing	0.38%	1.21%	3.16	0.40%	2.45%	6.14	0.29%	0.32%	1.10
Pharmaceutical Manufacturing	0.11%	0.30%	2.63	0.36%	3.36%	9.33	0.18%	1.65%	9.21
ICT Manufacturing	49.11%	10.35%	0.21	33.71%	13.57%	0.40	35.25%	21.12%	0.60
Electrical Equipment Manufacturing	3.25%	2.12%	0.65	5.45%	4.91%	0.90	3.40%	1.15%	0.34
Machinery Manufacturing	9.33%	43.50%	4.66	1.64%	15.48%	9.42	3.98%	18.55%	4.66
Automobile Manufacturing	1.31%	1.25%	0.96	25.37%	14.71%	0.58	30.43%	1.03%	0.03
Other Transportation Manufacturing (Including Aerospace)	2.52%	14.57%	5.77	0.75%	1.16%	1.55	0.26%	8.10%	30.58
Telecommunication Services	0.00%	0.06%	-	0.01%	0.13%	21.91	0.00%	1.67%	-
ICT Services	0.00%	0.17%	-	0.00%	0.00%	-	0.00%	0.18%	-
Research and Development Services	0.00%	0.00%	-	0.00%	0.18%	-	0.58%	5.50%	9.43

In 2002, 49 percent of U.S. imports of final goods from Taiwan were ICT products, more than twice as many as in 2014, while 44 percent of U.S. exports to Taiwan were machinery goods, which has since fallen to 9 percent. Mexico produces significantly fewer final ICT goods than it did in 2002, while the proportion of automotive manufacturing imports has held steady. Final machinery goods now make up a larger share of U.S. exports to Mexico, but increases in imports from Mexico have made that relationship more balanced.

Unlike Taiwan and Mexico, Korea's final goods trade relationship with the United States has grown more specialized. ICT and automotive goods comprised nearly two-thirds of U.S. imports from Korea, while ICT and machinery goods each represented about one-fifth of U.S. exports to Korea in 2002. Twelve years later, the ICT sector had become much less central to U.S.-Korea final goods trade, but automotive goods had become 46 percent of imports, and R&D services has grown to represent 21 percent of exports.

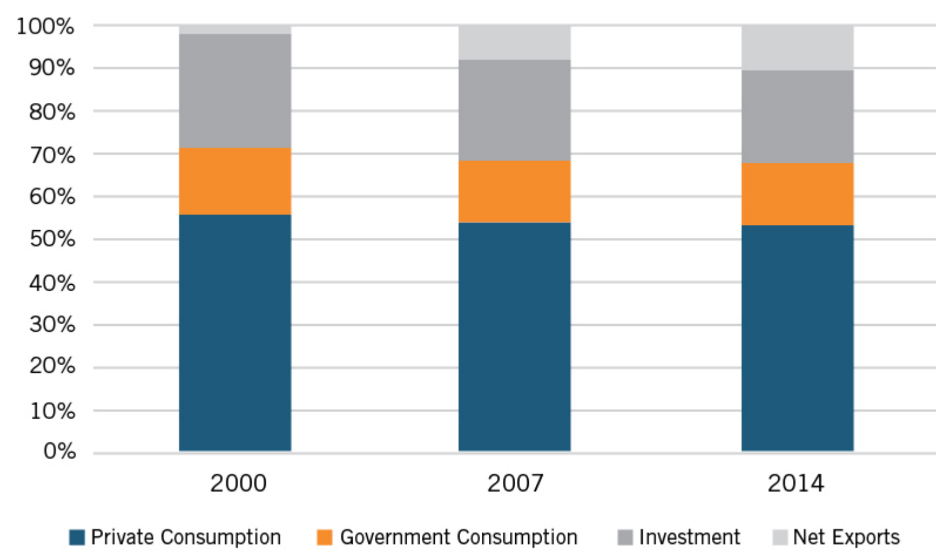
EXAMINING U.S.-TAIWAN TRADE AND ECONOMIC LINKAGES

In order to better understand the nature of these linkages, this section examines trade linkages between Taiwan and the United States, particularly in the production of advanced-technology goods.

Taiwan's Dependence on the International, and American, Economy

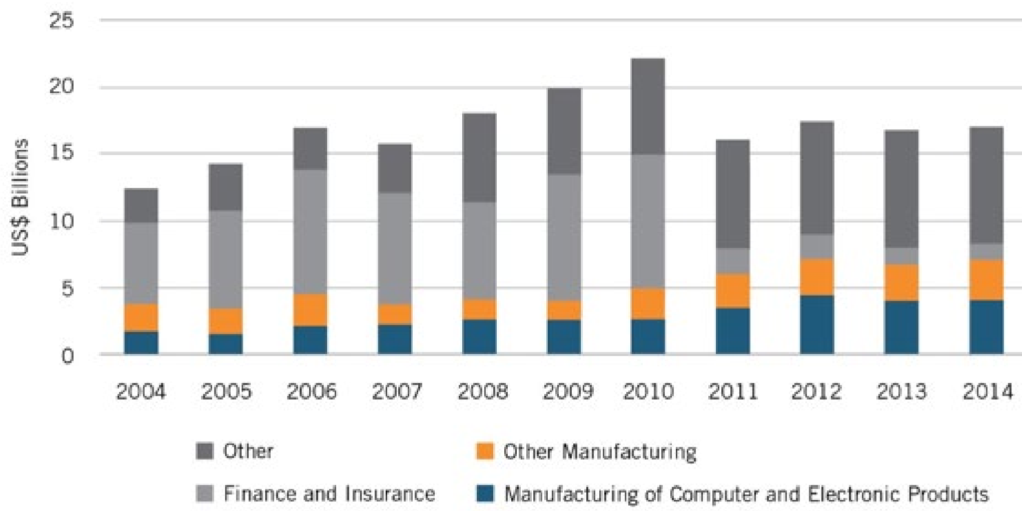
Much of Taiwan's economic growth has been based on access to international markets, including the United States'. The contribution of net exports to Taiwanese GDP increased from less than 2 percent in 2000 to 13 percent over the first half of 2015, as figure 3 shows.[43] In 2016, Taiwanese exports totaled $372 billion.[44] In terms of composition, over 99 percent of Taiwanese goods exports come from the industrial sector, and over 70 percent of Taiwan's exports consist of intermediate goods.[45] ICT goods are a vital component of Taiwanese exports, accounting for 40 percent of Taiwan's goods exports (and 21 percent of imports).[46] (ICT manufacturing is also a vital source of Taiwanese jobs: The country is second in the world (behind China), employing 5.8 percent of the global ICT manufacturing workforce.)[47]

Figure 3: Taiwan's GDP by Contribution[48]



The United States is Taiwan's second-largest trading partner (behind China) and its largest source of foreign direct investment (FDI). U.S. FDI in Taiwan (total stock) was $17 billion in 2017, a 6.9 percent increase from 2016, and was led by manufacturing, wholesale trade, and the finance and insurance sectors.[49] Figure 4 depicts U.S. foreign direct investment into Taiwan, by sector, from 2004 to 2014, showing the importance of manufacturing. U.S. investment in Taiwan's high-tech industries increased 151 percent from 2005 to 2014, while U.S. investment in Taiwan's finance and insurance sector, which reached a high of $10 billion in 2010, decreased 87 percent to $1.3 billion in 2014.[50] Conversely, in 2017, Taiwan's FDI in the United States (stock) was estimated at $8.1 billion, although a survey by the Taiwanese government indicated that Taiwanese businesses are in the process of making $26 billion worth of investments in the United States (including a new Foxconn plant in Wisconsin), which are expected to create 15,000 jobs.

Figure 4: U.S. FDI Flows Into Taiwan, by Sector, 2004–2014[51]



The World Trade Organization (WTO) provides data on countries' participation in global value chains, calculated as the sum of foreign value-added content of a country's exports and value added supplied to other countries' exports. As figure 5 shows, WTO found that, as a share of total exports, Taiwan is the second-most dependent country in the world in global value chains (and really, as Asia's seventh-largest economy, the first truly significant global economy on the list, if one leaves aside tiny Luxembourg). Korea is sixth using this measure, also showing how dependent that nation is on exports feeding into global value chains. By contrast, for the 63 nations for which WTO provides information, Mexico is the 43rd most dependent on global value chains and the United States the 57th. (WTO rankings are included here to enable understanding of global value chain participation by a wider set of countries globally, and to show how important GVCs are to Taiwan.)

Despite the importance to Taiwan of participating in global value chains, there is evidence that increased competition from China has to some degree impeded Taiwan's competitiveness over the past two decades. In a 2016 paper evaluating "The Global Value Chain and the Competitiveness of Asian Countries," Kiyota, Oikawa, and Yoshioka examined the competitiveness of Asian manufacturers and their capacity to generate income from global value chains.[52] As table 13 shows, from 1995 to 2011, Taiwan's share of world manufacturing GVC income fell by almost 40 percent, from 1.3 percent to 0.8 percent.

Figure 5: Countries by Global Value Chain Participation Rate, as Share of Total Exports[53]

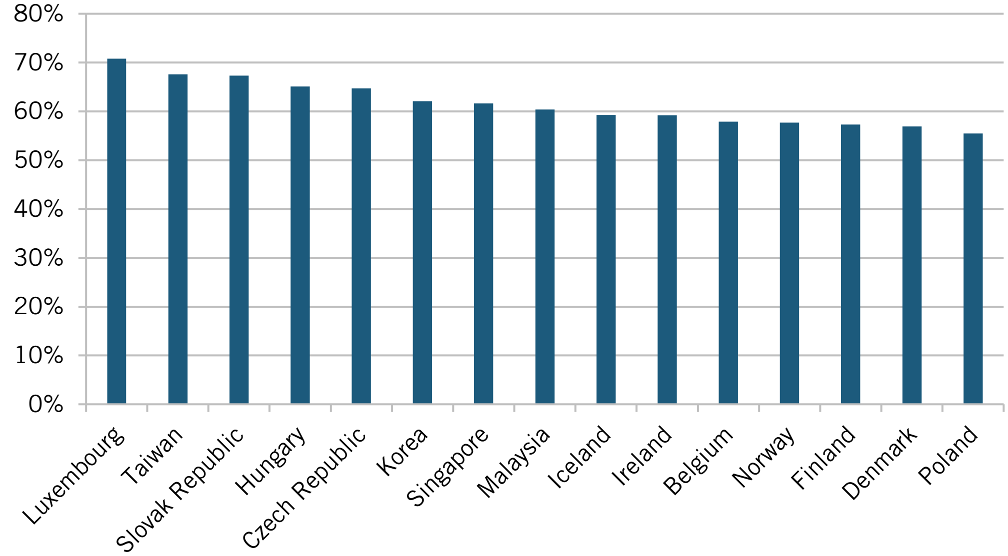


Table 13: Real Manufacturers' GVC Income in Asian Countries (in 1995 U.S. $Millions)[54]

Country	Real Manufacturers' GVC Income		Share of World Manufacturers' GVC Income	
	1995	2011	1995	2011
China	280,325	1,626,578	4.1%	16.2%
India	124,482	336,877	1.8%	3.4%
Indonesia	84,716	168,601	1.2%	1.7%
Japan	1,159,456	734,694	16.9%	7.3%
Korea	156,577	214,578	2.3%	2.1%
Taiwan	88,338	85,086	1.3%	0.8%
Germany	663,129	682,369	9.7%	6.8%
United States	1,325,204	1,456,101	19.3%	14.5%

To be fair, that share of world manufacturing GVC income fell for virtually all of the countries referenced in table 13, including Japan, Korea, Germany, and the United States, reflecting primarily a fourfold increase in China's share of income from world manufacturing global value chains (and a slight rise for India). This is a particular concern for Taiwan, because, as the U.S.-China Economic and Security Review Commission has noted, China has been increasingly trying to squeeze Taiwan out of global manufacturing value chains, particularly for ICT products. As the Commission's 2016 report, "Taiwan's Economy Amid Political Transition," explains:

> Taiwan's semiconductor industry, a hallmark of its export-oriented economy, is facing a growing threat of decline as Chinese companies and the so-called "red supply chain" begin to dominate regional ICT manufacturing…. As China works to bolster its semiconductor industry, it will continue producing parts and components at lower prices to replace those made by Taiwanese firms, further increasing competition and driving down Taiwan[ese] companies' profits.[55]

China's rise as a threat to Taiwanese—not to mention Korean, German, and American—participation in global value chains for the production of ICT demonstrates both the vital importance of contesting unfair, innovation-mercantilist Chinese trade practices as well as the need to implement policies that deepen trade linkages with like-minded nations, including Mexico through the U.S.-Mexico-Canada (USMCA) free trade agreement (FTA), the updated Korea-U.S. (KORUS) FTA, and ideally a future FTA with Taiwan.[56]

The Mutual Importance of Taiwan's and America's Economies to One Another

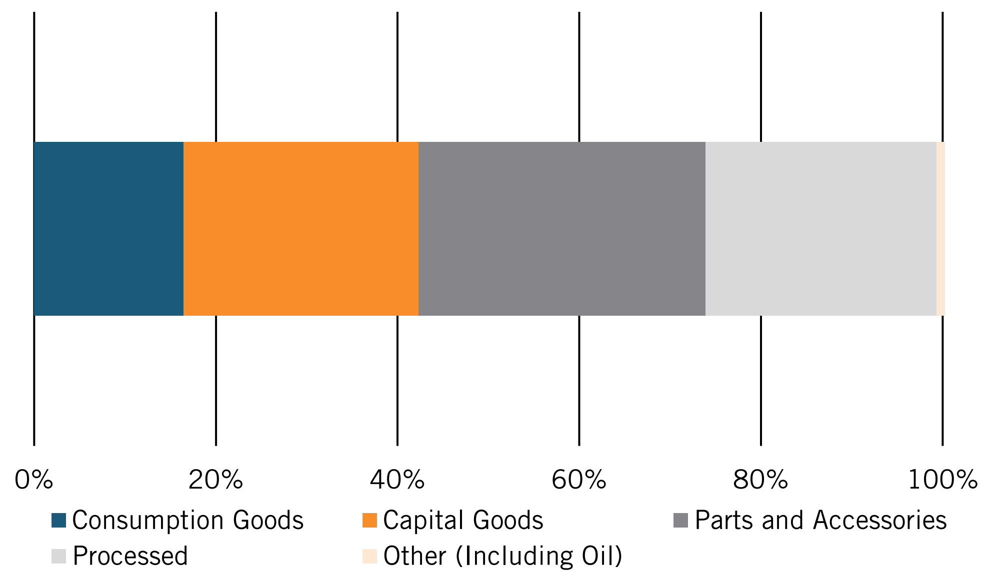
The importance of Taiwan's economy to the United States extends well beyond exports, and includes particularly Taiwanese enterprises' role as key suppliers of intermediate goods that make the business models and products of America's advanced-technology companies possible.

Taiwan is America's 11th-largest trading partner, 13th-largest source of imports, and 14th most-significant export destination.[57] Bilateral U.S. goods and services trade with Taiwan totaled $86.2 billion in 2017, comprising $35.6 billion in exports, and imports of $50.5 billion.[58] U.S. exports of goods and services to Taiwan supported almost 210,000 American jobs in 2015, with an estimated 130,000 supported by goods exports, and 79,000 by services exports.[59] In 2017, America's leading goods exports to Taiwan included $5.0 billion in machinery, $4.9 billion in electrical machinery (including semiconductor manufacturing machinery), $3.3 billion in agriculture, $2.9 billion in aircraft, $1.8 billion in optical and medical instruments, and $863 million in organic chemicals. In 2017, American services exports to Taiwan reached $9.9 billion (a 59 percent increase over 2007 levels), with leading services exports including intellectual property (particularly in industrial processes), travel, and transportation.[60] Total U.S. exports to Taiwan grew by 8 percent from 2000 to 2017, while imports grew 2 percent over that period.[61]

However, the importance of Taiwan to the U.S. economy goes far beyond exports and the jobs they directly support. Rather, it includes Taiwanese firms' participation in value chains for the production of advanced-technology products, helping to make the business models of U.S. advanced-technology companies tenable. Taiwan's role as a provider of key competitively priced inputs and components is essential to a variety of U.S. high-tech industries ranging from information and communications technology to automotive and aerospace to heavy machinery and other advanced-manufacturing industries.

As the Congressional Research Service (CRS) has stated, "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."[62] Indeed, 86 percent of Taiwan's exports to the United States comprise intermediate goods such as semi-finished products, parts, and capital goods U.S. companies use to produce final products in the U.S. market (as figure 6 shows).[63] (Figure 6 references Taiwanese exports to the United States.) Taiwanese-headquartered manufacturers play key roles both in the manufacture of intermediate components and final assembly of a wide range of ICT goods, including mobile phones, desktop and laptop computers, computing devices, and semiconductors from U.S.-headquartered ICT firms. That is evidenced by Taiwanese data on export orders received by its firms from abroad, which indicate the percentage of export orders produced abroad (e.g., a Taiwanese firm fulfilling a requisition order of products to be exported abroad with production that occurs in a third-party country) increased from 13 percent in 2000 to 53 percent in 2017, with this figure rising from 25 percent to 94 percent for ICT products.[64] Taiwanese government data suggests its manufacturing firms received export orders from the United States worth $137.8 billion in 2018 (a number three times greater than that from official data on U.S. imports from Taiwan in 2017).[65] From 2000 to 2017, U.S. orders to Taiwanese firms increased by 181 percent, with the United States the largest source of export orders from Taiwan in 2017 at 28 percent (surpassing China and Hong Kong's combined share of 25 percent each). As CRS noted, these figures "indicate that U.S.-Taiwan commercial ties are significantly greater (and more complex) than are reflected in standard bilateral trade data."[66]

Figure 6: The Structure of Taiwan-U.S. Exports, 2017[67]



The United Nations Conference on Trade and Development's (UNCTAD) Merchandise Trade Specialization and Correlation Indices analyze trade performance and the degree of competition and dependencies between countries through trade.[68] The Trade Specialization Index reveals that the degree of vertical division of upstream and downstream industries between Taiwan and the United States is 78 percent, reflecting deeply integrated supply chains and a healthy complementarity and division of labor between the Taiwanese and U.S. economies.[69] Reinforcing ITIF's findings from this report, Professor Peter Chow concluded that the index of intra-industry trade (i.e., trade within the same industry) between the United States and Taiwan was more than 0.4 out of a maximum of 1.0 in the past decade, which was one the highest scores among America's major trading partners in East Asia.[70] Chow further estimated that the percentage of Taiwan's exports to the U.S. global supply chain is greater than those from Indonesia, the Philippines, and Thailand combined.[71] Put simply, U.S. and Taiwanese industries complement one another, are connected by a vertical division of labor, are closely integrated, and work effectively together. Nowhere are the tight linkages between the U.S. and Taiwanese economies more important than in the ICT sector, as the following case studies of the Apple iPod and the semiconductor sector show.

The Apple iPod

A classic example of the depth of U.S.-Taiwan trade linkages is the Apple iPod.[72] Dedrick, Kraemer, and Linden in their seminal paper, "Who Profits from Innovation in Global Value Chains? A Study of the iPod and Notebook PCs," estimated the value captured by nations and enterprises therein from the production of iPods and notebook computers.[73] The study noted that many U.S. companies sign contracts with Taiwanese enterprises to manufacture their products, and then ship them to the United States, where the products are sold by U.S. firms under their own brand name.[74] For instance, in 2005, Taiwanese contract manufacturer Foxconn assembled Apple's 30 gigabyte video iPod (primarily in China, from parts sourced in Asia) at a total cost of $144 to manufacture each unit.[75] (Notably, Foxconn relies on Apple for half of its profit.)[76] The study estimated that just $4, or 2.8 percent, of the total cost was attributable to the Chinese workers assembling it, and that, with a market price of $299, Apple charged a markup of $155 per unit, attributable to transportation costs, retail and distributor margins, and Apple's profits. The study estimated that Apple earned $80 on each unit sold, making it the largest beneficiary. As the study concluded, "Apple's innovation in developing and engineering the iPod and its ability to source most of its production to low-cost countries, such as China, has helped enable it to become a highly competitive and profitable firm (as well as a source for high-paying jobs in the United States)." As the Congressional Research Service concluded from the study:

> The iPod example illustrates that the rapidly changing nature of global supply chains has made it increasingly difficult to interpret the implications of U.S. trade data. Such data may show where products are being imported from, but they often fail to reflect who benefits from that trade.[77]

Or, as OECD has noted in its work developing Trade in Value Added (TIVA) analytics, "The value added is increasingly uncorrelated from the flows of physical goods (intermediate or final)."[78] In other words, one can't just look at top-line trade numbers (raw imports and exports) to understand where the real value is being produced—and enjoyed—in the global economy.

Extending Dedrick, Kraemer, and Linden's analysis to wages, Alberro found that "in the iPod case, the global allocation of jobs led to an allocation of earning of more than two-thirds in favor of U.S. workers and one-third for foreign workers."[79] As Guillaume Delautre wrote in his report "The Distribution of Value Added Among Firms and Countries: The Case of the ICT Manufacturing Sector," the Apple iPod case, "confirms the fact that even if innovative products are manufactured offshore in low-cost countries, they contribute to the creation of valuable jobs, in particular in design, product development or marketing, in the country of origin, the United States."[80] It is estimated the iPod value chain created 41,000 jobs worldwide in 2006, with those in America distributed largely evenly between high-wage engineers and managers and lower-wage retail and nonprofessional workers.

Moreover, U.S. companies locating affiliate activity in other nations, such as Taiwan, supports jobs back at home. In fact, one study found that an increase in U.S. affiliate employment of 1 percent is associated with an increase in parent-company employment of 0.2 percent.[81] In other words, U.S. affiliate activity abroad is often a complement to, rather than a substitute for, the activity of parent companies in the United States.[82]

The Semiconductor Industry

The participation of Taiwanese partners in global value chains for semiconductor manufacturing has been a key ingredient in the success of the U.S. semiconductor industry. Taiwanese players initially specialized in contract manufacturing, pioneering the fabless-foundry model of semiconductor production. In the fabless-foundry model, production is split: Design companies focus on design and contract out manufacturing (fabrication), and are thus "fabless," while foundry companies concentrate on contract manufacturing activity. The fabless-foundry model derives efficiencies from the delineation of tasks and specialization, allowing the fabless companies to focus on design and innovation and to avoid heavy investment in setting up, maintaining, and upgrading foundries.[83] In the fabless-foundry model, countries' roles differ according to the activities performed. For instance, the United States leads in the design segment of the value chain, while Asian countries, particularly Taiwan, have concentrated on manufacturing and assembly, testing, and packaging.[84]

As Macher and Mowery elucidated in their report "Vertical Specialization and Industry Structure in High Technology Industries":

> The growth in vertical specialization in semiconductors since 1985 reflects the influence of both market-related and technological factors. Scale economies lowered production costs, expanding the range of potential end-user applications for semiconductors and creating additional opportunities for entry by vertically specialized firms. The increasing capital requirements of semiconductor manufacturing provided another impetus to vertical specialization, since these higher fixed costs make it necessary to produce large volumes of a limited array of semiconductor components in order to achieve lower unit costs. The design cycle for new semiconductor products also has become shorter and product lifecycles more uncertain, making it more

> difficult to determine whether demand for a single product will fully utilize the capacity of a fabrication facility that is devoted exclusively to a particular product and increasing the risks of investing in such "dedicated" capacity.[85]

U.S.-headquartered ICT companies—including Apple, Broadcomm, Qualcomm, Intel, NVIDIA, Xylinx, and many others—account for approximately 65 percent of global demand for fabless semiconductor manufacturing, with about half of the U.S. semiconductor industry deploying a fabless business model.[86] Taiwanese-headquartered semiconductor foundries—including Taiwan Semiconductor Manufacturing Company (TSMC), United Microelectronics, Quanta, Pegasus, and others—account for 73 percent of global foundry-based semiconductor revenues.[87] TSMC alone accounts for approximately half of the world's foundry-based semiconductor manufacturing capacity, supporting production of virtually all of Apple's cell phone processing chips, all of video-game-chip-maker NVIDIA's graphics processing units, and all of Xylinix's field-programmable gate array integrated circuits. Analysts estimate that, in 2017, integrated circuits accounted for 40 percent of Taiwan's total exports.[88]

The fabless-foundry model played a key role in enabling America to remain at the forefront of global semiconductor development, disseminating risk while permitting U.S. semiconductor companies to focus on the highest value-added activities in the sector.

The fabless-foundry model has been key for the global—and U.S. —semiconductor industry because it has enabled the industry to spread out the risks of its capital investments so that the fabless design company does not have to incur the risk of significant capital expenditures, or investing in the R&D for manufacturing process technologies. Back in the 1990s the U.S. and Japanese semiconductor industries were essentially at parity, with an equivalent level of global market share. Since then, the United States has retained about half the global semiconductor market, while Japan's share has fallen to about 10 percent. And a key reason for this has been that Japanese companies never truly took advantage of global value chains, preferring to keep most of their front-end fabrication in Japan. In contrast, the U.S. semiconductor industry leveraged global value chains, allowing enterprises in other nations, and especially in Taiwan, to specialize in manufacturing, assembly, testing, and packaging, while U.S.-headquartered companies largely specialized in the higher-value-added activities of branding, R&D, chip design, and understanding how to leverage the chip sets into a wide range of high-value-added goods from smartphones to autonomous vehicles to Internet of Things applications. This empowered a key difference between the U.S. and Japanese semiconductor sectors over the past three decades, with the American firms being able to keep production costs low, making them more cost competitive, in part through leveraging specialized value chain partners. In essence, Taiwan offered a "one-stop service," providing a wide range of services from design to production to logistics. For several U.S. semiconductor firms, Taiwanese partners do the manufacturing, assembly, testing, and packaging better, more efficiently, and cheaper, which has allowed some U.S. semiconductor manufacturers to specialize in the higher-value-added stages of economic activity.

At the same time, however, U.S. companies such as Applied Materials have remained world leaders in the production of the equipment used to manufacture the semiconductors themselves. With the global semiconductor industry continuing to innovate, and now going toward 7-nanometer chips, new semiconductor fabs will be needed.[89] This dynamic has made Taiwan a key export market for U.S. production of semiconductor manufacturing equipment, with Taiwan accounting for 30 percent of U.S. exports of semiconductor manufacturing equipment. (In fact, by 2025, the purchase of U.S. semiconductor equipment from Taiwan will reach $5.58 billion.) This shows the complementary nature, and vertical integration, of U.S.-Taiwan-semiconductor-sector manufacturing and trade.

Though TSMC pioneered the fabless foundry model for semiconductors, Taiwanese contract manufacturing is pronounced across all facets of ICT manufacturing. In 2018, Taiwan's 19 largest contract manufacturers generated $394 billion in revenues.[90] Taiwanese-based companies such as HTC became globally renown in the 1990s and early 2000s by doing highly efficient contract work for brands such as Apple, Dell, and Toshiba.[91] Taiwanese companies today produce 94 percent of the world's motherboards and notebook PCs.[92] And 90 percent of the world's laptop sales come from five manufacturing companies in Taiwan: Quanta Computer, Compal Electronics, Pegatron, Wistron, and Inventec.[93] Taiwan has become an indispensable player in global value chains for the production of ICTs.

Taiwan's Innovation Agenda

As noted, Taiwan's heritage in the ICT sector began with contract manufacturing. However, the spillover effects of producing foreign technology has helped some Taiwanese contractors begin to innovate on their own; for example, HTC develops globally competitive smartphones, and Asustek Computer (Asus) produces popular tablet computers.[94] Taiwanese companies such as Quanta and Wistron have become original design manufacturers (ODMs) for many global PC brands. And Taiwanese semiconductor companies themselves are increasingly moving up the value chain into semiconductor design. In fact, Taiwanese companies account for 18 percent of global revenues from the fabless segment of the global semiconductor value chain.[95]

However, some fear "the legacy of Taiwan's efficiency model of doing contract work for foreign firms is now a burden insofar as Taiwan's technology experts are more adept at advancing cost-effective ideas than truly creative ones."[96] While Taiwanese companies continue to lead in laptop sales, it is estimated that competition from Chinese and Vietnamese manufacturers have decreased the profits of Taiwanese laptop makers by 50 percent over the past decade.[97] Some are concerned that challenges exist in Taiwan's corporate culture, "where the drive to invent and market new products is not sufficiently prized."[98]

To address these challenges, Taiwan has begun to take steps to move from an investment-driven to an innovation-driven stage by focusing on becoming a knowledge-based economy.[99] Taiwan more than doubled its R&D expenditures from 2000 to 2014, while Taiwan's share of R&D expenditures contributed by Taiwanese industry increased from 64 percent to 77 percent over the same period.[100] More importantly, Taiwan announced in early 2018 a new "Five Plus Two" innovation policy, which aims to expand industries and projects related to the Internet of Things, bio-technology, green energy, smart technology, and defense ("Five"), while also promoting agricultural efficiency and a circular economy ("plus Two").[101] Taiwanese leaders have called for building an Asian version of Silicon Valley in Taiwan that is designed to partner with innovation clusters in Silicon Valley for technology, talent, capital, and markets, as well as to link Taiwan to next-generation technology excellence, both in the United States and other Asian countries.[102] Around Internet of Things in particular, Taiwan suffers from a lack of comprehensive development plans, little involvement in international standards formulation, and insufficient integration in local Internet of Things communities, so there are strong opportunities for collaboration between Taiwanese and U.S. firms in Internet of Things, artificial intelligence, and other advanced-technology areas.[103] (U.S. industry could gain from collaboration on these topics by exchange of best practices, gaining practical experience in new application environments, and deepening commercial relationships in these domains.) The Five Plus Two initiative further seeks to reestablish strategic industrial cooperation mechanisms with America, Europe, Japan, and other advanced economies, further deepening integration of the U.S.-Taiwan supply chain, and creating a transnational management model based on multinational production.[104]

The Five Plus Two initiative is complemented by a concerted effort to address the so-called "five shortages"—land, water, electric and gas power, talent, and manpower—areas where resources need to be improved, increased, or otherwise protected.[105] These approaches are paired with Taiwan's "New Southbound" policy, intended to expedite trade, investment, and cultural interactions with southeast and south Asian countries.[106] Collectively, Taiwanese leaders seek for these strategies to drive Taiwan's further transformation into a high-value-added, knowledge-based economy, and secure Taiwanese enterprises' capacity to add value into 21st century global value chains.

ANALYTIC CONCLUSIONS

The U.S. economy is deeply interlinked with the economies of Mexico, Korea, and Taiwan. One finding from research is that, as much as enterprises in these nations are key suppliers into U.S. value chains in advanced-technology industries, U.S. exports of inputs and intermediate goods are equally vital to several industries—especially pharmaceutical and chemical manufacturing—in the partner countries. (For instance, across all industries studied, though excepting automotive, Mexico actually relies more on U.S. inputs for the manufacture of final products than the United States relies on Mexico for inputs of final products.) This report has demonstrated some of the different roles countries play in ICT manufacturing value chains: Korea is more an exporter of final goods while Taiwan serves as a "linking" country focused on contract manufacturing and making value-added contributions to intermediate goods and sending them further along global value chains. It has shown the deep interlinkages between the American, Korean, Mexican, and Taiwanese ICT manufacturing sectors. U.S. industries such as semiconductor equipment manufacturing are actually key suppliers and exporters to Taiwanese firms, and on a trade-within-industry basis, the U.S. ICT manufacturing sector actually has a $660 million trade surplus with Taiwan. And on a value-added basis, America's ICT sector trade deficit with Taiwan is less than half what the gross trade figures would suggest. More importantly, U.S. and Taiwanese ICT enterprises play complementary roles in value chains for a variety of ICT goods including semiconductors, mobile phones, laptop and desktop computers, and computing devices and peripherals.

POLICY RECOMMENDATIONS

The following presents policy recommendations Congress and the Trump administration should pursue vis-à-vis economic and trade relationships with the three study countries.

Pursue a U.S.-Taiwan Free Trade Agreement

Taiwan is a democratic, free-market economy that embraces enterprise-led, rules-based economic exchange. It is not just a key trade and economic partner of the United States, but also a strategic ally of the United States. As this report has shown, Taiwanese enterprises play a key role in supporting U.S. supply chains across a range of industries including ICT, automotive, aerospace, and many others. The Trump administration has signaled it favors bilateral over multilateral or plurilateral trade deals. Accordingly, the administration should move beyond the Trade and Investment Framework Agreement (TIFA) with Taiwan (originally signed in 1984) and pursue negotiation of a bilateral U.S.-Taiwan free trade agreement, 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 the United States Trade Representative should commence negotiations to enter into a bilateral trade agreement with Taiwan.[107] 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.[108]

Analysts have found 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, increase real GDP by $3.5 billion, would decrease the U.S. trade deficit with Taiwan by 75 percent, and would result in the generation of an additional 27,000 U.S. jobs.[109]

Pass the Revised United States-Mexico-Canada Agreement

On November 30, 2018, the United States concluded a revised United States-Mexico-Canada Agreement (USMCA).[110] The USMCA takes a number of important steps in updating the original agreement to reflect the realities of modern trade, including introducing new disciplines governing digital trade and upgrading intellectual property provisions. The USMCA also sets new, high standards for combatting unfair "innovation mercantilist" trade practices, such as including new disciplines and restrictions on state-owned enterprises and taking steps to preclude countries from manipulating their currencies.[111] Further, in North America, the United States, Canada, and Mexico have formed a high-wage/low-wage partnership, bringing complementary labor forces, investments, innovation capacities, and industry strengths together to create a region that is very competitive globally. Within this relationship, the United States represents the source of much of the R&D, design, innovation, and high-value-added manufacturing, while Mexico provides some of the lower-tech, lower-cost, and more labor-intensive manufacturing activity. The USMCA is well-positioned to play an important role in supporting the flow of goods and services across North American borders as part of complex production networks that source intermediate goods and services from wherever it is most competitive, meaning the USMCA can thus play an important role in making North America a more globally competitive manufacturing environment. Accordingly, the 116th Congress should pass the current version of the USMCA negotiators from the three nations agreed to.

Assist Taiwanese Participation in International Forums

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.[112] 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 and Interpol.[113] 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."[114] The United States should continue to facilitate Taiwan's engagement in these types of international forums.

Encourage Taiwanese Participation in the Comprehensive and Progressive Agreement for Trans-Pacific Partnership

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 year, Taiwan has begun the process of reviewing and revising laws and regulations to bring itself into compliance with CPTPP provisions, a process which will help bring Taiwan's regulatory regime more closely in line with international standards and practices.[115] The United States should encourage Taiwanese participation in the CPTPP. The United States should also seriously consider reengaging its partners and joining the CPTPP itself.

Reanimate the Trade in Services Agreement

Services account for 70 percent of the global economy, yet as this report has noted, the fact that global services trade has not been as liberalized as goods trade forestalls opportunities for deeper global trade integration. To address this and bring services trade into the digital age, 23 economies, including Taiwan, have joined together to negotiate a Trade in Services Agreement (TISA). The 23 members negotiating TISA represent 75 percent of the world's $44 trillion services market.[116] Provided the agreement effectively supports trade in innovation-based services, it has the potential to create a trade environment that would significantly spur global innovation and associated productivity gains.[117]

Confront Chinese Innovation Mercantilism

There is a growing understanding that China is an outlier when it comes to global norms and rules governing trade, investment, and economic policy, and that the unremitting and even accelerating "innovation-mercantilist" behavior on the part of the Chinese government represents a threat not only to the U.S. and Taiwanese (not to mention Korean and Mexican) economies, particularly their advanced industries, but indeed to the entire global economic and trade system.[118] China seeks global dominance across a wide array of advanced industries, and has used a wide variety of innovation mercantilist policies to achieve that goal. These policies have included forced IP and technology transfer or forced local production as a condition of market access; theft of foreign IP; curtailment and even outright denial of access to Chinese markets in certain sectors; manipulation of technology standards; special benefits for state-owned enterprises; capricious cases designed to force foreign companies to license technology at a discount; refusing to allow access to key resources (e.g., rare earth elements) unless companies locate in China; and even government-subsidized acquisitions of foreign technology firms.[119] As ITIF wrote in "Stopping China's Mercantilism: A Doctrine of Constructive, Alliance-Backed Confrontation," U.S. administrations need to continue to pursue an equally broad, "whole-of-government" range of policies and strategies to contest ongoing Chinese innovation mercantilism, including enrolling like-minded allies to contest Chinese mercantilism, establishing stronger processes and institutional arrangements within the U.S. government, and adopting a "results-oriented" trade approach with China.

Liberalize High-Tech Export Controls

The U.S. Commerce Department's Bureau of Industry and Security (BIS) has issued an advance notice of proposed rulemaking regarding extending U.S. export controls to what are termed "emerging and foundational technologies" (EFTs)—new or foundational technologies that in some cases are essential to national security and are not currently covered by existing export control rules.[120] It seeks to establish appropriate controls, including interim controls on the export, reexport, or transfer (in-country) of emerging and foundational technologies. ITIF has argued that U.S. export controls need to be updated in consideration of a number of factors, including: 1) military and intelligence applications; 2) the nature of the technology being transferred in terms of whether it is a final product, an intermediate product, a process, or intellectual property; and 3) the extent to which foreign countries subject to controls can obtain the controlled technology either domestically or from other nations.[121] In some cases, such as with components for high-performance computing (i.e., supercomputers), products made by Taiwanese vendors are of equivalent performance levels with U.S. ones, yet the U.S. regime would block American firms' exports of those technologies, denying U.S. firms export opportunities and stifling trade with foreign partners.[122] The United States should continue this process of modernizing its export control regime, and, where appropriate, facilitate the liberalization of U.S. exports of advanced technology to Taiwan.[123]

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.[124] 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.[125] An innovation experts working group could make comparative assessments of innovation strengths and weaknesses between the United States and Taiwan in sectors such as artificial intelligence, the Internet of Things, smart cities, data analytics, biotechnology, and global value chain integration best practices.

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ABOUT THE AUTHORS

Stephen J. Ezell is ITIF Vice President for Global Innovation Policy and focuses on science, technology, and innovation policy as well as international competitiveness and trade policy issues. He is the coauthor of *Innovating in a Service Driven Economy: Insights Application, and Practice* (Palgrave McMillan, 2015) and *Innovation Economics: The Race for Global Advantage* (Yale 2012).

Caleb Foote is a research assistant at ITIF. Prior to joining ITIF, Caleb graduated from Brown University, with a concentration in Economics. He previously interned for TechHelp and serves as a trustee of the American Parliamentary Debate Association.

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