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Goldman Sachs

MADE IN THE USA ...OR CHINA?

25 Years of Supply Chain Investment at a Crossroads

Potential policy shifts in the US and China aimed at boosting local manufacturing threaten to upend 25 years of investment in global supply chains. We examine what it would cost, both in capital and time, to relocate production and how it would impact companies, workers, and consumers. We draw on the unique paths to production for three very different items with global appeal -- smartphones, apparel and airplanes – and interview economists and experts to identify links in the supply chain where the variables of labor, IP, product cycles and automation line up to create the potential for new trade patterns to emerge.

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Contents

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The prices in the body of this report are based on the market close of March 24, 2017.

Trump, Taxes and Trade

For more analysis of the Trump Administration's proposals on taxes, trade, and regulation, **see our 360 page** and explore the highlights below.

The Great China Debates (VI): Fears about Trade, Feb. 20, 2017
Americas: Technology: Transition to Trump Implications for TMT, Feb. 13, 2017
US Daily: President Trump's Options on Trade and Tariffs, Feb. 6, 2017
Top of Mind: Trade Wars, Feb. 6, 2017
Implications of Possible US Trade Protectionism on Production in Asia, Jan. 20, 2017
US Daily: The Inflation Impact of a Border-Adjusted Corporate Tax, Jan. 3, 2017
US Economics Analyst: Corporate Tax Reform in 2017, Dec. 3, 2016
Trade Relationships: It's Complicated, Nov. 23, 2016

PM Summary: 25 years and $300 bn later: Can supply chains move?

Potential policy shifts in the United States and China aimed at boosting local manufacturing threaten to upend 25 years of investment in global supply chains. We examine what it would cost, both in capital and time, to relocate production and how it would impact companies, workers, and consumers. We draw on the unique paths to production for three very different items with global appeal – smartphones, apparel and airplanes – to identify links in the supply chain where the variables of labor, IP, and product cycles create the potential for new trade patterns to emerge.

We believe it would take at least five years to move the supply chains for smartphones or apparel to the United States, largely due to labor challenges (both on costs and supply). **We estimate production costs could increase by 46% for apparel and 37% for smartphones if made in the United States, and in turn lead to about a 15% increase in the price for consumers in the United States** (assuming no change to OEM/retail profits, and prior to any FX changes). **We see obstacles for China to make large commercial planes related to IP, safety, and long product cycles**.

Some facts that surprised us:

1. Automation has the potential to reduce the number of traditional line workers in phone assembly but create new engineering roles. One expert estimated that automation can reduce the number of people needed for final assembly by 40-70%. However, this would require OEMs to change the product cycle/design to make automation practical. See our interviews with experts from Jabil and Flex on pages 29 and 30 for details.
2. China buys more robots than the United States even though manufacturing labor costs just $2-3/hour.
3. >50% of jobs in smartphone and apparel manufacturing are in the final stages of production, so policies that cause only parts of the supply chain to shift may not create very many jobs.

Our report breaks into three chapters:

What does ~$300 bn of FDI get you in terms of a global supply chain? See how the FDI splits out and the impact on trade flows on pages 7-13

Chapter 1: China and US Trade 101 – ~$300 bn later, supply chains are linked and the US has a $350 bn goods trade deficit with China

Two things in particular are surprising to us about the foreign direct investment (FDI) data: a) Nearly $300 bn of gross cumulative FDI has been invested by US entities in China and Chinese entities in the United States over the last 25 years according to data from the Rhodium Group. b) In 2015, FDI from China in the United States was larger than US FDI in China for the first time in the dataset (although we appreciate capital controls and FX issues could have had an impact on this).

The former head of Motorola's global supply chain talks about how and why the company shifted production to China on page 14.

Data suggests that the FDI by US companies in China was both to gain market access and to reduce labor costs (China employs well over 100 million people in manufacturing compared with only 12 million in the United States). **You may not have known that China is a larger market for phones, airplanes and apparel than the United States**.

Global FDI has led to trade deficits for the United States with China in areas such as electronics and apparel, and for China with the United States in markets such as transportation and agriculture.

Chapter 2: Policy in transition – Labor is a key obstacle for the US and IP is a main challenge for China in achieving domestic goals

Proposed US policies from President Trump, such as border taxes and tariffs, aim to increase local manufacturing but China's "Made in China 2025" initiative has a potentially competing goal of increasing local production in areas like planes and semis.

What impact does a 10% reduction in US imports have on China's GDP? – See our interview with GS Senior Asia Economist Goohoon Kwon on page 25 to learn more.

Notable estimates from the Goldman Sachs Economics teams featured in this section include: 1) A destination-based tax with border adjustment could cause the aggregate price level in the United States to increase by 0.8%, net of margin contraction and FX movement. 2) US companies face average tariffs on exports of 4-6.5%, but Chinese imports face average tariffs of about 3% in the United States.

In the United States a common challenge to doing more manufacturing is labor, both the 6-7X higher cost per hour than China (though the different mix of manufacturing makes comparisons difficult) and the availability of skilled labor. **In China the main challenge is around sufficient IP.** A number that surprised us: **China has increased its R&D to 2.1% of GDP, up from less than 1% in 2000**, and compared to the United States, where R&D intensity was 2.8% of GDP in 2015 and 2.6% in 2000.

Chapter 3: Case studies on smartphones, apparel, and planes

Want to know what it would take to automate phone final assembly? We interview the experts at both Flex and Jabil on pages 29 and 30.

For phones, we believe it could take five years and require $30-$35 bn in capex to move the supply chain to the United States, without taking into account changes in the production processes that would likely come with any major shift. Assuming workers could be found and not accounting for further automation, we estimate that the cost of production could increase by 37%. However, given that nearly all of this increase in production cost is due to labor for final assembly, OEMs could be incentivized to alter design/product cycles to enable automation.

For apparel, we believe it could take 5-10 years to find and train sufficient labor to move the supply chain to the US, as the industry has only about 250K manufacturing employees in the US vs. 8-9 million in China. Production costs could rise by 46%, and consumer prices could increase by about 14% (assuming no change in retailer/brand margins or FX impacts).

For planes, China is focused on developing technology but there is a duopoly on wide-body IP, product cycles are long, and the safety requirements are very high.

Stock implications

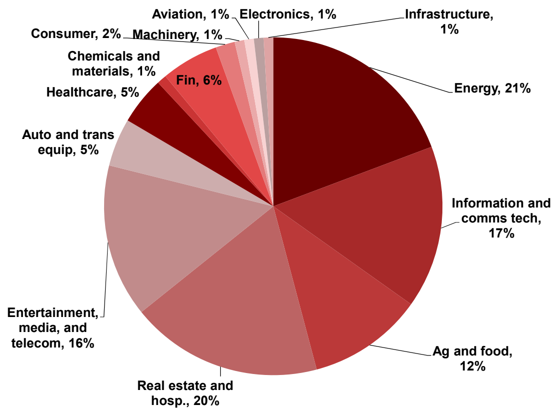
For **smartphones,** we believe US IDMs (e.g., **Intel, TI, Qorvo)** could benefit from a border tax or tariffs given that their US capacity could lead to share gain. We also think US final assemblers such as **Flex** and **Jabil** may benefit as they could take share. Companies most at risk include Asia foundries (e.g. **TSMC, Hua Hong**), packagers (**ASE/SPIL**) and final assemblers (**Hon Hai, Wistron, Pegatron**), given each company's potential to lose share. We also see risks for OEMs like **Apple** as demand could be hurt from higher prices.

For **apparel,** we see mostly negative implications for individual companies. For instance, we think domestic apparel brands with significant US exposure and low margins (**AEO, GPS, URBN, ASNA**) as well as domestic wholesale apparel brands forced to take up pricing with major retail partners (**PVH, UAA, RL, VFC**) will suffer the most given that these companies would have to pass through to consumers the 14% price increases we estimate are necessary to offset the impact of higher input costs. Similarly, we believe some Asia-based OEMs would move along with brands' sourcing strategies and build capacity in the United States, but we think these companies' profits would likely suffer as a result of having to share the cost inflation with brands. Thus, we think Asia-based OEMs with both higher US exposure and lower margins – such as **Stella** and **Makalot –** are worst positioned given their sensitivity to margin squeeze due to cost increases, and **Shenzhou** is best positioned.

For planes, **Airbus** could benefit over **Boeing** if China places retaliatory restrictions specifically on US products.

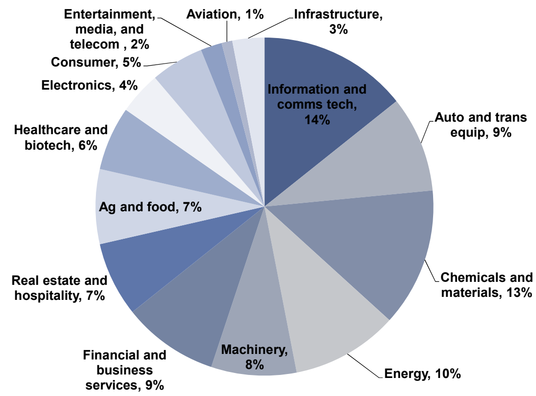
Made in the USA or China? 6 key charts

Exhibit 1: FDI between China and the United States...
Gross China FDI in the USA 1990-2015 ($64 bn in total)



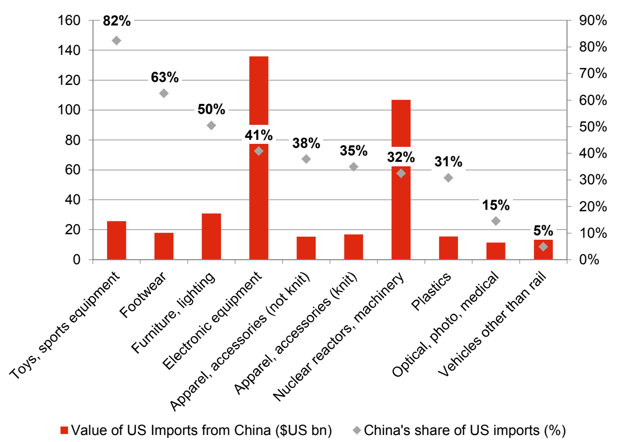
Source: Rhodium Group

Exhibit 2: ... has totaled ~$300 bn over the last 25 years
Gross USA FDI in China, 1990-2015 ($228 bn in total)



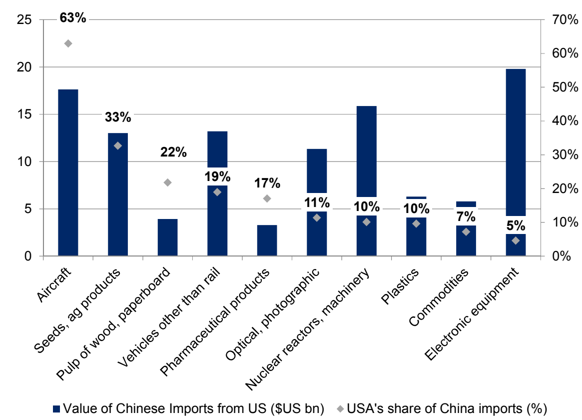
Source: Rhodium Group

Exhibit 3: US imports from China include tech, textiles
Value of US imports from China ($US bn); China's share (%)



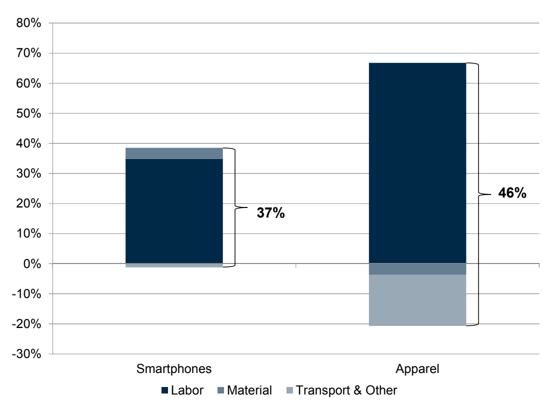
Source: UN Comtrade

Exhibit 4: China imports from US include planes and ag
Value of Chinese imports from the US ($ bn); US share (%)



Source: UN Comtrade

Exhibit 5: Labor is the key driver of higher costs in the US
Net increase in production cost in the US



Source: Goldman Sachs Global Investment Research

Exhibit 6: Barriers to moving global supply chains
Costs associated with moving the airplane, smartphone, and apparel supply chains

	Airplanes	Smartphones	Apparel
CAPEX to set up supply chain ($ bn)	$30	$30-35	$40-50
Production cost increase if moved	--	↑ 37%	↑ 46%
Retail price increase if moved	--	↑ ~15%	↑ 14%
Product Cycle	Years to Decades	Months to Years	Months to Years
IP barriers	High	Medium	Low

Source: Goldman Sachs Global Investment Research

State of the (Dis)Union in 10 Key Metrics

Metric	UNITED STATES	CHINA
1. Merchandise trade between USA & China (*in $USD mn, 2015*)	Imports - $481,881 | Exports - $116,186	Imports - $149,781 | Exports - $448,273
2. Markets with largest net trade surpluses (*in $USD bn, 2015*)	Aerospace and Parts - $14.9 Seeds, fruits etc. - $10.7 Paper products - $3.4	Electronics - $123.2 Machinery & Appliances- $94.8 Furniture - $30.5
3. Foreign Direct Investment (*in $USD bn*)	USA to China: 1990 - 2015: $228 | 2015: $13	USA to China: 1990 - 2015: $64 | 2015: $15
4. Disposable income per capita (2015) (*in USD*)	$14,281	$4,706
5. R&D intensity (*R&D spend as a % GDP*)	2000 - 2.6 2015 - 2.8	2000 - 0.9 2015 - 2.1
6. % of market demand (*in 2015*)	Apparel - 20% Smartphones - 11% Planes - 17%	Apparel - 21% Smartphones - 31% Planes - 25%
7. Output per worker (*2015, constant 2005 $USD*)	$98,990	$7,318
8. Automation (*Multipurpose industrial robots (annual orders and per 10k manufacturing employees) - 2015*)	Annual order - 27,500 Robots per 10K manufacturing employees - 176	Annual order - 68,600 Robots per 10K manufacturing employees - 49
9. Number of people employed in manufacturing (*2013, in millions*)	11.96	113.58
10. Cost of manufacturing labour (*$USD per month, 2013*)	$3,977	$598

Chapter 1: China and USA Trade 101

Highlights from this section

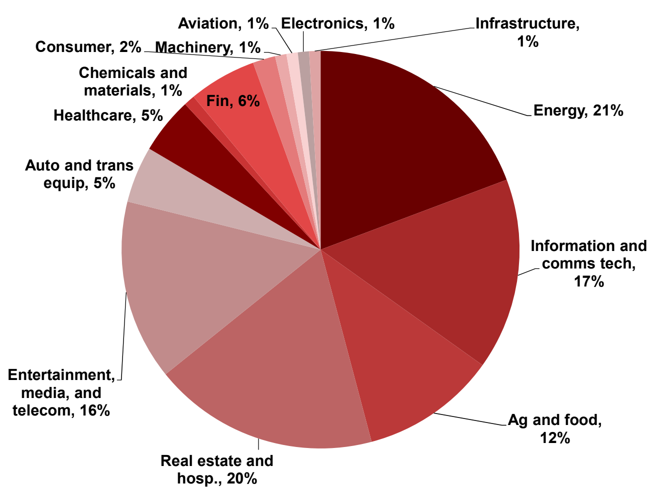
- Economic links between the United States and China have been growing for years as US companies invested nearly $230 bn in China from 1990 to 2015, and Chinese companies invested $64 bn in the United States over the same period.
- Many of the largest trade flows are in markets where there has been significant cross-border investment. For example, China's exports to the United States in tech and electrical equipment grew at a 17% CAGR from 2000 to 2015, and China's shoe and apparel exports grew at a 16% CAGR over the same period.
- We believe that investment in China by US companies has been driven by an interest in new revenue opportunities, at times by the advantage of being near other suppliers, and also by the opportunity to spend less on labor.

Examining Foreign Direct Investment and impact on trade flows

The economic links between the United States and China have been increasing for years, and current US policy proposals aimed at increasing US manufacturing have the potential to upend 25 years of supply chain investments. According to a joint report from the Rhodium Group and the National Committee on US China Relations using bottom-up transaction data, from 1990 to 2015 US companies and subsidiaries invested $228 bn in China in total, while Chinese-based entities invested $64 bn in the United States (Exhibits 7-8).

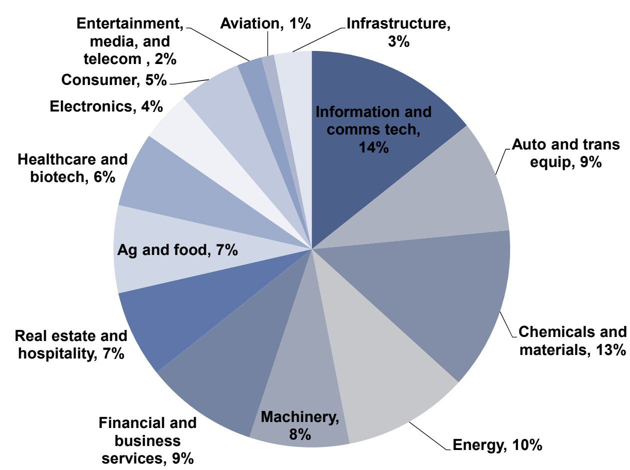
US companies have invested primarily in the IT & Communications, Chemicals, and Materials industries in China. Chinese investments in the United States have been driven primarily by Energy and Real Estate, but increasingly investments have been in Tech.

Exhibit 7: Direct investment in US by China companies
Cumulative gross China FDI in the USA by industry, 1990-2015 ($64 bn in total)



Source: Rhodium Group

Exhibit 8: Direct investment in China by US companies
Cumulative gross USA FDI in China by industry, 1990-2015 ($228 bn in total)



Source: Rhodium Group

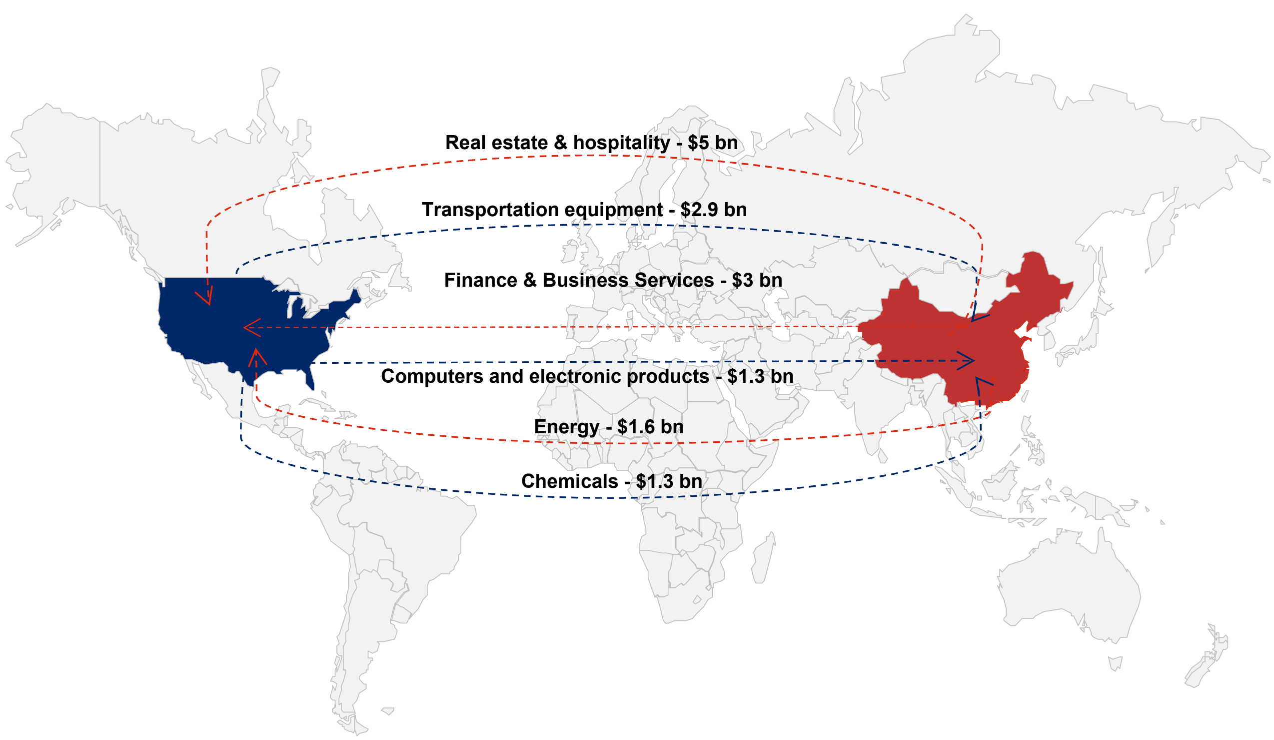
FDI has linked the supply chains of the United States and China in several areas as companies have either set up factories internationally or acquired IP to enter new markets. The Rhodium dataset showing $228 bn of cumulative FDI by US companies includes over 1,300 US companies that set up operations in China between 1990 and 2015, of which 430 invested more than $50 million and 56 that invested more than $1 billion.

- **71% of total US FDI was invested in greenfield projects such as factories, and the balance was used for acquisitions, according to the Rhodium data**.

Chinese companies carried out 1,200 individual transactions for a combined value of $64 billion over the same period—85% having occurred in the past five years. **In contrast to FDI in China by US companies, acquisitions have accounted for almost 90% of investment by Chinese companies in the United States.**

Chinese FDI topped US FDI for the first time in 2015. China FDI in 2015 was targeted at the real estate, finance and energy markets. Part of this FDI from China in the United States, especially in the real estate sector, may have been to shift currency risk and capital exposure. US FDI in China in 2015 was largest in the transportation, electronics and chemicals markets (Exhibit 9).

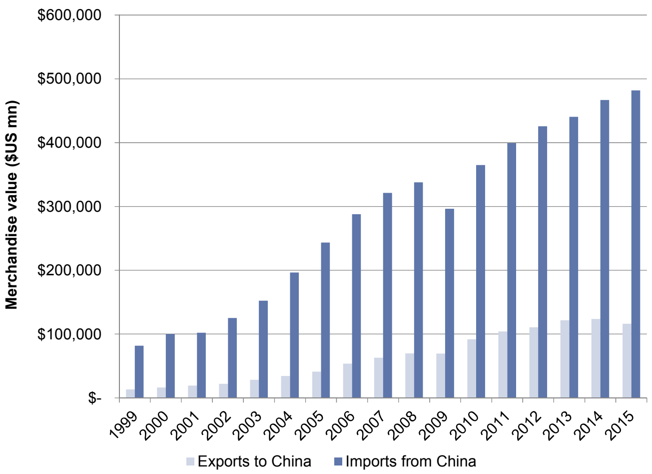
Exhibit 9: In 2015, China FDI in the United States outpaced US FDI in China for the first time
China-US FDI in 2015



Source: Rhodium Group, Bureau of Economic Analysis

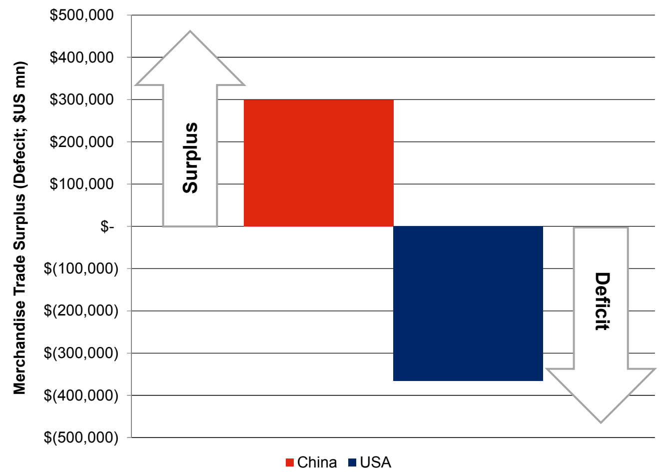
This increase in investment, the setting up of factories and the acquisition of IP have together contributed to a large increase in the trade flows between China and the United States. The United States imported about $480 bn of merchandise from China in 2015, which is an increase of about $400 bn since 2000, or a CAGR of 11%. The United States exported only about $115 bn of goods to China in 2015, leaving the United States with a deficit of roughly $350 bn (Exhibits 10-11). The United States accounted for 18% of China's total exports in 2015, and exports to the United States accounted for 3% of China's GDP.

Exhibit 10: Trade between the US and China has grown…
Merchandise value of US trade with China



Source: US Census Bureau

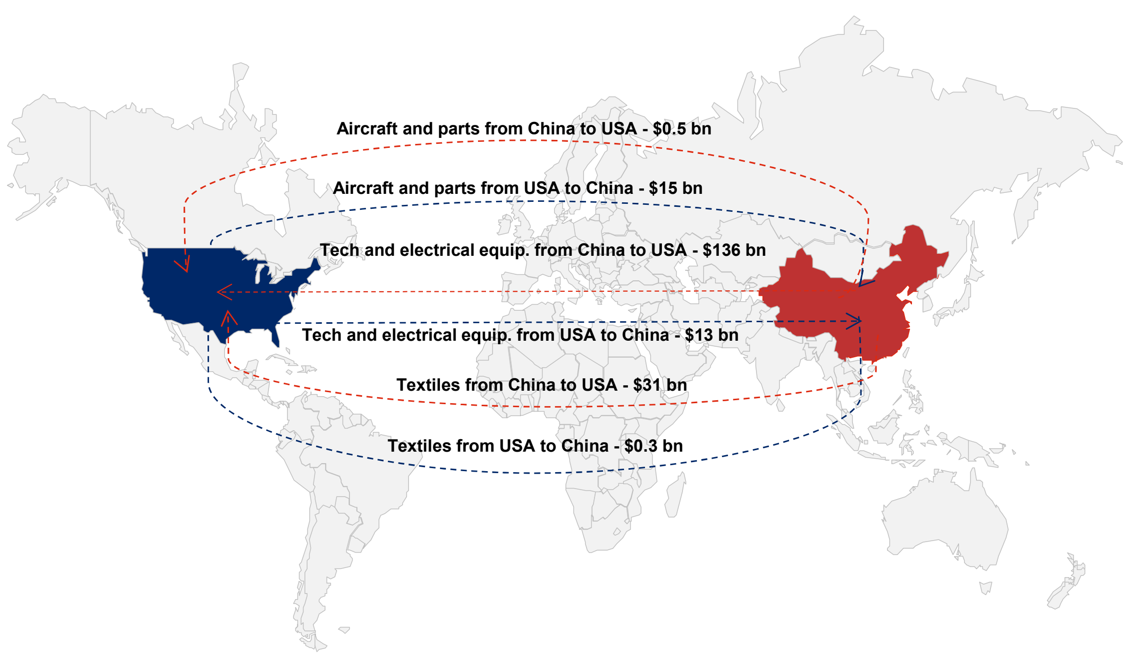
Exhibit 11: …with the US running a deficit on goods
2015 balance of trade surplus/deficit for US with China of trade ex. services between US and China



Source: US Census Bureau, China General Administration of Customs, Hong Kong Census and Statistics Department

Many of the largest trade flows are in the markets where there has been significant cross-border investment (Exhibit 12). For example in tech and electrical equipment, the United States imported $136 bn of goods from China in 2015, up from about $20 bn 15 years before, or a CAGR of 13%. US exports globally in this category increased at just a 1% CAGR over the same time period. Similarly, the United States imported about $31 bn of apparel and shoes from China in 2015, up from $8 bn in 2000. Global exports from the United States in this category were $3 bn in 2015, compared with about $4 bn in 2000, or a CAGR of negative 2%.

Exhibit 12: In 2015 the US imported ~$480 bn of goods from China, driven by categories such as textiles and electronics
Value of imported goods in $US bn in 2015

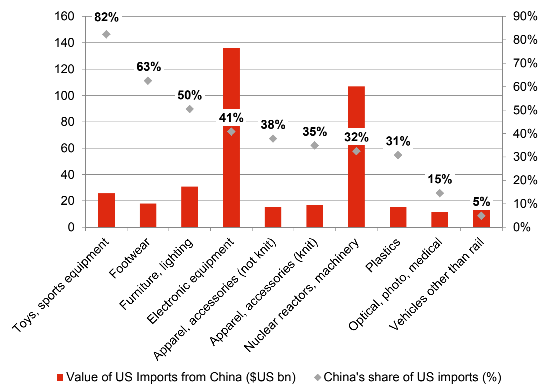


Source: UN Comtrade

The value of products that the United States imports from China is not only large in dollar terms, but China accounts for a high percentage of total imports in many categories (and in certain consumer products like toys and umbrellas, China accounts for 80-90% of all US imports; Exhibit 13). China also accounts for a high percentage of US imports of shoes, furniture, and electronics.

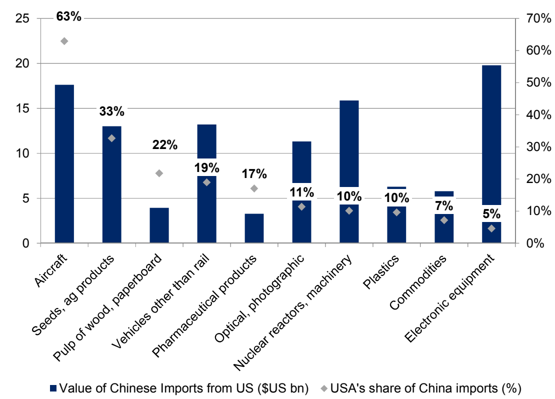
The United States runs a surplus with China in markets like transportation and agricultural products. A market in which US firms account for the highest percentage of China's imports is Aircraft and related parts, where US firms had 63% share of China's imports (Exhibit 14). The United States also exports other transportation equipment to China such as cars, but US firms account for a smaller percentage of China's total imports of cars – about 20%.

Exhibit 13: China key exports to the US include textiles and electronics
Value of US imports from China ($US bn); China's share of US imports (%)



Source: UN Comtrade

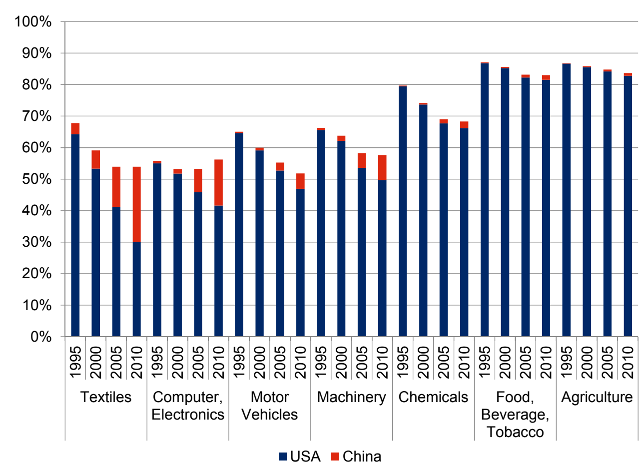
Exhibit 14: The key US exports to China are aircraft and agricultural products
Value of Chinese imports from the US ($ bn); US share of China's imports



Source: UN Comtrade

In addition, OECD data show that Chinese firms are capturing more of the total value of US products over time in markets such as textiles and electronics. For example, in textiles Chinese entities accounted for 3.5% of the total value in 1995; the proportion had increased to 24% in 2010. Similarly in tech, China accounted for 1% of total product value in 1995, and this increased to 15% by 2010 (Exhibit 15).

Exhibit 15: Chinese firms are taking on more of the total product value of US imports
Origin of value added of US final demand over time



Source: OECD, Goldman Sachs Global Investment Research

Ricardian Model of Trade suggests there should be specialization

One driver of foreign direct investment may be explained by the **theory of comparative advantage**.

Most contemporary economists who champion free trade trace the intellectual lineage of their position to 19th-century British economist David Ricardo's theory of Comparative Advantage—a concept he developed in his 1817 book *On the Principles of Political Economy and Taxation*. The theory is relatively straightforward: Individual countries in a global economy will "… specialize in the production of those goods which it can produce relatively cheaply and import those goods for the production of which foreign countries possess a comparative advantage," according to Haberler Gottfried from Princeton University (Haberler Gottfried, "A Survey of International Trade Theory," *Princeton University Press,* July 1961, p. 7.). In other words (as noted by MIT economists Arnaud Costinot and Dave Donelson), "… different factors of production specialize in different economic activities based on their relative productivity differences" (Arnaud Costinot and Dave Donaldson, "Ricardo's Theory of Competitive Advantage: Old Idea, New Evidence," *MIT Press,* May 2012, p. 1.)

To illustrate, Ricardo imagined two countries—England and Portugal—producing two goods—cloth and wine—with one factor—labor—as the sole means of production. According to this famous example, while in England a gallon of wine cost 120 and a yard of cloth 100 hours of work, in Portugal the cost of wine is 80 and a yard of cloth 90 hours of work, respectively. Therefore, Portugal clearly has an absolute advantage over England in the production of either good. However, Portugal's advantage is comparatively better in wine production (80/120 < 90/100). Consequently, Portugal will produce wine and England will produce cloth (and the two countries will trade these goods) precisely because specializing in the industry in which a country has a comparative advantage allows it not only to produce more units of the good than its counterparts, but also to import more units of the good for which it does not enjoy a comparative advantage than it could produce on its own. Thus, according to Costinot and Donaldson's interpretation of Ricardo's famous example, "if English workers are relatively better at producing cloth than wine compared to Portuguese workers, England will produce cloth, Portugal will produce wine, and at least one of these two countries will be completely specialized in one of these two sectors" (Costinot and Donaldson, p. 1).

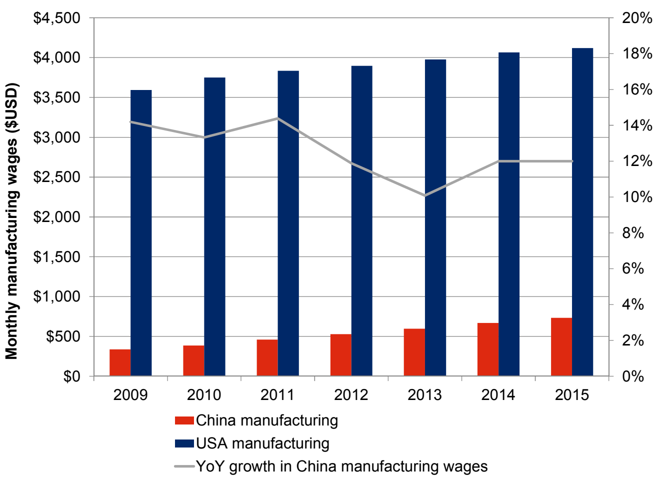
C. Fred Bergsten, Gary Clyde Hufbauer, and Sean Miner of the Peterson Institute explore this topic in their report "Bridging the Pacific: Toward Free Trade and Investment Between China and the United States." They state that there are significant advantages to both the United States and China to continue to engage in international trade. Specifically, the think tank notes that exports between the two countries expand "… their scale of production and jobs in sectors where they have demonstrable comparative advantages." They argue that both consumers and producers win if neither goes it alone: consumers gain from a "cheaper and more diversified array of goods and services" and producers from obtaining "lower-cost inputs for their final products," thus "strengthening supply chains" (C. Fred Bergsten, Gary Clyde Hufbauer, and Sean Miner, "Bridging the Pacific: Toward Free Trade and Investment Between China and the United States," *Peterson Institute for International Economics*, May 15, 2014, p. 10).

FDI in China: Labor savings, market access, proximity to suppliers

We believe cost reduction, increased market access and proximity to suppliers all played a role in the shift of US manufacturing to China. Regardless of policy, attempts to shift the balance back will take years, require a great deal of capital and face significant structural impediments, in our view.

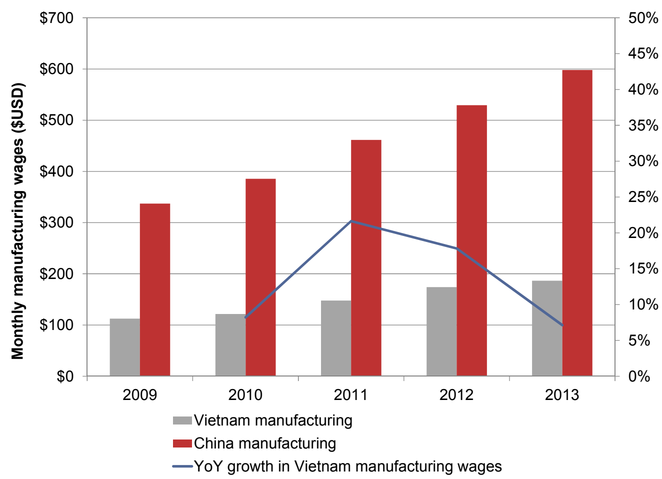
The incentive to use international labor can be sizeable. Manufacturing employees in the United States earn about $4,000 per month, compared with roughly $700 to $750 per month in China in 2015 (Exhibit 16). But differences in the makeup of the manufacturing jobs between the two countries make comparisons difficult. And with Chinese manufacturing wages rising 10% a year, the gap has narrowed and Chinese wages are well above countries such as Vietnam (Exhibit 17).

Exhibit 16: Wages in the US are well above China…
Monthly manufacturing wages



Source: International Labor Organization, Goldman Sachs GIR

Exhibit 17: …but wages are cheaper still in Vietnam
Monthly manufacturing wages

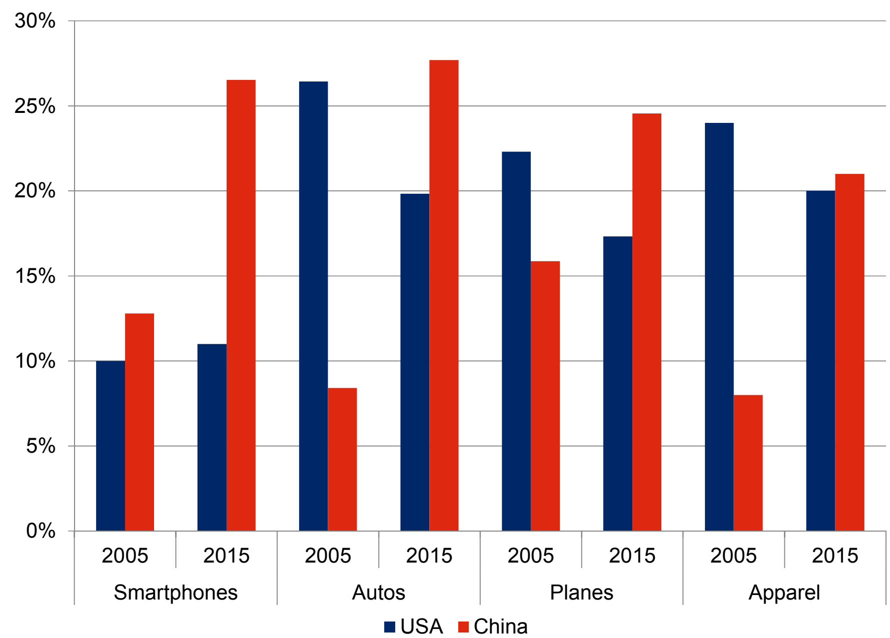


Source: International Labor Organization

China has grown into an important consumer market for many products (Exhibit 18). For instance, while in 2005 the China smartphone market totaled 6.9 million units, in 2015 that number rose 65x to nearly 450 million units, faster than the overall market's growth from about 54 million units in 2005 to over 1,400 mn units in 2015.

Similarly, while the global auto market increased at a 3% CAGR from 64 million units in 2005 to 88 million units in 2015, unit sales in China grew from 5 million in 2005 (8% market share) to 24 million in 2015 (28% market share). The US share of final demand declined from 26% to 20% over this time period.

Exhibit 18: China has grown to become the largest end-market for several products
% of industry demand by country



Source: Gartner, IHS, Ascend, Goldman Sachs Global Investment Research

An interview with…former Motorola executive Rich Valin

We interviewed Rich Valin, the former Corporate Vice President of Finance - Integrated Supply Chain of Motorola Solutions, Inc.—a role including responsibility for eight business units, 70+ factories, and $25bn of goods and services purchased or procured on an annual basis. Mr. Valin oversaw the transition of Motorola's mobile supply chain to an integrated system under Chris Galvin.

When did Motorola begin to move manufacturing internationally, and what drove this process?

Bob Galvin, Motorola's CEO who saw an enormous opportunity in the Chinese market, went with Richard Nixon there in 1973. Motorola was the first and only multinational in the early 1980s that was granted a wholly owned license to operate in China—all others had to operate under a JV structure with a Chinese partner, often closely affiliated with the Chinese government. The opportunity was about market access, not only in China but also more broadly in Southeast Asia—Malaysia, Singapore, and the Philippines. There were two camps within the company: people who said let's build everything in the US with mega-factories and the other camp, which eventually won over, that said we need to be closer to the markets where we are selling into because we need to understand them—we need to design, build, and distribute products within the region in which they are intended to be used.

At the beginning, we didn't fully understand the importance of labor costs. As we were starting up, we didn't have world-class foreign facilities from a people, process, and quality point-of-view. However, as we got into it, and those organizations matured, we began to understand the impact of labor. We started to realize these factories were very efficient and so we decided to reposition products around the world.

Leaving productivity aside, I think pure-play labor was 18X or even 20X to 1 at the time —so every $1 spent in China was like spending $18 or $20 in the US. And while people would say that labor isn't that much content per phone, we figured out that you had labor associated with every component in the supply chain.

As we trained up our entities in Asia and for that matter in Mexico, some of our best engineers were outside the US from a manufacturing point of view. Whereas early on we struggled with the design competence of Asian engineers, as time went on they became pretty good and thus we became pretty comfortable launching products with a US design concept but everything else done abroad—directly out of our Asia facilities versus earlier we would do everything in the US and then move them to Asia after launching, manufacturing, etc.

What other key factors beyond labor drove the move internationally?

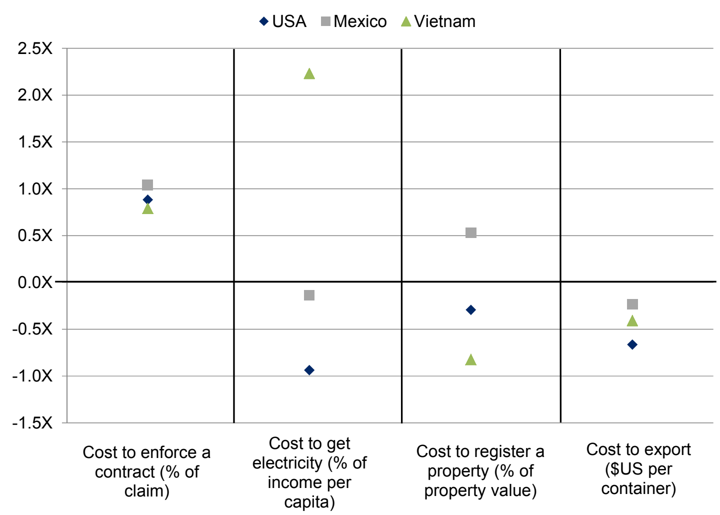
The other point is that guys like Motorola, Cisco, HP and others figured out that it wasn't economical to keep building manufacturing infrastructure on their own nickel—they couldn't finance all the factories. This is why contract manufacturers like Jabil, Flex, and Sanmina started to take off: They financed a lot of the capex for the OEMs. We would look at metrics like how much of our capacity was internal vs. external, and we tried to plan around that. Things really evolved around 1999 when we began to do business with Terry Gou at Foxconn. Terry was aggressive and tenacious as a business man, and he had big dreams to dominate the contract manufacturing space. We'd go to Hong Kong to meet with Terry and ask for 20 mn units – and he would say ok. They'd set it all up at limited costs for us. Thus, it was an easy way for us to expand and move to a variable cost model and be cost efficient—it was asset light.

Shipping and time to market were also factors. As the globe got a lot smaller from a sales point of view and the logistics industry became more mature, our modeling got very sophisticated on how we would try to move product around. That's when Mexico became a significant player for a lot of companies: It was the same template but the cost structure is a bit different—Mexico has a higher wage cost structure vs. Asia. China was maybe $1/hour and Mexico was $3.5/hour and US was $20/hour in labor costs. As critical mass grew in China, Singapore, Malaysia, and Mexico the supply chain started to grow. Again, the labor component started to trickle down to the rest of the supply chain and variations in oil and gas prices could be mitigated by a balanced approach to manufacturing with a regional footprint.

Cost of doing business varies – electricity is less expensive in the United States and environmental enforcement may lag in China

As further evidence that reductions in labor rates have played a role in FDI, data from the World Bank suggest that the cost of doing business is actually less in the United States than in China for some factors such as electricity costs (Exhibit 19).

Exhibit 19: Cost of doing business is more attractive in USA than China on some metrics
2016 World Bank Cost of Doing Business Database relative to China (parity is 0.0X)

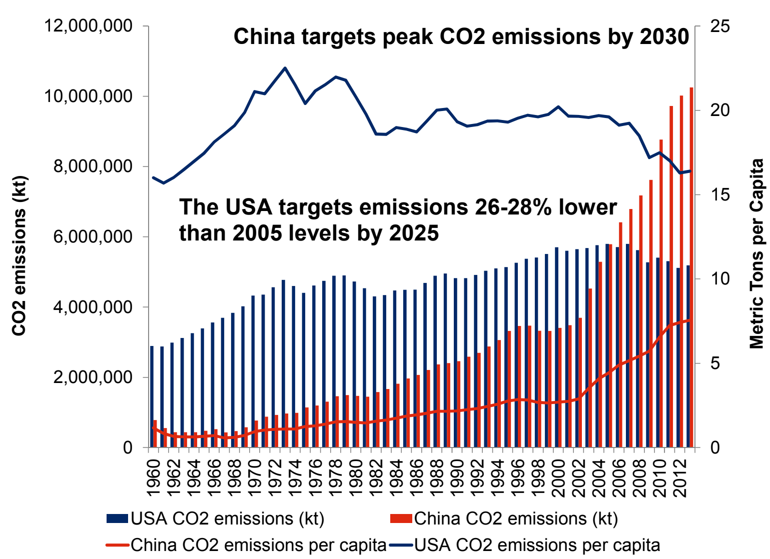


Source: World Bank

"With the exception of soil and water contamination control, regulation in China is largely on par with the US with respect to technical requirements. The key difference, for decades, is lack of enforcement in China"
– Jabil VP of Corporate Social & Environmental Responsibility Eric Austermann

One area where the cost of doing business in China is lower is in environmental compliance. On paper, many of the regulations are similar, but our industry discussions suggest that regulations are not always enforced in China. Further, we note that China has less stringent plans for carbon dioxide emissions control than the United States (Exhibit 20).

Exhibit 20: The United States has more stringent CO_2 emissions regulations than China
CO_2 emissions regulation targets



Source: World Bank

An interview with…Jabil's Eric Austermann

Eric Austermann, Vice President, Corporate Social & Environmental Responsibility, at Jabil provided some context on the differences in environmental regulation related to manufacturing in China and in the United States.

How do the US and China compare from an environmental perspective for manufacturers?

With the exception of soil and groundwater contamination control, environmental regulation in China is largely on par with the US with respect to technical requirements. Soil and groundwater contamination has become a focus in 2016 with stronger requirements expected to be fully in place by 2020.

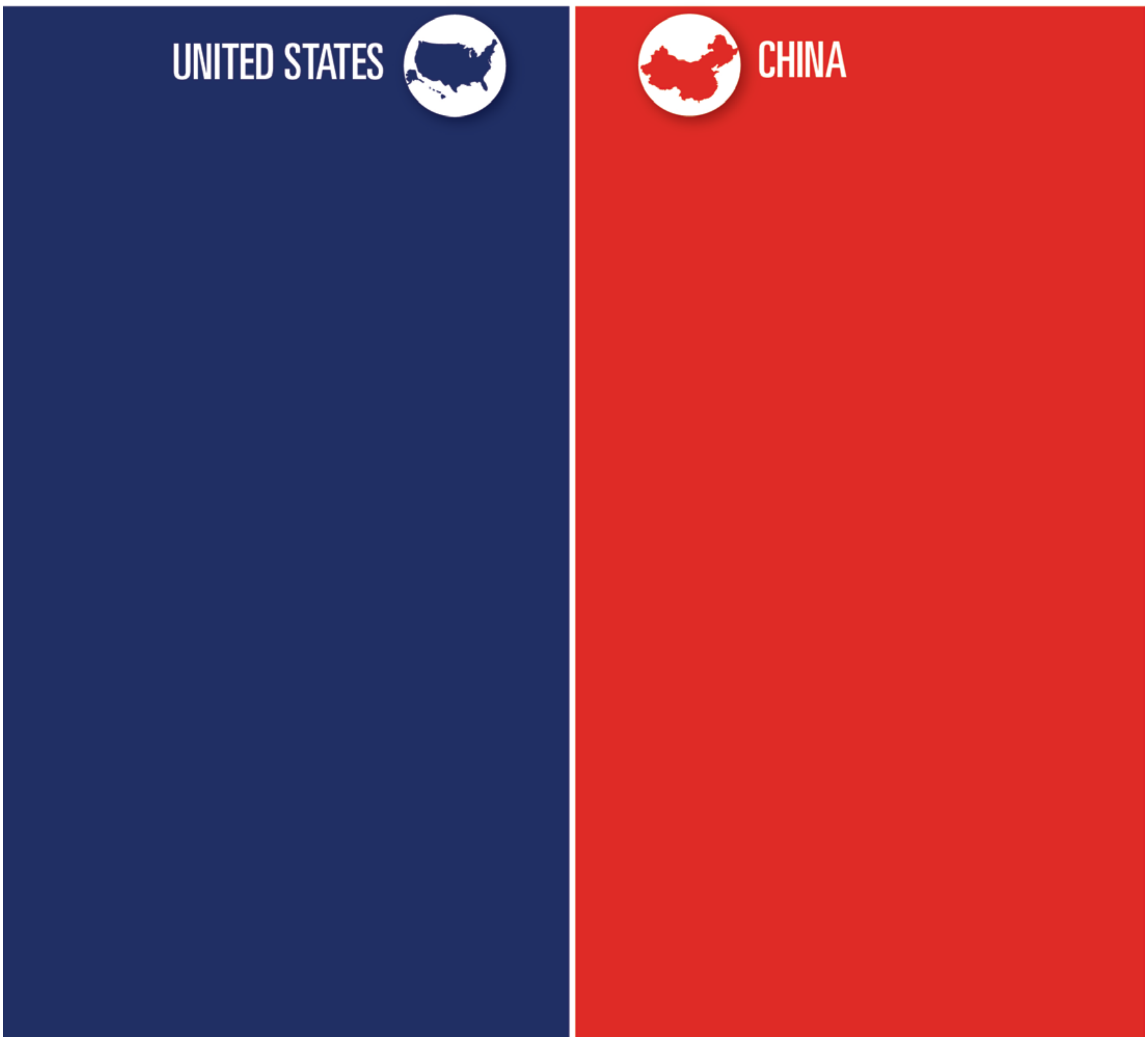
The key difference, for decades (as we know) is lack of enforcement in China. This directly impacts cost of compliance. Weak enforcement drives complacency, not to mention the "follower" or "wait and see" mindset. Clearly this drives behavior that either defrays or completely defers investments, reducing cost significantly.

However, government structures have been gradually changing since 2015 with more alignment to central government, shifting from local government. But, enforcement focus will remain on heavy industrial sectors for years to come.

In sum, from the perspective of technical requirements the gap between the US and China is nearly closed as many requirements are already aligned. From the perspective of enforcement, on the other hand, gaps remain—although we think these gaps are starting to close. Thus, we believe there are and will continue to be tangible compliance cost differences between the US—where costs are higher—and China—where costs are lower—driven by a lack of enforcement in China. And although the pull back on regulations by the current US administration may close the gap to some degree, the gap will never fully close unless China starts to enforce its regulations.

Chapter 2: Policy in transition

- What are the prospects for policy goals from both the US and China to increase local manufacturing? US policy goals face challenges around labor … both from supply and cost. China policy goals face challenges such as IP.
- Prices of goods in the United States could rise by 0.8% from a destination-based tax.
- Could automation solve these labor supply issues in the United States? See our interviews with the experts of Flex and Jabil to learn more.
- Goldman Sachs Senior Asia economist Goohoon Kwon estimates the impact to China's GDP if the US does reduce imports.



Chapter 2: Policy in transition

Highlights from this section

- The goal for the United States is to increase domestic manufacturing, while China is targeting increased local sourcing in certain industries.
- Prices of goods in the United States could rise by 0.8% from a destination-based tax.
- There could be a multi-year trade dispute in the WTO if the United States institutes a destination-based tax or tariffs.
- US companies face average tariffs of 4.0-6.5%, and China's exports to the United States face average tariffs of about 3%.
- We interview Goldman Sachs Senior Asia economist Goohoon Kwon on page 25.

Goal for the US administration – increase domestic manufacturing, with taxes and tariffs as potential tools to accomplish this

President Donald Trump has argued against running a large trade deficit and in favor of more US manufacturing, and he has called for changes to tax policy and tariffs to attempt to achieve this. We discuss changes on these fronts that the United States could make, and also the potential efficacy and impact of those policies according to economists.

However, the domestic savings rate also influences the trade deficit, and as discussed by Gary Hufbauer and Euijin Jung of the Peterson Institute (Gary Clyde Hufbauer and Euijin Jung, "Is Our Trade Deficit a Problem?" February 2, 2017, *The Peterson Institute for International Economics*), an economic agenda calling for tax cuts and infrastructure spending is typically not a prescription for reducing trade deficits. The Congressional Budget Office currently projects the US budget deficit will be around 3% of GDP in the next few years.

Taxes

President Trump and members of the US Congress such as House Speaker Paul Ryan have called for changes in tax policy that would make the cost of domestic production more attractive financially, as detailed in the December 3, 2016 *US Economics Analyst* "Corporate Tax Reform in 2017." These measures include reducing the US federal statutory corporate tax rate, and under the House Republican blueprint, a destination-based tax with border adjustment (Exhibit 21).

Exhibit 21: Tax proposals could incentivize more US manufacturing

	Current Law	House Republican Blueprint	Trump Proposal
Domestic corporate rate	35%	20%	15%
Business expensing	Accelerated deprecation w/ 50% bonus through 2017, 40% 2018, 30% 2019	100% expensed at time of investment	Allow option of 100% expensing
Net interest deductibility	Unlimited	Repeal deductability	Repeal deductability for those who expense
Foreign income	35% (minus foreign tax credits)	0% (full territorial system)	15% (repeal deferral but allow foreign tax credits)
Repatriation	35% (minus foreign tax credits)	8.75% on cash 3.5% otherwise	10% on previously untaxed earnings
Destination-basis/ border adjustment	N/A	Deny deduction of import costs, exclude export-related income	N/A

Source: Goldman Sachs Global Investment Research

The destination-based tax with border adjustment (DBTBA) called for in the House Republican blueprint advocates for a tax on cash flow, and this allows for deductibility of domestic expenses but exempts exports from the tax base. Further, both the House Republican blueprint and the proposal from President Trump call for lowering the federal statutory corporate tax rate to 20% and 15%, respectively. In aggregate, these efforts could make US production relatively more attractive.

The Goldman Sachs US Economics team estimated on December 3, 2016 that implementing the House Republican blueprint would push the US budget deficit up to about 6% of GDP by 2020, and implementing President Trump's proposal would move the budget deficit to 7% of GDP by 2020, compared to their baseline estimate of about 5% of GDP by 2020. This is before considering any potential reductions in government spending.

Beyond the potential budget effects, Gary Hufbauer and Lucy Lu of the Peterson Institute examine the pros and cons in their January 2017 brief "Border Tax Adjustments: Assessing Risks and Rewards". **They argue benefits from a DBTBA** may include lower incentives for US corporations to invert, addressing the unfairness in WTO rules that allow for value-added taxes for other countries, a potential reduction in the US trade deficit, and higher household savings. **However, potential drawbacks** are higher prices for US consumers, and the view of some that a DBTBA would lead to a percent-for-percent appreciation in the US dollar and would therefore not be useful.

On the topic of higher prices, Goldman Sachs US Economist David Mericle estimates in a note from January 3, 2017 titled *US Daily: The Inflation Impact of a Border-Adjusted Corporate Tax,* that the DBTBA would **raise prices by about 0.8%** in year one. This estimate of 0.8% is net of factors such as US dollar appreciation and margin compression for retailers.

Our economics team sees a 20% probability of a destination based tax becoming law.

Tariffs

President Trump has also suggested that the United States should impose a 45% tariff on imports from China. As detailed by Gary Clyde Hufbauer of the Peterson Institute (Gary Clyde Hufbauer, "As President, Trump Can Shackle Trade. But Will He? January 5, 2017, *The Peterson Institute for International Economics*), the President has wide latitude from laws like the Trade Act of 1974 and the International Emergency Powers Act to institute tariffs when the United States is running a large balance of payments deficit or in the interest of national security (Exhibit 22).

Exhibit 22: The US president has broad latitude on tariffs
Summary of key statutes according to the Peterson Institute

Name of statute	Authorization trigger	Presidential powers
Trade agreements		
NAFTA implementation act of 1993	Proclamation of tariffs	Proclaim return to MFN tariffs on imports from Canada and Mexico
	Maintain general level of reciprocal concessions with Mexico and Canada	Proclaim additional duties following consultations with Congress
Limited statutes		
Trade Expansion Act of 1962, Section 232(b)	Finding of an adverse impact on national security from imports	Impose tariffs or quotas as needed to offset the adverse impact
Trade Act of 1974, Section 122	Large and serious US balance of payments deficit	Impose tariffs up to 15 percent, or quantitative restrictions, or both for up to 150 days against one or more countries with large balance of payments surpluses
Trade Act of 1974, Section 301	Foreign country denies the United States its FTA rights or carries out practices that are unjustifiable, unreasonable, or discriminatory	Retaliatory actions, at presidential discretion, including tariffs and quotas
Almost unlimited statutes		
Trading with the Enemy Act of 1917	During time of war	All forms of international commerce, plus the power to freeze and seize foreign-owned assets of all kinds
International Emergency Economic Powers Act of 1977	National emergency	All forms of international commerce, plus the power to freeze foreign-owned assets of all kinds

FTA = free trade agreement; MFN = most favored nation; NAFTA = North American Free Trade Agreement

Source: Peterson Institute

The USA currently has average tariffs of about 2.9% on Chinese imports and 1.7% overall, according to WTO data. However, Goldman Sachs US Economists Zach Pandl and Alec Phillips noted in their piece published on February 6, 2017, *US Daily: President Trump's Options on Trade and Tariffs*, using WTO data, that the **average tariff on US exports is in the range of 4.0-6.5**%. They point out that President Trump has proposed having equal tariffs on imports that US exporters face. They further argue that the President can use a combination of measures to achieve this, including revoking Most Favored Nation (MFN) status of trading partners, exiting free trade agreements, appealing to the WTO, or utilizing the broad authority the president has as outlined in Exhibit 22.

How might China respond to US tariffs or border taxes?

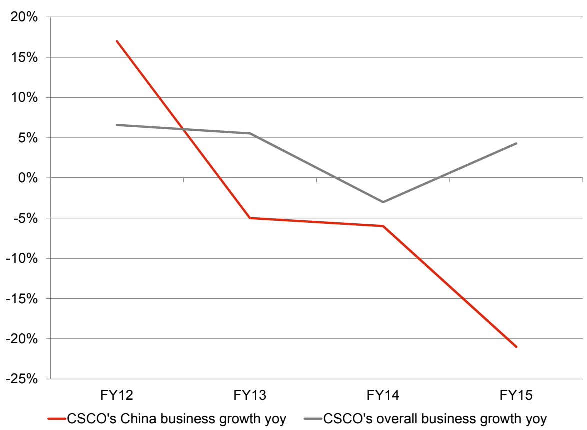
Options for China to respond to US tariffs or border taxes include retaliatory tariffs, making business conditions harder for US companies in China, and FX policy changes.

For example, in an interview with Goldman Sachs *Top of Mind* editor Allison Nathan published on February 6, 2017, Tu Xinquan (Dean and Professor at the China Institute for WTO studies at the University of International Business and Economics in Beijing) suggests that China will not tolerate even a 1% increase in tariffs above what applies to other countries. He believes an initial step would be retaliatory tariffs on US products like cars and airplanes.

Our economists David Mericle and Alec Phillips argue in the February 17, 2017 *US Daily: Trade Disputes: What Happens When You Break the Rules?* that they do not expect an outright trade war, but tariffs could lead to trade disputes. For example, a 45% tariff on China imports could result in a roughly $200 bn dispute in the WTO, and historical disputes have taken many years to resolve. Goldman Sachs China Equity Strategist Kinger Lau also suggested in a February 20, 2017 report that China can step up enforcement against US companies. In the last few years, General Motors, Qualcomm and Microsoft have all faced scrutiny on antitrust concerns.

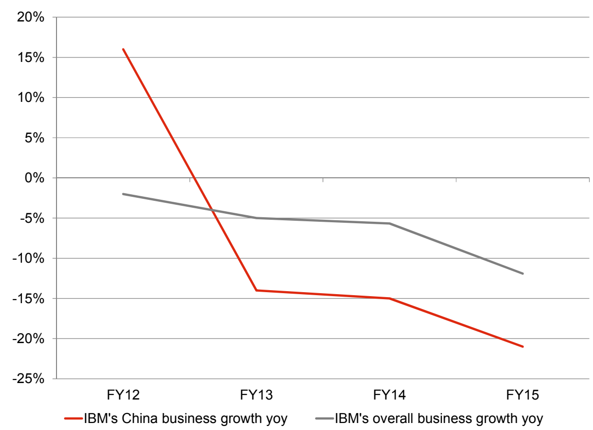
A historical example illustrating how the Chinese government might potentially respond occurred in the weeks following the Edward Snowden leaks in 2QCY13, when China removed several large US tech companies—including Cisco, Citrix Systems, and Intel's McAfee—from the Central Government Procurement Center's (CGPC) list (see *Reuters,* "China drops leading tech brands for certain state purchases," February 27, 2015). Cisco's China business declined by 5% in FY13 and 6% in FY14; on IBM's 3Q13 earnings call, the CFO said that sales into China were down 22% yoy.

Exhibit 23: Cisco's sales into China fell…
CSCO China business sales growth



Source: Company data, Goldman Sachs Global Investment Research

Exhibit 24: …as did IBM's post the Snowden leaks
IBM China business sales growth



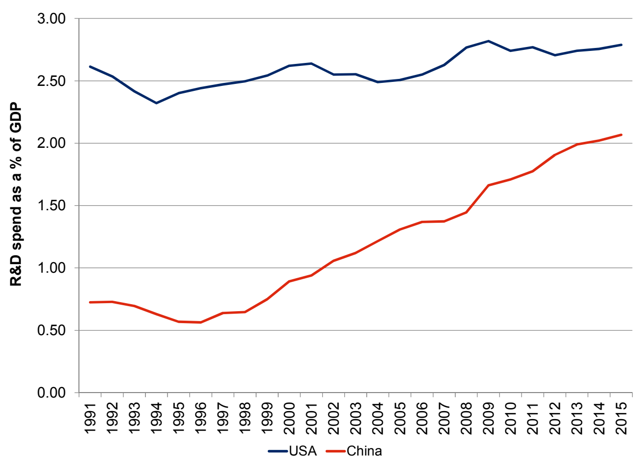
Source: Company data, Goldman Sachs Global Investment Research

Goals for China – Economic self-reliance/independence

Since the Chinese economy began to rapidly industrialize in the 1950s, the Chinese government has released a series of thirteen "Five-Year Plans" (FYPs) that outline top priorities for—among other things—developing self-sufficient industries and gaining market share in key sectors from worldwide competitors. The 12th Five-Year Plan (2011-2015), for instance, was "focused on moving up the value-added chain" as well as "promoting indigenous innovation," in the words of US-China Economic Security Review commissioner Michael Wessel.

To help accomplish this goal, R&D spending in China has increased, according to OECD data. R&D was less than 1% of GPD in China in 1991, and it has increased to more than 2% as of 2015 (and vs. the United States at 2.8% of GDP; Exhibit 25).

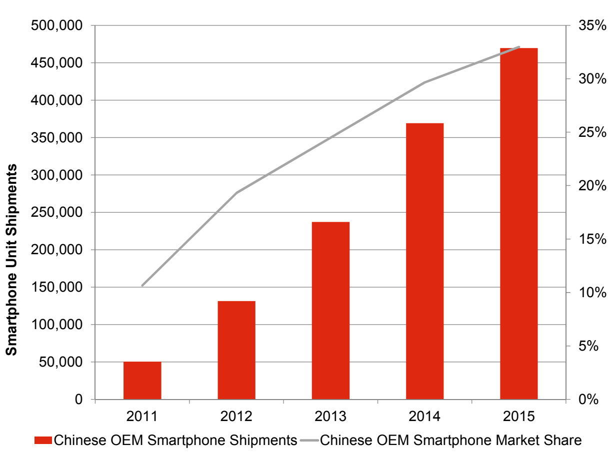
Exhibit 25: R&D intensity has been increasing in China and is now closer to the US
GERD (gross domestic expenditure on research and development) as a percentage of GDP



Source: OECD

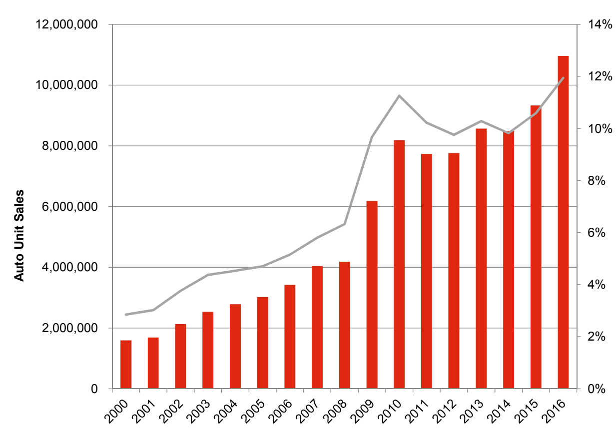
In some markets such as smartphones and the automotive industry this increased focus is likely to be contributing to higher market share (Exhibits 26-27). **Chinese phone OEMs have grown global market share to 33% in 2015 from 11% in 2011. Similarly, Chinese automotive OEMs have grown global market share to 12% in 2016 from 3% in 2000.**

Exhibit 26: China brands have gained share in phones...
Market share of Chinese smartphone OEMs



Source: Gartner

Exhibit 27: ...and in cars
Market share of Chinese auto OEMs

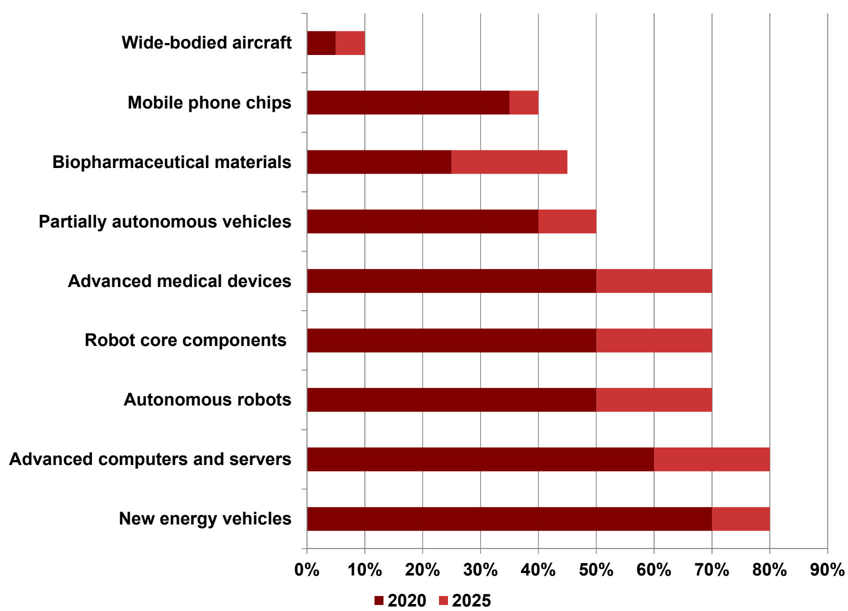


Source: IHS

In March 2016, the National People's Congress of China ratified the government's current priorities in the 13th FYP. Along with laying out about a 6.5% GDP growth CAGR target, the 13th FYP and associated policy directives such as the "Made in China 2025" and "Internet Plus" initiatives focus on a key Chinese goal: moving up the value-added manufacturing supply chain. Accordingly, the US-China Economic and Security Review Commission 2017 staff research report, published on February 14, 2017, notes that the most recent FYP "continues a shift…toward rebalancing the economy away from infrastructure and export-led growth and toward more consumption-led, higher-value-added growth" (Katherine Koleski, "The 13th Five-Year Plan," *U.S.-China Economic and Security Review Commission,* February 14, 2017, pg. 4).

To accelerate this transition, the government is focused on upgrading emerging industries via technology transfers, regulating foreign investment and technology imports, and promoting Chinese technological exports. "Made in China 2025" further seeks to "build domestic firms that are globally competitive with a goal of gradually substituting foreign technology and products with local technology and production first at home then abroad" in ten industries: new energy vehicles, next-generation IT, biotech, new materials, aerospace, shipping, railways, robotics, power equipment, and agricultural machinery per the US-China Economic and Security Review Commission's 2017 staff research report. To support "Made in China 2025", the Chinese government laid out key targets for several verticals (Exhibit 28).

Exhibit 28: Select China 2020 and 2025 technology localization targets
Domestic production as a share of domestic market

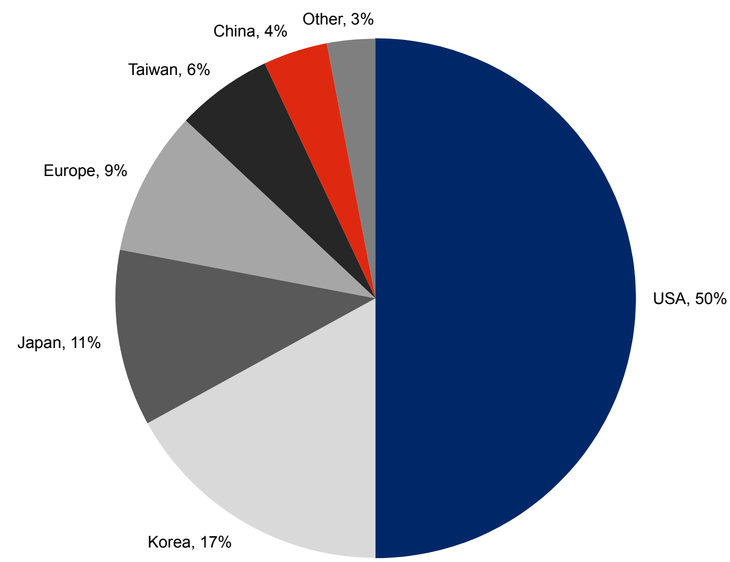


Source: Chinese Academy of Engineering, U.S.-China Economic and Security Review Commission

China's focus on semiconductor independence illustrates its aspirations

There is one technology that binds together all of the industries mentioned above—semiconductors. In fact, the international law firm Morrison & Foerster notes in "Getting the Deal Done: China, Semiconductors, and CFIUS" (Nicholas Spiliotes, Aki Bayz, and Betre Gizaw, "Getting the Deal Done: China, Semiconductors, and CFIUS," *The M&A Journal,* Volume 16, Number 5) that semiconductors are a "key component in nearly every electronic device" that "represent the core of a long list of systems with potential military applications." Thus, especially given this technology's dual-use nature, it comes as no surprise that the Chinese government has systematically tried, in every recent FYP iteration, to improve this industry's competitiveness. This is particularly true given that about 30% of global semiconductor shipments were to China in 2015, and yet China based companies comprise just 4% of global market share for final chip sales, according to the Semiconductor Industry Association (SIA; Exhibit 29). In contrast, US-based semi companies have about 50% semiconductor market share.

Exhibit 29: China companies have just 4% share of the semi industry vs. the US at 50%
2015 semiconductor market revenue share per the SIA



Source: SIA

In an attempt to close the gap, a special Chinese government task force developed an aggressive growth strategy as part of the 13th FYP targeting a 20% annual industry CAGR. The government (via the China Integrated Circuit Industry Investment Fund) has committed up to 1 trillion yuan (about US$150 bn) to develop and acquire semiconductor IP over the next five to ten years with the ultimate goal of becoming self-sufficient for 75% of semi needs by 2025, and having a world-class semiconductor supply chain by 2030.

Accordingly, Chinese-based entities have made a number of attempts to acquire foreign-based semiconductor-related IP: According to M&A analytics provider Dealogic, Chinese investors attempted to acquire 21 different international chipmakers in 2015. Notable recent M&A transactions by China-based entities have included OmniVision, NXP's standard products and RF power businesses, and ISSI. In addition, China-based companies are increasingly partnering with US-based companies like Intel (partnered with Rockchip for mobile chips) and Qualcomm (partnered with Guizho Province for server chips), in part by providing the US companies with sales relationships in the largest geographic market for semiconductors.

The US government has watched these efforts closely. On January 26, 2017, for example, the President's Council of Advisors on Science and Technology issued a report warning that a "concerted push by China to reshape the market in its favor, using industrial policies backed by over one hundred billion dollars in government-directed funds, threatens the competitiveness of U.S. industry and the national and global benefits it brings."

An interview with…GS Economist Goohoon Kwon

To better assess the risks and opportunities for the US and China from increased local manufacturing, we spoke with our Senior Asia Economist Goohoon Kwon.

Mr. Kwon and colleagues have analyzed *the potential direct and follow-on effects from reductions in both US and China imports, and conclude that Asia is highly vulnerable to US trade protectionism. In the event of across-the-board reductions in US imports by 1% of GDP, they say Taiwan and Korea could have output losses amounting to about 0.7%-0.8% of GDP, with about half the losses from indirect effects. The impact on China would be relatively smaller at 0.6% of GDP. Specific industries in China that would be most impacted by a reduction in US imports would be Electronics, Electrical Equipment, Machinery, Textiles, and Automotive. Importantly, they find that a comparable move by China to reduce US imports would be even more damaging to Taiwan, Korea, as well as Asia as a whole.*

What are the risks to China from the US trying to produce more domestically, both in terms of GDP and jobs?

The impact would be quite significant, although quantifying it obviously depends on how the US proceeds, whether with a border tax or specific tariffs, for example. At the end of the day, if the US government's intention is to encourage more domestic production—not just against China but more broadly—then it will significantly impact China's GDP. In terms of numbers, if the US instituted a limited tariff increase of 20%, which we estimate would reduce US imports by 10%, then the pure supply-side effect on Chinese GDP would be a 0.3% decline—a number that could increase rapidly from retaliation or spillover effects to other domestic activity. In terms of jobs, the government can do a lot of things to encourage employment elsewhere so I will just stick to quantifying the GDP impact.

Can CNY currency devaluation offset the impact to China's GDP from potential US import reductions?

In our work, yes—CNY currency devaluation can help in principle. However, if the currency of an Asian country weakens from a broad external shock—not specific to that country—then all other Asian currencies will likely weaken as well, diluting or even reversing competitiveness gains from the initial depreciation. Moreover, given China's role as a regional hub of supply chains, China's currency is so influential in Asia that if the currency moves then other currencies would have to move as well—not because those countries want to but because they would need to due to potentially huge losses in competitiveness. Japanese yen and Chinese yuan are to a certain extent anchor currencies in the region, so our view is that they could lose more than they gain through depreciation of their currencies in the face of US import reductions.

Japan and Korea appear more self-reliant than the US at making certain products like cars and computers. What are the main drivers of this, and to the extent this difference is policy-driven, what have been the economic pros and cons for Japan and Korea from these policies?

The main driver is the initial conditions. The first thing I would note is that Japan and Korea started industrialization much later than the United States and hence have long been catching up: they started small initially for domestic markets, relying on domestic suppliers and then their companies have grown large and international like American ones, which has enabled them to start outsourcing. An analogy could be made with startups – when you start your business and when you try to catch up, you have to start small with resources available around you before your business is growing up.

Additionally, at least in the case of Korea, there has been a financing issue when they operate abroad. If a Korean company wants to do business abroad (Japan may have had a similar issue twenty to thirty years ago), it would be much easier for these companies to obtain financing domestically – if they operate abroad, Korean banks would not be able to help them much in the event of a financial squeeze: they would need dollar funding and that's not the currency the Korean banks operate in, which would make their funding costs more expensive than local competitors. Further, if Korean companies operating abroad try to fund from foreign banks, the cost of funding would be significantly higher then what they could borrow domestically from Korean banks.

There are also natural cultural issues preferring staying in the home country. But if you look at Samsung and Hyundai, for example, they behave like US companies in terms of outsourcing given that 90% of Korean smartphones are produced overseas, as are 60% of Korean cars. Other Korean companies, on the other hand, are not as internationally integrated as these two—not because they choose to be, but simply because they are not as advanced as those two companies.

In terms of pros, if the supply chain is close to you then you are much more flexible and less vulnerable to disruptions overseas, and there is much less political risk. Thus you have stability as well as control. The primary con is that it's not as efficient. If you can manage well overseas supply chains that entail operational and disruption risks, you are better off.

Are there best practices for the USA from an economic perspective to follow if it wants to also become more self-reliant without making its companies less competitive and raising the cost of production?

According to the smile curve model of supply chains, value is added at downstream, midstream and upstream segments of the supply chain. The biggest opportunity is at the start of the supply chain where R&D and technology dominate. At the end of the supply chain are branding, marketing, distribution and after-services, where you could make the biggest gains and differentiate. The middle is for assembling or standardized manufacturing like commodity production. If the US tries to spend money to produce more in the middle of the supply chain domestically, it won't be very sustainable because it is not even what the Korea and Chinese companies are doing—even they outsource parts of the routine assembling operation.

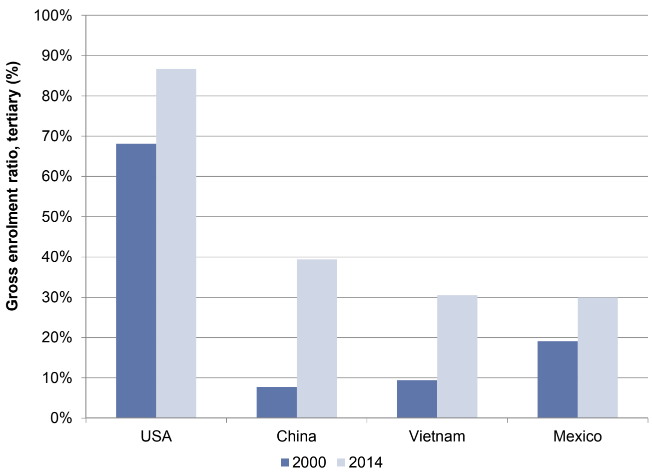
The common challenge to bringing manufacturing to the US is labor; Automation could change the skillset needed for a "line worker"

The common challenge to bringing manufacturing jobs to the United States in smartphones and textiles is labor, broadly defined, including the cost of labor and the availability of skilled employees.

While we discussed the hourly wage differential issue previously in this report (and we examine what it would mean for consumer prices in our case studies on apparel and smartphones later on), **in this section we discuss the availability of skilled labor to meet the types of manufacturing jobs of the future**.

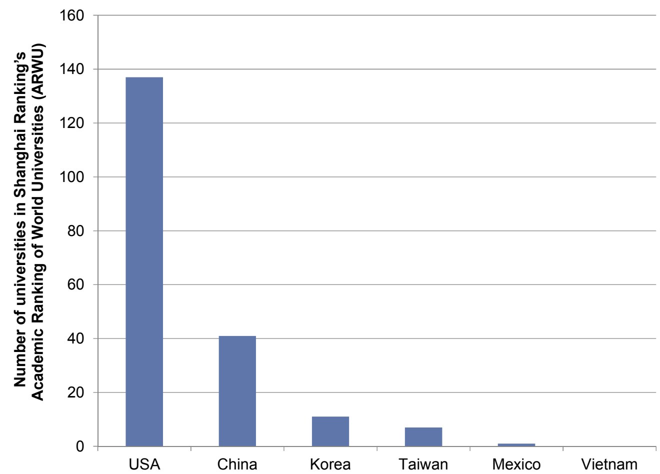
The United States continues to have high levels of college education and highly ranked colleges, according to data from UNESCO and college ranking surveys. China has closed the gap with the United States in terms of the percent of the population gaining degrees since 2000, but there is still a higher enrollment rate in the United States (Exhibits 30-31).

Exhibit 30: China's college education attainment levels have significantly increased…
% of population with tertiary education



Source: UNESCO

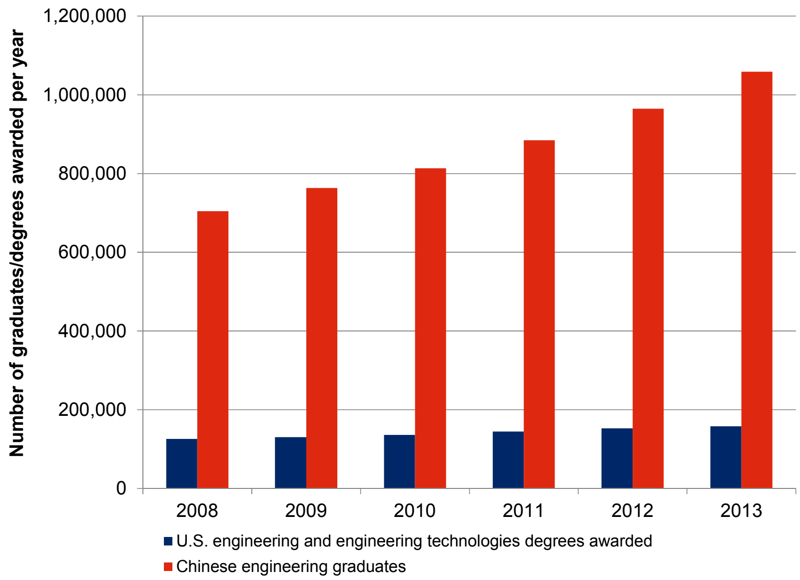
Exhibit 31: …although the US still has higher-ranked colleges and higher overall enrollment
Number of universities within the top 500 globally



Source: Times Higher Education – 2016 Shanghai Rankings

However, the number of degrees in engineering that students are attaining in China is significantly higher than in the United States. China awarded over 1 million engineering degrees in 2013 compared to the United States, with fewer than 200,000 (Exhibit 32).

Exhibit 32: The number of engineering degrees awarded in China is significantly higher than in the United States
Number of graduates/degrees awarded per year



Source: National Center for Education Statistics, China National Bureau of Statics

"Automated factories require higher skilled engineers and technicians to deploy, commission, and maintain the equipment" – Jabil VP of Automation John Dulchinos

"A rough number is that for every ten people in assembly, automation will remove four to seven. Let's assume you keep three people. Those three people will not be the same: You will need two engineers to drive the automation in terms of programming and quality control" – François Barbier, President Global Operations at Flex

Given the large increase in labor costs in the United States, as well as the relatively limited number of trained employees left doing manufacturing (200-300K in textiles and textile product mills in total, and about 1 mn in electronics), one way that manufacturing could increase in the United States is through a higher degree of automation.

OEMs would need to design specific products for automation to make it economically feasible in high-volume applications like smartphones that have short product cycles, including ensuring the tools could be used for more than a year.

However, if automation were to become practical for labor-intensive processes such as smartphone assembly, then we believe some production could shift to the United States with relatively low tax/policy incentives.

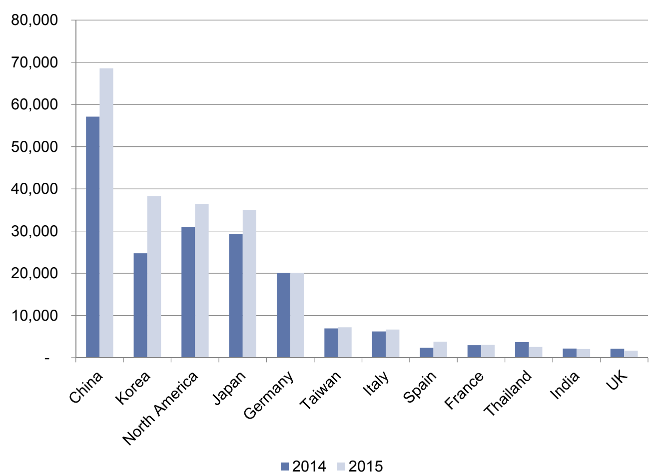
Importantly, automation would change the types of jobs of the "manufacturing line worker" of the future, and would require more engineering skills to do process control, statistical tests and basic programming. These jobs often require engineering degrees, and China is training more engineers than the United States.

The change in the type of job that automation requires is important in our view, as it suggests it may create more high income engineering jobs even if it results in fewer total positions. For example, François Barbier, President Global Operations and Components at Flex, has suggested that in smartphone manufacturing, for every ten people that had been involved in basic final assembly, automation could remove four to seven jobs. However, there may only be one or two traditional line worker jobs remaining, and there would be a few new engineering jobs needed for debugging, programming and quality control. We have our full interview on automating smartphone manufacturing with Mr. Barbier at the end of this section of the report. Similarly, Jabil's VP of Automation John Dulchinos noted, "Automated factories require higher skilled engineers and technicians to deploy, commission and maintain the equipment. While the overall factory headcount is reduced, the level of skilled workers increases leading to a higher percentage of engineers in an automated factory." See our interview with Mr. Dulchinos at the end of this section for more detail.

Some economists also believe there are long-term benefits from having manufacturing locally, even if it leads to higher costs. Harvard professors Gary Pisano and Willy Shih explore this topic in their 2012 book *Producing Prosperity: Why America Needs a Manufacturing Renaissance*. They argue that part of the competitive advantage for an industry or country comes from **a local network or "industrial commons" within which clustering allows companies to benefit from the availability of labor and suppliers, as well as knowledge gleaned from face-to-face interactions in the local network.** In addition, they believe that while in the short-term competitive advantage may cause a company to separate manufacturing from R&D, in certain industries this could have long-term damage to a company's ability to innovate since it may take longer to fine-tune the product ramp with the engineers separate from the manufacturing. They argue that long-term, countries without manufacturing may lose understanding of the full product development process and lose their competitive edge in design and R&D.

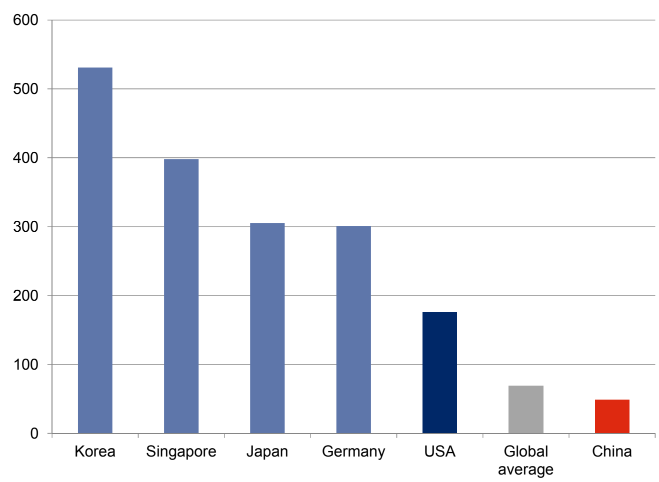
As a measure of where China and the United States stand on automation, we examined robotics penetration. **Surprisingly, even though labor is inexpensive in China, China is the largest market for robotics sales and comprised about 27% of total global demand** (Exhibit 33). We believe this suggests labor costs are not the only factor in deciding to add automation or where to do manufacturing. However, China continues to trail other countries in robot density, with 49 robots per 10,000 manufacturing employees vs. the United States at 176 in 2015 (Exhibit 34).

Exhibit 33: China is the largest consumer of robots…
Annual shipments of multipurpose industrial robots



Source: International Federation of Robotics

Exhibit 34: …but still trails on robot density
Robots per 10,000 manufacturing employees



Source: International Federation of Robotics

Without the ability to increase levels of automation, it could be difficult to move entire supply chains like smartphones and textiles to the United States for several years, as the labor force would need to be trained.

However, products that allow a high degree of customization may still be produced in the United States at lower cost than in China even without border taxes or tariffs. For example Motorola Mobility attempted to carry out final assembly in Texas for the Moto X, a product for which consumers could make final design choices for several elements like the case and button design. Shipping each individualized product from Asia would add too much cost and time. In addition, shoe companies such as Nike and Adidas are exploring doing more local manufacturing with a higher degree of automation to increase time to market and allow for more e-commerce/customization.

An interview with…Flex's François Barbier

We conducted an interview with François Barbier, President, Global Operations and Components at Flex. We discussed key issues about moving smartphone manufacturing to the US, and if this could be automated.

Are there any metrics you can share on how much of your business has been automated, how that has changed over time, and where that may go over the next 3-5 years?

If you look across the board at all of the different industries—including medical, auto, home appliances, and capital equipment, to name a few—a ballpark estimate is 60-70% automation across the board. But remember we have 100+ locations and thousands of customers, so you might find a factory that is 80% automated and another that is only 40%. I believe there is a limit to automation; you will never see 100% automation for certain products we manufacture, for several reasons. First, we have products that have a very short product lifecycle. As a result, there is no return on investment to fully automate the process. Second, products with flexible inputs are harder to automate as placement must be precise. Finally, gaining incremental automation can be prohibitively expensive. For us, getting to 90% automation for most products is very expensive and getting to 95% may be irrational from a financial perspective – there are diminishing returns. Medical device production is very difficult to automate given the complexity involved, lack of volume, and lack of return on investment.

What role does automation currently play in smartphone manufacturing, and is it possible for smartphone manufacturing to be 100% automated?

Today, roughly 60-70% of the smartphone production process is fully automated, including the construction of the circuit board and associated electrical components, display, enclosure, microphone, and speakers. The remaining non-automated 30-40% or so consists largely of the final assembly of these components—a process that is not 100% precise and thus currently the most difficult thing to automate. For instance, the plastic enclosures on current generation smartphones are designed for humans to use screws to assemble. Moreover, many elements on current smartphones are connected via a wire, which is flexible and best suited for manual assembly.

I personally believe it is possible to design the next generation of smartphones for closer to 100% automated manufacturing, but companies need to design products with this in mind at the very beginning of the product life cycle, twelve months prior to product ramps. When you design a product for automation, you need to preposition the mechanical parts in a very precise way. Luckily, a lot of smartphone parts can be designed in a way that their assembly is possible to automate. Thus, designing for automation is the key element to take into account to have a fully automated process later on.

What is the investment needed to automate a line that does for example 5 million smartphones a year?

The front-end process is already mostly automated, so no further investment is needed there. Automating the back-end production without having a product designed specifically for automated production would be crazy—maybe $100 mn in costs. But, if you have a design that is made for automation you can reduce that amount by 3X. So in the 5 million unit example costs would likely be roughly $20-30 mn if the product is designed for automation.

What does the composition of remaining staff look like in an automated factory – does the number of skilled jobs actually go up on an absolute basis in terms of engineers to run the line vs. more basic labor?

A rough number is that for every ten people in assembly, automation will remove four to seven. Let's assume you keep three people. Those three people will not be the same three people working on the manual process: You will need two to drive the automation in terms of maintenance, programming, quality control, and you still have a need for one logistics person on the line—cleaning, feeding the material, etc.

Is automation equipment available off the shelf, or does Flex need to make that in house? How good are US suppliers, and how good are China suppliers of automation tools?

There are companies building robot arms in the US, but not a ton any more. The major companies are Japanese, German, and Swiss, and the Chinese are close behind.

Can you discuss differences in the how to operate in the USA vs. in China from a labor supply and environmental perspective? Are there tangible cost differences for compliance?

I think the situation in the US is relatively favorable. We are in a country where hiring practices are very convenient. And while there is potential for improvement, I would describe the current environment as friendly. I feel good about this compared to many of the countries in our company. In the US, we have six million square feet of manufacturing operations with 9,000 people. From an environmental perspective, I would say that we are in an industry that does not have too large an impact on the environment except for some specific wet processes. Right now we have one plant in the US where we do anodizing, which we implemented four or five years ago. There was a lot of regulation and constraint we had to implement to be compliant, and this was in Texas, which is a pretty business-friendly environment. Technology advancements are enabling our business—including the wet processes—to be environmentally friendly and clean.

An interview with…Jabil's John Dulchinos

We discussed factory automation with John Dulchinos, VP of Global Automation and 3D Printing at Jabil Circuit.

What role is automation having on your operations? Are there any common factors that you need to see to make automation worthwhile?

Jabil views automation as a strategic capability and uses automation extensively across our global footprint of factories. We have close to 300 highly automated SMT (Surface Mount Technology) circuit board assembly lines. We also employ thousands of additional robots in other application areas like material handling, assembly, inspection and test. Automation has allowed Jabil to consistently lower the cost of the products that we produce, even as labor rates have been increasing at more than a 10% CAGR in the primary markets where we operate.

The nature of our business is quite varied from high-volume/short product life cycle mobile phone components to mid-volume/high-mix electronic assembly to high-volume/medium-life molded packaging containers to high-volume/long-life medical devices. The types of operations, the manufacturing processes, and the level and types of automation vary.

Many factors determine the viability of using automation on a product or manufacturing process including the production volumes, product life, the geometry of the product, the sophistication of the process and number of product variants, the cost, time and risk associated with developing and commissioning an automated solution, the cost and availability of labor, the effectiveness of human labor to accomplish the manufacturing processes, etc. These factors need to be taken together to determine whether automation makes sense. For example, with the same unit volumes and product life there are parts of an automotive assembly plant where processes are fully automated, like spot welding and painting, and parts of the same plants where processes use very little automation, like final assembly. The level of complexity and cost required to solve each task varies dramatically. As a rule of thumb the amount of automation decreases the closer you get to the end-product – as the assembly processes become more complex and the number of variants increases.

At Jabil, we typically apply automation in applications where the product life cycle is long and the volumes are high, or in applications where we can reuse the automation on multiple product life cycles, or in applications where it is beyond human capabilities. To address the increasing importance of automation, Jabil has developed deep process expertise in the development, fabrication, and commissioning of automated solutions inside our factories as well as inside automation centers of excellence.

Specific to smartphones, the production volumes and product form factor favor automation; however, the short product life cycle and aggressive production ramp make implementing automation challenging. Unlike traditional products that follow a product ramp that approximates an S-curve, mobile phones reach peak production in the first quarter after product launch and then decay to less than 50% peak volume 2-3 quarters out. This means that 50% of the equipment used to produce smart phones or components could be out of commission in less than 2-3 quarters. To make automation viable, being able to retool the equipment and use it across multiple product life cycles is key. The automation of smartphones is being accomplished process step by process step. For example, PCBs for smart phones are highly automated as are basic processes such as screw driving. More complex processes such as final assembly are most likely not because of the high cost of custom parts feeding and tooling.

For smartphone components as with other products, the level of automation generally increases the lower the level of component because the processes are more difficult to do by hand and the investment in equipment can be used across more than one product life cycle. That said, the level of automation is driven by the individual process steps and the complexity of the resulting automated process. Labor still plays an important role in phone component production.

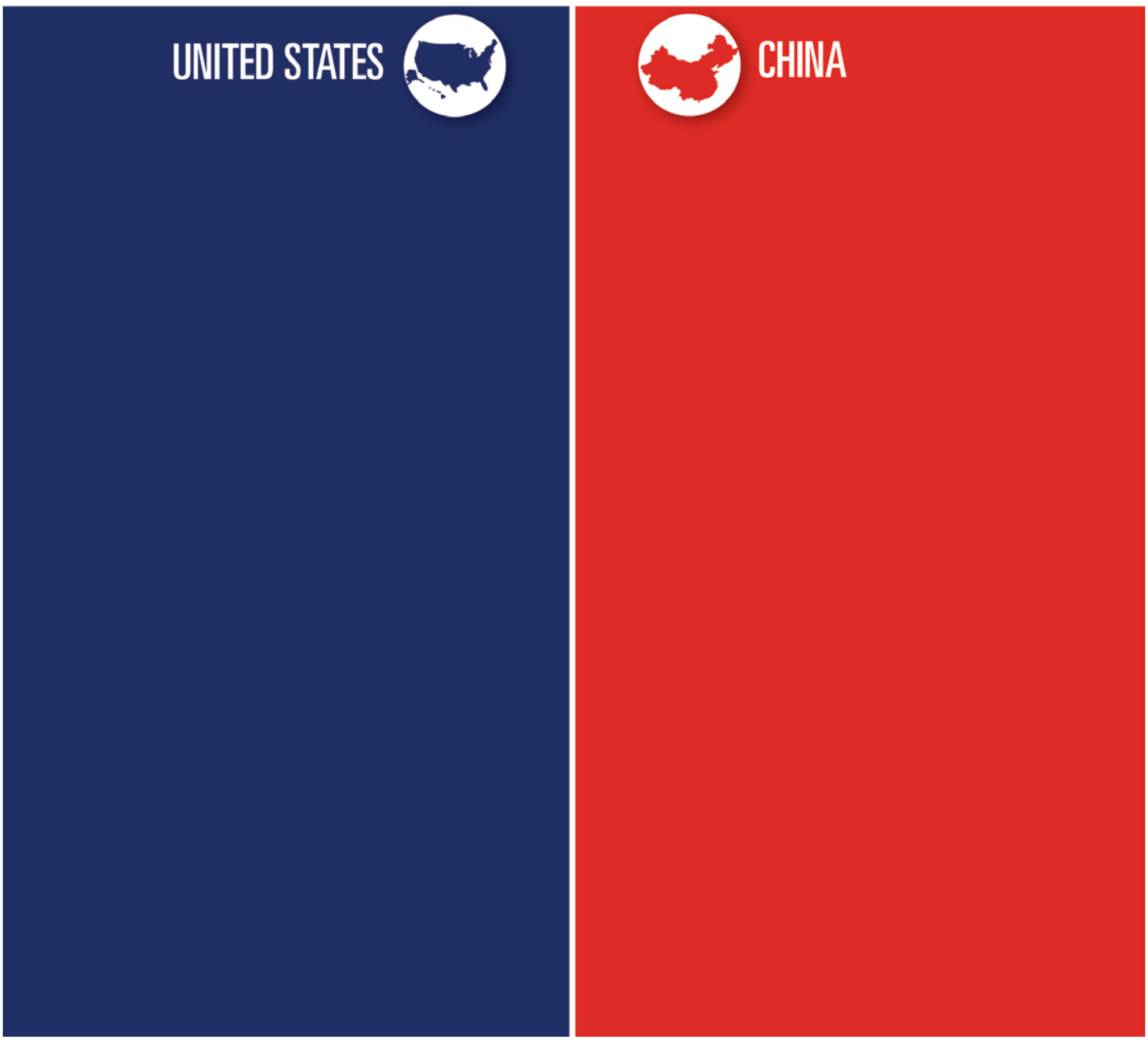
Automated factories require higher skilled engineers and technicians to deploy, commission and maintain the equipment. While the overall factory headcount is reduced, the level of skilled workers increases, leading to a higher percentage of engineers in an automated factory.

Chapter 3: Case studies on smartphones, apparel, and planes

- Phones: Moving the smartphone supply chain to the US would likely take at least five years but we think is possible if taxes or tariffs incentivize it. It could create jobs (without new automation) but prices would likely rise driven mostly by higher labor costs.

- Apparel: We see significant challenges around sufficient labor supply to moving the apparel supply chain to the United States. If it happened, higher prices could pressure retailers and brands

- Planes: We see significant challenges for China to start a large commercial aircraft industry related to IP, high safety requirements, and long product cycles



Case Study #1: Moving smartphone production to the US

Bottom line: It could take 5 years and cause consumer prices to rise by 15%

Around 1.5 bn smartphone units (US$428bn in value) were sold globally in 2016 (the **United States accounted for 12% or about 175 mn units**), making smart phones the largest technology product in the world (both by volume and value). The supply chain is global but manufacturing is mostly in Asia.

Given that we expect the smartphone industry to grow at a 3% CAGR for the next 5 years (2018-2022), the industry will need to add about a further 240mn units of capacity (about 40-50mn units a year) versus the 175mn units consumed in the United States per year. In this case study, we are assuming supply is added in a rational way and that industry supply/demand remains healthy. This means that we are setting up the scenario that most of the new capacity will be created in the United States for the next five years to support domestic consumption.

We see significant hurdles from costs and labor supply that would need to be overcome, but we believe this expansion is possible given the right incentives (and automation), and at the end (when all of the supply chain is moved to the US and operating efficiently) the cost of the units would increase by about 37% if made in the United States. **This shift would translate into an average cost increase of US$135 per phone that could be passed on to the domestic consumer**. In the case of an iPhone, assuming Apple's gross profit stays the same, the **retail price for a 32GB iPhone 7 could go from US$649 to US$784, and an iPhone 7 Plus sold at retail could go from US$769 to US$904.**

Assuming workers could be found and not accounting for any further automation, this shift at the end of the five year period could result in no more than 500,000 new US manufacturing jobs. **An important caveat being productivity gains in line with history would reduce that number, as would further automation.** The vast majority of the jobs in today's production processes are in final assembly, which costs $15-$25+ per hour in the United States vs. $2-$3 in China. Higher costs for final assembly are the largest element underlying the increase.

At a Glance: The Impact of Moving Smartphone Production

5-Year Impact

Capex investment	Production cost	Retail price
+$30-35bn	+37%	+15%

US Exposures

Positive for IDMs, Foundries & Final Assemblers
- Intel
- Qorvo
- TI
- ADI
- Maxim
- NXP
- Skyworks
- Flex
- Jabil

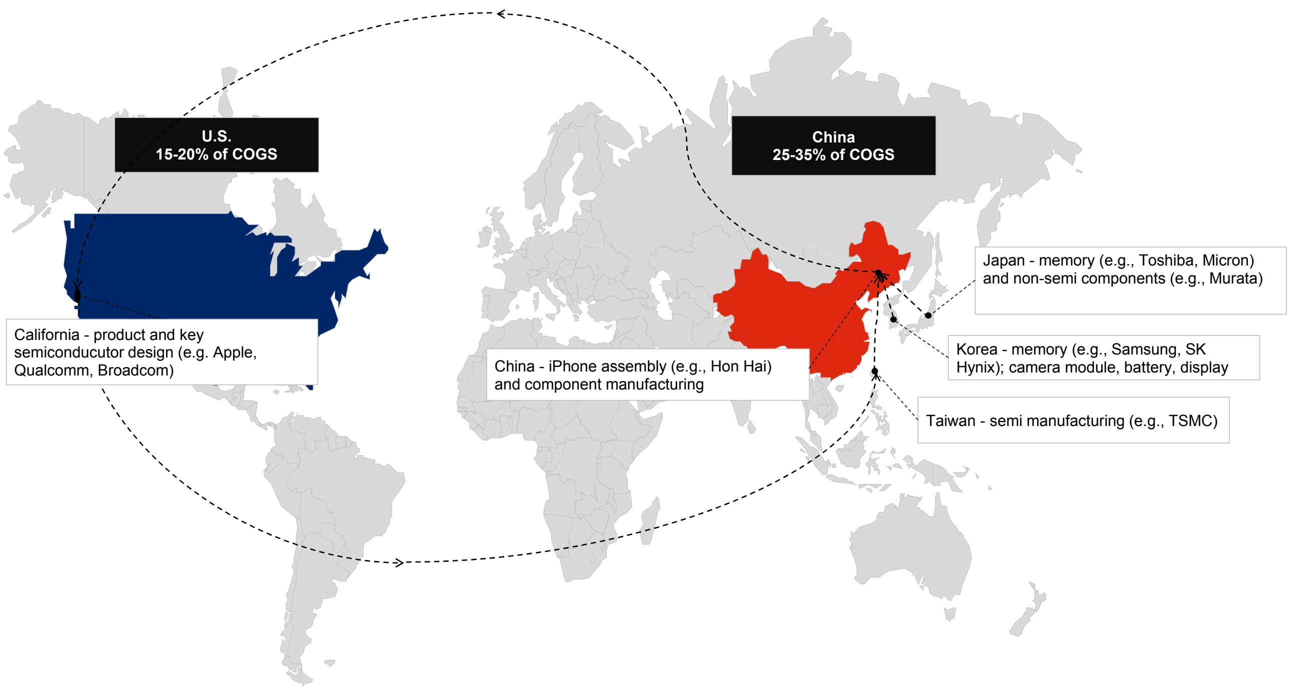
Negative for OEMs
- Apple

Asia Exposures

Negative for Foundries, Packagers and Final Assemblers
- TSMC
- Hua Hong
- ASE
- SPIL
- Hon Hai
- Wistron
- Pegatron

1) Overview of the smartphone supply chain (iPhone as an example)

Exhibit 35: Overview of the global supply chain for smartphones
Using key regions for the iPhone as an illustration



Source: Goldman Sachs Global Investment Research

Geographic costs as % of iPhone BOM (bill of materials):

- **China: 25-35%**
- **USA: 15-20%**

The iPhone supply chain is global (Exhibit 35).

We estimate that **15-20% of the costs for the iPhone bill of materials originates in the United States,** which consists mostly of design work. Most semiconductors are designed by companies including Apple, Qualcomm, and Broadcom in the United States, although the chips for the most part are manufactured in Taiwan (by TSMC).

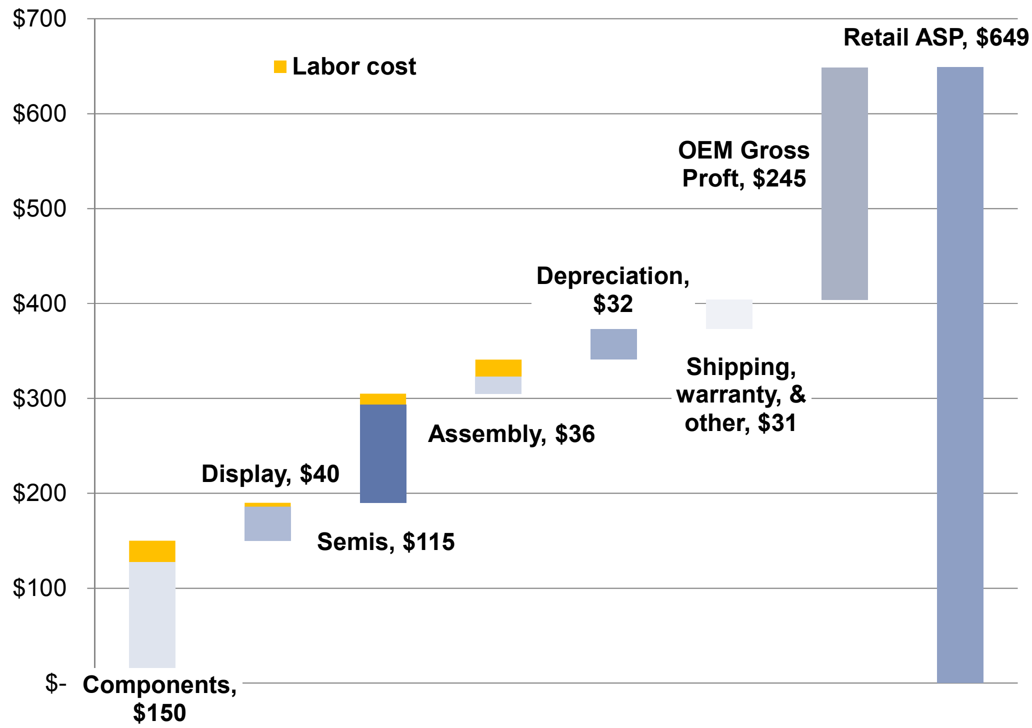
Japan and **Korea** are also key regions, and companies in those countries supply primarily memory and displays.

We estimate that **China accounts for about 25-35% of the product COGS for the iPhone**, mostly from final product assembly fees but also from **components that are manufactured locally by foreign companies** (e.g., Catcher, Samsung SDI, Flexium and more).

The highest dollar content inputs for a smartphone are semiconductors, as well as components like a display and metal case (Exhibit 36).

We estimate that wages for final **assembly account for about 5% of the typical smartphone cost, and total direct labor is about 15%** (when including labor needs for direct inputs like semiconductors). Labor costs are relatively minor, although this is due in part to the fact that the cost of labor in China is $2-3 per hour.

Exhibit 36: Semiconductors and Components are key inputs for a smartphone
Estimated bill of materials walk from cost to retail ASP (using iPhone as an example)



Source: Company data, Goldman Sachs Global Investment Research

We show key global companies in the smartphone supply chain based on geographic origin and key production locations in Exhibit 37.

Exhibit 37: Overview of global companies tied to the smartphone supply chain
Bill of material by supplier origin and production base using iPhone as an example; Note this list is illustrative, not exhaustive

iPhone parts	Production Location	Supplier origin	Company
Case	China	Taiwanese, American	Hon Hai, Catcher, Jabil
Display	Korea, Japan	Korean, Japanese	LGD, JDI, Sharp, Samsung
Controller	Taiwan	American	Apple, Qualcomm
Camera	Korea, Japan, Taiwan	Taiwanese, Korean, Japanese	LG Innotek, Sony, Alps, Largan, Genius
Memory - DRAM	Korea, USA, Japan, Taiwan, China	Korean, American	Samsung, Hynix, Micron (Inotera, Elpida)
Memory - NAND	Korea, USA, Japan, Singapore, China	Korean, American, Japanese	Samsung, Hynix, Micron, Toshiba, WD, Intel
Cellular	Taiwan	American	Qualcomm, Intel
SENSOR	Taiwan, Europe	American	Invensense, STMicro, etc..
PCB	China	Taiwanese	ZDT, Flexium
Communication	Taiwan	American	Broadcom
Small Components	China	Taiwanese	Hon Hai
Connector	China	Taiwanese	Hon Hai, Luxshare, Bizlink
Audio	China	Chinese	AAC, Goertek
Antenna	China	American, Taiwanese	Amphenol, Molex, Luxshare
Motor	China, Japan	Chinese, Japanese	AAC, Nidec
Assembly	China	Taiwanese	Hon Hai, Pegatron, Wistron

Source: Goldman Sachs Global Investment Research

2) What could the US and China gain or lose, and at what cost?

- **It would cost $30-$35 bn of capex investments**
- **Smartphone cost could go up by about 15% for US consumers**

Cost to move:
To the US: $30-$35 bn in capex

Increase in manufacturing cost to make in the US: 37%

Investments made from the United States to China (and vice versa) in the technology supply chain over the past 25 years have been:

- **US companies have invested USD $41 bn in China**
- **Chinese companies have invested USD $12 bn in the United States**

The global supply chain is the result of significant overseas investments over the last 25 years. According to the Rhodium Group, **foreign direct investment (FDI) from US companies in China for Information, Communications Technology, Electronics & Electrical Equipment totaled $41bn from 1990 through 2015, and Chinese companies invested $12bn in the United States over the same period in those industries.** The investments by US companies were typically for assembly and manufacturing, while the majority of FDI from China into the United States was for M&A.

The significant FDI between the United States and China is due partly to the establishment of expensive factories for certain components. For example, for smartphones, key components that make up a large portion of the bill of materials (such as memory, processors, and display) are often manufactured in very high volumes with only 10-15 key manufacturing sites globally. These sites can cost as much as $10 bn each.

This is in contrast to China, where many of the key components have production sites in China (albeit often owned by foreign firms like Samsung and Hon Hai), including facilities for memory semiconductors, assembly, and display.

Path to build a smartphone supply chain in the United States

To move the supply chain into the United States, it is important to understand the network effect, which is similar to what was discussed in the previous section (referencing work by Harvard professors Gary Pisano and Willy Shih) as an "industrial common" or a local network. Clustering allows companies to benefit from the availability of labor and suppliers. As more suppliers gather in the same geographic area, synergies are created that can lead the supply chain to become more efficient and competitive. In the past 25 years, this industrial common for the smartphone supply chain has been created in China.

We believe moving final assembly to the United States could be one of the main catalysts to trigger the supply chain migration. The final assembly can create a crowding–in effect to attract the component suppliers. For the non-semi components, suppliers typically want to stay close to the final assemblers to provide better service on response time during the design phase and better supply lines with inventory hubs during mass production.

Key components - such as foundry, memory, display and battery - already use highly automated manufacturing processes. We think the decision to build these factories/fabs in the United States could be more in the nature of a business decision. In the current state, most of the display/memory/foundry companies are from Korea, Japan or Taiwan, the construction of which led, we believe, to investments in their home countries. Hence, as long as there are enough incentives (e.g., lower taxes or possible government subsidies) for foreign companies that invest in the United States, we believe this process could be executed. There are some cost benefits in the United States such as lower electricity costs and savings on logistic/shipping costs. The founder of Foxconn, Terry Guo, recently commented on a potential US$7bn investment to build a display factory in the United States to support President Trump's proposed policy.

Hon Hai as a window into potential job gains

We used a combination of top-down and bottom-up approaches to estimate the number of manufacturing employees that would be needed to make smartphones in the United States. First, we view Hon Hai as a good proxy for the manufacturing jobs that could be created in the United States because not only is the company the largest final assembler of the iPhone, but it also produces many smartphone components (e.g., printed circuit board, connector, camera module, display, touch module, casing and other mechanicals). Hon Hai currently has about 1.2 mn employees in China, who include factory workers for final assembly and component manufacturing. We estimate that the iPhone contributes 50% of Hon Hai's revenue and given that the iPhone is more labor intensive (vs. PC, printer, game console and server), roughly 60% of the workforce should be iPhone-related, in our view. Hon Hai assembled about 70% of total iPhones produced in 2016, which implies that 720K workers were responsible for about 150mn units of iPhone production. Because the iPhone sits in the very high end segment (it accounts for about 14.6% global smartphone share in 2016, based on Goldman Sachs estimates) and has more production complexity than mid-and-low end smartphones, we estimate only 2/3 of the workforce would be required to build mid-to-low-end smartphones compared to the high end. We arrived at approximately 475K jobs that could be added to build 150mn smartphones a year from final assembly and non-semi components. By adding jobs from other sub-sectors (memory, foundry, battery and display), we arrive at about 500K jobs as the opportunity from moving the smartphone supply chain to United States, absent further automation and productivity gains that would reduce the final number. In terms of a bottom-up approach, we surveyed the Goldman Sachs Global Technology team on how much manufacturing labor content there typically is at each step of the supply chain. We note this presentation is illustrative in nature and that a range of outcomes could fall outside of it.

We estimate that over 90% of the job creation would be manufacturing level work from final assembly and component (non-semi) manufacturing, and this would also be the primary source of the higher costs to produce in the United States.

"I personally believe it is possible to design the next generation of smartphones for closer to 100% automated manufacturing, but companies need to design products with this in mind at the very beginning of the product life cycle, twelve months prior to product ramps."
François Barbier, President, Global Operations at Flex

We believe automating smartphone final assembly would be difficult but not impossible. To the **extent that the industry is able to shift to automation**, our discussions with industry experts **suggest that 40-70% of the assembly jobs may be eliminated** (albeit with a potential increase in jobs for more skilled technicians on an absolute basis within the mix of remaining jobs). The major challenges to automating smartphone manufacturing would be shifting to new designs with automation-friendly processes (such as how parts are attached), using primarily rigid and not flexible material inputs, and ensuring that suppliers standardize their parts very precisely. We believe OEMs would need to be willing to make design tradeoffs, and the time to align the supply chain to these changes could be several years. See our interview with François Barbier, President, Global Operations and Components at Flex for more information on what it may take to automate smartphone manufacturing in the United States, on page 29.

Capex required: $30-$35 bn

We believe it would be expensive for the smartphone supply chain to move entirely to the United States given the decades of investment that have been incurred in the engineering and manufacturing ecosystem.

We estimate that for all of the direct inputs (and not counting secondary material inputs like chemicals and raw materials) to be sourced domestically for the **roughly 175mn smartphones sold in the United States annually**, **would require about $30-$35 bn in new capex** (Exhibit 38).

Exhibit 38: Making smartphones entirely in the US would require $30-$35 bn in capex but may create 500k jobs
Opportunities, costs and challenges in moving supply chains to the United States

Smartphone	Capex and Labor Implications	
	Capex	Total Employment
Component	To Shift to USA ($US mn)	# of jobs from move
Assembly	2,500	385,000
Memory	10,000	2,500
Integrated Circuits (IC) Design	0	0
Semiconductor Foundry	5,000	2,500
Battery	250	1,500
Display	10,000	10,000
Components* (non-semi)	4,000	100,000
Total	31,750	501,500

* including passives, camera, lenses, casing, mechanicals

Source: Goldman Sachs Global Investment Research

Product cost: Increases by about 37%

We further estimate that the **cost of manufacturing a smartphone could increase by about 37% if the immediate supply chain (i.e., direct inputs) were moved entirely to the United States** (Exhibit 39). This is primarily from the higher cost of labor in the United States, and to a lesser extent from the extra cost to source material inputs in the United States (as these are now mostly in Asia, although this could evolve over time if more of the entire tech supply chain moved to the United States).

Exhibit 39: Making smartphones entirely in the United States could cause the price to increase by 37%
Key direct input costs to make a smartphone today, and the cost if made in the United States

Category	Dollar Cost per Unit									
	Total Cost - A = B + C + D + E			Supplier Gross Profit - B	Labor - C		Materials - D		Transport & Other - E	
Component	$ Today	$ To Make in USA	% increase	$	$ Today	$ To Make in USA	$ Today	$ To Make in USA	$ Today	$ To Make in USA
Assembly	36.0	140.8	**291%**	14.5	18.5	123.1	0.0	0.0	3.3	3.3
Battery	5.0	5.8	**16%**	0.9	0.6	1.2	2.9	3.2	0.6	0.6
Components (non semi)	150.0	171.9	**15%**	37.5	16.9	33.8	73.1	80.4	22.5	20.3
Display	40.0	43.9	**10%**	8.0	3.2	6.2	19.2	21.1	9.6	8.6
Semiconductor Foundry	30.0	31.1	**4%**	12.0	0.5	1.0	11.7	12.9	5.8	5.2
Memory	25.0	25.8	**3%**	8.8	0.3	0.6	10.6	11.6	5.4	4.8
Semiconductor Design	60.0	61.5	**2%**	30.0	3.0	3.0	15.0	16.5	12.0	12.0
Other	15.0	15.1	**1%**	2.3	3.2	3.2	1.0	1.1	8.6	8.6
Total	**361.0**	**496.0**	**37%**		**46.2**	**172.0**	**133.5**	**146.8**	**67.7**	**63.3**

Source: Goldman Sachs Global Investment Research

Assuming this roughly $135 manufacturing cost increase per phone was passed on to consumers and there was no change in handset OEM profit dollars (using Apple as an example), the price of a phone in retail could increase by about 15%. The retail price for a 32GB iPhone 7 could increase from US$649 to US$784, and the iPhone 7 Plus could go from US$769 to US$904.

3) What could realistically shift, and how long would it take?

We considered three criteria when assessing the ease of US migration within the supply chain: these included higher costs, alternative sourcing from the United States, and structural issues that include the various impacts on industry supply/demand, and labor availability.

We concluded that **semiconductor foundry might be the most at risk of shifting, while memory, display and battery could be moved after significant consideration of the required investments and possible oversupply risks. Moving final assembly is also possible once companies have secured the necessary labor force but this part of the process drives the majority of the cost increase in the absence of automation.**

We color coded each supply chain green, yellow and red (Exhibit 40).

- **Green** highlights supply chains with limited structural issues and within which existing suppliers could expand capacity (mostly as a business decision) in the United States or alternatively be supplied by US competitors.
- **Yellow** marks supply chains facing only limited structural issues but that would need significant investments and that would face the risk of oversupply with limited alternative supply from US competitors.
- **Red** is for supply chains facing structural issues in policy, regulation or resources that prevent production in the United States, or that enjoy significantly lower cost advantages by staying with the status quo (i.e., it is cheaper to make in China even with a 45% tariff) and no suppliers in the United States.

Exhibit 40: Foundry could be most likely to move given US supply options and low labor requirements
Key direct input costs to make a smartphone today, and the cost if made in the USA

Smartphone			
Ease of US migration	**Supply Chains**	**Alternate Source from USA**	**Key Issues to Move**
	Assembly	Yes. Flex and Jabil	Adds cost and labor may not be available, but capex needs are modest
	Memory	Limited today. Micron and Intel	New fab would create DRAM oversupply; NAND possible longer-term
	Semiconductor Foundry	Yes - Intel	Some business could shift to US semi manufacturing companies
	Battery	Limited	Risk of oversupply from a new factory
	Display	None	Would take 1-1.5 years and significant capex
	Non-semi components (Class A)	Yes	Labor cost, automation
	Non-semi components (Class B)	None	Policy, regulation, pollution, resource availability, material development

Source: Goldman Sachs Global Investment Research

What could shift to the US if tariffs or border taxes are put in place

- **Semi Manufacturing (Foundry)**: We believe companies like Intel could take share in making semiconductor chips from incumbent suppliers like TSMC. While it could take 18-24 months for designs to be re-qualified, we believe companies in the United States have this capability. To the extent that factories are already built (and in some situations this would be the case), the cost increase would be modest, in our view. Labor is relatively limited in semiconductor manufacturing, and a large semiconductor factory may employ only 1,500 people in direct labor.
- **Non-Semi Components (Class A)**: There are broad ranges in, and different types of non-semi components; hence, we separate the non-semi components into two categories, Class A and Class B. For Class A, there are essentially no structural issues and the process could be or is currently automated. The components that utilize highly automated manufacturing processes could be moved into the United States without many hurdles, such as printed circuit boards and camera modules, in our view. For Class B non-semi components, see below.

What is harder to shift to the United States

- **Assembly**: The majority of the jobs that would potentially be created would be in assembly, and we estimate that about 350,00-400,000 people per year in assembly support the 175 mn smartphones shipped each year to the United States. Given that smartphones have short product cycles and flexible material inputs, automation is difficult. Further, the disparity in labor costs ($15-$25+ per hour in the United States vs.

$2-3 in China), would likely dampen the level of assembly undertaken in the United States. Apple CEO Tim Cook has said finding this labor force, and the desired labor flexibility, is a challenge.

- **Memory (NAND flash)**: In recent history Intel and Samsung both produced NAND flash in the United States, although those factories are now used for other technologies. Given that NAND is a growing industry, over a long enough time period NAND could be added with relatively limited incremental cost. However, building a new fab in the short term would be likely to pressure industry supply/demand.
- **Display**: The display industry is expensive and subject to supply/demand volatility. While there are no US suppliers, many displays are made today in higher-cost regions like Japan, and this fact suggests it is possible to make displays cost effectively in the United States as well. We estimate that labor is about 10% of the COGS in display, and manufacturing is partly automated. Importantly, on January 13, 2017 the Nikkei reported that Hon Hai and its Sharp subsidiary are considering a $7 bn investment for a display factory in the United States.
- **Non-Semi Components (Class B)**: As noted above, there are broad ranges of, and different types of non-semi components; hence we separate the non-semi components into two categories. We have discussed Class A above. For Class B, there are significant production issues related to regulation, environmental constraints, material development and resource limitations, which when taken together make US domestic production highly unlikely. One example is the metal casing manufacturing process, which is both labor-intensive (for polishing and inspection) and whose surface finishing process (i.e., anodization for coloring) involves the use of toxic chemicals. We believe this is one of the reasons why there are no metal casing suppliers doing high-volume production in the United States. Another example is the ceramic maker such as Murata, which conducts its material development in Japan and may suffer from significantly lower efficiency/quality by having its material development processes decentralized.

Key stocks that may be impacted

As discussed *Transition to Trump TMT implications,* published on February 13, 2017, a **shift to a destination-based tax system would mean taxing products purchased domestically,** whether manufactured domestically or abroad, and not taxing products consumed abroad, whether manufactured domestically or abroad.

This proposal is intended to be conceptually similar to a value-added tax, which exists in virtually every other advanced economy and is normally “border adjusted” in a similar manner. Border adjustment in this context would be implemented by **denying firms the ability to deduct purchases of foreign goods or services from revenues** when calculating the tax base, and excluding export sales from tax. It would also likely **limit the ability of firms to benefit from moving their IP offshore**, as is done under the current system. However, the destination-basis proposal in the US House of Representatives plan allows companies to deduct the cost of domestic wages, putting it somewhere between an income tax and a value-added tax. **Overall, the Goldman Sachs US Economics team believes that the effect would be to raise the effective tax rate on income from imports and lower the rate on income from exports compared to current policy** (David Mericle, Alec Phillips, and Daan Struyven, *US Daily: What Would the Transition to Destination-Based Taxation Look Like?* December 8, 2016).

To screen for the companies that could be positively or negatively impacted in the smartphone supply chain, we therefore look at three metrics:

1) US capacity net of US sales

2) US sales exposure

3) Viable competitor that has US capacity as an alternative supplier

This framework is to help investors understand how much of company sales are attributed to "foreign cost of goods sold (COGS)" for finished goods such as a smartphone, airplane or apparel consumed in the United States, and if there is a US COGS alternative. Note that we screened stocks based on reported geographic exposure, and for some companies the end exposure could vary from what is one level up as reported in financial filings.

We separated the companies into two groups, one **with a US COGS alternative** (Exhibit 41) and another **without US COGS alternatives** (Exhibit 42). Within each group, the companies that have the largest positive spread between their US capacity and US revenue would generally be better off. These companies would be able to support their US revenue from the US factories. The companies that have a net excess of US capacity (after deducting their US revenue) could theoretically gain share from their competitors.

On the flip side, companies that have lower (or negative) net US capacity could be worse off, as their US capacity might not be able to support their US revenue, which could face higher taxes in a revised corporate tax system. However, suppliers with high US sales exposure (e.g., **Largan, Catcher, Alps, Nidec**) that face no alternative US competitors with US capacity would likely be unaffected as the tax burden would be shifted to their customers.

Companies at risk

Asia foundries (**TSMC, Hua Hong**), packagers (**ASE/SPIL**) and final assemblers (**Hon Hai, Wistron, Pegatron**) could be negatively impacted as they have high exposure to US revenue and could be faced with US competitors that produce domestically as alternative suppliers. Theoretically, customers (e.g., Apple) would prefer domestic COGS to avoid a border-adjusted tax.

Companies that could benefit

US IDMs and foundries could benefit the most from a border adjustment tax (e.g., **Intel, Qorvo, TI**) as their US capacity could lead to lower tax rates for their customers. US final assemblers (**Flex** and **Jabil**) could also benefit by taking share from their Asian peers.

Exhibit 41: Asian foundry, packager and final assemblers may be negatively impacted under the destination-based tax
Smartphone supply chain with competitors (with US capacity), sorted by net excess of US capacity

Company	% US capacity minus % US sales (higher the better)	% of sales to USA	Competitor with US capacity? Y/N
Qorvo	68%	12%	Y
Texas Instruments	48%	12%	Y
NXP	43%	7%	Y
Intel	40%	20%	Y
Skyworks	28%	2%	Y
Maxim	19%	11%	Y
Western Digital	13%	21%	Y
Micron	10%	16%	Y
Broadcom	9%	11%	Y
ON Semiconductor	8%	16%	Y
Jabil	8%	9%	Y
Flex	5%	11%	Y
SMIC	0%	0%	Y
Amphenol	-1%	30%	Y
Qualcomm	-2%	2%	Y
Taiyo Yuden	-3%	3%	Y
Samsung SDI	-3%	3%	Y
Hirose Electric	-6%	6%	Y
ADI	-8%	38%	Y
JAE	-10%	10%	Y
Toshiba	-13%	18%	Y
Shinko	-13%	13%	Y
Murata	-14%	14%	Y
Kyocera	-17%	17%	Y
Quanta	-18%	23%	Y
Samsung Electronics	-23%	26%	Y
UMC	-24%	24%	Y
SK Hynix	-30%	30%	Y
Pegatron	-33%	33%	Y
AAC	-35%	35%	Y
Hon Hai	-35%	40%	Y
SPIL	-37%	37%	Y
ASE	-40%	40%	Y
Hua Hong	-45%	45%	Y
Wistron	-47%	47%	Y
TSMC	-49%	49%	Y

Source: Company data, Goldman Sachs Global Investment Research

Exhibit 42: Non-semi components might not be negatively impacted given lack of alternative US supply
Smartphone supply chain without competitors (with US capacity), sorted by net excess of US capacity

Company	% US capacity minus % US sales (higher the better)	% of sales to USA	Competitor with US capacity? Y/N
Corning	2%	28%	N
Mediatek	0%	0%	N
Japan Display	0%	0%	N
Sony	0%	0%	N
Mitsubishi	-4%	9%	N
Oki	-4%	4%	N
Rohm	-4%	4%	N
Ibiden	-5%	5%	N
Nippon Ceramic	-6%	6%	N
LG Display	-7%	7%	N
NEC	-7%	7%	N
TDK	-8%	8%	N
Nitto Denko	-8%	8%	N
Minebea	-9%	9%	N
Fujitsu	-10%	10%	N
Nichicon	-10%	10%	N
Renesas	-10%	10%	N
Nidec	-17%	17%	N
Alps Electric	-20%	20%	N
Largan	-25%	25%	N
NGK Spark Plug	-29%	29%	N
Catcher	-34%	34%	N
Casetek	-42%	42%	N
TPK	-55%	55%	N

Source: Company data, Goldman Sachs Global Investment Research

Case Study #2: Moving apparel production to the US

Bottom line: Wages and a lack of labor supply are very high barriers

The global apparel market totaled US$1,323 bn in 2016, and of this, the US market accounted for 21% (or about $270 bn). Nearly all apparel sold in the United States is imported, with major trading partners including China (34% of imports), Mexico and Canada (15%), and Vietnam (13%), among others.

We estimate it could take 5-10 years to re-shore the entire apparel supply chain, requiring a total capital investment of $40-50bn for all US apparel consumption to be sourced domestically. Similar to the smartphone case study described above, there are major hurdles to bringing apparel manufacturing back to the United States, **the most crucial being the lack of skilled labor.** While upstream manufacturing (yarn and fabric production) has become increasingly automated, the final step (garment manufacturing) is still heavily labor-intensive. For context, China employs 8-9mn workers in the textile industry today vs. only about 250K in the United States. Further, the low headline unemployment rate in the United States (<5%) suggests limited labor capacity.

At a Glance: The Impact of Moving Apparel Production

5- to 10-Year Impact

Capex investment	Production cost	Retail price
+$40-50bn	+46%	+14%

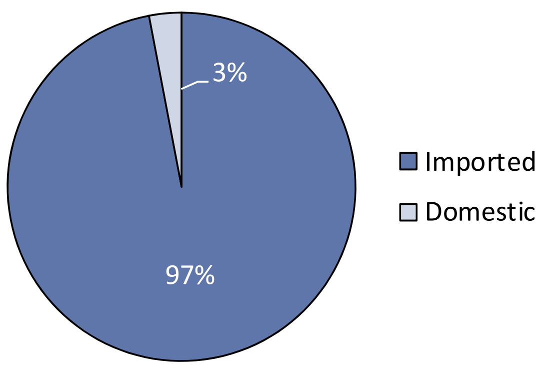
US Exposures

Negative for brands with low margins & lack of pricing power
- American Eagle Outfitters
- Urban Apparel
- Gap
- Under Armour
- Phillips Van-Heusen
- Ascena Retail
- Ralph Lauren
- VF Corp

Asia Exposures

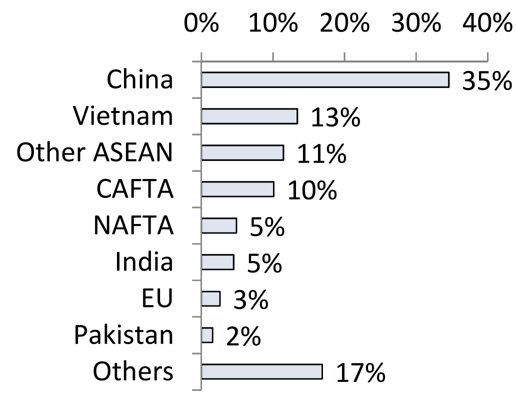
Negative for select manufacturers with high US exposure
- Stella
- Makalot

Exhibit 43: Nearly all US apparel is imported from other countries, with only 3% of product sourced domestically
Share of US apparel units consumed by origin



Source: American Apparel & Footwear Association, Goldman Sachs

Exhibit 44: …with China, Vietnam, other ASEAN countries, and NAFTA/CAFTA trading blocs the largest partners
Dollar value of US apparel imports by origin



Source: OTEXA, Goldman Sachs Global Investment Research

Understanding apparel's current production flow

The process. Unlike smartphone manufacturing, where individual parts are manufactured simultaneously and then moved into final assembly elsewhere, apparel manufacturing is a step-by-step process, with each individual process (yarn-making, fabric manufacturing, garment cutting and sewing) being a separate, crucial part of the value chain, with varying degrees of vertical integration among companies.

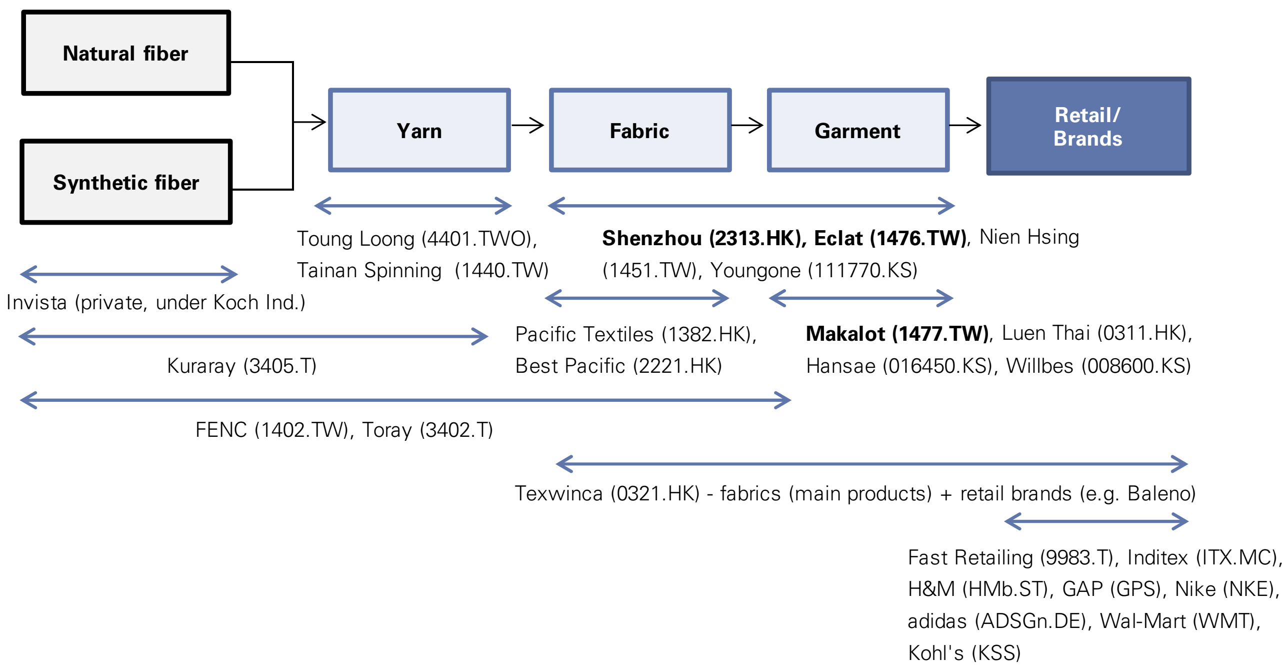
(1) **Yarn spinning.** Yarn-makers – also known as "spinners" – take raw fiber inputs (cotton, synthetic, or blends) and wind them into yarn. For spinners, the largest cost is raw materials, followed by capital and waste.

(2) **Fabric production.** Fabric manufacturers weave or knit the yarn into fabric. Fabric is often dyed, printed, and treated at this stage. The biggest costs for fabric producers are raw materials, followed by capital and energy.

(3) **Garment making.** Garment manufacturers take the manufactured fabric and cut and sew the product for final assembly. This final stage is typically the most labor-intensive, requiring skilled labor to cut and sew fabric.

Many textile manufacturers are specialized across production phases (examples include more technical products such as Eclat's fabric used in the activewear industry). Further, some companies have greater, if variable, degrees of vertical integration than others (Exhibit 45).

Exhibit 45: Apparel manufacturing is a lengthy process, from raw fiber procurement to yarn-making, fabric production, and ultimately garment making. Further, there are varying degrees of vertical integration and specialization
Overview of the textile production flow and major companies within the supply chain

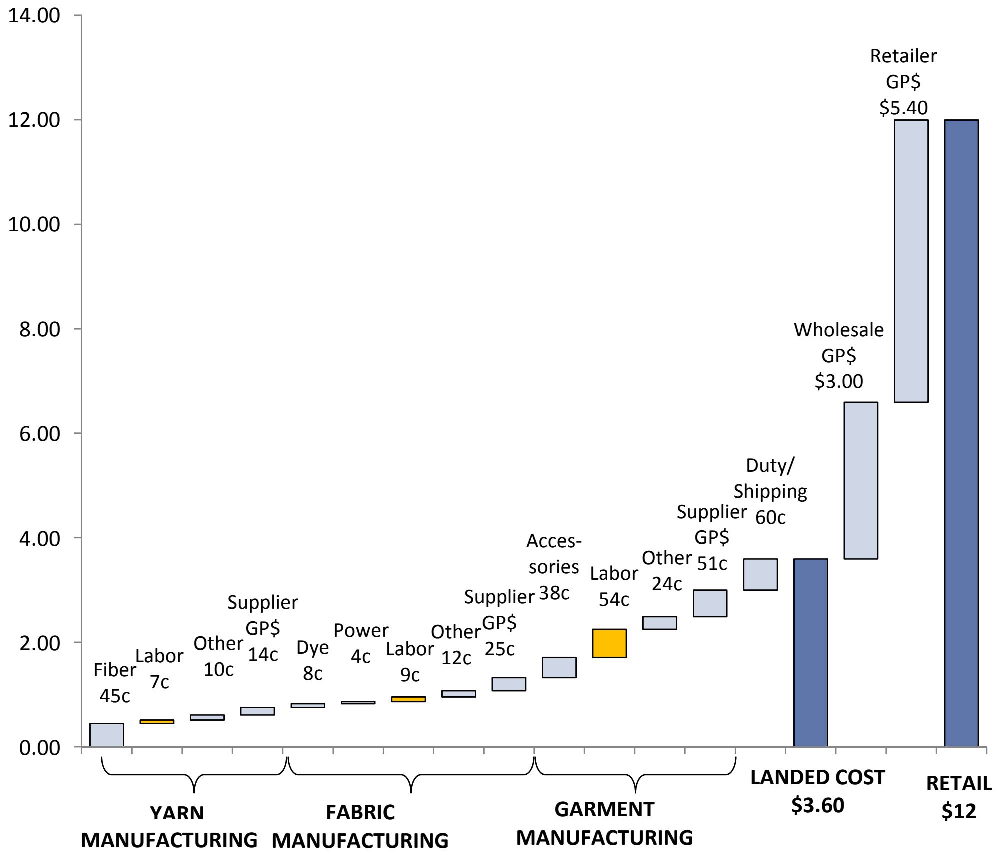


Source: Company data, Goldman Sachs Global Investment Research.

Breaking down the cost structure of a $12 T-shirt. In the example below, we dissect the cost structure of a hypothetical T-shirt that retails in the United States for $12. Embedded in the cost structure includes total free-on-board cost (FOB; i.e., before shipping and duties) of approximately $3. Key costs include materials (raw materials for yarn production, as well as additional materials for garment manufacturing), labor, and utilities (Exhibit 46).

- **Material costs: 30% of total FOB.** This is the largest cost of manufacturing, and includes raw materials (cotton, synthetics) in the yarn-spinning process as well as the cost of trim and accessories in the garment-making stage.
- **Labor costs: 23% of total FOB.** We estimate that labor costs within each phase of apparel manufacturing make up upwards of 23% of the total free-on-board (FOB) cost of a t-shirt. Most of these labor costs lie within the garment manufacturing industry, as cutting and sewing fabric is much more labor-intensive than the more capital-intensive functions further upstream.
- **Supplier gross profit: 30% of total FOB.** There are several steps between fiber and finished product, each requiring its own profit pool. We estimate supplier gross profit margins from yarn-spinning to garment manufacturing make up about 30% of the total FOB.
- **Other costs** include utilities, D&A, and shipping. Further, apparel imports into the United States are subject to upwards of 30%+ import duties depending on material, type, and value.

Exhibit 46: Apparel manufacturing is a multi-step process turning raw materials (fiber) into finished apparel merchandise. We estimate that for a $12 T-shirt, labor costs make up about 23% of the total free-on-board (FOB) cost
Cost structure of apparel manufacturing



Source: Company data, Goldman Sachs Global Investment Research

Assessing the jobs impact

Assuming workers could be found and not accounting for further automation and productivity gains, we estimate that 400-600K jobs could be created if the apparel supply chain were to be moved to the United States for production of domestic apparel. However, there are clear challenges due to the lack of labor capacity (as noted, there are now 0.2m textile workers in the United States versus 8.5m in China) and the much higher relative cost of labor. Again, this presentation is illustrative but we believe is a reasonable approximation.

We estimate below (Exhibit 47) how much workforce capacity would be required to recreate all of the US apparel currently being imported into the United States. To arrive at that figure, we take an average of both a top-down and a bottom-up analysis:

- **Our top-down analysis:** China's governments and large enterprises together employ about 8.5 mn textile workers. Based on government data, China exports 16% of its total textile output. Therefore, we estimate 1.3 mn Chinese textile workers are involved the apparel export industry. Further, 16% of China's apparel exports go to the United States. We therefore assume an equivalent share of China's textile workforce is dedicated to US exports (8.5mn x 16% x 16%), which gives us a US-facing textile workforce of about 200K employees. As China-sourced clothing comprises roughly a third of total US apparel imports, we therefore "gross up" China's 200,000 equivalent workers by the country's estimated share of US imports – assuming equivalent labor productivity across regions **– implying that a global workforce of about 600K is currently servicing the US apparel industry.**

- **Our bottom-up analysis:** First, we analyze recent investments in US yarn-making facilities (Keer Group, Gulf Coast Spinning) to estimate how many workers would be required to manufacture enough yarn to produce all apparel units currently being imported into the United States. Our assumptions include an average weight in yarn per apparel unit of 0.80 pounds, which assumes 0.5lbs per shirt and 1.5lbs per bottom (as per industry standards), and assuming a 2:1 tops to bottoms ratio, in line with a typical retailer's product mix. From there, we estimate the required workforce in the fabric-making industry based on the relative labor cost differential versus the yarn-spinning industry (labor costs are about a third higher in fabric manufacturing over yarn-spinning). For garment making, we use disclosures from companies (including HBI) regarding employment and total unit output to arrive at workers per unit. We estimate total unit imports of apparel of approximately 14bn, based $80bn in total value of imports (per the US Office of Textiles and Apparel), an assumed average apparel retail price of $17 (per Euromonitor), and therefore an estimated landed cost per unit of $5-$6 using our analysis above in Exhibit 46. **We estimate that to produce these 14bn apparel units in the United States roughly 400K workers would have to be added, not accounting for any automation or productivity gains.**

Jobs would come mostly from garment manufacturing, as upstream textile operations are highly automated. Within the textile industry, more than 50% of all jobs are in garment manufacturing. For context, the largest US yarn-spinner, Parkdale Mills, employs only 4,000-5,000 people. Shenzhou, the largest knitwear maker in China, employs more than 70,000. Further, upstream manufacturing is becoming increasingly automated. To use a recent example, Keer Group's $218mn investment in a yarn-making facility in Indian Land, South Carolina, which has the capacity to produce nearly 65-70mn pounds of yarn per year – enough yarn to make more than 150mn T-shirts – is estimated to create 500 jobs.

Exhibit 47: We use top-down and bottom-up analysis to assess the labor need if all apparel manufacturing intended for US consumption was moved domestically
Analysis of workforce additions based on bottom-up and top-down scenarios

Top-down labor model	
Total Chinese textile manufacturing workforce (1)	8.5mn
x China textile export %	16%
= Textile workforce dedicated to exports	1.3mn
x China's export exposure to the US	16%
= Textile workforce dedicated to US exports	0.2mn
/ China share of US textile imports	35%
= New workers if all textile production reshored	**0.580mn**

Bottom-up labor model	
Yarn spinning workers per mn units (2)	1.5
+ Fabric making workers per unit (3)	2.3
+ Garment making workers per unit (4)	25.0

= Total textile workers for mn units	28.8
x millions of units imported into US	14,000
= New workers if all textile production reshored	**0.404mn**

Average of top-down and bottom-up model	**0.492mn**

(1) Based on data from SOE's and large companies. Does not consider smaller textile manufacturers
(2) Using recent yarn-making facility investments in the US
(3) Based on analysis of fabric labor costs relative to yarn (+33%)
(4) Based on our estimates for HBI's workforce and unit output

Source: General Administration of Customs (China), National Bureau of Statistics (China), US Census Bureau, Goldman Sachs Global Investment Research.

Capex requirement: $40-50bn in capex to bring vertically integrated apparel manufacturing to the United States

We estimate total required investment per garment to be approximately US$3.50. We analyze precedents for capital investment in both upstream (yarn) and downstream (fabric, garment) manufacturing, using recent investment in a US yarn spinning facility from China's Keer Group ($218mn in 2013), as well as fabric and garment capex requirements from Asian OEMs (Shenzhou/Makalot). Based on estimated annual garment imports of 14 bn units into the United States and $3.50 in capex per garment, we estimate total investment needed to re shore a vertically integrated apparel industry would be in the US$40-50bn range (Exhibit 48).

Exhibit 48: We estimate a total investment of $40-50bn to re-shore textile capacity and replicate all of the apparel that the US currently imports
Estimated investment cost per garment; total investment required to manufacture each unit of US apparel imports

Cost per garment		Basis for estimates:
Yarn-spinning	$1.30	Recent investments and estimated yarn throughput (Keer America, Gulf Coast Spinning)
Fabric manufacturing	$0.70	Recent capex and throughput from Shenzhou (covered by Michelle Cheng)
Garment making	$1.50	Recent capex and throughput from Makalot (covered by Michelle Cheng)

Total	$3.50	
Total capex required:		
Estimated apparel units (bn)	14	GS estimates based on total US apparel imports and assumed pricing per garment
Total investment ($ bn)	**$48**	

Source: Company data, Goldman Sachs Global Investment Research

What can realistically be moved back to the US?

Bottom line

Higher wages and the lack of available labor are essentially insurmountable barriers to any re-shoring of US apparel manufacturing. Our analysis suggests that total costs for US retailers would be 14% higher if the production bases of apparel OEMs were moved to the United States from China, to fully offset manufacturers' increased costs while still maintaining brands and suppliers' gross profit structures.

Benefits of moving apparel manufacturing to the United States

There would theoretically be several benefits from moving textile manufacturing to the United States, including faster lead times for fashion brands, a reduction in freight and duty costs, and cheaper raw material prices (owing to lower cotton prices in the United States than in other major cotton-producing regions). Further, the United States already has some upstream (yarn-making) capacity, with many US-based yarn mills in operation.

- **Closer to end customer = faster time to market.** US-based fashion brands, as well as global brands that generate a large proportion of their sales in the United States, would benefit from shorter supply chain lead times driven by localized manufacturing. To cite one example, Inditex, the largest fast fashion apparel company in the world, relies on a significant percentage of locally sourced manufacturing (about 60%) to maintain rapid speed-to-market.
- **Saving on freight and duties.** US apparel imports are subject to 0-32% duties depending on material, type, and value. If the production base were moved fully back to the United States, apparel retailers would save on duty costs, partially offsetting the manufacturing cost increase. Further, freight costs would be reduced given that

production would shift to local sources. We estimate that for a basic $12 T-shirt, roughly $0.60 of the cost is specifically related to freight and duties (or about 16% of the total landed cost of the garment).

- **Raw material prices are generally lower.** Although synthetic fiber pricing varies, cotton is considerably cheaper in the United States than in China (NY Nearby Cotton is currently priced at $0.76/pound while the China Cotton Index is priced at $1.06/pound). As raw materials are the largest input cost and yarn-spinning facilities are increasingly automated, having upstream manufacturing closer to lower-cost inputs makes sense.
- **Upstream capacity is already "in the ground."** Owing to the cheaper cost of US-sourced raw fiber (cotton), there are many US-based yarn mills with significant capacity, including Parkdale Mills, Frontier Spinning Mills, Keer America, and Buhler Quality Yarns, among others. As an example, North Carolina – which has the largest textile mill industry in the United States – employs about 30,000 workers in 700 textile facilities, according to the Economic Development Partnership of North Carolina.
- **Lower power costs.** Power prices in the United States are about 40% lower than in China, which could marginally offset the cost increase from labor.

…but higher wages costs and lack of labor capacity are difficult hurdles to overcome. The apparel supply chain is still labor-intensive, especially further downstream in the manufacturing of garments. Because roughly 23% of total FOB costs are labor-related, the **corresponding wage inflation would necessitate a 14% increase in apparel pricing to maintain gross profit structures, even assuming all of the above savings on materials, freight and duties.**

- **Labor costs are considerably higher in the United States.** We estimate labor costs in the US are 3-4X times higher than in China, based on our analysis of average wages for the textile industry.
- **Lack of labor capacity.** The lack of slack in US labor market (<5% unemployment) is another barrier.
- **Years of training required.** Garment production requires skilled labor. To bring enough garment manufacturing jobs to the United States would require years of on-the-job training and significant investment in workplace training.

Exhibit 49: We estimate that total cost (including FOB price and duties) will increase by 46% if production is moved back to US from China; therefore, retail prices would need to increase by about 14% to maintain gross profit structures
Cost comparison for a T-shirt made in the United States vs in China

Apparel	Dollar Cost per Unit										
	Total Cost - A = B + C + D + E			Supplier GP$ - B	Labor - C		Materials - D		Transport & Other - E	
	$ Today	$ USA made	% increase	$	$ Today	$ USA made	$ Today	$ USA made	$ Today	$ USA made
Manufacturing cost	3.00	5.25	**75%**	**0.90**	**0.70**	**3.10**	**0.91**	**0.77**	**0.50**	**0.48**
Yarn - Spinning	0.75	0.85	13%	0.14	0.07	0.30	0.45	0.31	0.10	0.10
Fabric - Knit/Weave	0.57	0.86	51%	0.25	0.09	0.39	0.08	0.08	0.16	0.14
Garment - Cut/Sew	1.68	3.54	111%	0.51	0.54	2.41	0.38	0.38	0.24	0.24
Duties & Shipping	**0.60**	**0.00**	**-100%**	--	--	--	--	--	--	--
Total Landed Cost	**3.60**	**5.25**	**46%**	--	--	--	--	--	--	--
Wholesale GP$	3.00	3.00	0%	3.00	--	--	--	--	--	--
Retailer GP$	5.40	5.40	0%	5.40	--	--	--	--	--	--
Retail Price	**12.00**	**13.65**	**14%**	--	--	--	--	--	--	--

Source: Company data; Goldman Sachs Global Investment Research

What happens if apparel manufacturing moves to the US? Implications for companies up and down the supply chain

Negative implications for domestic branded apparel companies with low margins and lack of pricing power

In the example above, we estimate that to offset the impact of higher input costs, brands would need to pass through 14% price increases to maintain profitability. Given that the US apparel industry has been broadly deflationary – driven by growth in value-oriented apparel (off-price retailers and mass market outperforming specialty and department stores), increasing price transparency (via e-commerce) and the increased proliferation of fast-fashion – we believe price increases of this magnitude would be untenable. Within our coverage universe, the companies most negatively affected would be apparel brands with significant US exposure and low margins (AEO, GPS, URBN) together with wholesale apparel brands forced to take up pricing with major retail partners (PVH, UAA).

Mixed impact on Asia-based manufacturers

Select OEMs have experience running global production bases. Thus, we believe some OEMs may move along with brands' sourcing strategies and build capacity in the United States. However, OEM profits could suffer as they may have to share the cost inflation with brands. Thus, we believe OEMs with higher exposure to the United States and lower margins will have a higher sensitivity to margin squeezes due to increased costs. If we assume OEMs share 10% of higher US production costs for their US shipments, the OEMs' profits will be reduced by 3-48% in 2017-18E. **Shenzhou** faces the lightest impact given its smaller exposure to the United States, while **Stella** and **Makalot** face heavier impacts due to their higher US exposures and lower OPM.

Exhibit 50: Among our OEM coverage, we estimate a 10% sharing in the additional costs for production moving from Asia to US will cause OP reduction of 3-48%, depending on margins and US market exposure

Our sensitivity analysis of cost sharing impact on OEMs' profits

		Operating margin %		OP Impact	
	US sales mix*	2017E	2018E	2017E	2018E
Shenzhou	13%	22%	23%	-3%	-3%
Yue Yuen	35%	7%	7%	-25%	-24%
Eclat	58%	20%	20%	-15%	-14%
Stella	53%	6%	6%	-47%	-44%
Makalot	77%	8%	8%	-48%	-47%

based on 2015 figures

Source: Company data, Goldman Sachs Global Investment Research.

Case Study #3: Moving aircraft manufacturing to China

Bottom line: Key challenges for China to make large commercial aircraft include IP, safety, and long product cycles

China is attempting to build out its own local aerospace industry and aircraft manufacturing, including total aircraft design, development and assembly, along with the accompanying supply chain. Therefore, there are prospects for moving parts of the total global aircraft supply chain to China. **However, any major movement in the short-to-medium term looks unlikely to us.** The aircraft supply chains and manufacturing processes used by Boeing and Airbus are very well established in the rest of the world. Furthermore, building up an indigenous aircraft design, development and manufacturing industry is a complex, multi-decade process. Building a satisfactory and economically viable wide-body airliner is a very technologically sophisticated and complex process, one in which regulatory hurdles are particularly high, for obvious safety reasons. **In the long term**, China has SOEs such as COMAC and AVIC that are attempting to create the necessary technology for both large commercial planes and plane engines. The engine effort is being overseen by the China Aviation Engine Group.

Approximately 1,400 large commercial aircraft were sold in 2016, about 22% of which were delivered to China. None of these aircraft were manufactured by Chinese OEMs, with the market split between Boeing and Airbus. Most aircraft assembly is performed in the United States and Europe, with a limited share of work done in China. When the work is done in China, it is mainly through Boeing, Airbus, and western suppliers' subsidiaries and joint ventures, with a small share made by Chinese companies. **The larger challenge we think China poses to the incumbents in the short to medium term is *demand*. Should China decide not to continue to "buy American" in the short to medium term, Airbus could be a clear beneficiary, and Boeing could suffer.**

At a Glance: The Impact of Moving Aircraft Production

Impact

Capex investment

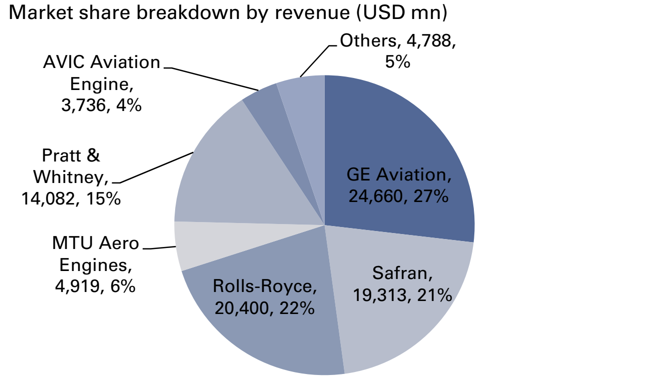
~$30bn

Building aircraft is technologically sophisticated

The large commercial aircraft market has been, and effectively remains, a duopoly (Boeing and Airbus). Commercial aircraft development is a time- and capital-intensive process, one that faces the significant hurdles of technology, know-how and close regulatory scrutiny, given safety requirements. Every single part in an aircraft needs to be certified by aviation authorities in order for the aircraft to be deemed flight-worthy. Currently, the Chinese civilian aerospace industry is in its infancy, and only a limited amount of parts production and aircraft assembly work is done domestically. China could look to accelerate its process to increase in-country manufacturing, with both indigenous companies and western supplier partnerships, but this will likely be a slow process.

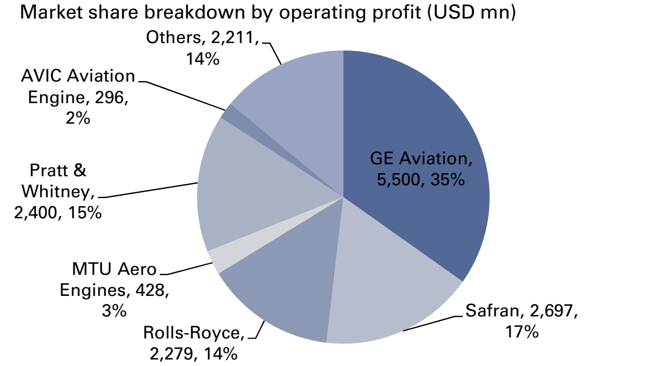
One of the primary technical areas that China would need to develop is engine technology. China SOEs COMAC and AVIC are working in this area, but as of 2015 they still had limited market share (Exhibits 51-52). The engine technology development efforts by AVIC and COMAC are conducted under the aegis of a broader SOE named the China Aviation Engine Group.

Exhibit 51: China suppliers have limited revenue share…
Revenue market share in engines as of 2015



Source: Company data, Goldman Sachs Global Investment Research

Exhibit 52: …and profit share in engines
Operating profit market share in engines as of 2015

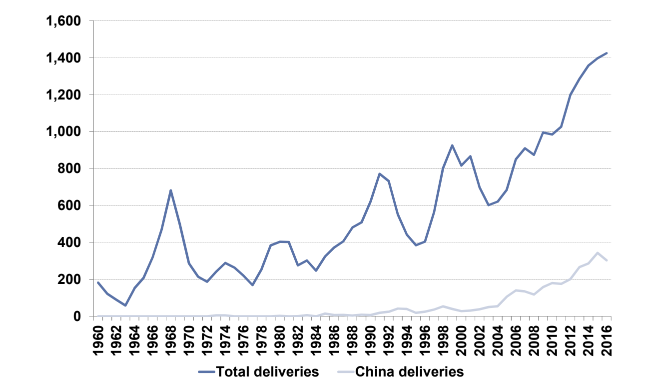


Source: Company data, Goldman Sachs Global Investment Research

China is a sizeable commercial aircraft customer

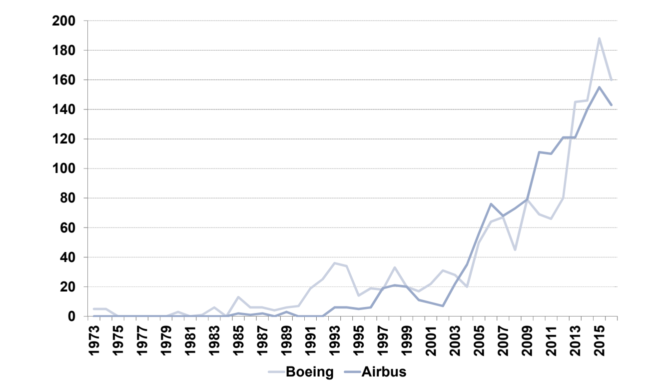
The Chinese government approves orders from all domestic airlines, and China has taken 21% of global aircraft deliveries in the past five years. Boeing and Airbus have competed aggressively for share as deliveries have increased. Boeing has recently taken that lead, in a market share comeback after Airbus put an A320 final assembly facility in Tianjin (Exhibits 53-54).

Exhibit 53: Total deliveries vs deliveries to China
China is more than 20% of global deliveries



Source: Ascend.

Exhibit 54: Boeing vs. Airbus deliveries to China
Boeing has recently taken the delivery lead from Airbus



Source: Ascend.

Overview of the commercial aircraft supply chain

The commercial aircraft supply chain is global. The main OEMs and suppliers are developed market companies, and a limited portion of the assembly and part of the production is done by these companies' subsidiaries within China (Exhibit 55).

Exhibit 55: Overview of large commercial aircraft supply chain

Manufacturing operations in China for main aerospace OEMs and suppliers are limited in size and scope

Aircraft supply chain	Production - World ex-China	Production - China
Aircraft OEM		
Boeing	Seattle, Charleston, Portland, Los Angeles, Salt Lake City (USA); Australia and Canada	Tianjin
Airbus	Toulouse (France), Hamburg (Germany), Alabama (US)	Tianjin
Aircraft parts & Materials		
Spirit AeroSystems	Wichita, Tulsa, McAlester, Kinston (USA); Prestwick (UK); Subang (Malaysia); Saint-Nazaire (France)	
Triumph Group	Nashville, Hawthorne, Red Oak, Grand Prairie, Milledgeville, Spokane, and Stuart (US)	
United Technologies - UTAS	24 locations in the US; Oakville (Canada); Mexicali, Sonora (Mexico); Bristol, Wolverhampton (UK); Buc, Saint Ouen l'Aumone, Saint-Marcel (France); Jasionka, Krosno (Poland); Bangalore (India)	
Honeywell Aerospace	15 locations in the US; Toronto (Canada); Olomouc (Czech Republic); Penang (Malaysia); Chihuahua (Mexico); Singapore; Yeovil (UK)	
General Electric Aviation	Evendale, Durham, Hooksett, Wilmongton, Madisonville, Rutland (USA); Bromont (Canada)	
Esterline	9 locations in the US; Farnborough, Gloucester, Stillington (UK); Montréal (Canada); Bourges, Marolles, Champagne (France); Kortrijk (Belgium); Tijuana (Mexico); Tangier (Morocco)	
Transdigm	39 locations in the US; Ashford, Bridgend, London, Letchworth, Bridport, Llangeinor (UK); Ingolstadt, Miesbach (Germany); Paks (Hungary); Herstal (Belgium); Holmestrand (Norway); Lund (Sweden); Nittambuwa (Sri Lanka); Matamoros, Nogales (Mexico)	Kunshan, Chongqing
Hexcel	8 locations in the US; Casablanca (Morocco); Les Avenieres, Nantes, Roussillon, Dagneux (France); Leicester, Duxford (UK); Parla, Illescas (Spain); Neumarkt (Austria); Stade (Germany); Welkenraedt (Belgium)	Tianjin
GKN Aerospace	Filton, Portsmouth, Luton (UK), Helmond, Papendrecht, Hoogeveen (Netherlands), Marknesse (Netherlands), Trollhatten (Sweden), Kongsberg (Norway), Eskişehir (Turkey), Chihuahua (Mexico), Mexicali (Mexico), Washington, Alabama, South Carolina (USA)	Hebei
Latecoere	Sonora (Mexico); Jacarei (Brazil); Letnany (Czech Republic); Lafourcade, Toulouse (France)	
Aernnova	Toledo, Alava, Seville, Orense, Cadiz, Zaragoza (Spain); Halli (Finland); Santiago de Queretaro (Mexico); Sao Jose dos Campos (Brazil); Ann Arbor (USA); Peterborough (UK); Brasov (Romania)	
Meggitt	16 locations in the US; Basingstoke, Rugby, Coventry, Dunstable, Ashford Kent, Hampshire, Heatric, Dorset, Lougborough (UK); Fresnillo, Queretaro (Mexico); Alberta (Canada); Piher (Spain); Archamps, Angoulême (France); Fribourg (Switzerland); Kvistgaard (Denmark); Singapore	Xiamen
Fuji Heavy Industries	Aichi, Tochigi (Japan)	
Avionics		
Rockwell Collins	10 locations in the US; Hyderabad (India); Mexicali (Mexico); Toulouse (France)	
Honeywell Aerospace	15 locations in the US; Toronto (Canada); Olomouc (Czech Republic); Penang (Malaysia); Chihuahua (Mexico); Singapore; Yeovil (UK)	
Thales	Aurora, Fullerton (USA); Vendome, Chatou, Etrelles, Moirans, Clergy (France); Dresden (Germany); Uttar Pradesh (India)	
General Electric Aviation	Evendale, Durham, Hooksett, Wilmongton, Madisonville, Rutland (USA); Bromont (Canada)	
Seats		
BE Aerospace	11 locations in the US; Batangas (Philippines); Leighton Buzzard, Kilkeel (UK); Lübeck (Germany); Nieuwegein (Netherlands)	
Zodiac	Niort, Chateaudun, Soignolles, Issoudun (France), Herborn (Germany), Texas, California (USA), Tumbol Ban Klang (Thailand), Prague (Czech Republic)	Tianjin
Engine supply chain	**Production Location**	**Production**
Engine OEMs		
United Technologies - Pratt & Whitney	12 locations in the US; Herstal (Belgium); Enfield, Ottawa, Mississauga, Mirabel, St-Hubert, Lethbridge (Canada); Tirat Carmel (Israel); Christchurch (New Zealand); Kalisz, Rzeszow (Poland); Singapore (Singapore); Taoyuan Hsien (Taiwan); Istanbul (Turkey)	Zhuzhou, Shanghai, Chengdu, Xi'an
Rolls-Royce	Reston, Indianapolis, Prince George Co., Novi Michigan (USA); Montreal, Vancouver (Canada); Toulouse (France); Dahlewitz (Germany); New Delhi (India); Italy; Poland; Singapore; Derby, Bristol (UK) Through ITP: Zamudio (Spain), Queretaro (Mexico), Lincoln (UK), Hyderabad (India)	
General Electric Aviation	Evendale, Durham, Hooksett, Wilmongton, Madisonville, Rutland (USA); Bromont (Canada)	
Engine sub-systems and component providers		
Safran	Montlucon, Poitiers, Fougeres, Dijon, Massy, Villaroche, Eragny, Mantes-La-Ville (France), Casablanca (Morocco), Bedford, Ashburn (USA), Sao Jose Dos Campos (Brazil)	
MTU	Munich (Germany); Poland	
GKN Aerospace	Filton, Portsmouth, Luton (UK), Helmond, Papendrecht, Hoogeveen (Netherlands), Marknesse (Netherlands), Trollhatten (Sweden), Kongsberg (Norway), Eskişehir (Turkey), Chihuahua (Mexico), Mexicali (Mexico), Washington, Alabama, South Carolina (USA)	Hebei
Avio	Naples, Turin, Brindisi (Italy), Bielsko-Biala (Poland)	
Mitsubishi Aircraft Corporation	Aichi, Nagoya (Japan); Houston, Addison, Tulsa (US); Mississauga (Canada); Hanoi (Vietnam); Amsterdam (Netherlands)	
Kawasaki Heavy Industries	Nagoya (Japan)	

Note: This list is not exhaustive.

Source: Company data, Goldman Sachs Global Investment Research.

Aerospace supply chain operations in China

OEM operations in China are a relatively small part of their manufacturing footprint.

- **Airbus.** Since 2008, Airbus has set up manufacturing and support operations in China, including tie-ups with local companies for customer support, logistics, training, engineering and composite manufacturing. Projects include a final assembly line for the A320 family (contract renewed in 2014 until 2025) and a completion and delivery center for the A330 (deliveries expected to begin in September 2017). In addition to the large commercial aircraft market, the helicopter market in China is a focus. Airbus will set up a final assembly line for H135 helicopters that is expected to start operation by 2018 and that should assemble 300 H135s over the next 10 years.
- **Boeing.** The company partners with Chinese firms to build a limited number of parts on the 737 NG, 737 MAX, 747, and 787. Boeing signed a 10-year contract in 2011 with Shanghai Aircraft Manufacturing Co to provide 737 horizontal stabilizers, the largest contract Boeing has ever had with a Chinese supplier. Boeing partners with multiple companies in China to manufacture parts for its commercial airplanes, and also to provide training, research and development centers to foster general aviation in China. In late 2016, Boeing decided to establish a 737 completion and delivery center in Zhoushan, an initiative that reportedly received opposition from the then-presidential candidate Donald Trump. We think these plans are likely to be revised if US and China trade issues emerge.

For the supply chain, most of the manufacturing footprint is also found in the United States or Europe, with a limited number of facilities located in China. For most companies, aerospace activities in China relate more to research and development and joint ventures.

Chinese aircraft not yet an alternative for western production

If shifting aircraft production from China is not an issue given the limited manufacturing footprint in the country, what about shifting more production into China, were China to stop buying American? Our view is that the Chinese civilian aerospace industry is still in the early stages and does not represent a viable alternative to western manufacturing at this point. So the beneficiary here would likely be Airbus at the expense of Boeing.

China entered the civilian aircraft production business in the early 2000s. COMAC, the Chinese aircraft manufacturer, has launched three aircraft programs since then. All have suffered development and design delays over the years, and only one has entered service. To date, COMAC has not been able to certify any of its aircraft under the FAA's stringent rules. Apart from certification by the Civil Aviation Administration of China (CAAC), COMAC's first foreign certification was in December 2016, by the Civil Aviation Authority of Congo, for COMAC's ARJ21 jetliner, according to *China Aviation Daily* (Exhibit 56).

Exhibit 56: COMAC aircraft development schedules
Chinese aircraft programs have suffered several development delays

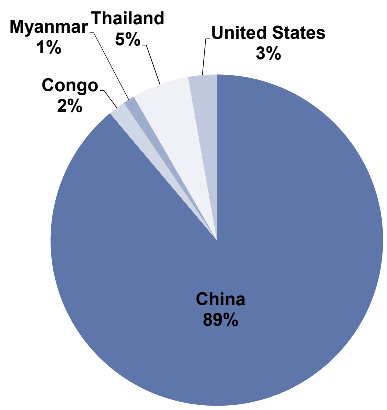
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
ARJ21	L			Fe	De		Fa							Da											
C919							L						Fe		De	Fa	Da								
C929													L							Fe		Fa		De	Da

Program Launch	L
Initial expected first flight	Fe
Initial expected delivery	De
Current expected / realized first flight	Fa
Current expected / realized first delivery	Da

Source: COMAC, media reports.

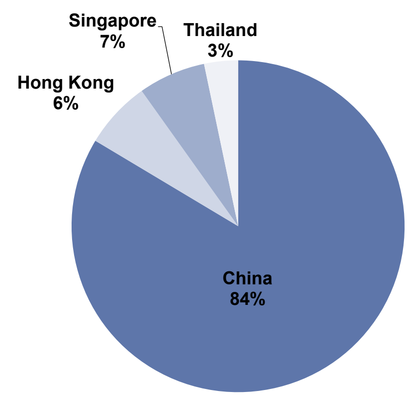
The majority of COMAC's backlog consists of Chinese airlines, which may suggest that hurdles for FAA certification have deterred orders from airlines in many regions of the world. The 5 ARJ21 orders in the United States were made by GECAS, a leasing company, which by design has flexibility to place aircraft in different regions (Exhibits 57-58).

Exhibit 57: ARJ21 backlog country breakdown
90% of the ARJ21 backlog in 2016 was contracted by Chinese carriers



Source: Ascend.

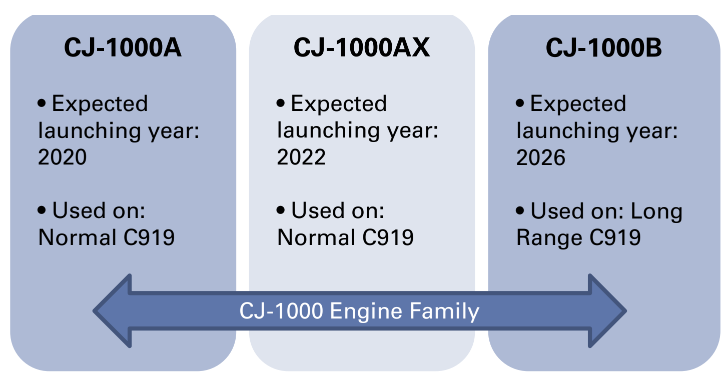
Exhibit 58: C919 backlog country breakdown
And the same applies to COMAC's C919



Source: Ascend.

Similar to the challenges with full wide-body commercial planes, AVIC has laid out a timeline for developing engine technology such as the CJ-1000A but has experienced delays (Exhibit 59).

Exhibit 59: AVIC has goals of developing engine technology
Overview of AVIC engine production targets



Source: Aviation Week

One of the reasons this problem is complex is that making an engine involves thousands of well-forged/machined/cast components. For instance, just on the fan blade, titanium side panels will be hot-twisted in a furnace with a chemical applied to form a honeycomb core to facilitate heat/air diffusion.

What would it cost China to enter the large commercial aircraft?

High barriers to entry in civil aerospace mean that China's disruption of the global duopoly would require substantial investment. In 2016, China accounted for about 22% of commercial deliveries, or 317 aircraft. **On our estimates, to build a domestic industry large enough to satisfy existing demand would require investment of close to $50bn, with about $20bn for R&D and $30bn in capex. Furthermore, reaching full production and customer acceptance could require many years, or even more than a decade.**

The required PP&E

Taking an average of Airbus and Boeing's total cumulative PP&E expenditures by 2016 suggests an investment of around $24bn to create an OE manufacturer capable of producing around 700 aircraft a year. To avoid the difficulty of scaling this number down and trying to size the benefits of economies of scale or the required "base" level of investment needed, we look at historic numbers. In 2004 Boeing and Airbus each delivered around 300 aircraft (China's domestic demand today), and the average total PP&E at that point was $12.7bn. This suggests that since 2004, Boeing and Airbus have grown volumes by around 130% with only 90% in additional PP&E investment. Taking the 2004 number ignores technological advances in the last decade, but also ignores the start-up inefficiencies likely to be experienced by China (both Airbus and Boeing were already well-established producers).

The required R&D

More significant than the PP&E spend, though, is the R&D required to develop a clean-sheet aircraft. This can vary, but on average the full development cost for a new commercial aircraft is around $8-12bn. Assuming both a narrow-body and a wide-body variant leads to an R&D expense of about $20bn.

The required supply chain

For the supply chain, we estimate that two-thirds of the COGS of an aircraft are "bought-in" costs for the OEMs. As a result, this suggests global supply chain sales of around $63bn. Across our covered civil aerospace suppliers, gross PP&E investment currently represents 44% of sales, implying a total supply chain investment of $27bn. Assuming Chinese volumes and the same economies of scale benefits as the OEMs leads to a need for $13.6bn of investment for a domestic supply chain.

The end result

Combined, this $12.7bn of PP&E for an OE manufacturer, $20bn of R&D for clean-sheet aircraft and $13.6bn for a supply chain suggests the need for investments in the range of $46bn to create a self-sufficient Chinese aerospace industry. In the United States approximately 500,000 people are employed in civil aerospace, with a further 400,000 in Europe. Based on China's percentage of worldwide commercial aircraft sales, shifting an equivalent percentage of that workforce to satisfy existing demand would result in a Chinese industry with some 200,000 jobs**. A low estimate suggests that at least a third of these civil aerospace jobs (around 67,000) would be in skilled manufacturing roles.**

Ratings, price targets, methodology, and key risks of select stocks

Exhibit 60: Ratings, price targets, methodology, and key risks
priced as of the close on March 24, 2017

Ticker	Company	Rating	Price Target	Latest Closing Price (3/24/17)	Methodology	Key Risks
2311.TW	Advanced Semiconductor Engineering	Neutral	NT$39.80	NT$39.65	10% premium to 2017E sector average P/B-ROE (10X)	Market share loss/gains; lower-/higher-than-expected SiP penetration
AIR.PA	Airbus Group	Buy	€ 84	€ 69.85	an EV/DCF multiple of 10X on our 2018 estimates, discounted back one year at 9%	Program delays, fx, large-scale M&A, and higher-than-expected CAPEX
AEO	American Eagle Outfitters Inc.	Sell	$12.00	$13.86	11X 24-month forward EPS	Upside risks include strong execution and market share gains
AAPL	Apple Inc.	Buy	$150.00	$140.64	16X CY17E EPS of $9.45	Product cycle execution, end demand, and a slower pace of innovation
ASNA	Ascena Retail Group	Neutral	$4.50	$3.80	12.5X 12-24-month forward EPS	Better or worse comp sales trends
BA	Boeing Co.	Sell	$132.00	$175.82	12.8X CY17E P/E	Key risks include (1) Capital deployment, (2) cost reduction efforts, (3) DoD spending.
2324.TW	Compal Electronics	Neutral	NT$22.50	NT$19.90	20% discount to 2017E sector average NTM P/B-ROE of 11X	Apple business profitability; notebook market share gains/losses and pricing pressure; lower-/higher-than-expected smartphone outsourcing rate
FLEX	Flex	Buy	$18.00	$16.64	15X CY17E EPS (including SBC)	Revenue, margins, and capital allocation
GPS	Gap Inc.	Neutral	$25.00	$23.26	12X 24-month forward EPS	Better comps or worse traffic
2317.TW	Hon Hai Precision	Neutral	NT$95.00	NT$90.60	2017E sector average NTM P/B-ROE of 11X	Execution from other ODMs and order allocation within Apple; market share of Chinese OEMs
1347.HK	Hua Hong Semiconductor Ltd.	Buy	HK$11.50	HK$11.20	85% fundamental value (0.96X FY17E P/B to NTM BVPS) and 15% M&A value (21% premium to fundamental PBR)	Higher-than-expected cost with capacity ramp
INTC	Intel Corp.	Neutral	$41.00	$35.16	15X normalized EPS of $2.70	PC trends, enterprise and hyperscale spending and technology transitions
JBL	Jabil Circuit Inc.	Neutral	$26.00	$28.74	13X CY17E EPS (including SBC) of $2.00	iPhone trends, M&A, margins, capital allocation, and large program changes
1477.TW	Makalot Industrial Co.	Sell	NT$108	NT$130.50	14X 2018E P/E	Stronger apparel consumption, faster capacity ramp-up for the new sportswear plant in Vietnam, better product mix, higher contribution from new clients, FX
4938.TW	Pegatron	Buy (CL)	NT$110.00	NT$86.20	2017E sector average NTM P/B-ROE of 11X	Lower yield/delay of new iPhone; lower notebook orders vs. other ODMs; lower consumer electronics sales; subsidiary Casetek's execution issue
PVH	PVH Corp.	Neutral	$111.00	$100.95	14X 12-24-month forward EPS	A pickup or slowdown in the base Calvin Klein/Tommy Hilfiger business and the integration program
QRVO	Qorvo Inc.	Neutral	$57.00	$67.64	11X normalized EPS of $5.20	Smartphone demand, cost synergy execution, competition
2382.TW	Quanta Computer	Neutral	NT$60	NT$65.40	2017E sector average NTM P/B-ROE of 11X	Greater-/less-than-expected demand from Apple Watch and hyperscale servers; competition in PC ODM; lower/higher yield rate for Apple Watch
RL	Ralph Lauren Corp.	Neutral	$85.00	$79.74	15X Q5-8 P/E	The key upside risk is cost savings/efficiencies and the key downside risk is sales weakness.
2313.HK	Shenzhou International Group	Buy (CL)	HK$58	HK$51.10	18X 2018E P/E	Slower sportswear demand growth, higher-than-expected labor cost increases, slower ramp-up in production in Vietnam, changes in FX
2325.TW	Siliconware Precision Industries	Neutral	NT$50	NT$49.25	50% weighting to an M&A valuation which applies to 18.4X 2017E P/E and 50% fundamental valuation weighting applied to 14.7X 2017E P/B-ROE	market share at key customers; weaker-/stronger-than-expected smartphone demand; pricing pressure
1836.HK	Stella International Holdings	Neutral	HK$12.40	HK$12.74	14X 2018E target P/E	Faster/slower growth in dress/casual shoes, better/worse efficiency in new capital and from geographical/product shifts, and FX
TXN	Texas Instruments Inc.	Sell	$65.00	$80.59	18X normalized EPS of $3.60	industrial/automotive recovery, M&A
2330.TW	TSMC	Neutral	NT$188	NT$192.5	13X NTM P/E	Upside risks include stronger-than-expected iPhone 8 demand; downside risks include higher-than-expected market share gain by Qualcomm's 14nm SOC
UAA	Under Armour Inc.	Neutral	$23.00	$19.66	45X 12-24-month forward EPS	On the plus side, sales guidance looks conservative vs. the run rate, expense control could drive better EBIT. On the negative side, weaker sales.
URBN	Urban Outfitters Inc.	Sell	$21.00	$22.94	13X P/E on Q5-8 EPS	Improved execution at Anthro, favorable tax reform
VFC	VF Corp.	Neutral	$49.00	$54.06	15X Q5-8 P/E	(+) Acceleration in Outdoor & Action (-) greater wholesale destocking
3231.TW	Wistron	Sell	NT$13.50	NT$27.90	0.5X 2017E trough P/B	Higher-than-expected notebook shipments and faster margin recovery
0551.HK	Yue Yuen Industrial	Buy	HK$33.00	HK$27.95	SOTP	Worse-than-expected production efficiency in China, weaker-than-expected volume growth in sports and casual shoes, rising raw material costs in the near term, and lower contribution from Pou Sheng

Source: Goldman Sachs Global Investment Research

Mindcraft: Our Thematic Deep Dives

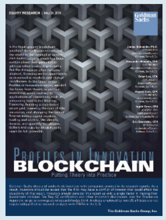
Innovation & Disruption

Virtual Reality

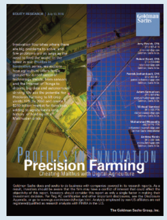
Drones

Factory of the Future

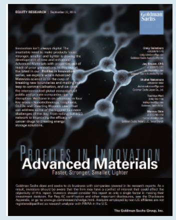
Blockchain



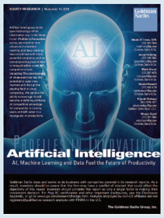
Precision Farming



Advanced Materials



Artificial Intelligence

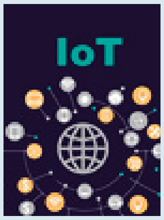


5G

Cars

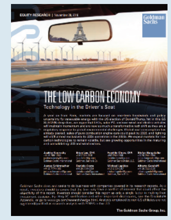
Future of Finance

Internet of Things



The Low Carbon Economy

Promising Tech

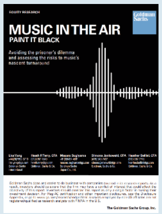


The Great Battery Race

Music's Return to Growth

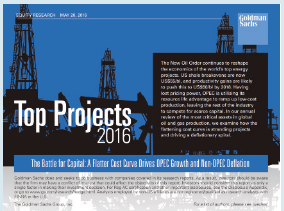
Opportunity

Risks

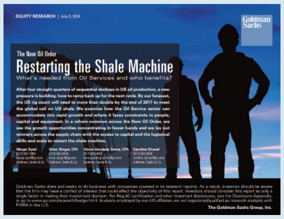


Commodity Corner

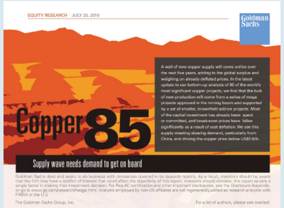
Top Oil & Gas Projects



Restarting the Shale Machine



Copper Glut



Insights & Policy

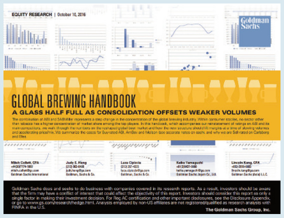
Top of Mind

Directors' Dilemma

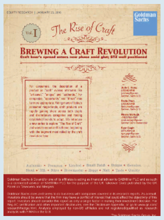
Fortnightly Thoughts

Consumer Currents

Big Beer's New Era

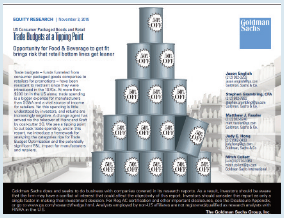


The Rise Of Craft



eCommerce's Infinite Shelf

Trading Budgets Tipping Point



Quantamentals

Rise of the Chinese Consumer

Consumer Close-Up

Millennials

The Great Wall of SKUs

E+Commerce

Asia Tech

Apple Suppliers' Dilemma

Asia Digital Banking

India Internet

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Reg AC

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