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## Global Semiconductors | Asia Pacific

# Potential impact if further restrictions are put on Huawei's semiconductor supply

HiSilicon is at the core of Huawei's local semiconductor supply for advanced chips, such as 5G, AI, and surveillance. We address the potential impact on the semi supply chain if it were to be further restricted.

## Investor concerns have been raised again since late April on Huawei's export ban:

We have written previously ([link](#)) on the potential change in US export policy (i.e., the 'de minimis rule' and the 'direct product rule') in the past few months – and there has been a step forward. On April 28, the US Commerce Department posted a draft of three new rules to further control exports of US technology to countries including China. That covers semiconductor supply that could be used for military purposes even under a civil entity. The grace period of the above rules should be 30-60 days, but that has led to investor concerns on potential disruption of Chinese companies, e.g., Huawei.

## Huawei's captive design house, HiSilicon, is currently supplying advanced chips internally:

Under current export restrictions, Huawei can still produce telecom equipment and smartphones, since: 1) US semi vendors may apply for the de minimis exception, as China's growth in 5G communication remains a key business opportunity; 2) for those chips restricted to supply (e.g., Xilinx's high-end FPGA), Huawei can design its own chips and produce them at TSMC. Tighter export control on only HiSilicon (vs. on the whole Huawei group) would have a different impact on the global semi supply chain, because Huawei's demand could continue – Huawei would just have to use third-party chips.

**1) Potential impact on US semis:** A HiSilicon ban would likely be most negative for the foundry supply chain (notably, equipment stocks such as AMAT, KLA and LRCX) and companies that have maintained high shipments to Huawei under the de minimis exception (MU, QROV, TXN). In a narrow sense, a HiSilicon ban could be positive for companies that would stand to benefit from any resulting Huawei share loss, including ADI, Xilinx and Marvell in infrastructure, QCOM in smartphone chipsets, and Avago, Qorvo and Skyworks in RF.

**2) Potential impact on Greater China semis:** TSMC, WIN Semi and KYEC are key foundry suppliers to HiSilicon. MediaTek (smartphone chips), SMIC (local foundry) and Realtek (networking chips) might see short-term gains. ACMR (equipment) and China IC design firms could benefit from China semi localization.

**3) Potential impact on non-US/China semis:** [Exhibit 1](#) lists global semi makers that could be affected by a HiSilicon ban. STMicro, Samsung, SEMCO, Renesas, Rohm might benefit; Advantest and Hynix might see short-term impacts.

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## The potential short-term impact on global semis if the tighter ban on HiSilicon were to occur

TSMC and its US equipment/IP vendors are key enablers to HiSilicon. TSMC supplies several HiSilicon-designed infrastructure chips, such as FPGA, CPU, AI accelerators, ASICs, surveillance SoCs and high-end converters. These chips currently are not able to be produced by the local China foundry, SMIC, with insufficient yield and capacity. Semi equipment producers are indirect suppliers to HiSilicon through the wafer foundry fabs. Among the others, US origin equipment/technology vendors are most critical, and difficult to be totally replaced by Japanese vendors. EDA/IP are also core for chip design, but HiSilicon has acquired a term-license beforehand.

A further ban on Huawei or HiSilicon would result in different outcomes to the semi supply chain. The restriction on Huawei could cause market share loss at its main chip vendors, as Huawei may lose market share to other system brands such as Samsung and Apple.

Tighter export controls on only HiSilicon (instead of the whole Huawei group) would result in a different impact on the global semi supply chain, since Huawei could still produce systems by using non-HiSilicon vendors, for example, Xilinx in FPGA and MediaTek in 5G smartphone SoC. The general impact would be on the direct suppliers to HiSilicon (e.g., TSMC, WIN Semi, and KYEC), which would suffer revenue shortfalls, whereas HiSilicon's competitors (e.g., MediaTek) may gain share.

If the ban on HiSilicon occurs, global semi stocks that have higher exposure to HiSilicon projects could react negatively in the short term, while some others may benefit - see as Exhibit 1.

**Exhibit 1:** Potential beneficiaries within global semi supply chain (at least one-year time frame) in the scenario of HiSilicon restriction

Beneficiaries		Above-average risks	
Ticker	Company name	Ticker	Company name
<b>US</b>			
XLNX.O	Xilinx	LRCX.O	Lam Research
MRVL.O	Marvell	AMAT.O	Applied Materials
QCOM.O	Qualcomm	KLAC.O	KLA
ADI.O	Analog Devices	MU.O	Micron
AMBA.O	Ambarella	QRVO.O	Qorvo
		TXN.O	Texas Instruments
<b>Europe</b>			
STM.PA	STMicro		
<b>Korea</b>			
005930.KS	Samsung	000660.KS	SK Hynix
009150.KS	Semco		
<b>Japan</b>			
6723.T	Renesas	6857.T	Advantest
6963.T	Rohm		
<b>China</b>			
0981.HK	SMIC		
ACMR.O	ACM Research		
603986.SS	GigaDevice		
<b>Taiwan</b>			
2454.TW	MediaTek	2330.TW	TSMC
		3105.TWO	WIN Semi
		2449.TW	KYEC
		3661.TW	Alchip

Source: Morgan Stanley Research

## US Semi implications (Joe Moore, Craig Hettenbach)

**In general - before discussing the HiSilicon restrictions - we have seen trade tensions as a negative for the US semiconductor group.** Short term, anxiety from the supply chain has resulted in Chinese companies building substantial buffer inventory. Intermediate term, it has pushed Chinese design win preference to European or Asian alternative to their US suppliers. And longer term, it has provided additional incentive for China to develop semiconductor self sufficiency.

In that sense, the escalation from HiSilicon restrictions, as well as any counter reaction from China, is a negative for the whole group, at a time where there are already significant fundamental challenges. US semiconductor stocks have been substantially and negatively impacted by the trade tensions of the last 18 months.

Having said that, there are a number of companies that could see some upside opportunities in the shorter term, as well as negatives. We would think about several categories of companies:

*Companies with high exposure to Huawei through various exceptions to the entity list rule*

*will be negatively impacted at the margin as Huawei's builds would likely contract:* Under the prior entity list restriction, several companies were able to maintain shipments to Huawei through the 75% de minimis exception. We would include here Micron, Texas Instruments, Qorvo, and Inphi. To be clear, though, most companies' forecasts have been given with a cautious view of Huawei's trajectory. Also, we note that the impact would be mitigated somewhat by demand at other customers - particularly for memory, where overall supply and demand would only have moderate impact.

*Companies that compete with HiSilicon, or that have high exposure to Huawei competitors, should benefit.* Companies that directly compete with HiSilicon include Qualcomm, Ambarella, and more recently Xilinx. Companies with high exposure to non Huawei base station vendors, such as Xilinx and Marvell, would also benefit. Qualcomm also is not currently collecting royalties from Huawei, so a share shift to competitors would be helpful. Ambarella would also be a direct beneficiary, given that HiSilicon is their primary competition in high end surveillance computer vision chips, and increasingly in autos as well.

*Companies in the foundry supply chain:* Applied Materials, KLA, and Lam Research could all be negatively impacted by potentially weaker foundry, as highlighted by our foundry team. Having said that, we would note that with front half loaded foundry spending budgets, this will be less of a factor in 2h.

**Semicap companies such as AMAT, LRCX and KLA would be negatively impacted indirectly as HiSilicon is one of TSMC's largest customers.** HiSilicon has been one of the large contributors to the strength in the logic WFE market that has buoyed semicap companies over the last 12 months. If HiSilicon was no longer able to purchase silicon from TSMC it would pressure semicap companies and would have outsized impact on those with most logic exposure such as KLA. Longer term if China's domestic chipmaking capabilities were accelerated it could produce some offsetting benefit assuming there were no further restriction on equipment sales to domestic chinese companies.

**In RF (radio frequency),** we think US suppliers (AVGO, QRVO, SWKS) remain well positioned at the high-end and in particular leadership in integrated modules, although we recognize increasing risk in the mid end. Huawei has been an important growth driver for Qorvo, representing 10% of revenue for Qorvo in the December 2019 quarter and averaging over mid single digits the last 3 quarters.

## European Semi implications (Dominik Olszewski)

**European chipmakers are potential interim beneficiaries of the centre of gravity for the supply chain moving eastwards.** If restrictions on export of US chips to China increase, depending on the exact shape of restrictions put in place, European chipmakers stand able to meet some of this Chinese demand. Market share where Europeans could prosper (where there is also meaningful US presence) include: microcontrollers, discretess and some sensor technologies. This would be particularly relevant for the likes of STM. The upside from potential design wins with Chinese customers are not baked into future estimates, nor do we think the current multiples reflect optionality on this mid-term theme. We have written about this longer-term potential "De-Americanisation" theme [in more detail here](#).

**Recent reports also mention a more specific tie-up involving STM.** Nikkei reported (28 April) that Huawei is working with STMicroelectronics to co-design mobile and automotive-related chips. The article talks about the potential for such an arrangement to "shield [Huawei] from Washington's possible tightening of export restrictions", as well as accelerating the company's progress in autonomous driving. Such a collaboration is said to bring the benefit of enabling Huawei to secure access to the latest development software.

**Regarding the potential policy decisions around Huawei, the STM CEO, Jean-Marc Chery, said** (at 1Q20 results - on 22 April): *policy proposals are "linked to technology with a metal pitch below 80nm, which potentially affect technology like a 14nm FinFET and below. And you know ST strategy on personal Electronics is to focus on subsystem like sensor, specialized imaging sensor, secure solution, analog, RF, mixed signal and power management, And all this technology is enabled with a metal pitch well above 80nm. So intrinsically, ST will not be impacted."* However, he also added *"I cannot forecast...what will be the overall impact if such a measure will occurs."*

## Japan Semi implications (Kazuo Yoshikawa)

### Above-average risk

**Advantest:** We estimate HiSilicon (including its OSATs) represented a high single digit percentage of Advantest's revenues in 2019.

### Potential beneficiaries

If restrictions on exports of US chips to China increase, Japanese chipmakers such as Renesas Electronics and Rohm may benefit from share gains in microcontrollers, battery management and other analog IC markets.

In the case of stricter controls, it is probably impossible to build a wafer fab without the support of AMAT and LAM. TEL cannot replace some of the differentiated processes served by US companies.

## Korea Tech implications (Shawn Kim)

Huawei is a large customer for both Hynix (~15% of revenue) and Samsung (~10% of memory revenue).

**Samsung:** We don't think HiSilicon can divert HPC to a Samsung foundry either given the US semi equipment supply. Huawei is 3% of total exposure mainly from memory. But could take high-end smartphone and 5G network equipment share from Huawei if that is included, as well as OLED panel share from non-Huawei Chinese smartphone OEMs. Samsung can benefit from smart share upside to non-Huawei Chinese customers in smartphones/networks. Samsung's revenue from the component business and iPhone OLED should also increase.

**SK Hynix:** The implication is slightly negative, given its high revenue exposure to Huawei, if Huawei were to experience some semi supply hiccup.

**Samsung Electro-Mechanics** has 20% MLCC revenue (~10% of total revenue) exposure to non-Huawei Chinese smartphones and should benefit.

## Greater China Semi implications (Charlie Chan, Daniel Yen)

Foundry vendors to HiSilicon have asked for a commitment for the placed orders, therefore, the revenue stream can still last for another quarter or two. But if the restrictions continue and Huawei starts to lose market share after running out of backlog, it could create some order shifts in 2021.

### Above-average risk:

**TSMC:** HiSilicon (Huawei's subsidiary) accounts for 15%-20% of TSMC's revenue, and it is one of the most aggressive users of TSMC's leading edge capacity. After the Huawei order backlog runs out, TSMC may suffer a few quarters of slower growth.

**WIN Semi:** 100% of HiSilicon's GaAs PA is produced by WIN Semi. HiSilicon accounts for 15% of revenue.

**KYEC:** Huawei's infrastructure chips account for 25% of company's revenue. The company does the final tests for ASIC, RF, AI accelerator, CPU, FPGA, and other networking chips.

**Alchip:** the company takes a 7nm CPU design service for China's HPC customer, which accounts for 10% of Alchip's revenue.

### Potential beneficiaries

**SMIC:** Huawei may try to shift some advanced semiconductor production to SMIC. However, SMIC's 14nm capacity is limited, and it is still not mature for most advanced chip production.

**MediaTek:** If Huawei is allowed to use third-party chips, MediaTek may benefit from the share gain. MediaTek currently supplies 30% of Huawei's smartphone chipset, mainly for low-end 4G phones.

**Realtek:** We think the company could benefit from market expansion (TV SoC and networking related chips) in China. Currently, HiSilicon is a strong competitor in TV SoC and STB controllers in China. The pricing environment could also be better as HiSilicon usually offers low prices.

**ACM Research:** China fabs may be more dependent on local equipment supply.

The exhibit below shows companies' exposure to the Huawei brand smartphone and networking system. This may serve as a source of sensitivity analysis if the ban is on Huawei instead of HiSilicon.

**Exhibit 2:** Global semi exposure to Huawei infrastructure and smartphone demand

Ticker	Total infrastructure exposure (2019e)			Total smartphone exposure (2019e)				Total Huawei
	Huawei Brand	Other brands	Total infra.	Huawei Brand	Other Android	Total Android	Apple iPhone	
Greater China Semi Foundries								
TSMC 2330.TW	5%	10%	15%	15%	10%	25%	20%	20%
UMC 2303.TW				5%	30%	35%	0%	5%
SMIC 0981.HK	10%	5%	15%	15%	15%	30%	0%	25%
Win Semi 3105.TWO	5%	15%	20%	15%	15%	30%	40%	20%
ASE 3711.TW	1%	4%	5%	10%	15%	25%	20%	11%
Chipbond 6147.TWO				13%	15%	28%	7%	13%
JCET 600584.SS	2%	3%	5%	10%	37%	47%	3%	12%
CHPT 6510.TWO	5%	0%	5%	25%	25%	50%	20%	30%
ASM Pacific 0522.HK	2%	3%	5%	10%	15%	25%	15%	12%
KYEC 2449.TW	20%	5%	25%	5%	20%	25%	5%	25%
Greater China IC Design/IDM								
Nanya Tech	10%	5%	15%	0%	13%	13%	0%	10%
Will Semi 603501.SS	1%	0%	1%	25%	50%	75%	0%	26%
Goodix 603160.SS				30%	68%	98%	0%	30%
Novatek 3034.TW				15%	23%	38%	0%	15%
MediaTek 2454.TW				3%	37%	40%	0%	3%
SIMO SIMO.O				3%	22%	25%	0%	3%
Silergy 6415.TW	1%	0%	1%	2%	3%	5%	0%	3%
Egis 6462.TWO				0%	100%	100%	0%	0%

Source: Morgan Stanley Research estimates



## Background of US semiconductor technology export controls

One year after Huawei was put on the US entity list, China's efforts in semi localization have been more successful than we had expected

Since Huawei was put on the US 'entity list' in May 2019, China semi localization has accelerated. The local semi alternatives got a chance to try to enter smartphone and infrastructure applications, although performance and cost are still not comparable to the US designs. Under the current export restrictions, Huawei can still produce telecom equipment and smartphones since: 1) US semi vendors still intend to supply to Huawei to participate in China growth in 5G, and 2) Huawei and other Chinese entities design their own chips which are allowed to be manufactured at advanced foundries like TSMC. We therefore think further tightening concerns from investors are valid.

**Exhibit 3:** 'National Security' sensitive projects: 5G communication, AI, surveillance

Date	China company	Business	Sanction
Apr-18	ZTE	Communication	Denial Order List
Oct-18	Fujian Jinhua	DRAM	Export embargo of components and software
May-19	Huawei	communication	Entity List
Jun-19	Sugon	Supercomputers / Datacenters	Entity List
Oct-19	Hikvision	Surveillance	Entity List
	Dahua Technology	Surveillance	Entity List
	IFLYTEK	AI	Entity List
	Megvii	AI	Entity List
	Sense Time	AI	Entity List

Source: US Department of Commerce, Morgan Stanley Research

### Why Huawei can still produce systems after being placed on the entity list a year ago

The 'de minimis rule' of a 25% threshold is too high, we believe, as semi vendors can shift their supply chain or IP source to suppliers that depend less on US technology exports.

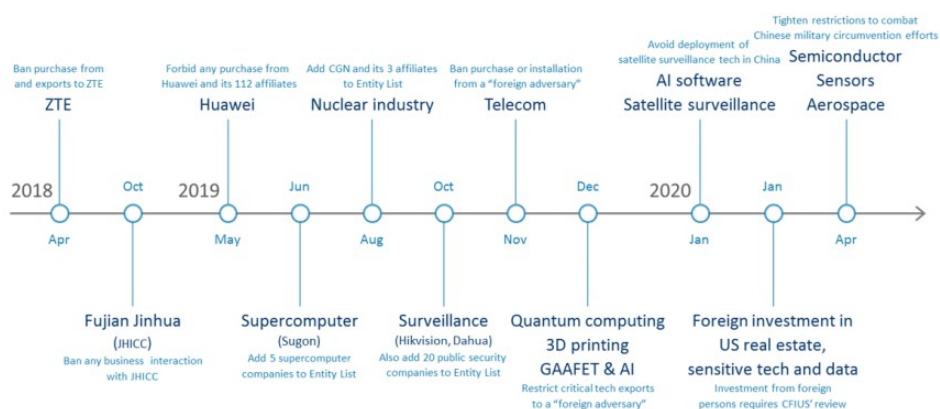
in our previous report, [TSMC: Tighter US technology exports: assessing the impact of this risk \(18 Feb 2020\)](#), we briefly discussed the implementation of the Direct Product Rule. That would require suppliers to Huawei to acquire a license from the US government. Because this rule applies to global vendors, not just TSMC, it is difficult to find a way to work around foundry supply for advanced chips.

### Recent US policy developments on technology exports to China

The exhibit below shows US technology controls introduced since 2018, which cover semiconductors, nuclear, telecoms, supercomputers, and even aerospace segments.

However, on April 28, according to [Nikkei Asian Review](#), "the US Commerce Department announced stricter controls on exports of American technologies to China, Russia and Venezuela to prevent their use in military applications. The new rules expand military end-use and end-user controls to cover items such as chip equipment, sensors and other technologies. They also remove a license exception for exports to civilian end-users in countries of national security concern, though it is not yet clear what if any impact this will have on trading activities with Huawei."

**Exhibit 4:** Time line of the US's technology export tightening



Source: Morgan Stanley Research

## HiSilicon is the core of Huawei's local semiconductor supply, while TSMC is the key enabler

HiSilicon is currently supplying Huawei's FPGA, CPU, AI accelerators, ASICs, and high-end converters, while its main foundry supplier is TSMC.

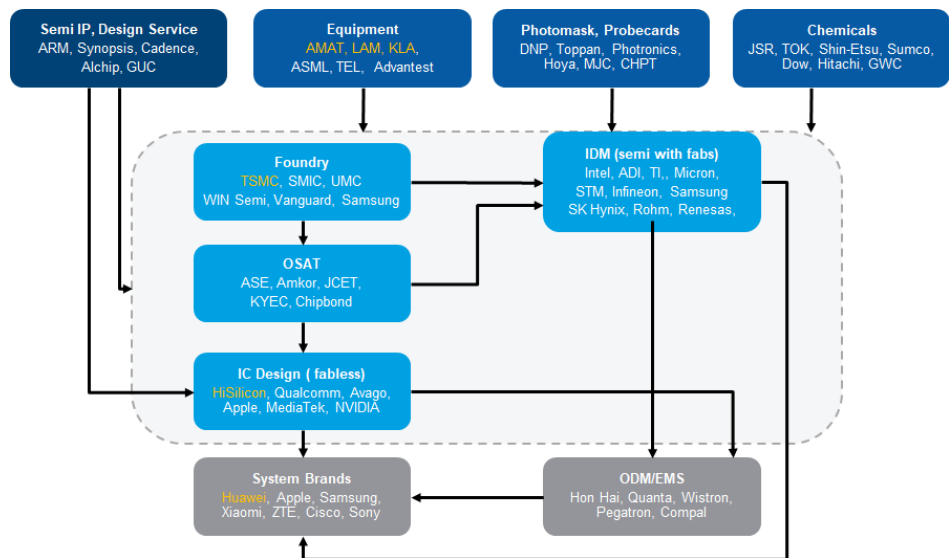
Some of TSMC's equipment/IP are supplied or originated from US vendors. For example, KLA for inspection tools, and ASML for lithography, are difficult to replace with Chinese local vendors and Japanese/European vendors. If the US were to reduce or stop the supply of critical equipment, it would be difficult for China to further migrate to a new generation, or expand its capacity.

China fabs still depend on the equipment supply and related maintenance services. In the Fujing Jinhua case, which was embargoed for equipment supply, the company could not further expand its capacity. In this case, China may need to consume its previously accumulated semi and system inventory, and need to use the local foundries' current capacity (such as SMIC, HLMC, and HHGrace) to produce older generation products which could be even less competitive.

**Exhibit 5:** The seven most critical vendors in China's semiconductor supply chain

Company	Ticker	Market Cap (US\$bn)	Location	Brief Description	Market Share (2018)
ASML	ASML.AS	115.8	Europe	Advanced lithography tools (EUV)	90%
ARM	Not listed	na	UK	ARM-based CPU core architecture	90%
WIN Semi	3105.TWO	3.9	Taiwan	GaAs foundry services for RF components	73%
KLA	KLAC.O	23.1	US	Inspection and process controlling tools	72%
TSMC	2330.TW	245.6	Taiwan	Advanced logic foundry services	56%
Infineon	IFXGn.DE	20.1	Europe	IGBT chip and power semis	29%
Synopsys	SNPS.O	20.4	US	EDA tools and IP	28%

Source: Gartner, Company Data, Morgan Stanley Research estimates

**Exhibit 6:** Global semiconductor supply chain flow chart

Source: Morgan Stanley Research

## Commentary by our US policy expert on Huawei, and by semiconductor vendors on the impact of the rule change

In the report, [US Public Policy Brief: Assessing COVID-19's Impact on US/China Trade \(6 May 2020\)](#), Morgan Stanley US Policy analyst Michael Zezas indicated that, "if the US were to impose further restrictions on the technology supplied to Chinese firms, Beijing could respond with some non-tariff measures on specific products."

We cannot predict the timing or possibility of a further Huawei ban, or the possibility of a response from China or the impact on the global economy. Instead, we quote industry association and related party commentary.

### SEMI (headquartered in the US)

"SEMI Warns Against New Unilateral U.S. Export Controls on Commercial Technology", "With U.S. producers accounting for roughly 40 percent market share, over \$21 billion in U.S. equipment sales to non-U.S. fabs could be affected." [SEMI Warns Against New Unilateral U.S. Export Controls on Commercial Technology](#), SEMI, March 3, 2020

### TSMC

TSMC said it shares the stance of SEMI, which urged the US government not to change the technology export rule (TSMC added that companies like TSMC should have a 30-day or 60-day grace period before the new export rule becomes effective, so it wouldn't be an immediate concern).

The company says it will comply with the new US rule if it becomes effective. TSMC and its customers have certified that their semiconductors are not for military usage.

## China semi localization to proceed further, to realize "self-controlled" semi technology

### Potential controls on semi technology sources, not just on chip production

There are indeed risks of a further tightening of US technology exports, for example, via potential restrictions on foundry suppliers producing advanced chips for Chinese companies, or a tighter review of equipment supplies to fabs that supply to the China market. However, our base case is to assume: 1) the restriction on US technology exports would focus more on national security, judging from the previous entity lists. Consumer-related products still follow market competition. 2) China will continue to build its own semi supply chain, in particular equipment, leading-edge foundries, memory, and infrastructure-related chip design. 3) In our base case, we see some duplication of semiconductor demand.

### **This assumes some dependency on US technology is still allowed**

The goal of China's semi localization is to replace imports of foreign designed/manufactured components, but the achievement of semi localization may still largely depend on US origin technologies, for both hardware and software. For China to achieve the bifurcation of technology, the full supply chain and ecosystem would need to decouple from US technology, either by developing the technology sources locally, and or by depending on non-US technology vendors.

#### 1. National security-sensitive semis

The most critical segment would be semiconductors that are related to China's infrastructure and national security, and which mostly depend on US vendors. For example, CPUs, GPUs, and memory for cloud data center servers. China's infrastructure indeed depends on power semis such as IGBTs and MOSFETs, but Europe and Japan account for 70% of global supply.

#### 2. China system brand semi consumption

The second priority would be addressing demand from China's system companies, which can decide the source of the semiconductor supply. The products involved are non-sensitive semiconductor products, and we believe Chinese vendors will gradually realize self sufficiency. We estimate the TAM is around US\$100-120bn, by assuming that Chinese system companies consumed around 20%-25% of global semis in 2019.

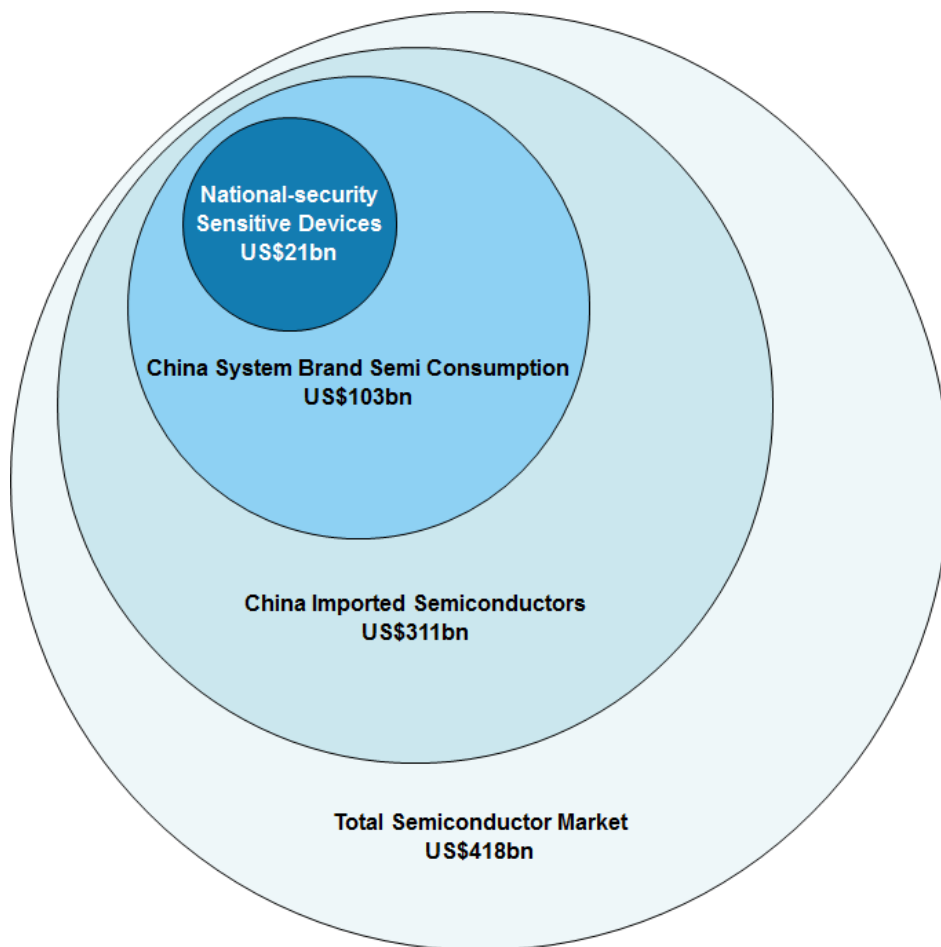
#### 3. China semi imports

The last would be imports for semiconductor assembly. For example, the Apple processors and memory shipped to Foxconn. A certain portion of the semiconductor procurement can be decided by the factory that owns the system design capacity (or so-called ODM).

#### 4. Global semi total market size

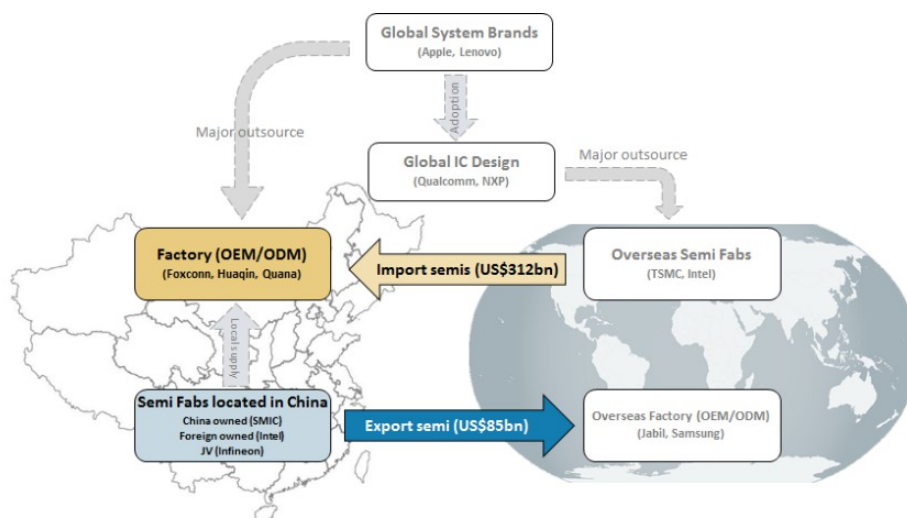
Some Chinese chip suppliers are able to supply to international brands, for example Will Semi and Goodix supply sensors to Samsung, while GigaDevice supplies NOR Flash to Apple Airpod. The TAM is the global semi industry revenue size of US\$418bn.

**Exhibit 7:** TAM for China Semis



Source: Gartner, Company Data, Morgan Stanley Research estimates

**Exhibit 8:** China imports US\$312bn in semis, but its own-brand system semi demand is only US\$100-102bn a year



Source: Gartner, Company Data, Morgan Stanley Research estimates

**Exhibit 9:** Few China IC design companies can supply to internal system brands

Company	Main Product	Global market share	China market share	Global brand customers
<b>Companies with global customers</b>				
Will Semi	CMOS image sensor	12%	24%	Samsung, LG
Goodix	Fingerprint sensor	60%	80%	Samsung
GigaDevice	NOR/MCU	15%	35%	Apple
Silergy	Analog IC	2%	4%	Samsung, Sony
<b>Companies without global customers</b>				
HiSilicon	Smartphone AP	11%	25%	
Spreadtrum	Smartphone AP	1%	4%	
Phytium	PC CPU	<1%	3%	
Bitmain	ASIC	4%	12%	
Canaan	ASIC	1%	2%	
Galaxy Core	CMOS image sensor	3%	5%	

Source: Gartner, Company Data, Morgan Stanley Research estimates for market share figures

## Share Prices

ACM Research Inc (ACMR.O): US\$53.84

Advanced Micro Devices (AMD.O): US\$55.74

Advantest (6857.T): JPY\$5,300

Alchip Technologies Ltd (3661.TW): NT\$280

Alibaba Group Holding (BABA.N): US\$205.4

Apple, Inc. (AAPL.O): US\$315.01

Applied Materials Inc. (AMAT.O): US\$54.01

ASM Pacific (0522.HK): HK\$81

ASMedia Technology Inc (5269.TW): NT\$918

ASML Holding NV (ASML.AS): €279.1

Broadcom Inc. (AVGO.O): US\$275.4

China Overseas Land & Investment Ltd. (0688.HK): HK\$26.2

Chipbond Technology Corp (6147.TWO): NT\$61.4

Epistar (2448.TW): NT\$39

GigaDevice Semiconductor Beijing Inc (603986.SS): Rmb220.38

Infineon Technologies AG (IFXGn.DE): €17.81

Intel Corporation (INTC.O): US\$60.13

Jiangsu Changjiang Electronics Tech (600584.SS) Rmb26.51

King Yuan Electronics Co Ltd (2449.TW): NT\$36.45

KLA Corp (KLAC.O): US\$168.78

Lam Research Corp (LRCX.O): US\$262.23

Macronix International Co Ltd (2337.TW): NT\$35.9

Marvell Technology Group Ltd (MRVL.O): US\$26.34

Maxim Integrated Products Inc. (MXIM.O): US\$54.6

MediaTek (2454.TW): NT\$410



Microchip Technology Inc. (MCHP.O): US\$88.3

Micron Technology Inc. (MU.O): US\$48.2

Nanya Technology Corp. (2408.TW): NT\$64.7

NVIDIA Corp. (NVDA.O): US\$322.62

NXP Semiconductor NV (NXPI.O): US\$102.56

Phison Electronics Corp(8299.TWO): NT\$284

Qorvo Inc (QRVO.O): US\$101.9

Qualcomm Inc. (QCOM.O): US\$80.48

Renesas Electronics (6723.T): JPY\$590

Rohm (6963.T): JPY\$7,130

Samsung Electro-Mechanics (009150.KS): KW\$116,500

Samsung Electronics (005935.KS): KW\$41,500

Shin-Etsu Chemical (4063.T): JPY\$12,120

Silergy Corp. (6415.TW): NT\$1,365

SK Hynix (000660.KS): KW\$84,500

Skyworks Solutions Inc (SWKS.O): US\$110.41

SMIC (0981.HK): HK\$17.04

STMicroelectronics NV (STM.PA): €22.81

Texas Instruments (TXN.O): US\$114.88

Tokyo Electron (8035.T): JPY\$22,720

Toshiba (6502.T): JPY\$2,764

TSMC (2330.TW): NT\$301

Vanguard International Semiconductor (5347.TWO): NT\$70.2

Western Digital (WDC.O): US\$42.39

WIN Semiconductors Corp (3105.TWO): NT\$282.5

Xilinx (XLNX.O): US\$86.45

Share prices as of May 11, 2020



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(as of April 30, 2020)

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STOCK RATING CATEGORY	COVERAGE UNIVERSE		INVESTMENT BANKING CLIENTS (IBC)			OTHER MATERIAL INVESTMENT SERVICES CLIENTS (MISC)	
	COUNT	% OF TOTAL	COUNT	% OF TOTAL IBC	% OF RATING CATEGORY	COUNT	% OF TOTAL OTHER MSC
<b>Overweight/Buy</b>	<b>1216</b>	<b>38%</b>	<b>300</b>	<b>42%</b>	<b>25%</b>	<b>533</b>	<b>37%</b>
<b>Equal-weight/Hold</b>	<b>1432</b>	<b>45%</b>	<b>325</b>	<b>46%</b>	<b>23%</b>	<b>698</b>	<b>48%</b>
<b>Not-Rated/Hold</b>	<b>3</b>	<b>0%</b>	<b>1</b>	<b>0%</b>	<b>33%</b>	<b>3</b>	<b>0%</b>
<b>Underweight/Sell</b>	<b>553</b>	<b>17%</b>	<b>81</b>	<b>11%</b>	<b>15%</b>	<b>220</b>	<b>15%</b>
<b>TOTAL</b>	<b>3,204</b>		<b>707</b>			<b>1454</b>	

Data include common stock and ADRs currently assigned ratings. Investment Banking Clients are companies from whom Morgan Stanley received investment banking compensation in the last 12 months. Due to rounding off of decimals, the percentages provided in the "% of total" column may not add up to exactly 100 percent.

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Overweight (O). The stock's total return is expected to exceed the average total return of the analyst's industry (or industry team's) coverage universe, on a risk-adjusted basis, over the next 12-18 months.

Equal-weight (E). The stock's total return is expected to be in line with the average total return of the analyst's industry (or industry team's) coverage universe, on a risk-adjusted basis, over the next 12-18 months.

Not-Rated (NR). Currently the analyst does not have adequate conviction about the stock's total return relative to the average total return of the analyst's industry (or industry team's) coverage universe, on a risk-adjusted basis, over the next 12-18 months.

Underweight (U). The stock's total return is expected to be below the average total return of the analyst's industry (or industry team's) coverage universe, on a risk-adjusted basis, over the next 12-18 months.

Unless otherwise specified, the time frame for price targets included in Morgan Stanley Research is 12 to 18 months.

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Attractive (A): The analyst expects the performance of his or her industry coverage universe over the next 12-18 months to be attractive vs. the relevant broad market benchmark, as indicated below.

In-Line (I): The analyst expects the performance of his or her industry coverage universe over the next 12-18 months to be in line with the relevant broad market benchmark, as indicated below.

Cautious (C): The analyst views the performance of his or her industry coverage universe over the next 12-18 months with caution vs. the relevant broad market benchmark, as indicated below.

Benchmarks for each region are as follows: North America - S&P 500; Latin America - relevant MSCI country index or MSCI Latin America Index; Europe - MSCI Europe; Japan - TOPIX; Asia - relevant MSCI country index or MSCI sub-regional index or MSCI AC Asia Pacific ex Japan Index.

## Stock Price, Price Target and Rating History (See Rating Definitions)

Samsung Electro-Mechanics (009150.KS) - As of 5/11/20 in KRW  
Industry : S. Korea Technology



Stock Rating History: 5/1/15 : O/I; 9/16/15 : E/I; 2/15/17 : O/I; 11/26/17 : O/C; 11/21/18 : E/C; 7/30/19 : E/I; 10/6/19 : O/I; 11/18/19 : O/A

Price Target History: 2/2/15 : 85000; 7/13/15 : 65000; 7/29/15 : 64000; 2/18/16 : 66000; 4/27/16 : 58000; 7/22/16 : 55000; 1/9/17 : 51000; 1/25/17 : 58000; 2/15/17 : 74000; 3/29/17 : 82000; 5/30/17 : 93000; 7/7/17 : 127000; 10/19/17 : 130000; 1/22/18 : 120000; 5/20/18 : 170000; 8/1/18 : 200000; 11/1/18 : 170000; 11/21/18 : 115000; 12/17/18 : 109000; 1/22/19 : 100000; 4/16/19 : 115000; 7/4/19 : 100000; 7/24/19 : 92000; 10/6/19 : 140000; 1/29/20 : 150000; 2/20/20 : 165000; 3/19/20 : 130000; 4/1/20 : 120000

Source: Morgan Stanley Research Date Format : MM/DD/YY Price Target --- No Price Target Assigned (NA)

Stock Price (Not Covered by Current Analyst) — Stock Price (Covered by Current Analyst) —

Stock and Industry Ratings (abbreviations below) appear as ♦ Stock Rating/Industry View

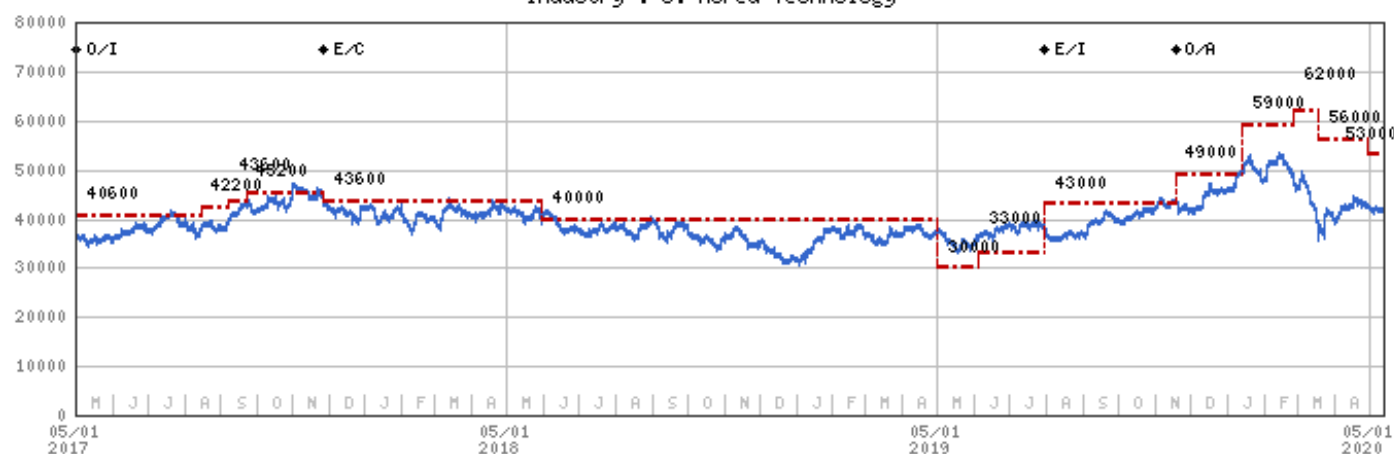
Stock Ratings: Overweight (O) Equal-weight (E) Underweight (U) Not-Rated (NR) No Rating Available (NA)

Industry View: Attractive (A) In-line (I) Cautious (C) No Rating (NR)

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Samsung Electronics (005935.KS) - As of 5/11/20 in KRW  
Industry : S. Korea Technology



Stock Rating History: 5/1/15 : E/I; 12/12/16 : O/I; 11/26/17 : E/C; 7/30/19 : E/I; 11/18/19 : O/A

Price Target History: 10/31/14 : 21880; 9/14/15 : 20720; 10/30/15 : 22200; 1/29/16 : 20800; 6/6/16 : 22400; 7/2/16 : 25200; 12/12/16 : 31200; 1/25/17 : 34400; 3/8/17 : 35800; 4/28/17 : 40600; 8/15/17 : 42200; 9/7/17 : 43600; 9/22/17 : 45200; 11/26/17 : 43600; 5/31/18 : 40000; 4/30/19 : 30000; 6/4/19 : 33000; 7/30/19 : 43000; 11/18/19 : 49000; 1/14/20 : 59000; 2/26/20 : 62000; 3/19/20 : 56000; 4/29/20 : 53000

Source: Morgan Stanley Research Date Format : MM/DD/YY Price Target --- No Price Target Assigned (NA)

Stock Price (Not Covered by Current Analyst) — Stock Price (Covered by Current Analyst) —

Stock and Industry Ratings (abbreviations below) appear as ♦ Stock Rating/Industry View

Stock Ratings: Overweight (O) Equal-weight (E) Underweight (U) Not-Rated (NR) No Rating Available (NA)

Industry View: Attractive (A) In-line (I) Cautious (C) No Rating (NR)

Effective January 13, 2014, the stocks covered by Morgan Stanley Asia Pacific will be rated relative to the analyst's industry (or industry team's) coverage.

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SK Hynix (000660.KS) - As of 5/11/20 in KRW  
Industry : S. Korea Technology

Stock Rating History: 5/1/15 : E/I; 6/15/15 : U/I; 12/21/15 : O/I; 2/8/17 : NA/I; 6/27/17 : O/I; 9/20/17 : NA/I; 11/26/17 : NA/C; 8/5/18 : U/C; 7/30/19 : E/I; 11/18/19 : O/A

Price Target History: 7/3/14 : 50000; 6/15/15 : 40000; 7/23/15 : 36000; 8/17/15 : 34000; 10/19/15 : 33000; 10/22/15 : 31000; 12/21/15 : 48000; 3/15/16 : 45000; 4/26/16 : 44000; 10/13/16 : 50000; 1/4/17 : 55000; 1/31/17 : 61000; 2/8/17 : NA; 6/27/17 : 80000; 8/15/17 : 82000; 9/20/17 : NA; 8/5/18 : 71000; 9/6/18 : 70000; 11/13/18 : 69000; 12/14/18 : 63000; 1/15/19 : 61000; 1/25/19 : 63000; 3/3/19 : 60000; 4/25/19 : 70000; 6/4/19 : 61000; 7/25/19 : 70000; 7/30/19 : 85000; 8/16/19 : 80000; 9/10/19 : 81000; 11/18/19 : 95000; 1/14/20 : 115000; 2/26/20 : 120000; 3/19/20 : 110000

Source: Morgan Stanley Research Date Format : MM/DD/YY Price Target -- No Price Target Assigned (NA)

Stock Price (Not Covered by Current Analyst) — Stock Price (Covered by Current Analyst) —

Stock and Industry Ratings (abbreviations below) appear as ♦ Stock Rating/Industry View

Stock Ratings: Overweight (O) Equal-weight (E) Underweight (U) Not-Rated (NR) No Rating Available (NA)

Industry View: Attractive (A) In-line (I) Cautious (C) No Rating (NR)

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#### INDUSTRY COVERAGE: Greater China Technology Semiconductors

COMPANY (TICKER)	RATING (AS OF)	PRICE* (05/12/2020)
<b>Charlie Chan</b>		
ACMR Research Inc (ACMR.O)	O (01/22/2020)	US\$53.84
Advanced Micro-Fabrication Equipment Inc (688012.SS)	U (03/20/2020)	Rmb184.88
Achip Technologies Ltd (3661.TW)	O (11/08/2019)	NT\$272.00
ASE Technology Holding Co. Ltd. (3711.TW)	E (09/24/2019)	NT\$68.10
ASM Pacific (0522.HK)	U (03/20/2020)	HK\$81.20
Chipbond Technology Corp (6147.TWO)	O (04/24/2019)	NT\$61.30
Chunghwa Precision Test Tech (6510.TWO)	E (11/08/2019)	NT\$675.00
Global Unichip Corp (3443.TW)	U (02/12/2020)	NT\$220.50
GlobalWafers Co Ltd (6488.TWO)	E (04/23/2020)	NT\$382.50
Jiangsu Changjiang Electronics Tech (600584.SS)	U (09/22/2015)	Rmb28.15
King Yuan Electronics Co Ltd (2449.TW)	O (09/24/2019)	NT\$36.20
MediaTek (2454.TW)	E (02/17/2020)	NT\$407.00
Nanya Technology Corp. (2408.TW)	U (10/08/2019)	NT\$63.60
Phison Electronics Corp (8299.TWO)	O (05/21/2019)	NT\$285.50
Silergy Corp. (6415.TW)	O (03/06/2020)	NT\$1,300.00
SMC (0981.HK)	U (02/17/2020)	HK\$17.14
TSMC (2330.TW)	O (09/05/2019)	NT\$295.00
UMC (2303.TW)	E (04/23/2020)	NT\$15.45
Universal Scientific Ind. (Shanghai) (601231.SS)	O (08/04/2015)	Rmb18.64
Vanguard International Semiconductor (5347.TWO)	U (04/23/2020)	NT\$70.80
Will Semiconductor Co Ltd Shanghai (603501.SS)	E (04/23/2020)	Rmb207.05
WIN Semiconductors Corp (3105.TWO)	O (04/18/2019)	NT\$274.50
<b>Daniel Yen, CFA</b>		
ASMedia Technology Inc (5269.TW)	O (01/17/2020)	NT\$930.00
Aspeed Technology (5274.TWO)	O (04/29/2020)	NT\$1,195.00
Egis Technology Inc (6462.TWO)	U (04/23/2020)	NT\$183.00
GigaDevice Semiconductor Beijing Inc (603986.SS)	O (04/24/2019)	Rmb217.89
Macronix International Co Ltd (2337.TW)	E (04/23/2020)	NT\$35.20
Montage Technology Co Ltd (688008.SS)	O (03/26/2020)	Rmb103.50
Novatek (3034.TW)	E (04/23/2020)	NT\$204.00
Parade Technologies Ltd (4966.TWO)	O (03/03/2019)	NT\$786.00
Realtek Semiconductor (2379.TW)	O (08/03/2018)	NT\$244.00
Shenzhen Goodix Technology Co Ltd (603160.SS)	E (04/23/2020)	Rmb238.00
Winbond Electronics Corp (2344.TW)	E (04/23/2020)	NT\$13.50
WPG Holdings (3702.TW)	O (07/31/2017)	NT\$38.70
<b>Jeff Hsu</b>		
Silicon Motion (SIMO.O)	E (03/20/2020)	US\$44.29

Stock Ratings are subject to change. Please see latest research for each company.

\* Historical prices are not split adjusted.



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