

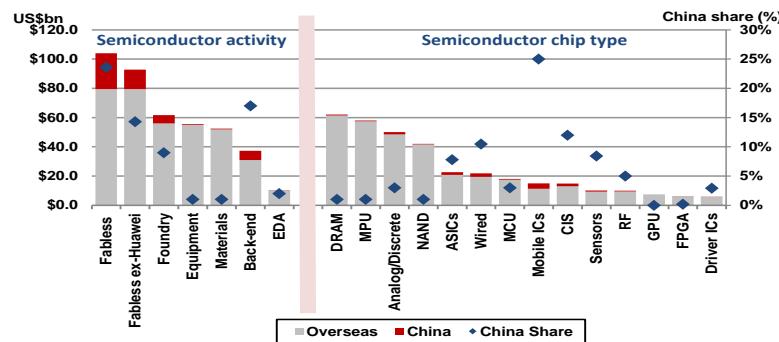
# Global Semiconductors Sector

## The uneven rise of China's IC industry

Semiconductor Devices | Industry Primer | Global Sector Themes

## Connections Series

**Figure 1: China's IC progress is uneven across the semiconductor sector**



Source: Company data, Credit Suisse estimates

- **Greater China ecosystem in-depth.** In a follow-on to our China semiconductor reports, including [China's ascent](#) and [supply chain localisation](#), this report updates on the US-China policy implications, China's manufacturing, design and tech supply chain, and the fabless industry map. Leveraging our full global semis team, we also take an in-depth look at equipment, materials, RF, Power, CPU, national IC fund investments, China fab projects, and profile 21 covered and Not Covered China IC companies' business overview, drivers, near-term outlook, and valuation.
- **Semiconductors strategic importance rises.** The semiconductor industry at US\$450 bn and growing at a 6% CAGR since 2001 and rising as % of GDP is critical to the US\$2 tn electronic market and strategic areas of cloud computing, 5G, network infrastructure, AI, and IoT. COVID-19 has only accelerated the digitisation trends and the importance of domestic self-sufficient supply chains, in contrast to the industry's traditional global chain. The US is looking to protect its leading 48% share consisting of its leading IDMs, fabless, equipment and EDA/IP, while China is looking to gain self-sufficiency and increase its 5% share, which lags its 20-25% share of tech demand and 30-40% hardware share.
- **China gains to continue at an uneven pace.** After two decades of focus, China's traction in semiconductors has been mixed, with fabless leading at 22% share (15% ex-Huawei), back-end now at 17%, and foundry remaining at 9% due to TSMC's advanced technology lead and low-single digits in equipment, materials, EDA/IP, IDM, and memory. China's ramp of incentives, capital markets at high valuations, and localisation should continue growth, though limited by high barriers (advanced foundry, EDA/IP, and equipment), M&A, tool/IP restrictions, and partial decoupling of supply chains and end markets.
- **Stocks to benefit from China's IC localisation.** We view the best-placed stocks for China's ecosystem rise in foundry (TSMC, SMIC, Win and Hua Hong), back-end (ASMP, Disco, Advantest, Huatian, and Tongfu), Fabless (Mediatek, Will, Maxscend and Alchip), EDA (CDN, SNPS), high performance analog/power (TXN, ADI, IXF) and equipment leaders AMAT, ASML, ASMI, KLAC, LRCX, TEL and Screen.

### Research Analysts

**Randy Abrams, CFA**  
 886 2 2715 6366  
 randy.abrams@credit-suisse.com

**Chaolien Tseng**  
 852 2101 6795  
 chaolien.tseng@credit-suisse.com

**John W. Pitzer**  
 212 538 4610  
 john.pitzer@credit-suisse.com

### Contributing Analysts

**Jerry Su**  
 886 2 2715 6361  
 jerry.su@credit-suisse.com

**Keon Han**  
 82 2 3707 3740  
 keon.han@credit-suisse.com

**Hideyuki Maekawa**  
 81 3 4550 9723  
 hideyuki.maekawa@credit-suisse.com

**Achal Sultania**  
 44 20 7883 6884  
 achal.sultania@credit-suisse.com

**Haas Liu**  
 886 2 2715 6365  
 haas.liu@credit-suisse.com

**Yoshiyasu Takemura**  
 81 3 4550 7358  
 yoshiyasu.takemura@credit-suisse.com

**Sang Uk Kim**  
 82 2 3707 3795  
 sang.kim@credit-suisse.com

**Dalya Hahn**  
 212 325 7843  
 dalya.hahn@credit-suisse.com

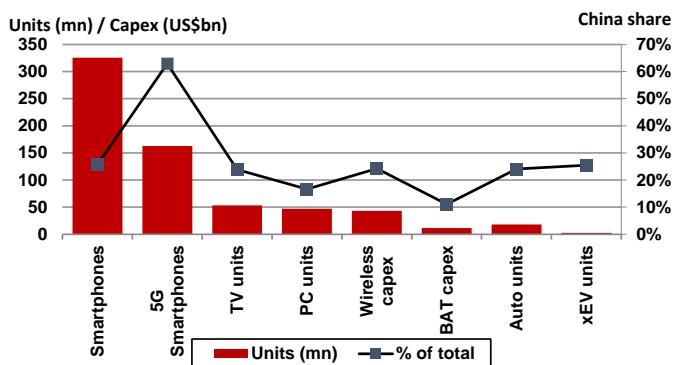
**Daisuke Tanimoto**  
 81 3 4550 7371  
 daisuke.tanimoto@credit-suisse.com

**DISCLOSURE APPENDIX AT THE BACK OF THIS REPORT CONTAINS IMPORTANT DISCLOSURES, ANALYST CERTIFICATIONS, LEGAL ENTITY DISCLOSURE AND THE STATUS OF NON-US ANALYSTS.** US Disclosure: Credit Suisse does and seeks to do business with companies covered in its research reports. As a result, investors should be aware that the Firm may have a conflict of interest that could affect the objectivity of this report. Investors should consider this report as only a single factor in making their investment decision.

This document is being provided for the exclusive use of SHIBIN XIE at ALLIANZ GLOBAL INVESTORS US LLC.

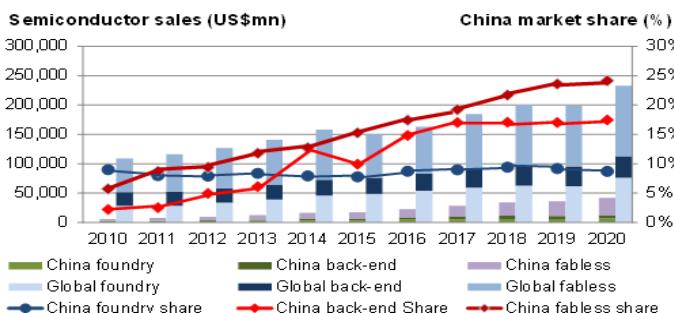
## Focus charts

**Figure 2: China at 25% to 30% of industry tech demand**



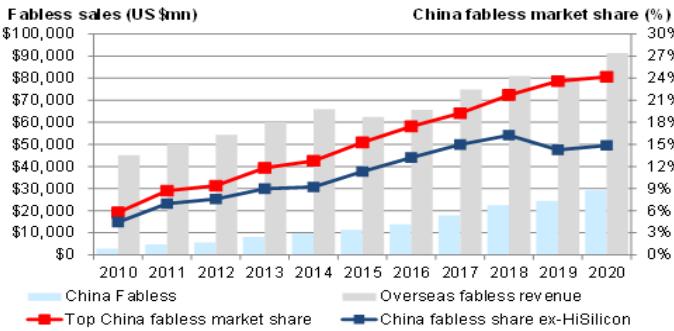
Source: IDC, Omdia, company data, Credit Suisse estimates

**Figure 4: China gains faster in fabless/back-end over foundry**



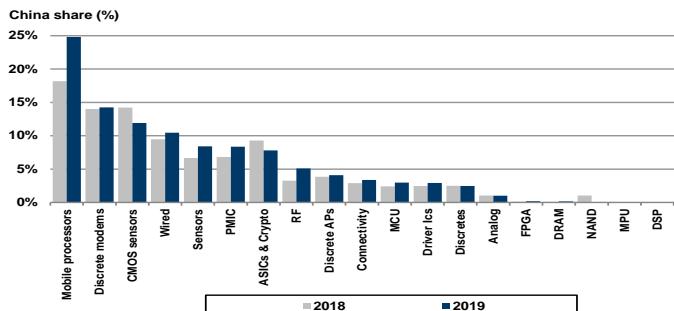
Source: Company data, Credit Suisse estimates

**Figure 6: China IC design share at 24%, 15% ex-HiSilicon**



Source: Company data, Credit Suisse estimates

**Figure 8: China IC design gained 70 bp share to 3.9% in 2019**

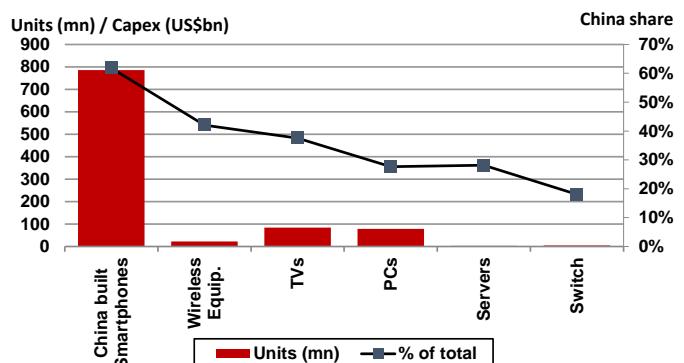


Source: Company data, Gartner, Credit Suisse estimates

Global Semiconductors Sector

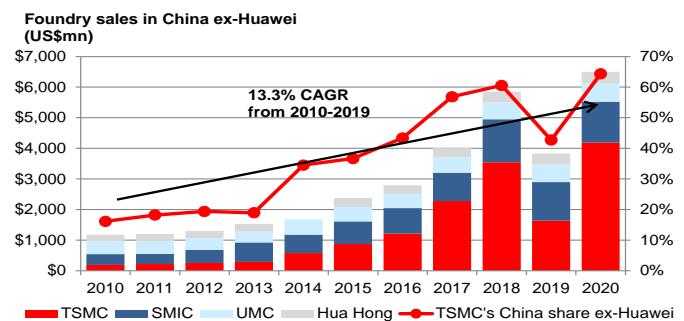
This document is being provided for the exclusive use of SHIBIN XIE at ALLIANZ GLOBAL INVESTORS US LLC.

**Figure 3: China OEMs as a channel for ICs at 30-40% share**



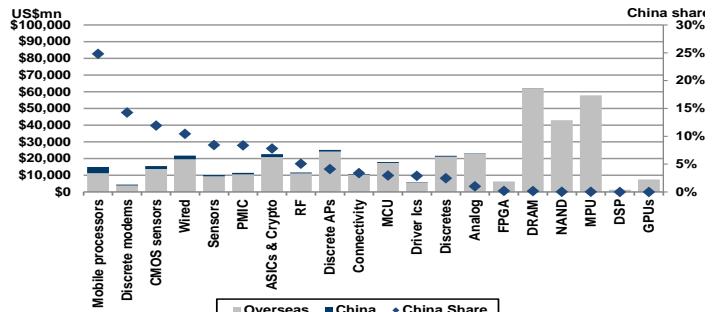
Source: IDC, Omdia, company data, Credit Suisse estimates

**Figure 5: TSMC's share gains at China fabless, ex-Huawei**



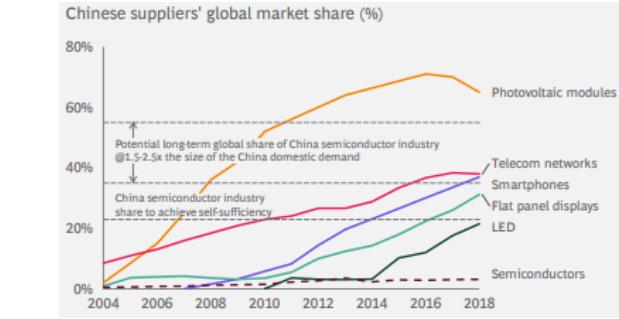
Source: Company data, Credit Suisse estimates

**Figure 7: China IC design share higher in Comm-ICs**



Source: Gartner, Company data, Credit Suisse estimates

**Figure 9: Chip industry wary of margin erosion in other sectors**



Source: Gartner, SCI Verkehr GmbH, IEA, PVPS, Earth Policy Institute, Counterpoint, BI Intelligence, IHS Markit

# The uneven rise of China's IC industry

In a follow-on to our China semiconductor reports, including [China's ascent](#) and [supply chain localisation](#), we update on the US-China policy implications, China's manufacturing and design and tech supply chain, and the fabless industry map. We also take an in-depth look at materials, equipment, RF, Power and CPU, IC fund investments, China fab projects, and profile 22 China IC companies based on their business overview, drivers, near-term outlook and valuation.

**China's semiconductor localisation effort continues**

## Semiconductors' strategic importance rising

The industry remains a critical component of electronics systems now at US\$450 bn in sales and with a steady 4% CAGR since the 2000/2007 peaks and 6% CAGR from 2001/2009 troughs to current. The industry has maintained 0.5% of global nominal GDP (and rising to 0.8% of real GDP) supplying diverse end-markets of PCs (25%), handsets (23%), cloud/data centre (18%), autos/industrial (each 12%) and wireless infrastructure (10%) critical to national development. The US is trying to protect its leading 48% industry share comprising its strong base of IDMs, fabless, semi equipment and EDA/IP, but relies on a globally connected industry with outsourced manufacturing largely in Asia. At the same time, China is now a large market with 20-25% of hardware tech demand and a 30-40% of OEM share, but striving to catch up in semiconductors where its share is 5% due to lags in some ICs, IDMs, EDA, and equipment.

**China striving to catch-up with its market at 20-25% of tech and 30-40% of OEM share, but only 5% of semiconductor share**

## China's IC mfg. still trying to gain competitiveness

Chinese manufacturers have had only mild progress after two decades of investment due to high barriers in technology, scale, know-how and talent development in advanced manufacturing. In **foundry**, China's share has been stable at ~9% in the past decade, despite National IC fund investments and heavy attention on this sector as the centre of China's industrial development. TSMC's wide lead on process technology supplemented by its growing advanced packaging portfolio allows it to address the high-end compute, mobile and networking demand. In the **back-end** space, China has increased share to 17% now, although profitability is still a concern until it further gains advanced packaging capability.

**China's foundry share has stayed 9% while back-end is now up to 17%**

## Rising breadth of China IC design

In **IC design**, traction has been more pronounced, to lift share from 4% in 2010 to 22% in 2020, although it is a milder 15% excluding HiSilicon, now restricted by the US government from fabricating using US tools and has not penetrated some higher-barrier processors or high-performance RF and analog. Market share is the highest in the mobile segment (processor, modem, wireless power management, connectivity, and CMOS sensors), wired connectivity (led by Huawei) and some new high-volume applications seeing strong support in China (cryptocurrency and AI). Market share is still below 5% in ~70% of the overall industry—most notably processors, memory, GPU, FPGA, analog, MCU, and RF, though has risen in the past year.

**IC design share has increased from 4% to 22% in the past decade; 15% excluding Huawei**

For equipment and materials, we estimate China players are at least 5-10 years behind their global suppliers, or even longer for areas where there is no volume production by Chinese companies yet. Chinese suppliers may still witness high growth in the next five years given China's strong drive for domestic replacement. In memory, China is finally producing and may ramp to low single-digits % of DRAM/NAND in 2021, not enough yet to create oversupply.

## IC stocks leveraged to China's development

China's localisation and advancement of its semiconductor industry have been a rising theme in the past six years since it introduced its National Guideline in 2014 but has accelerated the past couple of years from rising US tensions, accelerated domestic support, and China's growing tech capital market. We profile 21 China companies plus highlight companies in each sector we view best placed for growth from China's ecosystem in foundry (TSMC, Win, SMIC, and Hua Hong), back-end (ASMP, Disco, Advantest, Huatian, and Tongfu), IC design (Mediatek, Will Semi, Maxscend, CR Micro and Alchip), EDA (CDN, SNPS), high performance analog/power (TXN, ADI, IFX) and equipment AMAT, ASML, ASMI, KLAC, LRCX, TEL and Screen.

**Top stocks leveraged to China's continued localisation**

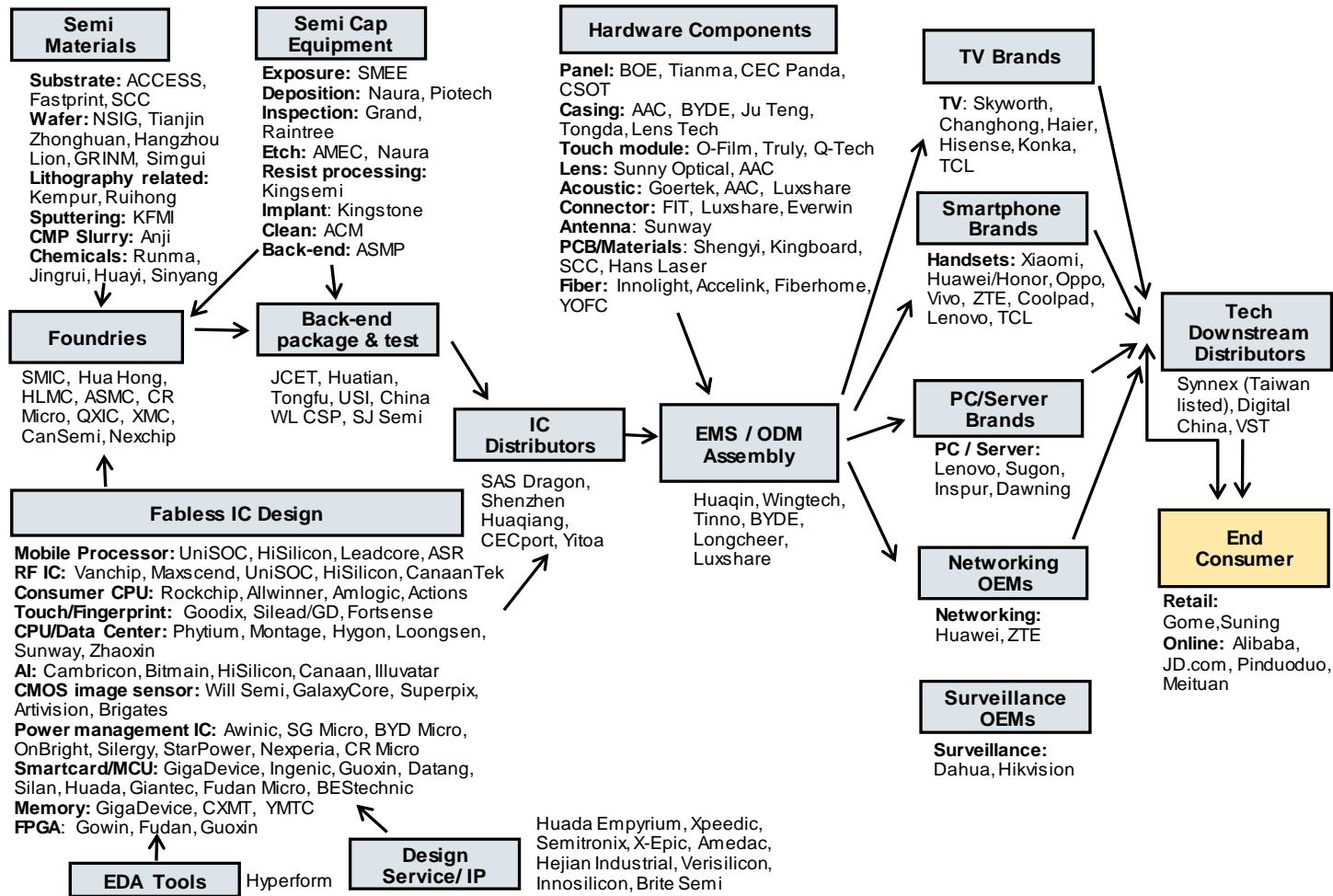
# Table of Contents

<b>Focus charts</b>	<b>2</b>
<b>The uneven rise of China's IC industry</b>	<b>3</b>
Semiconductors' strategic importance rising .....	3
China's IC mfg. still trying to gain competitiveness.....	3
Rising breadth of China IC design .....	3
IC stocks leveraged to China's development .....	3
<b>China tech supply chain map</b>	<b>6</b>
<b>China IC supply chain map</b>	<b>7</b>
<b>Valuation comp table</b>	<b>8</b>
<b>Semiconductors' strategic importance rising</b>	<b>10</b>
The US trying to protect its leadership position .....	11
China trying to build its semiconductor self-sufficiency.....	15
China continuing measures to develop its IC industry .....	17
Domestic funding and capital markets backing China's IC development .....	22
China's IC implications to the US and overseas sector .....	29
US resistance to slow China's rise and maintain its industry leadership .....	32
US now trying to re-build its own supply chain.....	34
<b>China's IC manufacturing still trying to gain competitiveness</b>	<b>38</b>
Foundry in-depth look: recent acceleration though advanced development further capped by the US .....	39
Back-end: turning focus towards profitability .....	47
Memory: finally producing, not yet creating oversupply .....	49
Equipment and semiconductor materials still nascent.....	54
Silicon wafer global competitive landscape .....	61
<b>Rising breadth of China IC design</b>	<b>71</b>
China RF to grow its tiny market share .....	78
Power semi market dominated by global giants, but China players growing their penetration	83
CPU localisation a priority for the China government.....	87
AI investment also accelerating since 2014.....	100
Competitive landscape for Design Services .....	102
<b>IC stocks leveraged to China's development</b>	<b>105</b>
Foundry: TSMC offers leverage on advanced technology, SMIC/Hua Hong for the local IC suppliers.....	106

Back-end: Huatian and Tongfu our preferred picks for share gains in China; Advantest, ASM Pacific and Disco in equipment .....	106
IC design: Mediatek benefitting from China OEM's 5G push, Will Semi and Maxscend from localisation .....	107
Equipment: Leading US/Japan suppliers offer best leverage to China's capex investment	107
<b>China semiconductor company tear sheets</b>	<b>109</b>
<b>ACM Research (Shanghai) (ACMR.OQ, Not Covered)</b>	<b>110</b>
<b>AMEC (688012.SS, Not Covered)</b>	<b>112</b>
<b>Amlogic (688099.SS, Not Covered)</b>	<b>114</b>
<b>Anji Technology (688019.SS, Not Covered)</b>	<b>116</b>
<b>Bestechnic (688608.SS, Not Covered)</b>	<b>118</b>
<b>CR Micro (688396.SS, Outperform)</b>	<b>120</b>
<b>Gigadevice (603986.SS, Neutral)</b>	<b>124</b>
<b>Goodix (603160.SS, Underperform)</b>	<b>127</b>
<b>Huahong Semi (1347.HK, Neutral)</b>	<b>130</b>
<b>Huatian (002185.SZ, Outperform)</b>	<b>134</b>
<b>J CET (600584.SS, Underperform)</b>	<b>137</b>
<b>Maxscend (300782.SZ, Outperform)</b>	<b>141</b>
<b>Montage (688008.SS, Neutral)</b>	<b>144</b>
<b>Naura (002371.SZ, Not Covered)</b>	<b>148</b>
<b>NSIG (688126.SS, Not Covered)</b>	<b>150</b>
<b>Sanan (600703.SS, Neutral)</b>	<b>152</b>
<b>Shanghai Sinyang (300236.SZ, Not Covered)</b>	<b>155</b>
<b>Shanghai Wanye (600641.SS, Not Covered)</b>	<b>157</b>
<b>SMIC (0981.HK/688981.SH, Neutral)</b>	<b>159</b>
<b>Tongfu (002156.SZ, Outperform)</b>	<b>162</b>
<b>Will Semi (603501.SS, Outperform)</b>	<b>166</b>

# China tech supply chain map

Figure 10: China building out a complete tech supply chain



Source: Company data, Credit Suisse estimates

Xuan Lin of Credit Suisse Founder Securities Limited ("CSFS") provided administrative and other support in the preparation of this research report that do not require a licence. CSFS is a Sino-foreign joint venture between Founder Securities Co., Ltd. and Credit Suisse AG. CSFS is not licensed to provide securities investment advisory service by the China Securities Regulatory Commission in the People's Republic of China.

# China IC supply chain map

Figure 11: Map of China IC design companies

Mobile processor	Ticker	MCU	Ticker	Memory	Ticker	Power, MOSFET, IGBT
Huawei HiSilicon	Private	Gigadevice	603986	Gigadevice	603986	Huawei HiSilicon
UNISOC (Unigroup Spreadtrum-RDA)	Private	Ingenic	300223	Innotron / CXMT	Private	SG Micro
Allwinner	300458	Unigroup Guoxin Microelectronics	002049	YMTC / XMC (Tsinghua Unigroup)	Private	StarPower Semi
Rockchip	603892	SinoWealth	300327	Ingenic / ISSI	300223	Silan
Leadcore	Private	Silan	600460	Giantec	688123	Shanghai Bellng
ASR Micro	Private	Goodix	603160	Fujian Jinhua	Private	Nexperia / Wingtech
Pinecone (Xiaomi)	1810 HK	Datang Microelectronics	Private	Reliance Memory (JV of Rambus and Gigadevice)	Private	CR Micro
Sanechips (ZTE Microelectronics)	Private	Huada Semiconductor	Private	Unigroup Guoxin Microelectronics	002049	Silergy
<b>PC/server CPU</b>	<b>Ticker</b>	<b>Giantec</b>	<b>688123</b>	<b>Memory interface chip &amp; PCIe retimer</b>	<b>Ticker</b>	<b>Will Semi</b>
Phytium	Private	BYD Microelectronics (within BYD)	1211 HK	Montage Technology	688008	Yangjie
Huawei HiSilicon	Private	Yi-xin	Private	<b>SSD/eMMC controller</b>	Jiangsu JieJie Microelectronics	300623
Hygon	Private	MindMotion	Private	Huawei HiSilicon	Private	BYD Microelectronics (within BYD)
Loongson	Private	WinnerMicro	Private	Goke Microelectronics	300672	Wuxi NCE Power
Sunway	Private	<b>Fingerprint sensor &amp; touch controller</b>	Jiangsu Huacun Electronic Technology	Private	Good-ARK	002079
Zhaoxin	Private	Goodix	603160	Tsinghua Dera	Private	Zhuzhou CRRC Times Electric's semi entity
<b>Cloud, Server, NPU, AI</b>	<b>Gigadevice (Silead)</b>		<b>603986</b>	<b>SinoChip Semiconductors</b>	Private	3898 HK
Huawei HiSilicon	Private	Fortsense	Private	Yeestor	Private	Sun.King Power Elec
Cambriion	Private	Betterlife	835288	StoreArt	Private	Sino-Microelectronics
Montage Technology	688008	Chipone	Private	Konsemi	Private	3Peak Inc
Alibaba	BABA	BYD Microelectronics (within BYD)	1211 HK	<b>Audio, video, surveillance, image processing</b>	Private	Superchip (Fine Made Electronics)
Eeasy Tech	Private	<b>CIS / ToF sensor</b>	Huawei HiSilicon	Private	Chipown	300671
Huaxintong	Private	OmniVision / Will Semi	603501	Fulhan	Private	ETEK
Big Fish (Xiaomi)	1810 HK	Galaxy core	Private	Goke Microelectronics	300613	UNISOC (Unigroup Spreadtrum-RDA)
ThinkForce	Private	BYD Microelectronics (within BYD)	1211 HK	Rockchip	603892	SAIC Infineon Automotive Power Module
Iluvatar	Private	SmartSens	Private	Dahua	002236	ETASolutions Co.,
<b>FPGA</b>	<b>Silicon Integrated</b>		Private	Bestronic	688608	Leshan Radio
Gowin	Private	Goodix	603160	Beken	603068	Beijing Zhisi Microelectronics
Fudan Micro	1385 HK	<b>DDI (Display driver IC)</b>	Zhuhai Jiel	Private	Private	Private
Unigroup Guoxin Microelectronics	002049	SinoWealth	300327	Eeasy Tech	Private	Private
Anlogic	Private	Solomon Systech	2878 HK	Vimicro	Private	Changzhou Galaxy Century Microelectronics
Herculus Microelectronics	Private	Will Semi	603501	Arbostyn	Private	WeEn Semiconductor
Huada Semiconductor	Private	Galaxy core	Private	YITU	Private	Jiangsu CAS-IGBT Technology
DeePhi (Acquired by Xilinx)	XLNX	Chipone	Private	Horizon Robotics	Private	Beijing Yandong Microelectronics
<b>CPU</b>	<b>Wi-Fi, BLE connectivity</b>		Private	Sanechips (ZTE Microelectronics)	Private	Private
Phytium	Private	Huawei HiSilicon	Private	Ingenic	300223	RF switch, LNA, PA
Zhaoxin	Private	UNISOC (Unigroup Spreadtrum-RDA)	Private	Goodix	603160	Maxscend
HiSilicon	Private	Espressif Systems	688018	CCVUI	Private	Huawei HiSilicon
Loongson	Private	Beken	603068	Analogix (DisplayPort, Tcon, ASIC)	Private	Vanchip
Hygon	Private	Winner Micro	Private	<b>IC for bank card, sim card, security card</b>	Private	UniChip (Will Semi's subsidiary)
Sunway	Private	Goodix	603160	Nationz Technologies	300077	Sanechips (ZTE Microelectronics)
<b>GPU</b>	<b>Siflower</b>		Private	Unigroup Guoxin Microelectronics	002049	Xinyi Semi
Jingjia Micro	300474	Etra Semi	Private	Shanghai Fudan	1385 HK	Kangxi Communication
Zhaoxin	Private	Tianyi Hexin	Private	Huada Semiconductor	Private	Smarter Micro
<b>Automotive</b>	<b>Xinyi Semi</b>		Private	<b>LED driver, MEMS sensor, discrete</b>	Private	ChipBetter
Nav Info / AutoChip	002405	Amlogic	688099	Silan	600460	OnMicro
BYD Microelectronics (within BYD)	1211 HK	<b>Drone, robot SoC</b>	Shanghai Bellng	Private	600171	Lansus
Wingtech	600745	Arbostyn	Private	Yangjie	300373	Jiamei Xinjin (CanaanTek)
Goodix	603160	<b>Cryptocurrency ASIC</b>	Private	<b>STB</b>	Private	Awinic
Will Semi	603501	Bitmain	Private	Goke Microelectronics	300672	RadRock
Horizon Robotics	Private	Canaan	CAN	Amlogic	688099	Private
Huawei HiSilicon	Private	Ebang Communication	Private	Avalink	Private	Espressif Systems
Sanechips (ZTE Microelectronics)	Private	<b>Aerospace, satellite IC</b>	Private	Sanechips (ZTE Microelectronics)	Private	688018
Allystar	Private	Orbita	300053	Private	Private	Private
Yi-xin	Private	UniStrong	002383	Private	Private	Private

Source: Company data, Credit Suisse

## Valuation comp table

Figure 12: Semiconductor valuation metrics

Company	Ticker	Local Price 1/19/2021	Mkt Cap (US\$mn)	Ent. Value (US\$mn)	P/E Multiple (x) 2020	P/E Multiple (x) 2021	EV/EBITDA (x) 2020	EV/EBITDA (x) 2021	EV/Sales (x) 2020	EV/Sales (x) 2021	P/B Multiple (x) 2020	P/B Multiple (x) 2021	ROE 2020	ROE 2021
<b>Foundries</b>														
TSMC	2330.TW	\$627.00	\$580,344	\$519,867	31.4	29.9	17.6	15.4	11.8	10.6	8.8	7.6	28.0	30.0
UMC	2303.TW	\$53.00	\$23,501	\$20,114	27.8	22.1	9.4	8.6	3.6	3.4	2.9	2.7	10.3	12.3
Vanguard	5347.TWO	\$118.50	\$6,926	\$6,115	30.9	22.7	17.3	13.3	5.6	4.8	6.3	5.7	20.3	22.3
Towerjazz	TSEM.OQ	\$28.45	\$2,801	\$2,397	30.8	18.4	7.2	5.3	1.9	1.6	2.2	2.0	7.3	10.9
X-Fab	XFAB.PA	\$7.00	\$1,107	\$1,032	-37.4	76.1	17.4	10.7	2.1	1.8	1.5	1.5	-4.0	1.9
Win Semi	3105.TWO	\$445.00	\$6,736	\$6,130	27.4	29.6	15.8	15.6	7.3	7.1	6.0	5.7	22.0	24.0
<b>Foundry Median:</b>					<b>29.3</b>	<b>26.1</b>	<b>16.5</b>	<b>12.0</b>	<b>4.6</b>	<b>4.1</b>	<b>4.4</b>	<b>4.2</b>	<b>15.3</b>	<b>17.3</b>
<b>Foundry Mean:</b>					<b>18.5</b>	<b>33.1</b>	<b>14.1</b>	<b>11.5</b>	<b>5.4</b>	<b>4.9</b>	<b>4.6</b>	<b>4.2</b>	<b>14.0</b>	<b>16.9</b>
<b>China Foundries</b>														
SMIC Hong Kong	0981.HK	\$29.60	\$22,742	\$16,579	54.1	79.0	9.7	9.4	3.9	3.8	2.1	2.0	3.8	2.5
SMIC Shanghai	688981.SS	\$62.46	\$24,243	\$18,640	125.5	183.4	10.9	10.5	4.4	4.3	4.8	4.7	3.8	2.5
Hua Hong	1347.HK	\$48.50	\$8,119	\$8,305	98.9	65.5	34.8	15.8	8.7	7.0	3.5	3.4	3.5	5.1
CR Micro	688396.SS	\$72.20	\$13,530	\$13,530	90.1	68.0	56.5	45.6	12.8	10.8	10.0	8.8	36.5	47.1
Sanan	600703.SS	\$32.87	\$22,693	\$22,198	117.7	75.0	31.5	24.8	16.8	13.8	5.0	4.8	4.3	6.4
<b>China Foundry Median:</b>					<b>98.9</b>	<b>75.0</b>	<b>31.5</b>	<b>15.8</b>	<b>8.7</b>	<b>7.0</b>	<b>4.8</b>	<b>4.7</b>	<b>3.8</b>	<b>5.1</b>
<b>China Foundry Mean:</b>					<b>97.3</b>	<b>94.2</b>	<b>28.7</b>	<b>21.2</b>	<b>9.3</b>	<b>7.9</b>	<b>5.1</b>	<b>4.7</b>	<b>10.4</b>	<b>12.8</b>
<b>China Foundry Median Premium:</b>					<b>238%</b>	<b>187%</b>	<b>91%</b>	<b>32%</b>	<b>88%</b>	<b>70%</b>	<b>8%</b>	<b>11%</b>	<b>-75%</b>	<b>-70%</b>
<b>China Foundry Mean Premium:</b>					<b>427%</b>	<b>184%</b>	<b>103%</b>	<b>85%</b>	<b>73%</b>	<b>63%</b>	<b>10%</b>	<b>13%</b>	<b>-26%</b>	<b>-25%</b>
<b>Equipment Companies</b>														
ASM Pacific	0522.HK	\$117.00	\$6,200	\$5,945	54.0	20.6	29.4	12.7	2.8	2.5	4.2	3.8	7.8	18.3
Applied Materials	AMAT	\$103.14	\$94,196	\$94,293	24.8	21.4	21.4	17.8	5.5	4.8	9.0	6.5	36.3	30.4
KLA	KLAC	\$304.13	\$46,976	\$48,465	29.4	24.4	24.1	17.4	8.3	7.6	17.9	13.1	60.9	53.8
Lam Research	LRCX	\$547.53	\$78,849	\$77,961	34.5	24.9	27.6	19.1	7.8	6.0	15.8	10.4	45.7	41.9
ASML	ASML	\$437.60	\$183,572	\$182,360	56.5	47.1	43.4	37.4	13.6	12.2	13.1	12.4	23.2	26.4
ASM Int'l	ASMI.AS	\$213.20	\$7,225	\$6,846	36.1	29.0	18.3	16.6	6.3	5.7	5.5	5.2	15.5	18.2
Tokyo Electron	8035.T	\$44,130.00	\$65,963	\$213,962	37.7	43.9	24.3	26.5	5.8	6.1	8.5	7.6	22.6	17.4
SCREEN	7735.T	\$8,860.00	\$3,976	\$4,075	82.5	29.1	20.7	13.1	1.4	1.5	2.4	2.2	2.9	7.6
Chungwha Precision	6510.TWO	\$974.00	\$1,140	\$959	34.6	34.2	19.2	18.9	7.0	6.9	4.5	4.3	13.1	12.5
<b>Equipment Median:</b>					<b>36.1</b>	<b>29.0</b>	<b>24.1</b>	<b>17.8</b>	<b>6.3</b>	<b>6.0</b>	<b>8.5</b>	<b>6.5</b>	<b>22.6</b>	<b>18.3</b>
<b>Equipment Mean:</b>					<b>43.3</b>	<b>30.5</b>	<b>25.4</b>	<b>20.0</b>	<b>6.5</b>	<b>5.9</b>	<b>9.0</b>	<b>7.3</b>	<b>25.3</b>	<b>25.2</b>
*ACM Research	ACMR.OQ	\$94.60	\$1,747	\$1,579	87.9	56.5	63.6	34.6	10.3	7.3	9.9	8.6	13.4	18.9
*AMEC	688012.SS	\$183.00	\$15,086	\$15,086	278.5	239.8	382.1	215.4	41.5	29.0	23.9	21.8	8.3	8.8
*Anji Technology	688019.SS	\$347.01	\$2,840	\$2,840	143.2	121.8	179.7	125.1	46.0	32.6	18.3	16.0	12.2	13.0
*Naura	002371.SZ	\$231.01	\$17,676	\$17,676	233.6	160.2	118.6	86.9	20.6	15.1	17.6	16.1	7.6	9.8
*Shanghai Wanye	600641.SS	\$16.90	\$2,495	\$2,495	39.5	35.2	31.1	35.6	13.6	12.1	2.4	2.1	6.4	6.6
<b>China Equipment Median:</b>					<b>143.2</b>	<b>121.8</b>	<b>118.6</b>	<b>86.9</b>	<b>20.6</b>	<b>15.1</b>	<b>17.6</b>	<b>16.0</b>	<b>8.3</b>	<b>9.8</b>
<b>China Equipment Mean:</b>					<b>156.5</b>	<b>122.7</b>	<b>155.0</b>	<b>99.6</b>	<b>26.4</b>	<b>19.2</b>	<b>14.4</b>	<b>12.9</b>	<b>9.6</b>	<b>11.4</b>
<b>China Equipment Median Premium:</b>					<b>296%</b>	<b>320%</b>	<b>393%</b>	<b>388%</b>	<b>226%</b>	<b>152%</b>	<b>107%</b>	<b>147%</b>	<b>-63%</b>	<b>-46%</b>
<b>China Equipment Mean Premium:</b>					<b>261%</b>	<b>302%</b>	<b>511%</b>	<b>399%</b>	<b>306%</b>	<b>225%</b>	<b>60%</b>	<b>77%</b>	<b>-62%</b>	<b>-55%</b>
<b>Materials Companies</b>														
Globalwafers	6488.TWO	\$666.00	\$10,395	\$8,987	22.5	20.2	12.4	10.1	4.9	4.2	5.8	5.3	25.9	31.6
Visual Photonics	2455.TW	\$114.00	\$752	\$725	40.5	27.8	21.5	15.7	8.0	6.3	7.3	6.6	18.0	18.0
Sumco	3436.T	\$2,413.00	\$6,755	\$7,872	29.2	34.5	9.8	9.8	2.8	2.9	2.2	2.2	7.7	9.0
Shin-Etsu	4063.T	\$19,290.00	\$77,012	\$66,499	25.5	26.2	12.9	13.4	4.5	4.7	2.8	2.6	11.8	11.1
<b>Materials Median:</b>					<b>27.4</b>	<b>27.0</b>	<b>12.6</b>	<b>11.7</b>	<b>4.7</b>	<b>4.5</b>	<b>4.3</b>	<b>4.0</b>	<b>14.9</b>	<b>14.5</b>
<b>Materials Mean:</b>					<b>29.4</b>	<b>27.2</b>	<b>14.2</b>	<b>12.2</b>	<b>5.1</b>	<b>4.5</b>	<b>4.5</b>	<b>4.2</b>	<b>15.9</b>	<b>17.4</b>
*NSIG	688126.SS	\$36.72	\$14,037	\$14,037	4590.0	292.5	186.6	46.0	34.3	12.3	12.3	-1.3	0.0	
*Shanghai Sinyang	300236.SZ	\$52.31	\$2,343	\$2,343	186.8	121.7	123.6	76.0	19.3	13.4	9.8	9.2	5.3	7.5
<b>China Materials Median:</b>					<b>186.8</b>	<b>2355.8</b>	<b>208.1</b>	<b>131.3</b>	<b>32.7</b>	<b>23.8</b>	<b>11.0</b>	<b>10.8</b>	<b>2.0</b>	<b>3.7</b>
<b>China Materials Mean:</b>					<b>186.8</b>	<b>2355.8</b>	<b>208.1</b>	<b>131.3</b>	<b>32.7</b>	<b>23.8</b>	<b>11.0</b>	<b>10.8</b>	<b>2.0</b>	<b>3.7</b>
<b>China Materials Median Premium:</b>					<b>582%</b>	<b>8621%</b>	<b>1545%</b>	<b>1020%</b>	<b>592%</b>	<b>431%</b>	<b>157%</b>	<b>172%</b>	<b>-87%</b>	<b>-74%</b>
<b>China Materials Mean Premium:</b>					<b>535%</b>	<b>8569%</b>	<b>1370%</b>	<b>973%</b>	<b>544%</b>	<b>426%</b>	<b>144%</b>	<b>158%</b>	<b>-87%</b>	<b>-79%</b>
<b>Back-end Companies</b>														
ASE Industrials	3711.TW	\$105.50	\$16,338	\$20,960	14.8	15.4	7.1	6.4	1.3	1.1	2.1	2.0	14.3	16.3
Amkor	AMKR.OQ	\$18.04	\$4,374	\$5,084	14.4	12.9	5.2	4.5	1.0	0.9	1.9	1.7	13.2	13.1
Powertech	6239.TW	\$101.50	\$2,822	\$2,881	11.6	10.7	3.5	3.3	1.1	1.1	1.7	1.6	14.7	16.7
ChipMOS	8150.TW	\$37.05	\$962	\$1,023	11.6	10.0	4.1	3.4	1.4	1.2	1.3	1.2	11.2	13.2
Chipbond	6147.TWO	\$74.50	\$1,740	\$1,527	13.3	11.0	5.3	4.6	2.0	1.7	1.6	1.5	11.9	13.9
Inari	INAR.KL	\$2.97	\$2,425	\$2,203	67.4	36.4	34.4	22.8	8.5	6.4	7.9	7.5	11.7	13.7
<b>Back-end Median:</b>					<b>13.9</b>	<b>12.0</b>	<b>5.3</b>	<b>4.5</b>	<b>1.3</b>	<b>1.1</b>	<b>1.8</b>	<b>1.6</b>	<b>12.6</b>	<b>13.8</b>
<b>Back-end Mean:</b>					<b>22.2</b>	<b>16.1</b>	<b>9.9</b>	<b>7.5</b>	<b>2.5</b>	<b>2.1</b>	<b>2.8</b>	<b>2.6</b>	<b>12.8</b>	<b>14.5</b>
JCET	600584.SS	\$47.17	\$11,653	\$12,210	81.5	69.8	17.2	16.7	3.3	3.2	5.7	5.1	7.4	8.8
Tianshui Huatian	002185.SZ	\$16.05	\$6,778	\$6,520	63.4	38.4	20.0	15.0	5.4	4.2	5.4	4.8	7.9	9.9
Tongfu Micro	002156.SZ	\$29.38	\$6,018	\$6,500	87.3	55.8	20.4	16.6	3.9	3.2	4.1	3.8	5.9	8.7
<b>China Back-end Median:</b>					<b>81.5</b>	<b>55.8</b>	<b>20.0</b>	<b>16.6</b>	<b>3.9</b>	<b>3.2</b>	<b>5.4</b>	<b>4.8</b>	<b>7.4</b>	<b>8.8</b>
<b>China Back-end Mean:</b>					<b>77.4</b>	<b>54.7</b>	<b>19.2</b>	<b>16.1</b>	<b>4.2</b>	<b>3.6</b>	<b>5.0</b>	<b>4.6</b>	<b>7.1</b>	<b>9.2</b>
<b>China Back-end Median Premium:</b>					<b>488%</b>	<b>367%</b>	<b>278%</b>	<b>266%</b>	<b>193%</b>	<b>185%</b>	<b>200%</b>	<b>191%</b>	<b>-41%</b>	<b>-36%</b>
<b>China Back-end Mean Premium:</b>					<b>249%</b>	<b>241%</b>	<b>93%</b>	<b>115%</b>	<b>65%</b>	<b>73%</b>	<b>84%</b>	<b>77%</b>	<b>-45%</b>	<b>-37%</b>

Note: Priced as at 19-Jan-2021.

Source: Company data, Credit Suisse estimates for covered companies, the BLOOMBERG PROFESSIONAL™ service for Not Covered companies

**Figure 13: Semiconductor valuation metrics**

Company	Ticker	Local Price 1/19/2021	Mkt Cap (US\$mn)	Ent. Value (US\$mn)	P/E Multiple (x) 2020	P/E Multiple (x) 2021	EV/EBITDA (x) 2020	EV/EBITDA (x) 2021	EV/Sales (x) 2020	EV/Sales (x) 2021	P/B Multiple (x) 2020	P/B Multiple (x) 2021	ROE 2020	ROE 2021
<b>Taiwan Fabless</b>														
Mediatek	2454.TW	\$879.00	\$49,890	\$40,978	35.0	25.3	24.3	17.7	3.5	2.9	3.9	3.6	11.2	14.4
Novatek	3034.TW	\$410.00	\$8,906	\$7,528	21.1	16.0	15.5	11.8	2.8	2.4	6.4	5.6	30.2	35.0
Realtek	2379.TW	\$469.00	\$8,549	\$6,857	27.3	23.4	20.7	17.9	2.6	2.3	7.9	7.1	29.1	30.2
Egis	6462.TWO	\$164.50	\$419	\$337	13.0	9.9	9.8	7.3	1.7	1.4	4.8	3.9	36.7	39.1
Elan	2458.TW	\$171.00	\$1,855	\$1,642	16.3	11.7	12.3	9.2	3.4	2.6	5.8	4.9	35.6	41.7
ASpeed	5274.TWO	\$2,000.00	\$2,450	\$2,193	68.6	53.4	50.5	41.7	21.9	18.3	24.4	20.9	33.5	36.1
Global Unichip	3443.TW	\$413.00	\$1,976	\$1,745	76.8	41.2	37.8	24.8	3.9	3.2	12.7	10.9	16.7	28.9
Himax	HIMX	\$8.07	\$1,390	\$1,503	34.4	22.4	19.7	13.8	1.6	1.4	3.0	2.8	8.6	12.6
Parade	4966.TWO	\$1,315.00	\$3,791	\$3,180	30.1	25.5	25.0	20.9	6.4	5.7	7.7	6.6	25.5	25.8
Silergy	6415.TW	\$2,745.00	\$9,102	\$9,102	81.3	59.6	77.0	57.7	18.6	14.8	14.5	12.2	19.2	22.2
<b>Taiwan Fabless Median:</b>					<b>32.3</b>	<b>24.4</b>	<b>22.5</b>	<b>17.8</b>	<b>3.4</b>	<b>2.7</b>	<b>7.0</b>	<b>6.1</b>	<b>27.3</b>	<b>29.6</b>
<b>Taiwan Fabless Mean:</b>					<b>40.4</b>	<b>28.8</b>	<b>29.2</b>	<b>22.3</b>	<b>6.6</b>	<b>5.5</b>	<b>9.1</b>	<b>7.8</b>	<b>24.6</b>	<b>28.6</b>
<b>Overseas Semiconductor Companies</b>														
Broadcom	AVGO	\$445.85	\$204,317	\$237,761	20.1	17.0	17.4	15.5	10.0	9.0	7.6	7.7	40.9	43.7
Marvell	MRVL	\$50.77	\$34,107	\$34,899	77.2	54.3	76.9	52.2	12.9	11.6	4.0	3.9	5.1	7.1
Analog Devices	ADI.OQ	\$157.75	\$58,286	\$62,375	32.2	27.4	25.3	21.6	11.1	9.9	4.9	4.9	15.2	17.9
Microchip	MCHP.OQ	\$148.56	\$38,681	\$47,761	30.0	26.6	21.6	19.6	9.2	9.0	7.1	7.1	24.0	27.8
Analog Devices	ADI.OQ	\$157.75	\$58,286	\$62,375	32.2	27.4	25.3	21.6	11.1	9.9	4.9	4.9	15.4	16.2
Texas Instruments	TXN.OQ	\$169.19	\$155,307	\$156,866	32.0	29.3	27.1	24.3	11.2	10.4	17.9	13.9	55.7	47.2
ON Semi	ON.OQ	\$36.71	\$15,096	\$17,589	48.2	28.3	15.9	13.0	3.5	3.1	4.6	4.7	9.6	16.7
Silicon Motion	SIMO	\$49.42	\$1,784	\$1,390	16.2	15.6	11.3	9.8	2.6	2.4	2.9	2.6	17.7	17.8
INTC	INTC	\$57.58	\$235,963	\$256,463	11.8	12.2	8.0	8.5	3.0	2.3	2.0	2.0	24.4	23.7
Nvidia	NVDA	\$514.38	\$318,401	\$309,495	88.8	52.9	75.2	39.6	28.3	18.8	25.8	19.9	33.2	40.7
Synopsys	SNPS	\$258.92	\$13,161	\$38,515	46.7	41.1	10.5	9.0	3.3	3.0	8.1	7.1	19.2	17.1
Cadence	CDNS	\$134.64	\$11,908	\$36,803	49.9	46.9	11.6	10.4	4.2	3.9	14.8	11.8	29.6	24.6
<b>US Semiconductor Median:</b>					<b>37.0</b>	<b>28.8</b>	<b>23.4</b>	<b>20.6</b>	<b>10.0</b>	<b>9.2</b>	<b>7.3</b>	<b>7.1</b>	<b>24.2</b>	<b>24.2</b>
<b>US Semiconductor Mean:</b>					<b>44.6</b>	<b>35.4</b>	<b>31.4</b>	<b>24.3</b>	<b>9.4</b>	<b>8.1</b>	<b>10.7</b>	<b>9.0</b>	<b>25.7</b>	<b>26.3</b>
<b>China Fabless</b>														
Goodix	603160.SS	\$155.70	\$10,984	\$10,394	46.7	46.0	49.6	42.6	9.4	8.7	8.2	7.1	17.4	15.5
Will Semi	603501.SS	\$314.89	\$42,106	\$42,106	101.9	52.3	73.1	39.9	13.8	10.1	24.0	15.9	23.6	30.5
*Bestechnic	688608.SS	\$350.00	\$6,473	\$6,473	224.4	107.7	0.0	0.0	41.1	23.7	8.0	7.5	36.5	47.1
*Wingtech	600745.SS	\$127.15	\$24,397	\$25,628	47.6	34.2	27.3	20.3	2.5	1.9	5.0	4.4	12.1	14.7
Montage	688008.SS	\$98.97	\$17,234	\$16,168	99.8	77.1	113.9	79.1	52.3	37.0	13.6	11.9	13.7	15.5
Gigadevice	603986.SS	\$225.00	\$16,354	\$15,565	110.2	76.9	89.6	59.4	21.8	15.3	9.9	8.8	8.8	11.5
Maxscend	300782.SZ	\$660.00	\$18,310	\$18,148	117.9	89.1	104.8	77.2	42.5	31.3	45.7	31.3	39.1	37.5
*Amlogic	688099.SS	\$79.71	\$5,051	\$5,051	342.1	92.8	0.0	0.0	11.6	7.6	11.3	10.2	3.4	11.4
*SG Micro	300661.SZ	\$313.98	\$7,567	\$7,481	167.4	115.6	162.3	115.4	40.5	29.6	34.8	27.9	21.2	24.1
*NavInfo	002405.SZ	\$15.78	\$4,770	\$4,534	151.7	72.1	82.7	45.9	12.1	9.4	3.8	3.7	2.8	5.1
<b>China Fabless Median:</b>					<b>114.1</b>	<b>77.0</b>	<b>86.1</b>	<b>52.7</b>	<b>17.8</b>	<b>12.7</b>	<b>10.6</b>	<b>9.5</b>	<b>15.6</b>	<b>15.5</b>
<b>China Fabless Mean:</b>					<b>141.0</b>	<b>76.4</b>	<b>87.9</b>	<b>60.0</b>	<b>24.8</b>	<b>17.5</b>	<b>16.4</b>	<b>12.9</b>	<b>17.9</b>	<b>21.3</b>
<b>China Fabless Median Premium:</b>					<b>253%</b>	<b>216%</b>	<b>283%</b>	<b>196%</b>	<b>418%</b>	<b>363%</b>	<b>51%</b>	<b>56%</b>	<b>-43%</b>	<b>-48%</b>
<b>China Fabless Mean Premium:</b>					<b>249%</b>	<b>165%</b>	<b>201%</b>	<b>169%</b>	<b>273%</b>	<b>218%</b>	<b>80%</b>	<b>64%</b>	<b>-27%</b>	<b>-26%</b>
<b>IC design service</b>														
Global Unichip	3443.TW	\$413.00	\$1,976	\$1,745	72.1	38.2	39.4	24.2	3.9	3.1	12.0	10.1	16.7	26.4
Alchip	3661.TW	\$847.00	\$1,875	\$1,620	62.6	37.3	23.5	16.4	7.0	4.3	13.3	11.5	21.2	30.7
*Faraday	3035.TW	\$53.00	\$114	\$114	32.1	25.6	NM	NM	NM	NM	0.6	0.6	7.7	9.3
<b>IC design service Median:</b>					<b>62.6</b>	<b>37.3</b>	<b>31.4</b>	<b>20.3</b>	<b>5.5</b>	<b>3.7</b>	<b>12.0</b>	<b>10.1</b>	<b>16.7</b>	<b>26.4</b>
<b>IC design service Mean:</b>					<b>55.6</b>	<b>33.7</b>	<b>31.4</b>	<b>20.3</b>	<b>5.5</b>	<b>3.7</b>	<b>8.6</b>	<b>7.4</b>	<b>15.2</b>	<b>22.2</b>
*VeriSilicon	688521.SS	\$83.03	\$6,221	\$6,221		448.8					13.6	13.3	-0.7	3.3
<b>China IC design service Median:</b>						<b>448.8</b>					<b>13.6</b>	<b>13.3</b>	<b>-0.7</b>	<b>3.3</b>
<b>China IC design service Mean:</b>						<b>448.8</b>					<b>13.6</b>	<b>13.3</b>	<b>-0.7</b>	<b>3.3</b>
<b>China IC design service Median Premium:</b>						<b>1103%</b>					<b>13%</b>	<b>31%</b>	<b>-104%</b>	<b>-87%</b>
<b>China IC design service Mean Premium:</b>						<b>1231%</b>					<b>57%</b>	<b>79%</b>	<b>-105%</b>	<b>-85%</b>

Note: Priced as at 19-Jan-2021.

Source: Company data, Credit Suisse estimates for covered companies, the BLOOMBERG PROFESSIONAL™ service for Not Covered companies

# Semiconductors' strategic importance rising

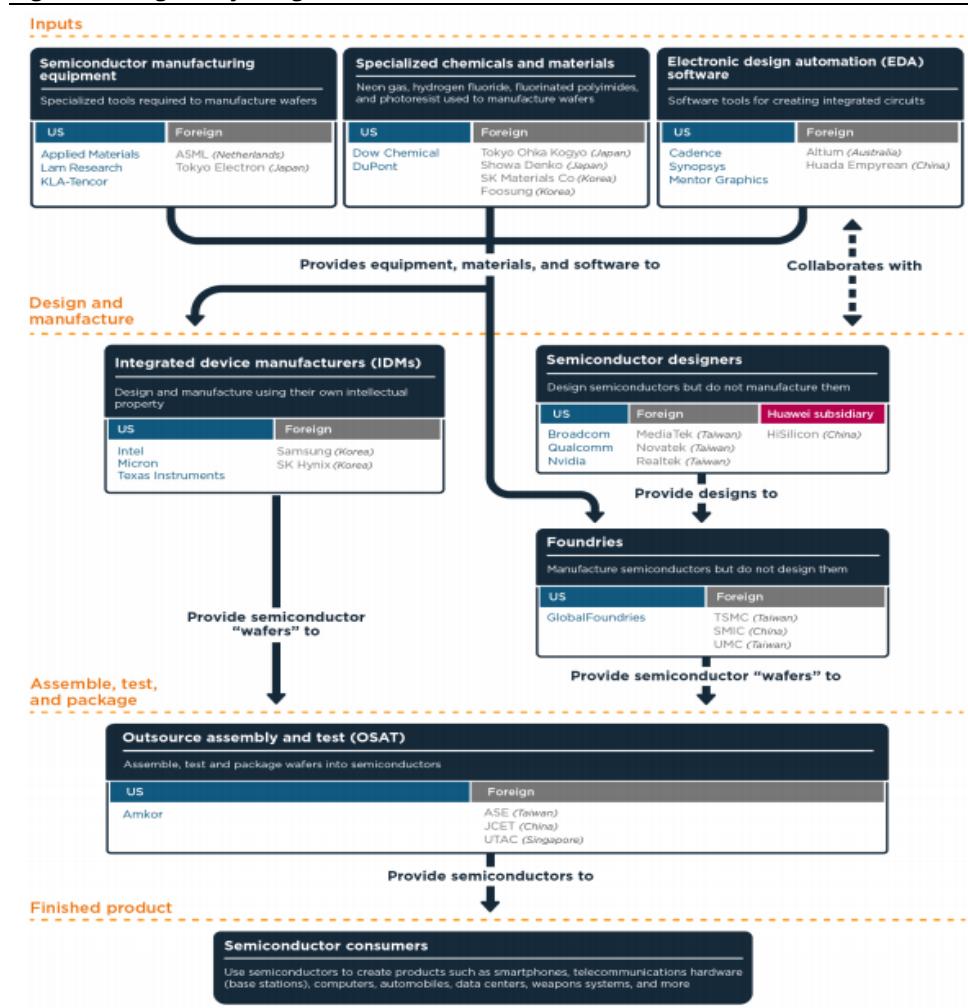
We focus our report in our on-going series of China semiconductor reports with an update on China's uneven but accelerating efforts to build its domestic supply chain in the face of US resistance. The industry development comes at a crucial time with the US political change post Trump's presidency which saw a wave of heightened restrictions on China's technology sector but also a continued accelerated drive by China to stimulate its domestic semiconductor sector.

The chip industry overall is seeing a revaluation as its strategic importance is better recognised by countries and investors as it has been accelerated by the pandemic. COVID-19 accelerated digitisation for corporates, consumers, schools, and government officials needing to shift everything to online. Semiconductors are a key driver of the main tech hardware cycles including 5G, AI, Industrial 4.0, Edge computing, EV, autonomous driving, and IoT, semiconductors are playing a bigger role in the geopolitical landscape.

The fear of supply chains getting broken or cut off by the pandemic, natural disasters, or politics has also accelerated countries' motivation for better production self-sufficiency. In semiconductors, the supply chain has become globally integrated, creating risk if any portion is cut off for fabless design companies to key inputs of equipment, materials, and software or outsourced fabrication and final test assembly.

**Semiconductors importance accelerating post COVID-19 with increased digitisation and increased drives for better domestic self-sufficiency**

**Figure 14: A globally integrated semiconductor chain**



Source: PIIE

The industry overall creates a huge value in global trade by historically being open, with the typical production lifecycle spanning 3-4 months across multiple countries, facilities, and

Global Semiconductors Sector

This document is being provided for the exclusive use of SHIBIN XIE at ALLIANZ GLOBAL INVESTORS US LLC.

suppliers through fabrication, assembly, test, distribution, EMS assembly and shipment into customer channels. The pandemic and the US-China political tension have served to increase the motivation of creating both a domestic ecosystem in China and also bringing some of the outsourced elements of chip production, assembly and test back to the US.

**Figure 15: Semiconductors' global supply chain creates risk if any links are broken**

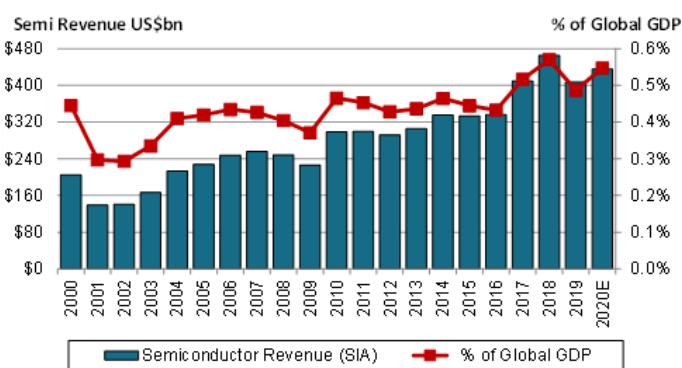
Typical semiconductor production process spans multiple countries: 4+ Countries, 4+ States, 3+ trips around the world, 25,000 miles travelled, 100 days TPT, 12 days in transit



Source: SIA Beyond Borders Report, UN Comtrade and Taiwan Customs Administration

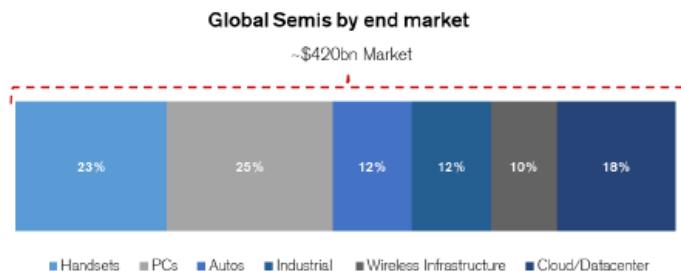
The industry remains a critical component of electronics systems now at US\$450 bn in sales and growing at a steady 4% CAGR since the 2000/07 peaks and 6% CAGR from 2001/09 troughs to current. Growth has also reaccelerated recently with diversified demand drivers supplemented by higher capital intensity and industry consolidation of equipment, IC design and capacity ex-China. In the past four years, semiconductors have maintained 0.5% of nominal GDP and increased their share of real GDP from 0.5% towards 0.8% and now supply to diverse end markets of PCs (25%), handsets (23%), cloud/data centre (18%), autos/industrial (each 12%), and wireless infrastructure (10%).

**Figure 16: Semiconductors have a 4% CAGR since 2000, rising as a % of global GDP**



Source: SIA, Credit Suisse estimates

**Figure 17: Semiconductor industry supplies to diverse end markets**



Source: Department of Defense – 2018 Defense Strategy of the US

## The US trying to protect its leadership position

The semiconductor sector is also becoming a key element of ensuring national security as the building block of advanced processing, communications, machine vision and sensing. The defence modernisation priorities for the US include development of domestic 5G, quantum computing, high-performance communication for its battlefield and radar systems, AI and

Global Semiconductors Sector

This document is being provided for the exclusive use of SHIBIN XIE at ALLIANZ GLOBAL INVESTORS US LLC.

autonomous systems for navigation and imaging, directed energy for laser weapon systems and radiation hardening for onboard sensor processing, communication and controls.

The strong US defence department's focus on upgrading military systems and also view of China as a strategic competitor has accelerated the US focus on limiting China's access to these advanced capabilities. Those efforts have emerged to set up new restrictions including adding Huawei, as a global leader in 5G communication, and SMIC, as China's leading foundry, to its entity list to require a licence for access to US technology.

**Figure 18: Key US defence modernisation priorities require advanced semiconductors**

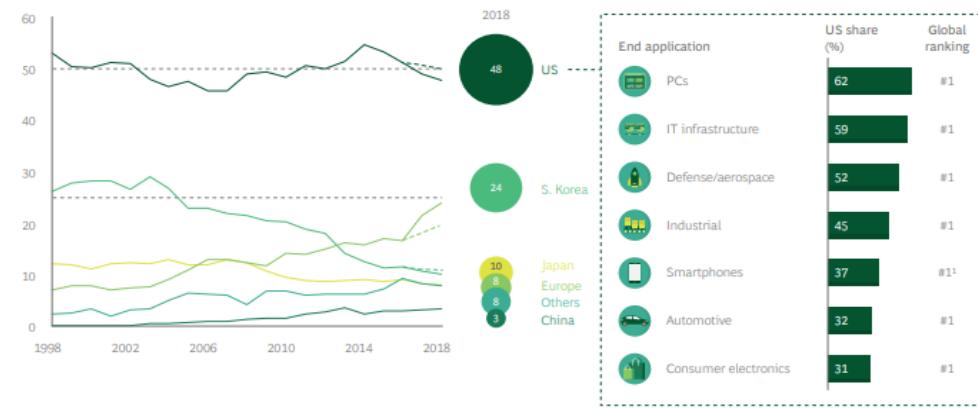
Key US defense modernization priorities	Required advanced in semiconductors
<b>Quantum computing</b>	Greater than 1000X enhancement in performance and efficiency of real-time identification, processing, response, and security using technologies such as quantum sensors
<b>Command, control and communications</b>	High-performance, low-power embedded processing; adaptive processing for multiple antennas and frequencies, for robust battlefield communication and radar systems
<b>AI and autonomous systems</b>	Vision, semantic, and navigational processing for high-performance imagers and navigation in military applications, supporting diverse unmanned/mixed-team capabilities
<b>Directed energy</b>	Advanced imagers, optoelectronic technology, signal processing, control systems and spectrum awareness for laser weapon systems
<b>Space and hypersonics</b>	Advanced in radiation hardening (damage resistance) for onboard sensor processing, communication, targeting, and controls

Source: US Department of Defense, Summary of the 2018 Defense Strategy of the USA

The US still has the leading semiconductor share position with 48% market share versus 24% for South Korea, 10% for Japan, 8% for Europe and Others (including Taiwan), and 5% for China. The US through its IDMs (Intel, TI, ADI, Micron, Qorvo, and Skyworks), leading fabless (AMD, Nvidia, Qualcomm, Broadcom, Marvell) and system companies (Apple, Amazon, and Microsoft) still holds leading positions across PCs (62%), IT infrastructure (59%), defence (52%), industrial (45%), smartphones (37%), auto (32%) and consumer (31%).

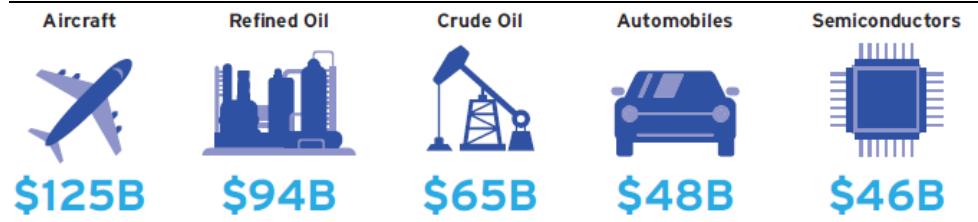
**The US has 48% market share across the semiconductor categories vs 5% for China**

**Figure 19: The US has near half global market share, China at 5% share**



Source: BCG analysis using Gartner and WSTS Data

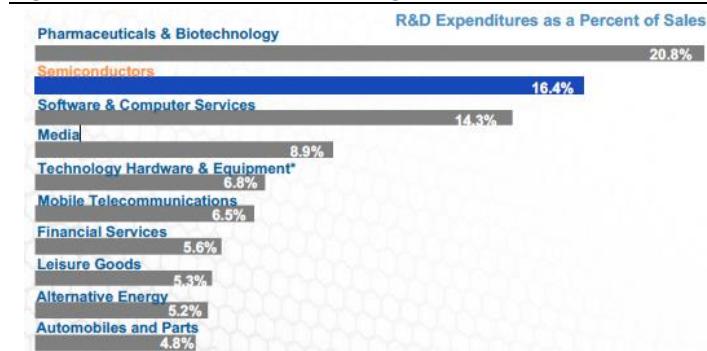
Semiconductors also carry strategic importance as one of few sectors supporting the US in trade against a net current account deficit that reached US\$498 bn in 2019. Within that, semiconductors are one of the few leading export categories at US\$46 bn, fifth after aircraft, refined and crude oil and automobiles. That deficit widened to US\$179 bn in 3Q20 with main deficit in goods where exports of US\$357 bn were far short of US\$603 bn goods imports.

**Figure 20: Semiconductors one of the top exports for the US in 2019**

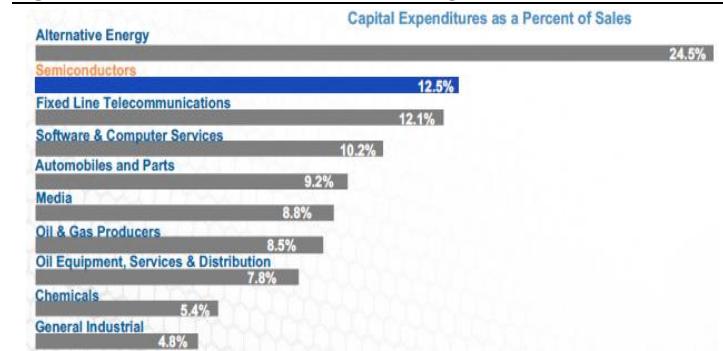
Source: US International Trade Commission

The sector also carries importance for quality domestic jobs as one of the most R&D and capital intensive sectors requiring high precision capital equipment. Semiconductors only lags pharma in R&D intensity with design companies averaging 16% of revenue, and capital intensity is second to alternative energy at 12.5% of sales, and much higher for the companies maintaining fabs. The SIA estimates the US semiconductor industry directly employs 240,000 with US\$180,000 R&D spending per headcount and US\$539,000 revenue generated per employee.

**Semiconductors an important high-value R&D and capital intensive market, making it strategic for national development**

**Figure 21: Semiconductors among the most R&D intensive**

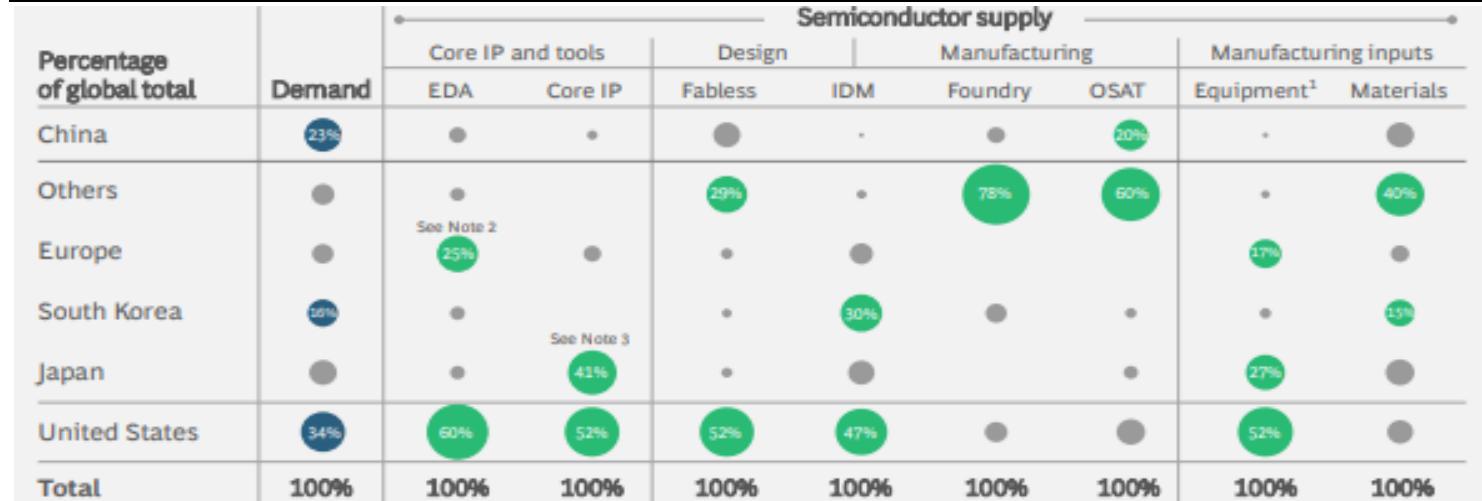
Source: The 2019 EU Industrial R&amp;D Investment Scoreboard

**Figure 22: Semiconductors also among the most capital intensive**

Source: The 2019 EU Industrial R&amp;D Investment Scoreboard

## The US leadership comes with an outsourced supply chain

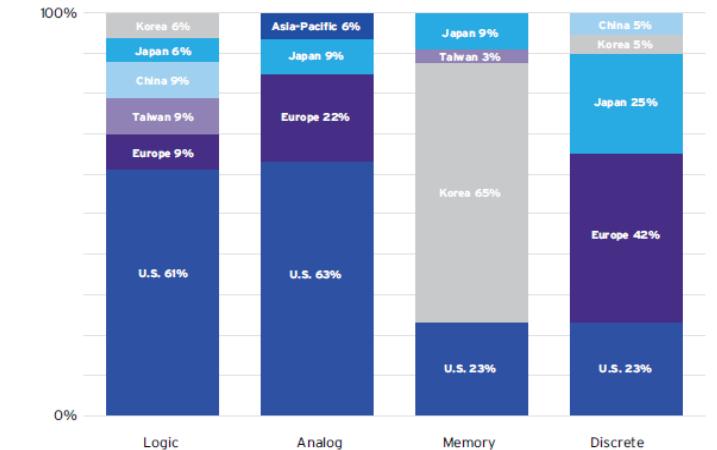
The US leadership in the industry has focussed on R&D intensive sectors including Core IP and tools (EDA software, IP), IC design at fabless companies, traditional IDMs from its legacy 1<sup>st</sup> wave leadership, and semiconductor capital equipment. It has largely outsourced production with limited foundry/back-end production in-country or domestic headquartered suppliers.

**Figure 23: The US still leads in core IP, design and IDM manufacturing; China emerging in fabless and manufacturing**

Source: BCG analysis based on data from Gartner, Allied Market Research and Griffin

By chip segment, US leadership is still high in logic (61%) and analog (63%), but significantly lags South Korea in memory (23%) and Europe and Japan in discretes with 23% share.

**Figure 24: Semiconductor country share by device type**



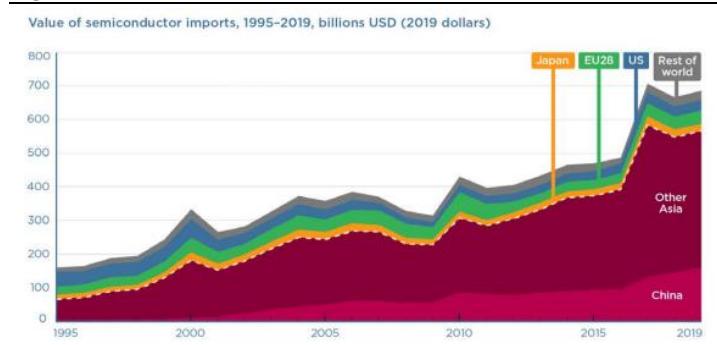
Source: SIA

Asian countries now leading in production, netting the largest export value share, with China emerging

As a result of the semiconductor production supply chain and also tech components and assembly moving to Asia since 2000, China is approaching US\$100 bn semiconductor imports, other Asian countries at US\$400 bn, and Japan/the US/Europe/ROW only at US\$150 bn. For semiconductor exports, Asian countries also lead, with China, Taiwan, Korea at over US\$100 bn, other Asian countries at US\$200 bn, and much smaller levels for US, Europe and Japan.

**Most tech production outsourced to Asia, shifting the export value to these regions**

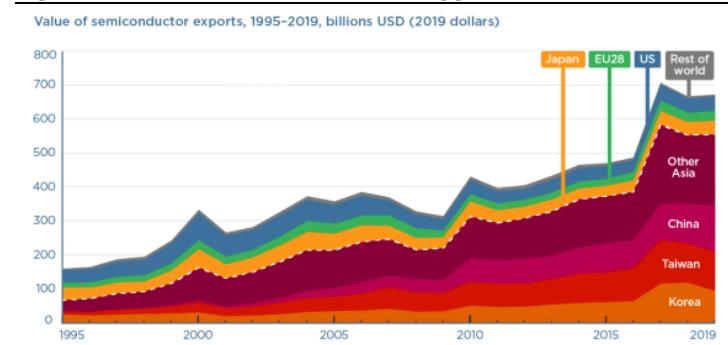
**Figure 26: Asian countries as a production hub lead IC imports**



Source: PIEE, BACI (2020), UN Comtrade via World Integrated Trade Solutions

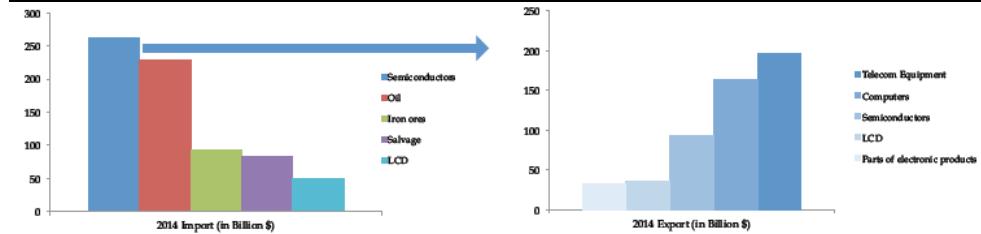
China as leading importer of semiconductors is linked to its role as electronics factory with Top 5 exports in telecom equipment, computers, semis, LCDs and electronics components.

**Figure 27: Asian countries also the biggest semi exporters**



Source: PIEE, BACI (2020), UN Comtrade via World Integrated Trade Solutions

**Figure 28: Relationship between China's semiconductor imports and Top 5 exports**



Source: UN Comtrade Database

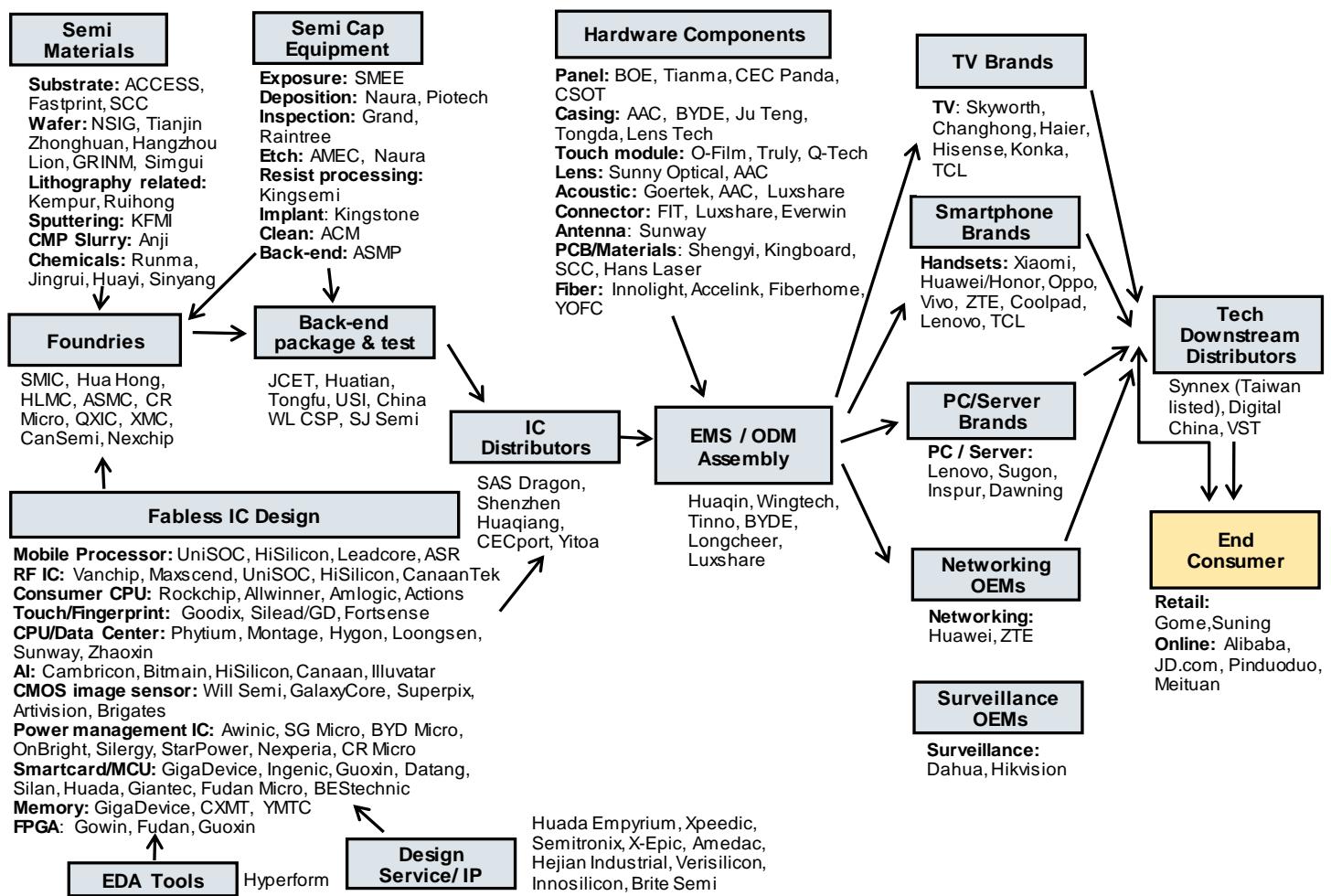
## China trying to build its semiconductor self-sufficiency

China has built a well-developed technology supply chain over the past 20 years as a major brand and producer of key electronics categories and strong suppliers in a number of hardware component categories. In tech hardware, China's smartphone brands have taken 60% of the global smartphone unit share, PC brands have established leadership through Lenovo, networking through Huawei and ZTE and TV brands emerging with TCL, Changhong, Skyworth, Konka, Haier and Hisense. The component sector has also been seeing competition rise in acoustics, casing, lens/camera module, optical components, connectors and fibre. The country is also leading in EMS, with most of the industry's TV and notebook production in China.

China has built up its supply chain in the past 20 years, though semiconductors still lag its downstream development

The presence of a large and growing hardware and component sector is pushing the national interest to develop its semiconductor sector to better secure its processing, communications, and storage and move further up the value chain while also lessening its import intensity to avoid impact from nationally and politically charged restrictions. We highlight the emerging supply chain in China and key suppliers emerging within semiconductor EDA and IP, materials, equipment, foundry, back-end, fabless and memory.

**Figure 29: China building out a complete tech supply chain**



Source: Company data, Credit Suisse estimates

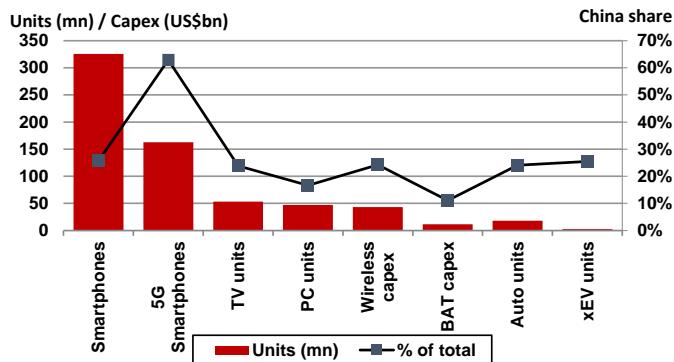
## China offers a large domestic market for its IC sector

China's rise as a major consumer of tech products and increased domestic brand share within China and as an exporter to emerging and some developed markets has created a large market for its IC sector as the initial target to gain competitiveness. We estimate China now represents

China now at 20-30% of tech unit demand and 30-40% OEM share of tech markets

20-30% of unit demand across smartphones, TVs, PCs, wireless and data centre capex, auto and xEV units, with over 60% share in the first year of 5G. In addition, OEMs have gained significant traction also increasing exports, with China built smartphones having 60% share, China network infrastructure suppliers led by Huawei/ZTE at 40% share, TV vendors approaching 40% unit share, PC/server vendors at close to 30% unit share and network switch vendors approaching 20% unit share.

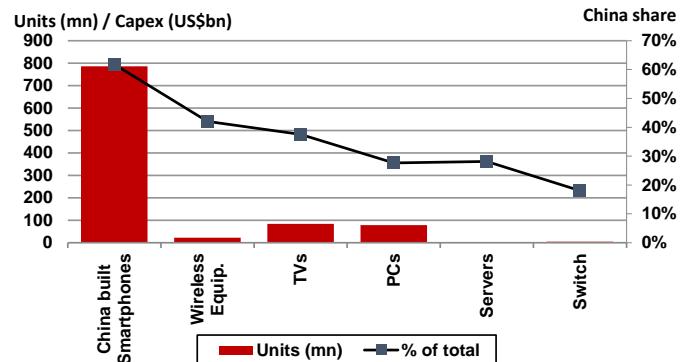
**Figure 30: China at 25% to 30% of industry tech demand**



Source: IDC, Omdia, company data, Credit Suisse estimates

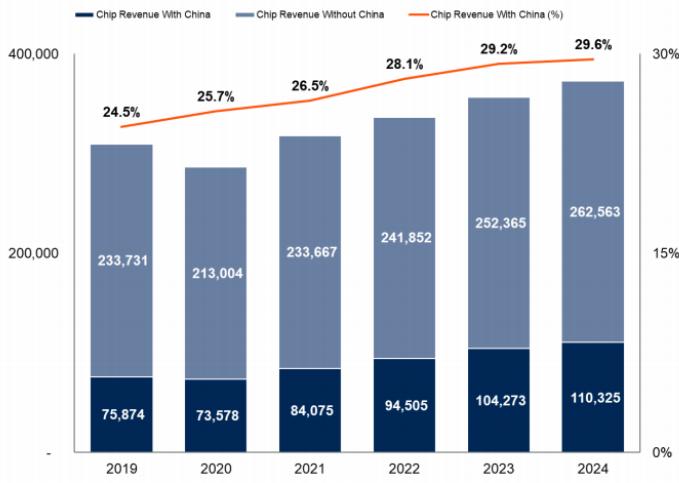
For logic semiconductors, China is projected to steadily increase from 25% to 30% of industry revenue from 2019 to 2024. Gartner projects that China OEMs will be increasing their semiconductor demand from US\$55 bn in 2016 to US\$90 bn by 2022, creating a large growing market for domestic IC suppliers if they can gain competitiveness.

**Figure 31: China OEMs as a channel for ICs at 30-40% share**



Source: IDC, Omdia, company data, Credit Suisse estimates

**Figure 32: China growing from 25% to 30% of industry demand (LHS: US\$ bn)**



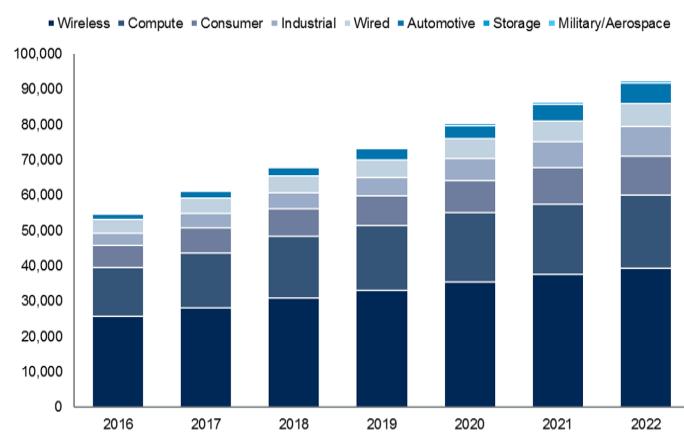
Source: Gartner

## China still lags supplying domestic and global demand

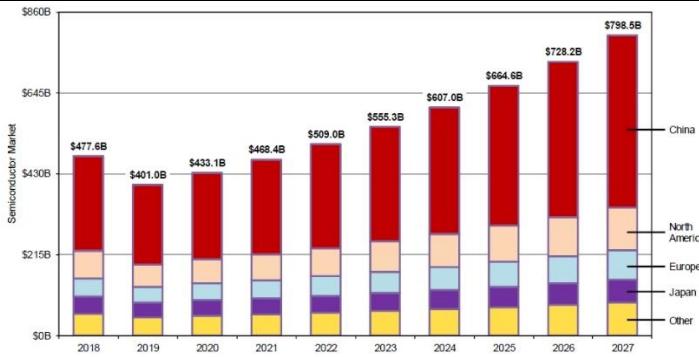
For the overall semiconductor market, China continues to try to close a gap to consumption by its hardware supply chain which is building products both for domestic consumption and for global OEMs exporting globally. China is now about 50% of the industry's US\$430 bn sales, but lags at only 18% of that production by its China's own semiconductor companies.

**Figure 33: China demand led by mobile, compute and consumer**

**Chinese OEM Chip Demand by End Market (\$M)**

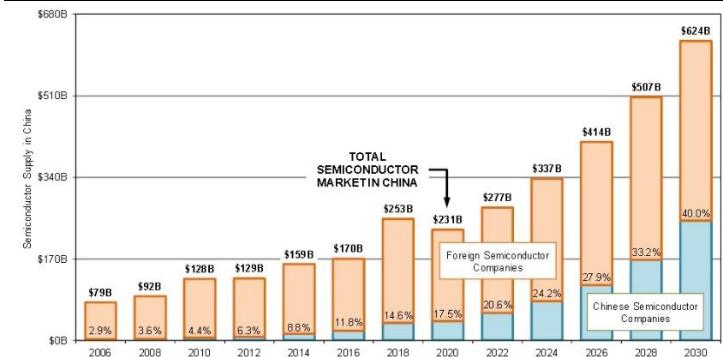


Source: Gartner

**Figure 34: China consumption is half of the semi industry**

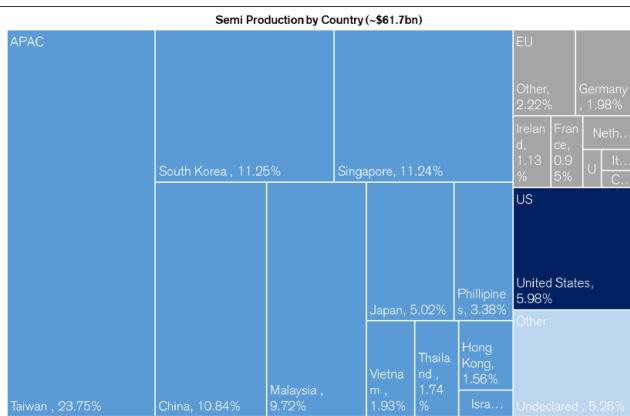
Source: IBS

China lags further in its base for global capacity, with only 11% of production in-country and only 13% of industry capex in 2020, though accelerating from only 2% when China commenced its accelerated domestic semiconductor plan in 2014. At that time, it started its commitment of substantially more funds including from the National IC fund, municipal funds and private equity.

**Figure 35: China vendors have only 18% share of the local ICs**

Source: IBS

**China only has 11% of its production in-country and 13% of semi industry capex**

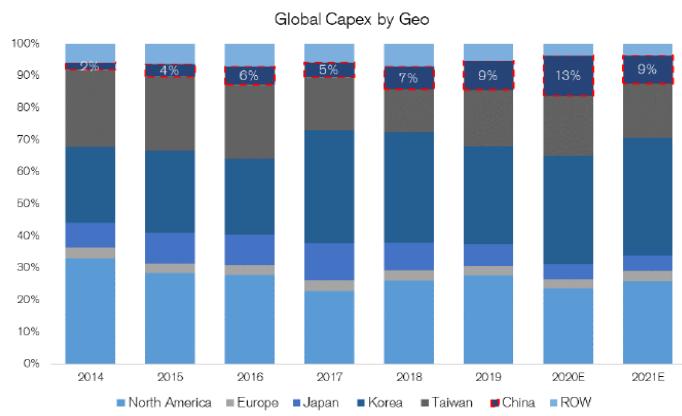
**Figure 36: China now has 11% of semiconductor production**

Source: Company data, Credit Suisse estimates

## China continuing measures to develop its IC industry

China has been trying to build its IC industry for decades through several policies with only limited success until the last five years. The policy support started notably with the State Council Document 18 to develop its IC industry in 2000. This policy offered favourable tax treatment for domestic IC chips and government investment in infrastructure, education, and basic research. In 2005, the US petitioned the WTO to drop the VAT rebates for China IC producers; however, some of the favourable industry policies were kept in place through 2010. The policy laid the ground work for the domestic industry, building it up to close to 10% of industry production by the financial crisis and US\$23 bn of sales, according to CCID.

China's State Council supplemented the policy with its guidelines on Scientific Technology development in 2006 for the next 15 years. It has set a target for R&D at 2.5% of China's GDP, with interim targets by 2020 to increase science and technology to 60% of the country's development and lowered reliance on foreign technology to less than 30%. The policy supported a Science and Technology development programme with projects to develop core devices, high-end chips, equipment and materials, China has prioritised technology development and has set targets to reach Top 5 in patents.

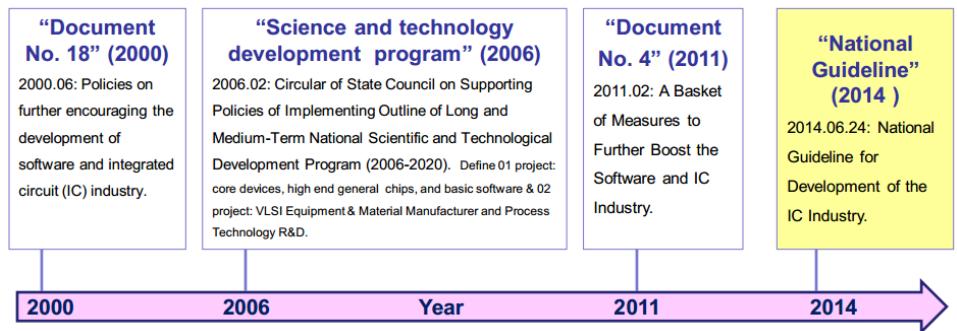
**Figure 37: China about 13% of semiconductor industry capex**

Source: Company data, Credit Suisse estimates

China's efforts accelerated with the National IC Development Guideline in 2014 and 'Made in China 2025' initiatives in 2015, jumpstarting the latest wave of development to build the local semiconductor industry, this time directing more public and private resources for the initiative. The key outcome from the guidelines is to achieve 20% of semiconductor industry revenue growth to US\$143 bn by 2020 (Rmb870 bn), raising China's internal supply of silicon from one-third to half by 2020 and 70% by 2025 to reduce import dependence and stimulate the economy to move up the value chain from labour intensive to high-skilled technology-intensive industries.

**The National Guideline and set-up of China's IC fund in 2014 jump-started industry development**

**Figure 38: China IC industry policies progress since 2000**



Source: SEMI

The national policy laid out plans behind its 20% growth target to achieve competitiveness across chip manufacturing, fabless IC design, back-end package and test, materials and equipment. By 2020, the target was to move from one-third to half of its chips from domestic production, reach competitiveness in advanced silicon capabilities (IoT, networking, cloud computing, big data), enter FinFet production and have back-end, equipment and materials solutions to be competitive enough to serve the global supply chain. Ultimately by 2030, China's target is to have a world-class IC value chain with a set of top-tier global chip players.

**Figure 39: China's 2014 National IC Guideline set aggressive targets for its chip industry**

	2015	2020	2030
<b>Semiconductor Revenue</b>	>350bn RMB (US\$55bn)	>870bn RMB (20% Growth CAGR)	World class IC industry value chain
<b>IC Manufacturing</b>	32/28nm mass production	16/14nm mass production	A set of leading tier 1 global semi players
<b>IC Design</b>	Approach international standards in some technologies (smartphones, networking)	Reach international leading edge in key technologies (mobile, networking, cloud computing, IoT, big data)	
<b>IC Package and Test</b>	>30% of sales from advanced packaging	Competitive with the global leaders	
<b>IC Materials</b>	12" silicon wafers in the production line	Competitive in the global supply chain	
<b>Semi. Equipment</b>	65-45nm tools in the production line	Competitive in the global supply chain	

Source: SEMI, China's National Guideline 2014, Credit Suisse

## Made in China 2025: Semis and IT sectors the focus

The Chinese government in May 2015 also laid out the first of three ten-year plans to transform China into a leading high-quality manufacturing powerhouse by 2049, transitioning the country from a volume-based labour-intensive chain into a high-tech integrated manufacturing base with leading global innovation. The country is looking to follow Germany's Industry 4.0 push to move towards more automated, efficient, networked, and connected manufacturing that also integrates production, supply chain, and customers.

**Made in China 2025 put semiconductors in focus even with the campaign moniker no longer promoted**

The first ten-year initiative in the Made-in-China 2025 campaign targets was for strengthening China's industrial base to enhance the quality of the manufacturing, foster Chinese brands and improve manufacturing innovation. The government prioritised ten sectors, although semiconductors and information technology are key focus areas in the programme. To promote the Made-in-China 2025 campaign, the MIIT planned to allocate resources more efficiently and encourage financial support from local governments and private funds on local semiconductor ecosystem development.

The plan combined some state planning for the framework but also market forces including IP protection and industry standard creation and a broader push to participate in international standards. Localisation is another goal of the programme, with a plan to raise the domestic content of core components and materials to 40% by 2020 and 70% by 2025.

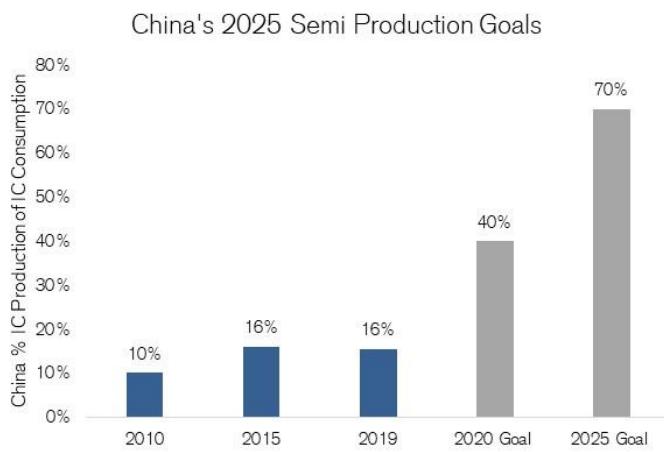
**Figure 40: Improvement targets for Made in China 2025**

Target	Indicator	2015	2020	2025
<b>Innovation</b>	R&D intensity as (% of sales)	0.95	1.26	1.68
	Patents per 100m of core business revenues	0.44	0.7	1.1
<b>Quality efficiency</b>	Manufacturing quality competitiveness index	83.5	84.5	85.5
	Manufacturing value added growth rate	NA	2% > 2015	4% > 2016
<b>Integration of Industrialisation and IT</b>	Manufacturing labour productivity growth rate	NA	+/-7.5 (13th 5YP CAGR)	+/-6.5 (13th 5YP CAGR)
	Broadband penetration (%)	50	70	82
<b>Environmental Improvements</b>	R&D digital design tool penetration	58	72	84
	Utilisation rate for numerical controls in critical processes (%)	33	50	64
<b>Environmental Improvements</b>	Energy consumption per unit of industrial value added	NA	18% < 2015	34% < 2015
	CO2 emissions per unit of industrial value added	NA	22% < 2015	40% < 2015
	Water consumption per unit of industrial value added	NA	23% < 2015	41% < 2015
	Utilisation rate of solid industrial waste (%)	85	73	79

Source: Refinitiv, Credit Suisse Global Strategy Research

Despite the aggressive goals, China's IC development has still lagged its plans, with production only increasing from 10% to 16% in 2019, short of the 40% goal by 2020 and making the 70% target a stretch. China's talent base and R&D investment even with government funding still significantly lags according to the OECD. The capex spent in China has also increased sizeably from the 2% of industry spend level in 2014 when the Semiconductor Guideline was issued though is still relatively modest, at 9-11% of spending, over the past two years.

**Figure 42: China's Plan for 2025 SEMI INDEPENDENCE**



Source: Company data, Centre for Strategic & International Studies

A BCG report estimates China's combined share in equipment/materials, design, fabrication and EDA is only at 3% global share designed and sold by Chinese companies and 23% of production sold by China companies. Factoring in foreign companies in China, the domestic

Global Semiconductors Sector

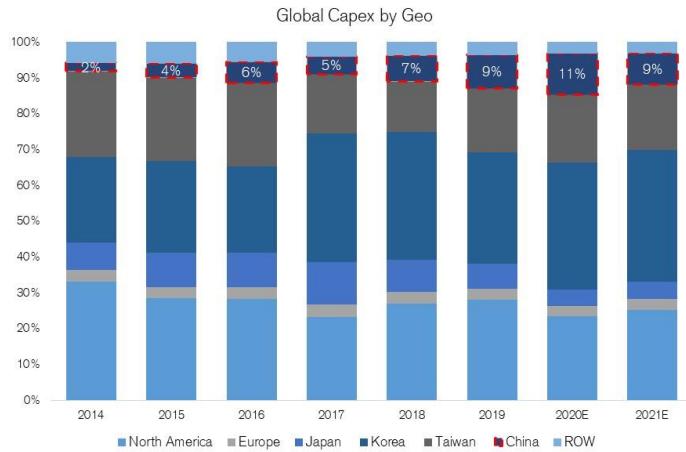
This document is being provided for the exclusive use of SHIBIN XIE at ALLIANZ GLOBAL INVESTORS US LLC.

**Figure 41: Made in China 2025 domestic champions**

Sector	Target and focus areas	Existing capability
Information Technology	Technological Innovation, particularly semiconductors	Limited but key focus sector for creating leadership in technology
Numerical control tools and robotics	Low and medium level automation capability. Focus on NC tool capability to improve manufacturing quality and productivity	Already a leader in low and medium level NC tools
Aerospace equipment	Focus on satellite capabilities and passenger jet transportation including aircraft engines	One passenger jet C919-2,400 planes possible by 2045
Marine engineering	Offshore infrastructure and high-tech ships	Existing investment and capabilities in South China Seas infrastructure
Railway equipment	Existing high speed train production. "One Belt, One Road" projects to improve competitiveness	High speed rail equipment sales to Russia and Malaysia. In discussions with over 20 countries for potential high speed railway equipment sales including US
Energy efficiency and electric vehicles	Domestic environmental clean-up priorities and long established domestic car manufacturing aspirations	Existing environment clean-up and emission reduction targets should support this segment. Visibility of innovation new fuel vehicles limited
Power equipment	Core priorities of smart grid and smart city technologies	Currently exporter of power equipment to India
New materials	Key government focus on "invention" and "innovation" in materials	Research into new materials in its infancy
Biopharma and medical devices	Existing success in low tech medical devices. Likelihood of success in biopharma and medicines less certain	Rapid growth in medical equipment market of 20% pa since 2009 from small base. Medical device capability currently small, low technology equipment and supplies
Agricultural machinery	Focus on improving quality in current manufacturing and potential export sector. Potential for international demand less clear	Domestic industry concentrated on low power tractors and small to medium machinery. Exports predominantly from JVs

Source: Refinitiv, Credit Suisse Global Strategy Research

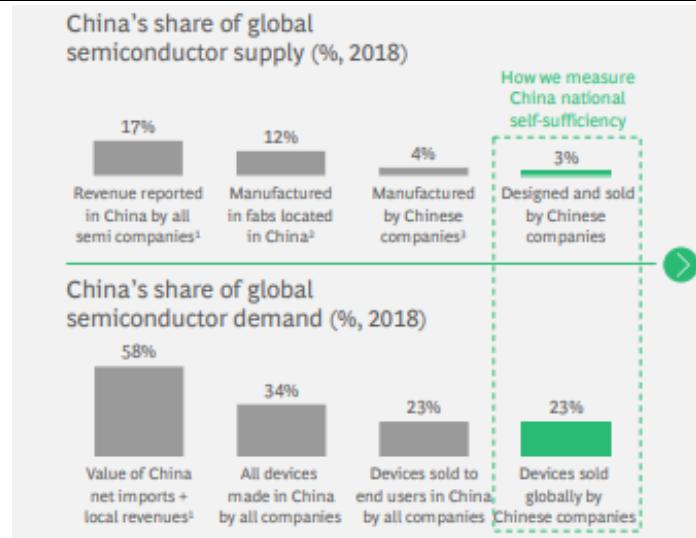
**Figure 43: China is still only 9-11% of industry capex**



Source: Company data, OECD

production increased to 33% of its supply share domestically in 2018. If the suppliers sustain a double-digit growth rate through 2025, that level would rise to 25-40% by domestic suppliers and 50-60% supplied by domestic and foreign suppliers operating in China, though short of the Made-in-China 2025 self-sufficiency objective of 70% of IC production domestically.

**Figure 44: China's share of supply lags its demand share**



Source: BCG analysis

**Figure 45: China with foreign companies may approach its goal**



Source: BCG analysis

## New policies in 2020 show continued support: with a continued shift from the Made in China 2025 moniker

In July 2020, China published the policy, *A Basket of Measures to Further Boost the IC and Software Industry*, to further support the development of the local IC industry. Compared to previous policies, we address the following key updates:

1. IC manufacturing companies or projects of 28nm or below nodes could get a waiver for the first ten-year corporate income tax if in operation for over 15 years;
2. IC design and software companies could get a waiver for the first five-year corporate income tax after turning profitable and lowered income tax rate of 10% thereafter;
3. Import tariff exemption for raw materials, consumables and semi equipment <65nm, specialty logic <250nm, and compound semi and advanced OSAT <500nm, vs previous import tariff exemption for certain raw materials, consumables and some equipment for ICs <500nm (some apply to ICs <250nm or investment > Rmb8 bn); and
4. China government encourages and supports IC companies to IPO in the A-share Sci-Tech Board or Growth Enterprises Market, with an accelerated IPO review process.

The new tax relief, government R&D grants, supported JVs backed by National IC fund and JV funds and encouragement of import substitution by SOEs, marked a continuation of China's economic policy. Despite accelerating its domestic industry support, China no longer actively mentions the Made in China 2025 targets which have met resistance by overseas industry participants and policy makers threatened by China's active import substitution policy objective.

**China has put forth more tax breaks and loosened listing requirements to fuel an active local capital market for chip companies**

**Figure 46: Policies update from *A Basket of Measures to Further Boost the IC and Software Industry (2020)***

Target sector	Change	New	Old	Previous policy
IC manufacturing	Added	Waive the 1st 10 year corporate income tax for IC manufacturing companies or projects for 28nm or below if in operations for over 15 years.	1st 5 years profit tax exempt & 50% reduction in the next 5 years for ICs <65nm set up after 1/1/18 or ICs <250nm set up before 12/31/17; 1st 2 years of profit tax exempt & 50% reduction in the following 3 years for IC <130nm set up after 1/1/18 or ICs <0.8 micro set up before 12/31/17.	Notice on Corporate Income Tax Policies for IC Manufacturing Companies (2018), Caishui Circular (2018)
IC design and software	Changed	Waive the first five-year corporate income tax after turning profitable, and lower the income tax thereafter to 10% (vs normal rate of 25%).	Waive the 1st 2 years of corporate income tax after turning profitable, and cutting in half to 12.5% for the next 3 years	Announcement on Corporate Income Tax Policies for IC Design and Software Companies (2019)
IC manufacturing, packaging, materials	Added	Waive import tariffs for raw materials, consumables and semi equipment <65nm, specialty logic < 250nm, and compound semi & advanced OSAT <500nm.	Waive Import tariffs for certain raw materials, consumables and some equipment for ICs <500nm (some apply to ICs <250nm or investment > Rmb8 bn)	Adjustment to the list of import tariff waiver for raw materials & consumable parts of IC companies (2015)
IC Industry	Expanded	2nd National IC fund in 2019 (US\$29bn).	1st National IC fund in 2014 (US\$20bn) + US\$150bn of municipal/private funding	MIT and China's Ministry of Finance Support
All IC companies	Added	Encourage and support IC companies to IPO in Sci-Tech Board or Growth Enterprises Market, with an accelerated IPO review process.	List in Hong Kong, US as an A-Share	A Basket of Measures to Further Boost the Software and IC Industry (2011)

Source: China State Council, Credit Suisse

## China's 14th Five-Year Plan: Technology advancement and independence

China's focus on developing its own technology industry and moving toward self-sufficiency should remain as strong as it has been for a few years now, following its recent measures to support the industry and objectives outlined in its 14<sup>th</sup> Five-Year Plan for 2021-25. Those tech-and-semiconductor-industry-supported investments and focus on self-sufficiency pre-date the Trump administration. However, over the medium term, China's dependence on US core technologies in software, equipment, materials, IP and some IC design categories is expected to remain quite high and does not yet offer easy sources to completely replace that dependence even outside China. In the long term, China aims to lead in 5G, AI, ADAS and digital finance, which should lead to further intensifying of the Sino-US tech battle as it tries to establish leadership and develop its own supply lines. As such, China's 14th Five-Year Plan is now coming together to address technology advancement and independence as core tenets.

The complete 14th Five-Year Plan is being formed and expected to be finalised by early-2021. Reading through [the proposals for formulating the 14th Five-Year Plan](#), which were published on 3 November, we expect three thematic investment stories for the technology and semiconductor sector:

**China's 14<sup>th</sup> Five-Year Plan for 2021-25 is targeting greater self-sufficiency**

- **Investment in strategic high-tech projects.** China to transform into an innovation-driven development economy and comprehensively build new development advantages. The proposal has listed strategic high-tech fields including artificial intelligence (AI), quantum information, vision processing and integrated circuits. We expect continuous support in funding, talent and technology from the public system for semiconductors.
- **Pushing 'New Infrastructure'.** The proposal required to systematically advance infrastructural construction. In order to support GDP growth to move towards a digital economy, China is strongly determined to build technology infrastructure, including 5G,

industry internet and large-scale data centres, creating great opportunities for communication infrastructure companies and IC suppliers.

- **Accelerating localisation.** The improvement in technology can appear via two key channels: innovation or acquisition. We expect policy efforts to facilitate both channels. Yet, tensions between the US and China have highlighted significant uncertainty and vulnerability in the acquisition of core technologies and essential inputs from foreign sources. Hence, more policy emphasis is expected to be placed on in-house development. The semiconductor industry is seeing the most urgent requirements for localisation given the current external environment. We believe semiconductor equipment and material companies should be the largest areas to see domestic investment on these grounds.

## **Domestic funding and capital markets backing China's IC development**

The policy support is coming through in tangible financial backing for companies including from the National IC Fund, local private equity funds and private VCs which is allowing semiconductor players both funding for investment projects and a large market capitalisation for additional talent acquisition, M&A and investments.

### **The China National IC Fund remains a major capital supplier**

China established its US\$20 bn integrated circuit fund in 2014 and followed with a second phase at US\$29 bn in June 2024. The National Integrated Circuit Industry Investment Fund (a.k.a. the Big Fund or the China IC Fund) has invested directly or indirectly in more than 60 China semi companies (including listed and non-listed ones), according to public information, and we believe there should be more investment in private companies not within our tracker.

With the second phase, China plans to conduct a series of advanced and strategic nation-level projects versus regarding semiconductors as an emerging growth opportunity five years ago in the 13th Five-Year Plan. We expect the fund to continue to provide capital support for a wide range of China semi companies in the next few years vs the market's expectation of focussing on a few sub-sectors for the Big Fund's phase II from 2020. Over the past three quarters, the Big Fund (Phase II) has invested in foundry, OSAT, IC design and memory companies. We note it has reduced holdings in 11 companies in 3Q20 (mainly in August and September), vs three and two in 1Q20 and 2Q20 respectively, and three more between 1 October and 4 December.

While some investors may read this as a negative signal that the Big Fund is reducing support, we would remind that the Big Fund also invested in multiple companies in 4Q20 (seven in our tracker, mostly private companies). The fund now carries investments in over 34 listed companies with a listed market cap of US\$21.5 bn, 9% average ownership in these companies' US\$240 bn listed market capitalisation as of 26 December. The funds' public holding value at US\$21.5 bn has already passed the US\$20 bn funding provided from the first fund, demonstrating a good return for its initial stakes due to the high multiples now backing the local IC suppliers on hopes for continued development with national priority and policy support.

**Figure 47: China IC fund major semiconductor holdings of listed companies, holdings trimmed on companies in orange and blue**

Listed companies	Priced 1/13/21 Ticker	Company Description	Holding (shares, mn)				Holding % (ownership %)				IC Fund Holding (\$)	Total Market cap	2020E Sales	Price/ Sales
			03/31/20	06/30/20	09/30/20	12/04/20	03/31/20	06/30/20	09/30/20	12/04/20				
NSIG	688126.SS	Bare Wafer	567.0	567.0	567.0	<b>567.0</b>	30.5%	22.9%	22.9%	22.9%	\$2,799	\$12,243	\$302	40.5
AMEC	688012.SS	Semi equipment	93.3	93.3	93.3	<b>93.3</b>	17.5%	17.5%	17.5%	17.5%	\$2,282	\$13,079	\$361	36.3
SMIC	0981.HK	Foundry	797.1	797.1	797.1	<b>797.1</b>	15.5%	14.0%	10.4%	10.4%	\$2,081	\$20,099	\$4,214	4.8
J CET	600584.SS	Back-end	304.5	304.5	304.5	<b>288.5</b>	19.0%	19.0%	19.0%	18.0%	\$2,073	\$11,516	\$3,873	3.0
Sanan	600703.SS	LED/RF Foundry	460.9	460.9	416.1	<b>379.4</b>	11.3%	11.3%	9.3%	8.5%	\$2,058	\$24,297	\$1,312	18.5
Naura	002371.SZ	Semi Equipment	49.2	49.2	44.3	<b>44.3</b>	9.9%	9.9%	8.9%	8.9%	\$1,531	\$17,168	\$853	20.1
Hua Hong	1347.HK	Foundry	242.4	242.4	242.4	<b>242.4</b>	18.8%	18.7%	18.7%	18.7%	\$1,331	\$7,114	\$951	7.5
Gigadevice	603986.SS	MCU/NOR	30.0	39.2	34.5	<b>34.5</b>	9.3%	8.3%	7.3%	7.3%	\$1,151	\$15,719	\$708	22.2
Tongfu	002156.SZ	Back-end	250.6	239.2	227.7	<b>227.7</b>	21.7%	20.7%	19.7%	17.1%	\$998	\$5,827	\$1,596	3.7
CR Micro	688396.SS	Analog/Foundry	34.2	78.1	78.1	<b>78.1</b>	2.9%	6.4%	6.4%	6.4%	\$832	\$12,942	\$1,046	12.4
Goodix	603160.SS	Sensor & Touch IC	25.6	25.6	21.3	<b>21.1</b>	5.6%	5.6%	4.7%	4.6%	\$517	\$11,216	\$1,098	10.2
BDStar Navigation	002151.SZ	GPS ICs/Modules	58.8	58.8	49.0	<b>49.0</b>	12.0%	12.0%	9.6%	9.6%	\$401	\$4,161	\$544	7.7
Verisilicon	688521.SS	IP & Design Service	34.7	34.7	34.7	<b>34.7</b>	8.0%	8.0%	7.2%	7.2%	\$374	\$5,218	\$252	20.7
WL CSP	603005.SS	Back-end	21.7	27.1	27.1	<b>27.1</b>	9.4%	8.4%	8.4%	8.4%	\$332	\$3,931	\$188	20.9
Sai Microelectronics	300456.SZ	MEMs/GaN Process	88.4	88.4	88.4	<b>88.4</b>	13.8%	13.8%	13.8%	13.8%	\$314	\$2,268	\$123	18.4
Jingjia Micro	300474.SZ	GPUs	27.5	27.5	27.5	<b>27.5</b>	9.1%	9.1%	9.1%	9.1%	\$302	\$3,306	\$120	27.5
Anji Micro	688019.SS	CMP/Resist	6.1	6.1	6.1	<b>6.1</b>	11.6%	11.6%	11.6%	11.6%	\$269	\$2,329	\$61	38.0
Yoke Technology	002409.SZ	Semi/Display Material	26.5	26.5	26.5	<b>26.5</b>	5.7%	5.7%	5.7%	5.7%	\$267	\$4,666	\$419	11.1
Rockchip	603893.SS	Consumer/IoT APs	25.9	25.9	25.9	<b>25.9</b>	6.3%	6.3%	6.3%	6.3%	\$252	\$4,003	\$278	14.4
Ingenic	300223.SZ	MCU, video, memory	0.0	16.8	16.8	<b>16.8</b>	0.0%	3.7%	3.6%	3.6%	\$212	\$5,904	\$73	80.6
Hangzhou Changchuan	300604.SZ	IC Test	31.0	31.0	31.0	<b>31.0</b>	9.9%	9.9%	9.9%	9.9%	\$180	\$1,823	\$120	15.2
Goke Micro	300672.SZ	STB, SSD, IoT SOCs	26.3	26.3	26.3	<b>26.3</b>	14.6%	14.6%	14.6%	14.6%	\$177	\$1,212	\$113	10.7
Wanye	600641.SS	Inv. Fund / Ion Implant	56.4	56.4	67.7	<b>67.7</b>	7.0%	7.0%	7.1%	7.1%	\$167	\$2,357	\$182	12.9
Wuxi Taiji Industry	600667.SS	Back-end & Chem fiber	130.0	130.0	108.9	<b>108.9</b>	6.2%	6.2%	5.2%	5.2%	\$160	\$3,087	\$2,588	1.2
Ninestar	002180.SZ	Printer/NFC ICs	32.1	32.1	32.1	<b>32.1</b>	3.0%	3.0%	3.0%	3.0%	\$128	\$4,248	\$3,120	1.4
Wuxi Chipown	688508.SS	Analog and LED ICs	7.5	7.5	7.5	<b>7.5</b>	8.9%	8.9%	6.7%	6.7%	\$93	\$1,400	\$64	21.8
Wingtech	600745.SS	ODM/Nexperia Analog	4.0	3.1	unknown	<b>unknown</b>	0.4%	0.3%	unknown	unknown	\$61	\$22,255	\$9,977	2.2
Navinfo	002405.SZ	Auto map, service, ICs	13.2	13.2	11.0	<b>11.0</b>	0.7%	0.7%	0.6%	0.6%	\$27	\$4,758	\$372	12.8
3peak Incorporated	688536.SH	Analog ICs	0.3	0.3	unknown	<b>unknown</b>	0.4%	0.4%	unknown	unknown	\$21	\$4,893	\$93	52.5
Expressif	688018.SS	Wifi/Bluetooth ICs	1.2	1.2	0.8	<b>0.8</b>	1.5%	1.5%	1.0%	1.0%	\$17	\$1,685	\$128	13.2
Beken	603068.SS	BT/Wifi/Audio ICs	1.4	1.4	1.4	<b>1.4</b>	0.7%	0.7%	0.7%	0.7%	\$15	\$1,968	\$182	10.8
Chipsea	688595.SS	MCU, BT/Wifi ICs	1.2	1.2	1.2	<b>1.2</b>	1.6%	1.6%	1.2%	1.2%	\$11	\$885	\$59	15.1
Allwinner	300458.SZ	Consumer/IoT APs	2.0	2.0	unknown	<b>unknown</b>	0.6%	0.6%	unknown	unknown	\$10	\$1,704	\$250	6.8
MEMsensing	688286.SS	MEMs devices	0.4	0.4	0.4	<b>0.4</b>	1.1%	1.1%	0.8%	0.8%	\$9	\$1,097	\$55	20.0
										8.9%	\$21,449	\$240,378	\$35,676	6.7

Source: Company data, Credit Suisse estimates

In addition to the listed companies, the National IC fund is also backing a number of high profile private companies in China. We believe these higher profile companies span many of the strategic sectors including foundry (SMIC fab JVs, Huali), memory (YMTC, CXMT, Puya, and Kingston's Payton back-end subsidiary), equipment (ACM), mobile (UniSOC), and IoT (ApexMic, KT, Bestechnic) and display/imaging (Galaxycore).

**China's IC fund has taken major stakes in many of China's leading IC companies**

**Figure 48: China IC fund holdings of high profile China private companies**

Non-listed companies	As of 12/04 Status	Company Description	Holding % (ownership %)				
			12/31/19	03/31/20	06/30/20	09/30/20	12/04/20
YMTC	Private	NAND Flash					49.0%
HLMC	Private	12" Foundry					39.2%
Payton Memory (JV with Kaifa)	Private	Memory Back-end					31.1%
SMIC 2020 Beijing JV	Private	Foundry					24.5%
UniSOC	Private, to IPO	Mobile AP and RF ICs	15.3%	15.3%	19.4%	19.4%	19.4%
SMIC South JV	Private	Foundry			14.6%	14.6%	14.6%
Innotron Memory/CXMT	Private	DRAM					14.1%
SMIC Ningbo JV	Private	RF SOI/Analog design					13.5%
APEXMIC, subsidiary of Ninestar	Private	MCU and Printer ICs					7.9%
KT Micro	Private, to IPO	RF and audio SOCs	1.6%	1.5%	1.5%	1.5%	1.5%
Puya Semiconductor	Private, to IPO	NOR and EEPROM	0.3%	0.3%	0.3%	0.3%	0.3%
Galaxycore	IPO approved	Driver IC and CIS	0.3%	0.3%	0.3%	0.3%	0.3%
Bestechnic (Shanghai)	IPO approved	Bluetooth/Audio SOCs	0.2%	0.2%	0.2%	0.2%	0.2%
ACM Research (shanghai)	IPO approved	Semi Equipment	0.1%	0.1%	0.1%	0.1%	0.1%

Source: Company data, Credit Suisse

## More China semis to list as A-share or on the Star Board

After 13 semis' A-share listings in 2019 and 16 YTD in 2020, there are still 45 high profile semiconductor companies that we believe have potential to list. The board is also allowing much earlier stage companies to list, including small-scale, loss-making China semiconductor suppliers. While few of these 45 semis have the same position in the ecosystem foundries as SMIC and Hua Hong, we think a few quality ones may drive sentiment if they continue to grow and expand market share in China.

A new phenomenon taking place is that the local ecosystem is seemingly turning more open for international semiconductor companies' China operations to list as A-share, vs a notable opposition in 2019. This should help, or allow, more international semi companies to participate in A-shares. Additionally, there are already over 2,000 semiconductor companies in China.

Another important momentum driver for the A-share semis sector could be the HK-SH Connect for the Sci-Tech Board. The regulators in Shanghai and Hong Kong have been in discussion to accelerate the inclusion of the A-share Sci-Tech Board in the HK-SH Connect. On 27 November, the regulators said it would be possible to include it in Connect in early-2021. Currently, there are 63 semis in the A-share market, including 25 on the Sci-Tech Board. The inclusion in the Connect should fuel fund flows for these semis and thus valuations.

**Figure 49: 45 higher profile private Chinese chip companies**

#	Company	Chinese name	Description
1	ACM Research Shanghai (Parent Co listing in US)	盛美股份(上海)	Equipment for wafer fab and back-end
2	Actions Technology	炬芯科技	TWS SoC
3	Analogix	硅谷数模	Display interface IC (DP, HDMI, USB)
4	Anhui North Core Linkage Microsystem	安徽芯动联科微系统	MEMS Gyro Sensor
5	ASR Micro	翱捷科技	Mobile and IoT AP and connectivity
6	AWINIC Tech	艾为电子	Analog, mixed signal and RFIC
7	Betterlife	贝特莱电子	Touch, AMOLED driver, fingerprint IC
8	Blue Rocket Electronics	蓝箭电子	Power discrete and IC
9	Blutrum	中科蓝讯	TWS, audio SoC
10	Brigates Micro	锐芯微	CMOS image sensors
11	Bright Semiconductor	博蓝特半导体	Substrate
12	BVD Semiconductor (Parent listing in HK)	比亚迪半导体	IGBT, CMOS image sensors
13	C'Core Technology	苏州国芯科技	IP, Custom design, fingerprint IC
14	Cai Qin Technology	灿勤科技	Filter, antenna
15	Chaoyang Micro	朝阳微电子	PMIC, AFE, and AI IoT IC
16	Circuit Fabology Microelectronics Equipment	芯基微电子装备	Direct write lithography and PCB tools
17	CRRC Times Electric's IGBT sub. (Parent listing in HK)	中车电气	IGBT
18	Dosilicon	东芯半导体	NOR, NAND, DRAM
19	ETEK Micro	力芯微	Power and analog IC
20	Everbright Photonics	长光华芯光电技术	Laser chip, VCSEL, Opto devices
21	FerroTec Hangzhou Semiconductor Wafer	杭州中欣晶圆半导体	Silicon wafer
22	Galaxy Microelectronics	银河微电	Diodes, linear IC
23	Galaxycore	格科微	CMOS Sensors and Driver ICs
24	Goertek's MEMS subsidiary	歌尔股份MEMS子公司 (分拆上市)	MEMS microphone and sensors
25	Innotron Memory	睿力集成	DRAM
26	Longsys	江波龙	NAND flash product
27	Loongson	龙芯中科	CPU
28	Macmic science & technology	宏微科技	Power discrete
29	MooreElite	摩尔精英	IC custom design
30	Nexchip (Powerchip's China JV)	晶合集成	Foundry for DDIC, CIS, PMIC and eNVM
31	Oriental Semi	东微半导体	MOSFET, IGBT
32	Phytium	飞腾	ARM CPU for PC and server
33	PowerTech Laser	联动科技	Semi discrete IC tester
34	Puya Semi	普冉半导体	NOR flash and EEPROM IC
35	Sage Micro	华澜微电子	SSD, USB, and memory controller IC
36	Shanghai Fudan (now listing in HK)	上海复旦	Smart card and MCU
37	Shanghai Microelectronics	上海微电子	Equipment for wafer fab and OSAT
38	SICC	山东天岳先进科技	SiC substrate
39	SKY Technology Development	中科仪	Equipment for semi, solar etc
40	Sun.King's IGBT business (Parent listing in HK)	赛晶半导体	IGBT
41	UniSOC	紫光展锐	Smartphone SoCs and RFICs
42	U-Precision Tech	华卓精科	Equipment
43	Vanchip	唯捷创芯	RF Power Amplifiers
44	WeEn Semi	瑞能半导体	Power discrete
45	Zuhzhou CRRC Times Electric	株洲中车时代	IGBT

Source: Company data, Credit Suisse

The large number of companies with less capability may incur a price war to the detriment of industry fundamentals, especially when the chip industry faces down cycles. But on the other hand, China's passion for semiconductors would facilitate local talent training and enterprises'

access to the capital market. Also, the industry history has showed that great and solid IC companies can emerge and grow from bubbles. The aggregate tracker of listed semiconductor sales has already rebounded from the deceleration to single-digit growth during the escalation of the trade/tech war in 2019 and is now rebounding toward +10% YoY growth by 3Q20.

**Figure 50: China listed semiconductor sales rebounding from the trade war slowdown**

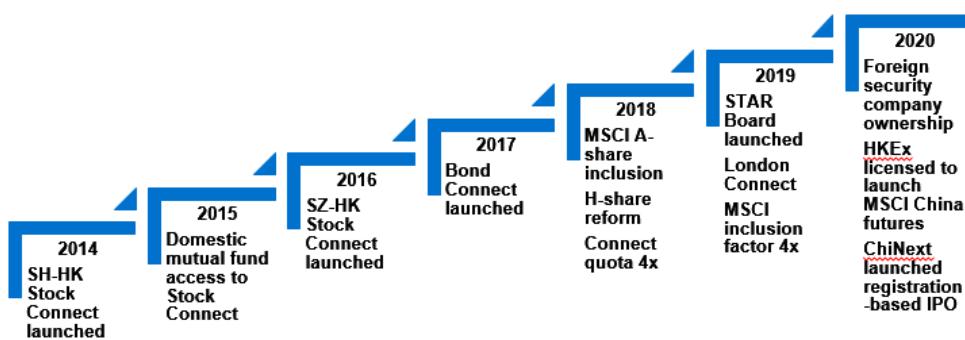


Source: The BLOOMBERG PROFESSIONAL™ service, Company data

## Capital markets: New listings provide capital and recognition to China's suppliers

In the past five years, we have seen a significant acceleration in the pace of capital market liberalisation measures in China. This represents a return to a trend that emerged in China prior to the Global Financial Crisis in 2008/09. These changes have continued and arguably accelerated despite headwinds such as pressure on the renminbi, the US/China trade war, and the China "crash" in 2015-16. Figure 125 summarises some of the key changes that we have seen since late 2014. Most of the changes have benefited both "sides" of the capital account, impacting flows both into and out of China.

**Figure 51: China accelerating its pace to open its capital markets**



Source: Company data, Credit Suisse

Multiple channels have been established and streamlined to facilitate cross-border equity flows with respect to China's foreign exchange controls. Since its introduction, Stock Connect has become the primary channel for cross-border equity market access. Although less relevant post-Stock Connect, the two Qualified Institutional Investor (QFII/RQFII) channels have both played a major role in cross-border equity-related flows prior to 2015. QFII and RQFII remain primary conduits for accessing onshore fixed income and the equity futures market (for hedging only), but have decreased in importance for cash equities. In September 2019, SAFE scrapped the quota (both aggregate and individual participant quotas) imposed on QFIIs and RQFIIs. In addition, in December 2019, the PBOC and SAFE released a draft regulation seeking opinions over consolidating QFII and RQFII into one programme, with a simplified registration process and the potential to expand the range of accessible products.

We aggregate Stock Connect and QFII/RQFII to represent the foreign funds. The aggregate market cap of the A-share technology sector held by foreign funds reached a historical high in 2Q20, though dropped a little in 3Q20. The holding market cap has been significantly raised to a high level in 2020, driven by: (1) the increased shareholding from northbound investors through the Stock Connect; and (2) the rally of the A-share technology sector's share price. We believe A-share's technology names have become increasingly attractive to foreign investors, and on the flip side, the impact of foreign fund flows on A-share has increased. With the de-escalation and normalisation of the trade war as Trump steps down, we expect foreign funds to raise their tech positions, not necessarily reaching the same level as domestic funds.

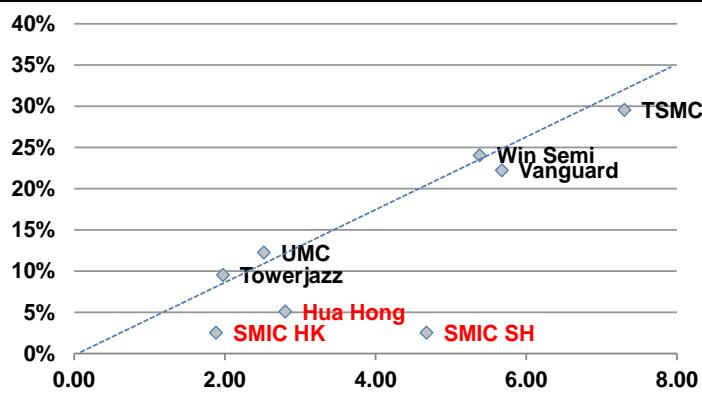
## Sizeable premium providing access to capital

A-share companies have traded at a 200%+ premium to the A-share market in the past five years so the high valuations could give a good source of funds for companies even at a relatively low profitability. We note foundries SMIC and Hua Hong trade at similar P/B to overseas peers despite ROEs below 5% while back-end companies at slightly lower 7-10% ROEs have P/B multiples of 3x-5x vs global peers trading at 1x-1.5x despite mid-teens ROEs.

**More than 30 China chip companies in process of A-share listings**

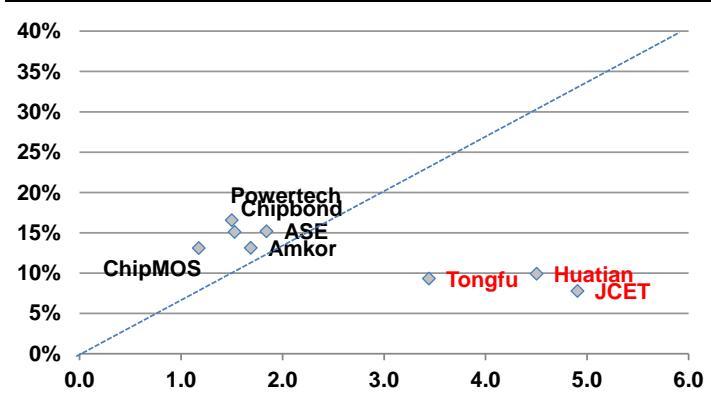
**China listings on A-shares trading at a premium to global peers' valuations despite lower returns**

**Figure 52: China foundries at a similar P/B despite lower ROE**



Source: Company data, Credit Suisse estimates

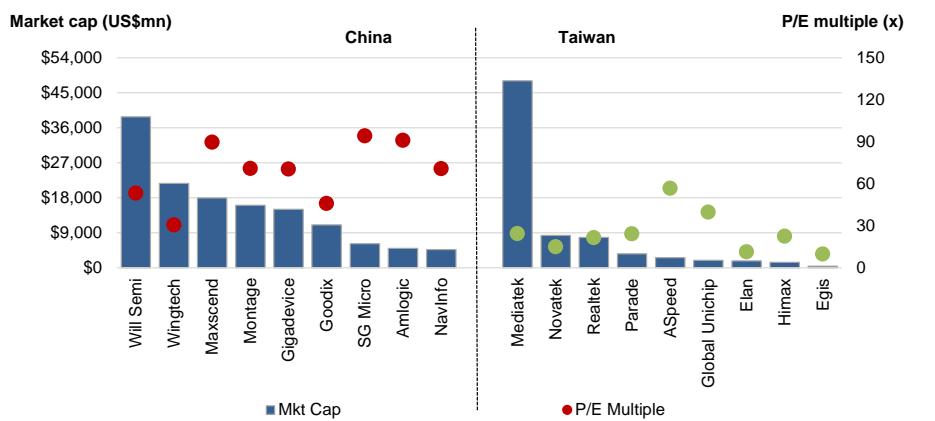
**Figure 53: China back-end at a P/B premium with lower ROEs**



Source: Company data, Credit Suisse estimates

The fabless sector is also seeing the same premiums open up, with leading China fabless valuations from US\$10-30 bn, dwarfing all but Mediatek in Taiwan with most trading at US\$1-10 bn valuations as the China fabless P/E's range at 60x-90x vs 15x-25x for the Taiwan fabless. The premium can help local companies with talent acquisition, M&A and funding of new investments projects though it does create risk of over-supply and adversely impacting industry returns, with investors willing to award growth at low profitability with high valuations.

**Figure 54: China fabless at a substantial premium P/E to Taiwan (66x vs 20x)**



Source: Company data, Credit Suisse estimates

## JV fabs ease the capex burden for advanced manufacturing

The China municipal funds have been helping the foundries build out capacity through JV fabs which allow the foundry operator to have operating control, but the JV contributes up to half of the capex outlay. During the first few years of fab investment, the high depreciation burden ensures losses but benefits the foundry P&L by sharing the loss of that operation with the JV partners. The contracts often allow the foundry to inject more capital over time to assume a larger ownership once the fab turns more profitable. Key foundry JV fabs include SMIC's JV 12" fabs in Shanghai and Beijing, Hua Hong's JV fab in Wuxi and UMC's JV in Xiamen.

**China has over 1mn wafers capacity planned, similar to TSMC's capacity base, with further 740k from overseas suppliers—though some, not all, would get built out in phases.**

The fabs are able to be funded despite low returns and along period to break even, prompting risk of oversupply. We track plans on paper to grow leading China fabs from 700k to 1.8 mn 12" WPM capacity, the equivalent of adding a TSMC (55% foundry share) to the industry's capacity if all is built out. Fortunately, most foundry projects are built in phases to meet coming demand in the next year rather than speculatively, to sit idle without customers.

**Figure 55: China has a number of domestic and foreign owned fabs in planning**

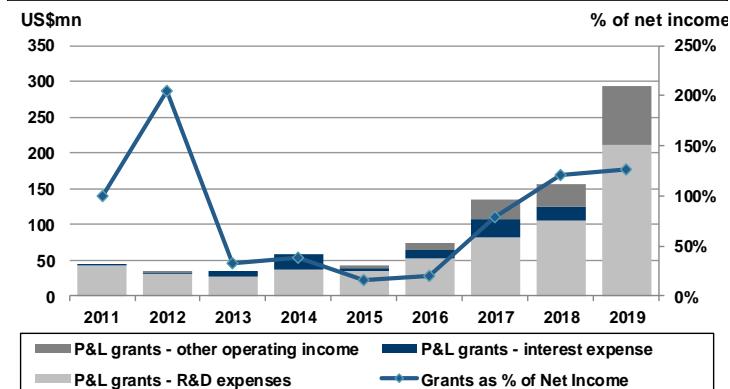
Origin Country	Company	Fab Site	Wafer size	Segment	Node (nm)	Installed (WPM)	Next phase	Final Capacity
China	Can Semi	Guangzhou	8"	Foundry	180-90nm	20,000	4,000	24,000
China	CR Micro	Qongqing	8"	IDM	0.35-0.18um	0	30,000	30,000
China	CXMT	Hefei	12"	DRAM	19nm	20,000	30,000	125,000
China	Fujian Jinhua	Fujian	12"	DRAM	25nm	On Hold	0	60,000
China	GTA Semi/ASMC	Shanghai	8"	Foundry	0.35-0.18um	10,000	60,000	60,000
China	GTA Semi/ASMC	Shanghai	12"	Foundry	65nm BCD	3,000	47,000	50,000
China	Hua Hong JV	Wuxi	12"	Foundry	90-55nm	20,000	20,000	80,000
China	Huali Micro	Pudong	12"	Foundry	28-14nm	60,000	20,000	80,000
China	SiEn	Qingdao	8"	Foundry	110nm+	0	0	80,000
China	SiEn	Qingdao	12"	Foundry	55/40nm	0	0	40,000
China	SMIC JV	Beijing	12"	Foundry	40/28nm	56,000	14,000	170,000
China	SMIC JV	Shanghai	12"	Foundry	14nm	7,000	8,000	35,000
China	XMC	Wuhan	12"	Foundry	90-45nm	60,000	20,000	80,000
China	YMTC	Wuhan	12"	3D NAND	3D NAND	20,000	30,000	300,000
<b>Upcoming fabs by domestic companies</b>						<b>236,000</b>	<b>219,000</b>	<b>1,035,000</b>
US	Alpha & Omega	Chongqing	8"	Discretes	130nm+	25,000	0	25,000
US	Alpha & Omega	Chongqing	12"	Discretes	130nm+	10,000	10,000	40,000
Korea	Hynix	Wuxi C3	12"	DRAM	1x nm	140,000	20,000	170,000
US	Intel	Dalian	12"	NAND	3D NAND	85,000	15,000	100,000
Taiwan	Powerchip Nexchip	Hefei	12"	Logic	90nm	25,000	15,000	40,000
Korea	Samsung	Xian	12"	3D NAND	3D NAND	150,000	110,000	260,000
Taiwan	TSMC	Nanjing	12"	Foundry	16nm	20,000	20,000	80,000
Taiwan	UMC JV	Xiamen	12"	Foundry	28nm	17,000	8,000	25,000
<b>Upcoming fabs by overseas companies</b>						<b>472,000</b>	<b>198,000</b>	<b>740,000</b>

Source: Company data, Credit Suisse estimates

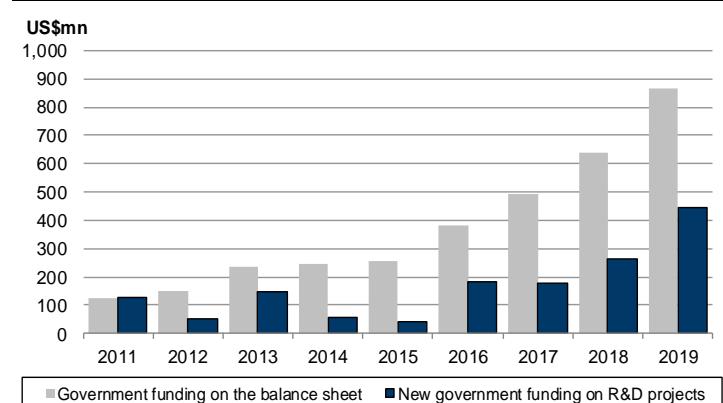
## R&D and equipment subsidies help manage the high cost of advanced technology development

China also provides support in terms of grants for the manufacturers tied to R&D projects and also investment grants that can offset interest expense. Our analysis of SMIC shows a steadily rising amount of government grants in the past five years since China's National Guideline for the IC industry in 2014 and its Made in China 2025 programme were implemented. The company's income statement recognition of grants for R&D, interest and other income has increased from US\$40-50 mn range during 2011-15 to near US\$300 mn in 2019. The funding for R&D, as the company also steps up meeting the national goal for FinFET commercialisation by 2020, has also accelerated, ramping up from US\$250 mn on the balance sheet during 2013-15 to over US\$850 mn in 2019, with new funding up from US\$\$40 mn in 2015 to US\$450 mn in 2019.

**China's subsidy and grant support has continued to rise in the case of SMIC**

**Figure 56: SMIC government grants rising since 2015**

Source: Company data, Credit Suisse estimates

**Figure 57: SMIC's government funding of R&D rising**

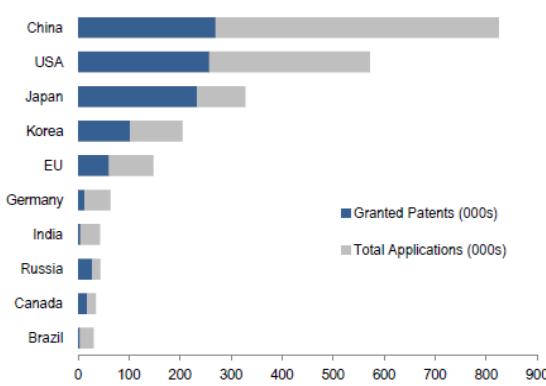
Source: Company data, Credit Suisse estimates

## Technology and IP from existing countries and companies supplemented by growing in-country talent

China is also looking to follow other countries that developed their semiconductor industry leveraging the insights of existing players. The electronics chain has had three major migrations of electronics' value and production, with the US leading in the 1950s-60s, a first migration to Japan and West Germany in the 1970s-80s, a second migration to the Asian Tigers in the 1990s-2000s (South Korea, Taiwan), and a migration with evolution to China in the 2010s.

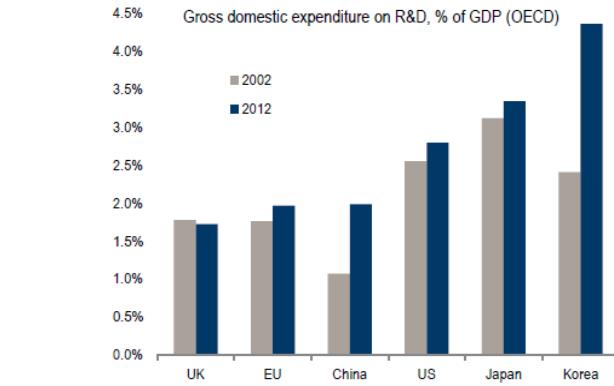
The Chinese lead companies have been aggressively offering packages to existing engineers from established companies to accelerate their build-up of know-how. According to H&L Management Consultants, a Taipei recruitment firm, more than 300 senior engineers from Taiwan moved to Chinese chip makers in 2018 and more than 1,000 since Beijing set up its National IC fund in 2014.

China has doubled its gross expenditure on R&D from 1% to 2% in the past decade (closer to the 3.0-3.5% for the US and Korea) and currently is in the lead in granted and total patents. China is also now graduating 7.5 mn citizens from college vs 3.3 mn in the US and may raise its global share of graduates from 18% in 2010 to 29% by 2020. In addition, China established the Thousand Talents programme in 2008 to attract foreign researchers and incentivise the return of Chinese scientists from abroad with a background in STEM.

**Figure 58: China has more applications and granted patents than any other country**

Source: Refinitiv, Credit Suisse Global Strategy Research

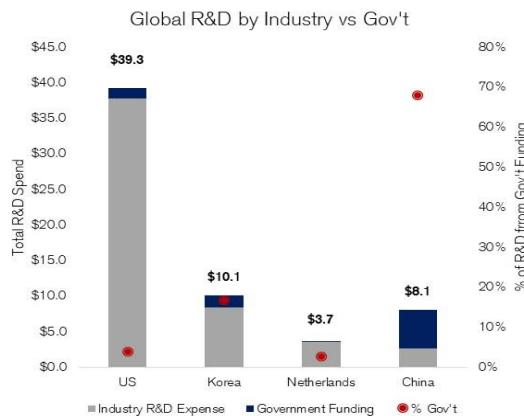
China's R&D ratio in semiconductors though is still coming off a much lower base, so the amount of R&D versus overseas companies still lags, with China funding at US\$8 bn vs the US

**Figure 59: China has overtaken the EU in R&D spend as a % of GDP (OECD data)**

Source: Refinitiv, Credit Suisse Global Strategy Research

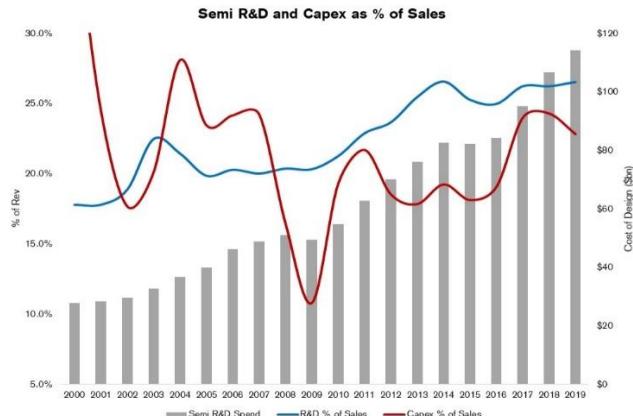
at US\$39 bn. R&D will be as much a burden for IC design side at 25% of sales as capex is for industry manufacturing also near 25% of revenue blended the IDM, fabless and foundry model.

**Figure 60: China R&D lags despite government subsidies**



Source: Refinitiv, Credit Suisse Global Strategy Research

**Figure 61: Semis R&D-intensive as it is capital-intensive**



Source: Refinitiv, Credit Suisse Global Strategy Research

## M&A another way to catch up, though now more difficult

The Chinese supply chain went through an aggressive series of M&As through 2012-15 and some selective deals in the past few years to build up its capabilities in acquiring established foreign companies. The high degree of activity has attracted attention and also caused government regulators to slow the approvals of deals, including the US CFIUS on the grounds of national security concerns. Before the M&A window narrowed, China completed deals including RDA (RF/Connectivity/DTV) and Spreadtrum (Mobile) to Tsinghua Unigroup, Montage (set-tops), ISSI to Ingénic (specialty memory), Omnipixel to Will Semiconductor (CMOS image sensors) and NXP's RF Power and Standard Products divisions (Nexperia). In the back-end, J CET acquired Stats Chippac to become the #3 global back-end supplier, Huatian closed on Flip Chip International and Unisem, while Tongfu Micro acquired two AMD advanced packaging facilities in China. In equipment, the E-Town Dragon Fund acquired Mattson, an equipment supplier of dry strip, etch, RTP and annealing used in front-end semiconductor manufacturing. ARM also spun off its China unit into a locally controlled company with better local access.

Companies currently view large-scale M&As as more difficult as either the US may block the deal or China may ask for concessions. Companies are wary of larger deals currently in light of US CFIUS and Presidential actions to block Broadcom-QCOM and China's Mofcom failure to approve Qualcomm-NXP. We expect the industry to still pursue acquisitions but political pressure increasingly will limit large scale global M&As or Chinese companies gaining IP quickly through acquisition, forcing it to maintain targets on smaller companies or acquiring IP or seeking lower profile JVs.

### China's M&A has slowed

## China's IC implications to the US and overseas sector

Over the last few years, it has been impossible to separate US semiconductors from the US/China geopolitical tensions. While restrictions placed on Huawei in May of 2019 by President Trump marked an escalation of the US' punitive actions against China's semiconductor aspirations, the US' policy to safeguard its semiconductor industry spans multiple administrations:

1. In 2003, President Bush appointed then AMAT CEO, James Morgan, Vice Chairman of the President's Export Council (PEC) an advisory body on international trade.
2. In 2010, the SIA relocated from San Jose, CA to Washington DC.
3. In 2016, President Obama announced a Semiconductor Working Group inside of the Presidential Council of Advisors on Science and Technology (PCAST), including Paul

Otellini, Rich Beyer, Paul Jacobs, and Mike Splinter among others, which authored in January 2017 a report entitled [Ensuring Long-Term US Leadership in Semiconductors](#).

4. In 2016, Fairchild Semiconductor rejected an acquisition offer from China Resources Microelectronics and Hua Capital Management citing concerns over the US approval process.

In addition, we remind investors that in March 2018, Broadcom withdrew its US\$117 bn bid to acquire QCOM after President Trump blocked the deal citing national security concerns. In May 2020, TSMC also announced its plans to build capacity in Arizona in collaboration with local and federal support, and most recently the DoC BIS has taken punitive action against SMIC.

Actions taken by the US government have only served to codify China's resolve to develop an independent domestic Semiconductor Industry, earmarking ~US\$118 bn in investments over the next five years ([China's 14th Five-Year Plan](#)). While the election of President Biden has largely been viewed as a modest de-escalation of US/China trade tensions—the SCE sector is up 40% since 2 November, vs SOX up 25%—it is clear that geopolitical considerations will continue to be an important dynamic of any investment view on the semiconductor industry and the balancing amongst IP Protection, National Security and Open Markets (China is ~20% of global chip production) will continue to present challenges and likely near-term dislocations in asset values.

We would highlight ten key themes for investing in the semiconductor sector:

1. **That which is strategically important is intrinsically valuable:** The US-China dynamics do not alter our Semiconductor Value Capture Thesis; in fact, the prominence of semis in US-China geopolitical relations only underscores the inherent value of the sector to global economies and national security. No one is proposing banning software into China—what software does is inherently difficult but not as foundational a technology as silicon.
2. **The semiconductor industry is both capex- and R&D-intensive:** China has been successful disrupting capex intensive industries (steel, solar, flat panel) but has been less successful disrupting R&D-intensive industries, with the exception of telecom. The semiconductor industry spends ~27% of revenue on R&D vs ~22% on capex—the R&D to revenue burden is the largest in the world, followed by pharma/biotech at only 22%.
3. **The US dominates two key choke points to China's semis aspirations—EDA software, semis cap equipment:** Any success China may have in developing a domestic semiconductor industry will still rely heavily on CNDS and SNPS for design software and ASML, AMAT, LRCX, KLAC, TEL for semiconductor capital equipment. Both sectors have meaningful mores which would argue that a truly independent China ecosystem is still decades into the future and US holds enough leverage to curtail China's progress by imposing restrictions/bans in these two critical areas, similar to what it has done in certain cases in the past year.
4. **The US will look to employ punitive and stimulative policies:** To date, the US has used mostly punitive tactics—restrictions/bans against ZTE, Huawei, SMIC, etc. We expect 2021 to place focus on stimulative policies including H.R. 7178 Creating Helpful Incentives to Produce Semiconductors for America Act (CHIPS Act), H.R 2881 Secure 5G Beyond Act. We also expect US semiconductor companies to be somewhat insulated to potential increases in corporate tax rates in CY22 and beyond.
5. **Domestic production of semiconductors will be a national priority in the US, Europe, Japan, and India.** Semiconductors have become as strategic to nation building as oil—similar to the SPR established in 1975, we expect the US and others to place a high priority on domestic production of semiconductors. Today, China represents ~12% of the 300 mm capacity with China/Taiwan representing ~35%. The US, in stark contrast, is ~12%, mostly concentrated in 3 IDMs, INTC, TXN, MU—i.e., the US fabless industry is even more dependent on international capacity.

6. **The Biden administration will be more predictable, albeit policy objectives will be mostly unchanged:** We have included a table which outlines President Biden's proposed cabinet and key policy personnel. While it is difficult to find China Hawks in Biden's historic sphere of influence, political expediency, especially against the back-drop of Rep Swalwell, is likely to force a more aggressive stance vis-a-vis China—albeit it is unlikely that China will be a pressing issue in January 2021.
7. **China will continue to make inroads, albeit likely at a measured pace:** Over the last 20 years—the approximate duration of China's focus on creating a domestic semis industry—China's domestic companies have increased from 2% of global semis revenue to 5%, despite an accumulative over US\$60 bn in investments. We see China continuing to make measured progress in NAND, CMOS image sensors, low-end analog, low-end RF, and MCUs. In addition, we expect European suppliers to fare better than US suppliers, as China prioritises independence from the US.
8. **COVID-19 could accelerate global supply chains transforming to being more sovereign, more redundant, more automated and more intelligent:** The global pandemic exposed key vulnerabilities to supply chains across the economy and could catalyse the political will to invest in domestic infrastructure especially in high tech, biotech, pharma, and healthcare. We expect supply chains to become more sovereign, more redundant and as a result more automated and more intelligent to offset higher costs. 2H CY21 could see increased investment in Industry 4.0, automation, and 5G.
9. **M&A approval process likely to become more complicated and time consuming:** M&A has been a key driver in semis, with 460 acquisitions with a nominal value of US\$535 bn over the last 20 years. While we continue to argue China uses M&A to drive concessions and is unlikely to outright block transactions, the US scrutiny is likely to increase, not decrease. Key M&As include ADI for Xilinx, NVDA for ARM, ADI for MXIM, MRVL for IPHI, CSCO for ACIA, among others.
10. **Worst-case scenario might not be that bad:** China continues to be a meaningful market for semiconductors (20% of global consumption). Semiconductors are more insulated than most industries to an all-out trade war between the US and China, as a full ban on China would significantly hamper its own ability to build a domestic semiconductor industry. China will need to continue to access the global semis market if it wants its economy to stay competitive, and the US will likely accelerate addressing key deficiencies in its own infrastructure.

**Figure 62: End-market exposure and degree of barriers to Chinese semiconductor efforts**

MOST INSULATED							LEAST INSULATED	
	EDA	Front End Equipment	High-end Analog	DRAM	Logic/SoC	Back End & Test	Microcontrollers	NAND
<b>Chinese Companies</b>	Hyperform	SMEE, Naura, Piotech, Grand, Awinic, SG Micro, BYD Raintree, AMEC, Kingsemi, Kingstone, ACM	Micro, OnBright, StarPower, CR Micro	Ingenic/ISSI, CXMT	Phytium, Montage, Hygon, Loongson, Sunway, Zhaoxin, HiSilicon, Rockchip, Allwinner, Amlogic, Actions, Vanchip, Maxscend, UniSOC, CanaanTek, ASR	JCET, Huatian, Tongfu, USI, China WL CSP SJ Semi	Unigroup, Will Semi, GigaDevice, Fudan Micro Silan, Giantec, NationZ	CEC, Huada Semi, YMTC
<b>ROW Companies</b>	Cadence, Synopsis, Mentor Graphics	AMAT, ASML, LRCX, Tokyo Electron, KLAC, SCREEN, Hitachi, Daifuku, ASMI, Murata, Nikon, Canon, Ebara, Tokyo TXN, ADI, IFX, ST, SWKS, Seimitsu, SEMES, Nuflare, NXPI, MXIM, ON, MCHP, BRKS, Wonik, Veeco, Aixtron, Renesas, MediaTek, Lasertec, Acelis, Ulvac, Disco, SMIT, Zeiss, Nova, Rudolph, Camtek	Samsung, SK Hynix Rohm, Toshiba, Winbond, MU	INTC, Xilinx, Samsung, TXN, QCOM, AVGO, Samsung, MediaTek, Novatek, MRVL, Magnachip, Lattice, Siltronix	AMKR, ASE, OSE Advantest, Anritsu TER	Renesas, NXPI, MCHP, MU, Samsung, WDC STM, IFX, TXN, Samsung, INTC, Korea Memory Toshiba	Macronix, Winbond	
<b>China Marketshare %</b>	-2%	-2%	3-5%	-1-2%	3-5%	-17%	-10-15%	-2-3%

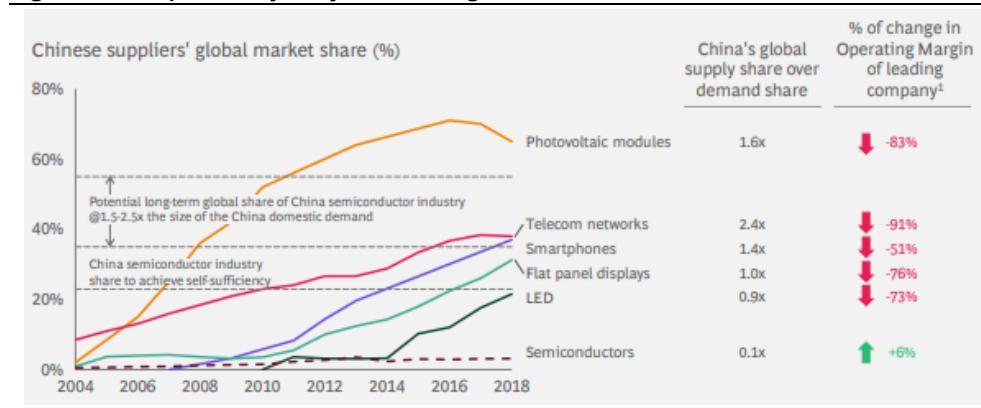
Source: Company data, Credit Suisse estimates

## US resistance to slow China's rise and maintain its industry leadership

The US has been resisting China's rise on concerns of national security, unfair competition from government policy support, and forced technology transfer, and to protect its leadership position from commoditisation and market share erosion. The US and other overseas countries and industry players worry about China's IP acquisition and commoditisation of industries after witnessing the margin compression in solar, LED, displays, telecom equipment, and Android smartphones, and are trying to maintain higher margins and barriers in semiconductors. Semiconductor has been an exception in seeing operating margin expansion, given the sharp margin erosion witnessed in other tech sectors where China rapidly expanded its footprint.

**US and overseas participants trying to avoid the commoditisation that crushed other tech industries profitability when China gained share bolstered by heavy domestic support**

**Figure 63: Chip industry wary of the margin erosion seen in other sectors from China**



## US policy actions accelerated under Trump, with tariffs and entity list restrictions on China suppliers

Broadly speaking, the US' action against China during the Trump administration came about in three areas: (1) tariffs, (2) entity lists and military end-use designations, and (3) the Clean Networks Act, with focus on curtailing the scope of Chinese telecom equipment in US networks. The trade and technology war started initially with tariffs coming through to narrow the trade gap with China. Most of the tariffs-related action against China from the US came in 2018 and 2019, but culminated with a trade agreement that prevented heavy tariffs on tech products in exchange for China purchase commitments on US exports.

Under the agreement, China had agreed to purchase an additional US\$200 bn worth of US exports (what was even then noted as a stretch target by most observers). Most tariffs were left in effect, and China did not address subsidies, forced IP transfer or state-owned enterprises—major prior issues that had actually started this trade dispute. As of October 2020, China imported just 57% of its 2020 YTD target of US goods under phase one of the agreement, according to US exports data (55% based on Chinese imports data).

**Figure 64: Trade tariff summary and current status**

	List 1	List 2	List 3	List 4A	List 4B
Announced Date Tariff	Jun 15, 2018 25%	Jun 15, 2018 25%	Jul 10, 2018 25%	Aug 13, 2019 15% > 7.5%	Aug 13, 2019 Cancelled
Tech Products Included	- Audio/ Video - Computer peripherals	- Semis	- Display related - Control/ switches - Printed Circuits - TV/ Monitors/ related parts - Computer peripherals - Audio/ Video - Routers/ Switches/Faxes	- Telephone sets - SSD Storage - Li-ion Batteries - PCs - Speaker/Headphones	- Smartphones - Notebook/Tablets - External monitors - Other tech end-products
Current Status	Effective - Jul 6, 2018	Effective - Aug 23, 2018	Effective - May 10, 2019, (10% - Sep 18 to May 19)	Effective - Dec 13, 2019 (15% - Sep 19 to Dec 19)	Effective - 15 Dec, 2019
Estimated Value of Tech Exports	2018: US\$ 1.1 bn 2019: US\$ 0.9 bn	2018: US\$ 3.7 bn 2019: US\$ 1.9 bn	2018: US\$ 72.2 bn 2019: US\$ 43.9 bn	2018: US\$ 17.2 bn 2019: US\$ 14.3 bn	2018: US\$ 87.5 bn 2019: US\$ 83.1 bn

Source: USTR, Credit Suisse

### Entity list actions having more impact on select companies

Huawei and its HiSilicon chip division received the heaviest strike, with restriction requiring a licence for any supplier from US or abroad using US tools and software to build its products. In semiconductors, SMIC is most notable for being added to the entity list in December. The US had a key leniency in that only licences for tools uniquely used for 10nm and below would be presumed denied while other mature tools would be reviewed case by case. Our report following the restriction noted [better than feared outcome](#) for SMIC as it would allow it to maintain its existing fab operations and could only cut off its very advanced technology development.

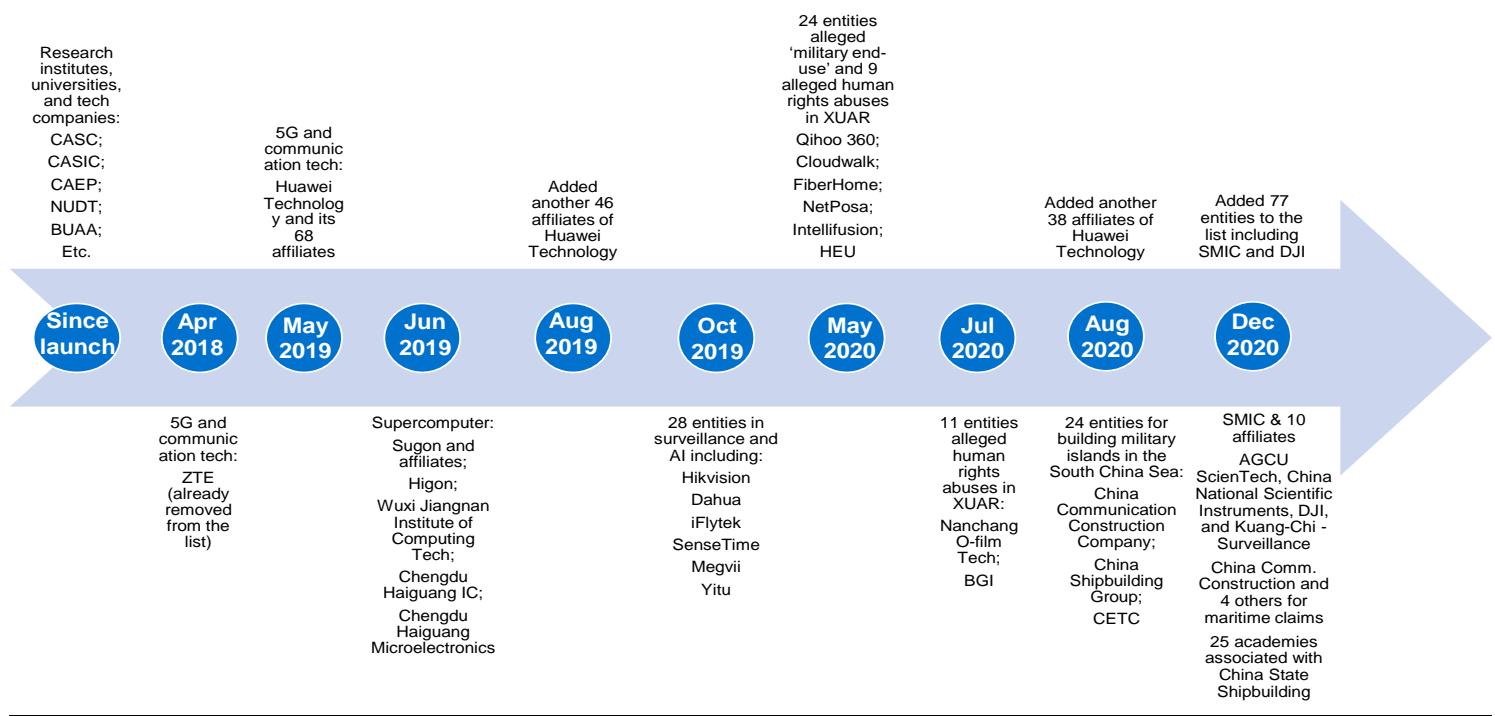
Beyond SMIC and Huawei, more than 200 Chinese companies/entities have been included in the US BIS's entity list. Entering 2020, the US restrictions on China expanded from the technology field into various fields, with barriers getting diversified (US uses various tools apart from tariff). Compared to 2018-19, the US has ended the use of a wide range of tariff tools post the Phase 1 reached on 13 December 2019, instead using precise strikes towards individual companies by leveraging various tools including the entity list.

**US has placed over 200 Chinese companies on the entity list, though Huawei and SMIC are the most notable for the hardware/semiconductor supply chain**

### 'Clean Network' programme

In addition to specific actions against certain Chinese companies, the US also introduced its 'Clean Network' initiative in April 2020, calling upon countries and corporations to join the effort to safeguard the privacy and thwart any attempt to obtain most sensitive information by "malign actors", by starting to demand a clean path for all 5G network traffic in and out of the US diplomatic facilities and disabling all untrusted IT vendors (including ZTE and Huawei).

On 5-Aug, the US State Department added five new provisions to its Clean Network programme, which aims to protect privacy for citizens and companies for their data and limit potential access by the Chinese Communist Party with [five new lines](#) in the US Department of State statement trying to ensure clean telecom networks, app stores and applications, cloud data centres and cable lines. The clean networks could also limit some China IC suppliers supplying into US communications networks and cloud data centres.

**Figure 65: Timeline of Chinese companies added to the US Commerce Department Entity List**

Source: US Commerce Department, Credit Suisse

## US now trying to re-build its own supply chain

The US is also now trying to correct years of under-investment in its own semiconductor fabrication and assembly following the lessons from the pandemic from having over-reliance on foreign suppliers for key medical gear. With the military rivalry with China growing and economic performance seeing ongoing sluggish growth in the manufacturing sector, US policy is starting to shift toward providing more public support. Grants/subsidies and tax incentives have far lagged other countries that have seen a rapid increase in their tech manufacturing base.

**Figure 66: Semiconductor manufacturing incentives gap: US vs ROW**

	China	South Korea	Singapore	Japan	Taiwan	Europe	Israel	US
Share of 300mm Manufacturing Capacity (2019)	12%	26.7%	6.5%	16.3%	22.9%	2.8%	0.8%	12%
Manufacturing Grants/Subsidies (2000-2020)	~\$50bn	\$7-10bn+	\$5bn+	\$5-7bn+	\$0.5bn+	\$2.5bn+	\$2.5bn+	\$0
Federal Tax Incentives (2000-2020)	5-yr tax holiday, Reduced tax rate, tax credits, VAT refunds	5-yr tax holiday, reduced tax rate, tax credits	Reduced tax rate (0-13%)	Tax credits	5-yr tax holiday	Tax credits	Reduced tax rate (6-12%), tax credits	None
Other Federal Incentives	Free/discounted land infrastructure support, Equipment leasing, preferential loans, localization policies	Infrastructure support, equipment incentives, workforce training	Equipment incentives, hiring credit	Preferential loans	Free/discounted land infrastructure support, preferential loans, workforce training, hiring credits	Preferential loans	Free or discounted land	None
% CAGR of 300mm Capacity (2013-2020)	15.7%	11.3%	10%	7.4%	6.5%	N/A	N/A	2.2%

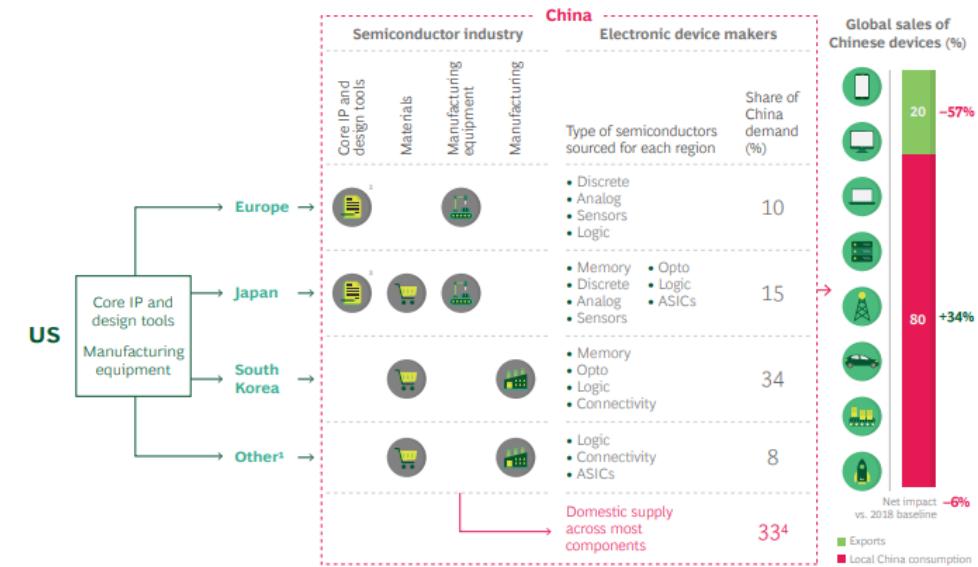
Source: Company data, Credit Suisse estimates

## Decoupling could lower the US leadership position

The US administration is trying to balance divergent commercial semiconductor industry interests to remain a leading global supplier to companies no matter the geography in a globally connected industry with policy objectives to improve national security and keep a gap over China by limiting China's access to US technology to boost its internal supply chain. BCG in a report commissioned with the SIA (Semiconductor Industry Association) dissected areas with overseas IP, materials, equipment and manufacturing could allow alternative suppliers to US.

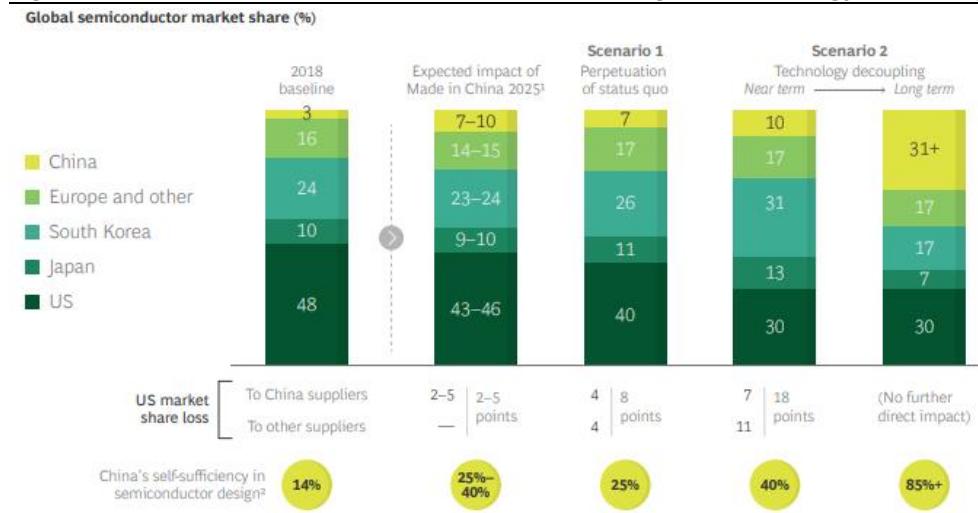
An SIA-commissioned BCG study cited potential share loss for the US industry from a more complete decoupling of supply chains

**Figure 67: China has options to diversify away from US suppliers**



In a status quo scenario, the report forecasted China's share rising with its Made in China 2025 objective from 3% to 7-20% by 2025, with the US' share falling from 48% to 43-46%. In a significant decoupling where the US cut off access to its technology to China, it forecasted China may lose overseas share from lower competitiveness but gain substantial domestic share substituting out US components, netting even sharper share gains. In that scenario, China would grow to 10% share by 2025 and long-term toward 31%, with the US' share falling from 48% to 30% as China accelerated efforts to source its own design or overseas players.

**Figure 68: US market share could be cut with China rising with technology decoupling**



## US policy under the Biden administration to strike some balance on commercial and national policy interests

Throughout the Trump administration, US-China relations have focussed more on punitive measures (Huawei bans, tariffs, and Entity List) than stimulative responses—and we argue that viewing through the latter could prove more useful as we enter a Biden administration. To be clear, we do not think directionally a Biden administration changes the US' long-term stance on China, but rather it makes the path there more predictable and drawn out.

We believe that the external environment of the US-China trade dispute should improve from some de-escalation by the US as it also listens to semiconductor industry groups trying to avoid a decoupling that requires foreign customers to diversify on fears of being cut off access or unable to supply all companies if it uses US tools/technology. While the US parties are showing bipartisan support for tougher policies on China, particularly for technology issues, we expect a more systematic approach including a reopening of discussions/negotiations between the two countries from the Biden government that could be positive to the sector. In our view, Biden would most likely try to forge a united stance on China trade with US allies, which would necessarily be a more slow-moving, more transparent and more predictable process than the unilateral policies that Trump pursued.

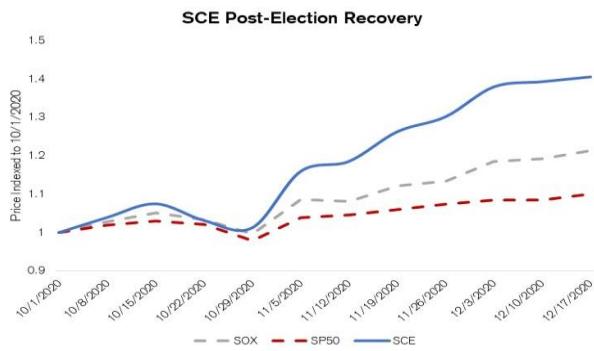
While we expect restrictions on the sale of key technologies to certain Chinese companies to stay in place, the scope will likely be better defined. Restrictions on using equipment or products from Chinese companies in government agencies or departments are likely to stay in place as well. Regarding the Huawei ban, we believe that restrictions on semiconductor fabrication or 5G chips will stay in place, but potentially more licences could be granted to legacy technologies.

We expect Biden would also pay closer heed to the World Trade Organisation and a rules-based trading system. Greater certainty and transparency would enhance businesses' ability to plan and would encourage investment.

Stocks are already pricing in a Biden administration with, at minimum, a less volatile relationship with China. Additionally, the major US semiconductor stocks (KLAC, LRCX, and AMAT) have proven to be a bigger Biden play than expected and are up 40-50% post-election versus 23% for the SOX index and 13% for the S&P 500, making up for the 15-20% correction after the military use restrictions placed on SMIC and fear of a faster decoupling of the supply-chains.

**US policy may try to balance commercial and national policy interests to maintain most of its supply of advanced technology globally**

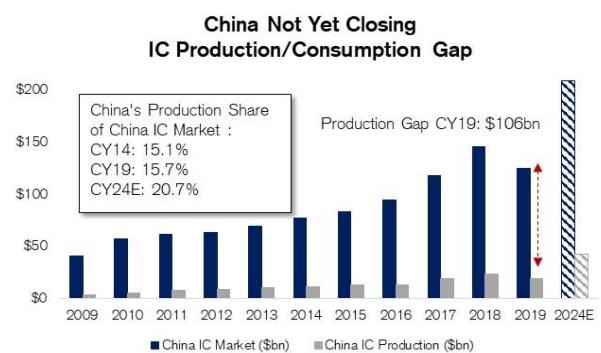
**Figure 69: SCE more of an election play than expected**



Source: FactSet

While Biden's cabinet may prove to contain more China "doves" than "hawks", we do not see these new cabinet members as truly being able to act dovish in our current political climate. We see the next four years of US-China policy as one characterised by more minor changes—related to tenor, tone, and tact—and hope that renewed focus on domestic semis policy (US Chips Act, 5G Infrastructure Bill) overrides headlines of punitive US-China measures.

**Figure 70: China still behind on IC production**



Source: IC Insights, Credit Suisse estimates

**Figure 71: Biden's Cabinet nominees suggest return to traditional diplomacy, but no major China policy changes**

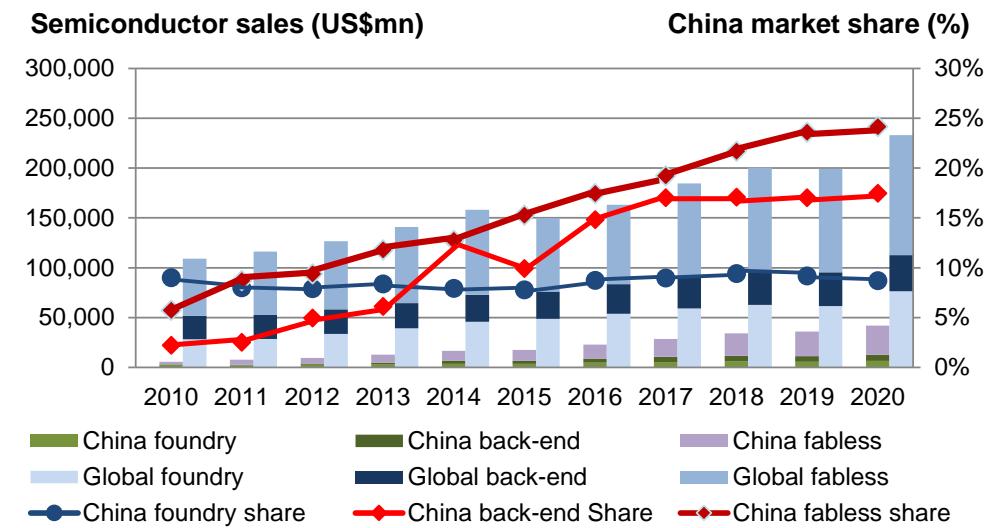
Position	Biden nominees	Trump administration	Biden nominees comments/policies
Secretary of Defense	Gen. Lloyd J. Austin III	Christopher C. Miller nominated 9 Nov (4 <sup>th</sup> under Trump after <a href="#">Mark Esper</a> was fired)	<ul style="list-style-type: none"> <li>Former commander of the military effort in Iraq, longtime Pentagon figure, but less known for his political leanings or interest in public-facing parts of the job.</li> <li>Some have suggested that General Austin's lower profile may suit Biden's hopes for a more muted Defense Department.</li> </ul>
Secretary of State	Anthony J. Blinken	Michael Pompeo	<ul style="list-style-type: none"> <li>Worked for the department under Obama, Clinton with 20+ years of experience.</li> <li>Blinken said he <a href="#">would support sanctions in response to Beijing</a> strengthening its control on the semiautonomous region of Hong Kong with a national security law.</li> <li>Seen by many in Democratic foreign-policy circles as a <a href="#">centrist</a>.</li> <li>Could signify re-engagement with US allies—by working with other countries; many analysts expect the <a href="#">U.S. can build more leverage in negotiations with China</a>.</li> <li>Blinken has in the past <a href="#">advocated a dual-track on China</a>, where the US "seeks to compete from a position of strength" while also "seek[ing] to work with China."</li> <li>Believes tariffs can work as a means of punishing China for trade violations, <a href="#">stating</a> that his team would "aggressively enforce American trade laws."</li> <li><i>See additional commentary: <a href="#">Blinken and US China Policies</a>.</i></li> </ul>
National Security Advisor	Jake Sullivan	Robert C. O'Brien	<ul style="list-style-type: none"> <li>Head of policy planning at the State Department under Hillary Clinton.</li> <li>Opposes "America First" guiding principle, saying it only <a href="#">isolated the United States</a> and created opportunities for its adversaries.</li> <li>Sullivan <a href="#">is emphatic that US strategy cannot be Cold War-redux</a>—China is a peer competitor with economic strength and must be treated as such.</li> <li><i>See also: <a href="#">Jake Sullivan and the Future of American Policy towards China</a>.</i></li> </ul>
US Trade Representative	Katherine Tai	Robert E. Lighthizer	<ul style="list-style-type: none"> <li>Experience as US House chief trade lawyer dealing with China policy.</li> <li>She also played a key role in creating the new North American Free Trade Agreement.</li> </ul>
Treasury Secretary	Janet Yellen	Steven Mnuchin	<ul style="list-style-type: none"> <li>Served as Fed Chair from 2014-18.</li> <li><a href="#">Monetary 'Dove', Somewhat Fiscal Hawk:</a> known for supporting lower interest rates and expressing concern about fiscal borrowing.</li> <li>Has supported paying for big spending programmes without raising taxes to offset the budgetary hit (Federal budget deficit record US\$3.1 tn in CY20).</li> <li>Supportive of free trade—expressed scepticism about Trump's China deal.</li> <li><a href="#">Ms. Yellen acknowledged</a> the US has "real issues" and "many valid concerns" with China, including China's infringement of US IP, subsidisation of state-owned enterprises and its control of crucial technology markets to foreign competition.</li> </ul>
Office of Management and Budget	Neera Tanden	Russel Vought	<ul style="list-style-type: none"> <li>Adviser to Hillary Clinton during 2016 campaign and outspoken critic of President Trump—one of Biden's most controversial nominees.</li> <li>Could signal Biden's focus on efforts to <a href="#">increase worker earnings</a> and reduce racial and gender discrimination in the economy.</li> </ul>
Director of White House Domestic Policy Council	Susan Rice	Cecilia Muñoz	<ul style="list-style-type: none"> <li>Former national security adviser and UN ambassador under Obama Administration.</li> <li>Signals the importance of domestic policy in Biden's early agenda.</li> <li>She has <a href="#">discussed replicating some elements of the National Security Council</a> in her new role, including a principals committee of Cabinet secretaries and others that could bring more structure to domestic policymaking.</li> </ul>

Source: WSJ, AP, Reuters, China Policy Institute, NY Times

# China's IC manufacturing still trying to gain competitiveness

The Chinese semiconductor sector is seeing varying degrees of success establishing self-sufficiency in its domestic ecosystem due to high barriers in the advanced semiconductor fabrication and moderate barriers and entrenched long-term high-volume supply agreements serving international customers in advanced package and test.

**Figure 72: China semiconductor industry continues to outgrow global peers**



Source: Company data, Credit Suisse estimates

In **foundry**, market share has been stable around 9% the past decade, despite National IC fund investments and heavy attention on this sector as the centre of China's industrial development. TSMC's wide lead on process technology supplemented by its growing advanced packaging portfolio allows it to address the high-end compute, mobile and networking demand. The Chinese foundries have kept up with market growth, but largely by leveraging their more legacy 8" and mature 12" process nodes to address high-volume consumer and wireless/wired connectivity, and specialty high-volume applications (CMOS image sensors, power management, bank cards, specialty memory).

**Randy Abrams, CFA**  
886 2 2715 6366  
randy.abrams@credit-suisse.com

**Chaoliem Tseng**  
852 2101 6795  
chaoliem.tseng@credit-suisse.com

**John W. Pitzer**  
1 212 538 4610  
john.pitzer@credit-suisse.com

**Hideyuki Maekawa**  
81 3 4550 9723  
hideyuki.maekawa@credit-suisse.com

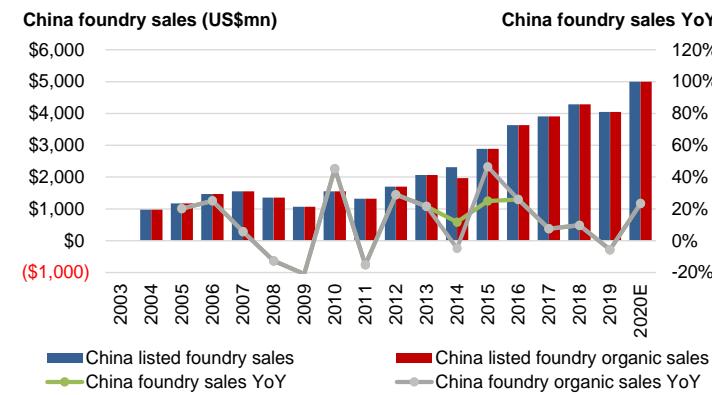
**Yoshiyasu Takemura**  
81 3 4550 7358  
yoshiyasu.takemura@credit-suisse.com

**Achal Sultania**  
44 20 7883 6884  
achal.sultania@credit-suisse.com

**Haas Liu**  
886 2 2715 6365  
haas.liu@credit-suisse.com

**China foundry share has remained 9% the past decade**

**Figure 73: China foundry sales ramped in 2020 after slow years**



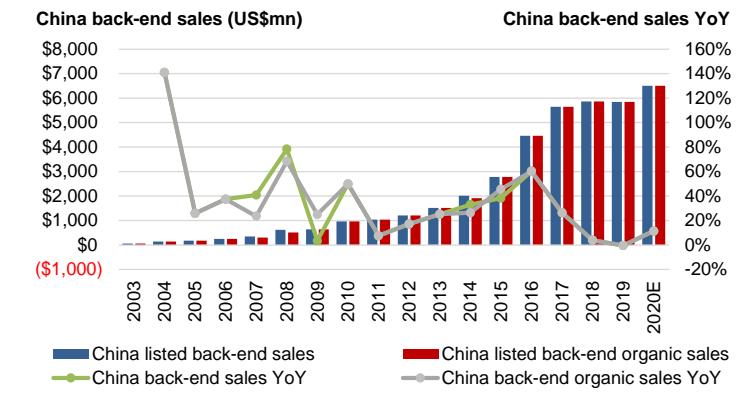
Source: The BLOOMBERG PROFESSIONAL™ service, company data estimates

In the **back-end** space, China has increased share following the M&A of overseas companies, and through a combination of aggressive pricing, targeting of SiP with high sales contribution but low margin, and addressing the growing base of local fabless and international companies

Global Semiconductors Sector

This document is being provided for the exclusive use of SHIBIN XIE at ALLIANZ GLOBAL INVESTORS US LLC.

**Figure 74: China back-end accelerated by M&A in 2015-16**



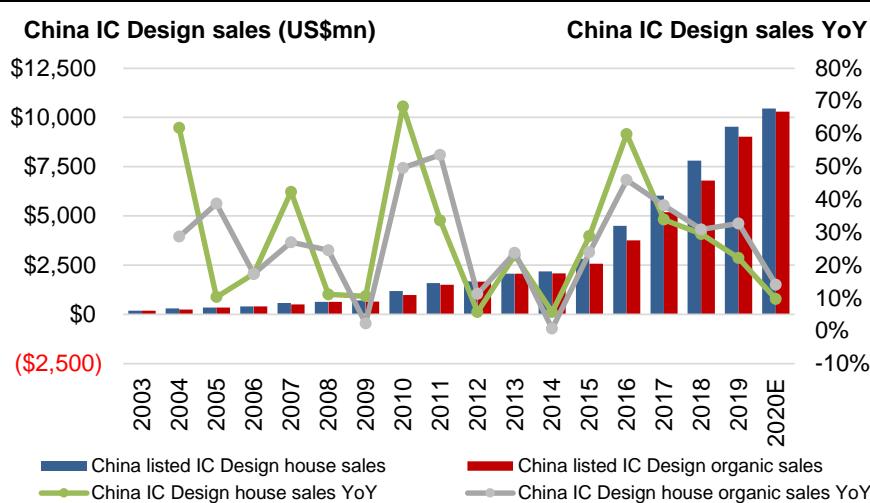
Source: The BLOOMBERG PROFESSIONAL™ service, company data estimates

with supply chains in China. The companies, following acquisition, can address the mainstream high-volume packaging—including flip chip and wafer level packaging—though lag foundry leader TSMC integrating high-end applications on its silicon interposers and high density fan-out process. Market share has been rising, and now at 17%, although profitability is still a concern with Chinese players operating at mid-single-digit operating margins.

In **IC design**, traction has been more pronounced, to lift share from 4% in 2010 to 22% in 2020, although this is a more mild 15% excluding HiSilicon now restricted by the US government from fabricating using US tools and has not penetrated some higher barrier processors or high performance RF and analog. Market share is the highest in the mobile segment (processor, modem, wireless power management, connectivity, CMOS sensors), wired connectivity (led by Huawei) and some new high-volume applications seeing strong support in China (crypto-currency and AI). Market share is still below 5% in approximately 70% of the overall industry—most notably processors, memory, GPU, FPGA, analog, MCU and RF has risen in the past year.

**China's back-end share through M&A has risen from 8% to 17% while IC design has grown from 4% to 22% (though 15% ex-Huawei)**

**Figure 75: China IC design growth accelerated from 2015-19**



Source: Company data, Credit Suisse estimates

## Foundry in-depth look: recent acceleration though advanced development further capped by the US

China has been committed to the foundry sector for the past two decades, with Hua Hong founded in the late 1990s and SMIC and Grace Semiconductor in 2000 charged with creating local champions for contract semiconductor manufacturing. Despite consistent government support, several industry cycles of investment and management teams, the China foundry sector's share in 2020 remains 8.7%, virtually unchanged from the 8.4% share it held in 2009, although has clawed back 90 bp of share since bottoming in 2015 at 7.8%.

**Figure 76: China foundries led by SMIC and Hua Hong, but still modest in the global picture**

Foundry	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	CAGR 2011-2018
SMIC	\$1,070	\$1,554	\$1,319	\$1,702	\$2,069	\$1,970	\$2,229	\$2,914	\$3,101	\$3,351	\$3,116	\$3,893	11.3%
Hua Hong (plus Grace)	\$357	\$620	\$610	\$572	\$585	\$665	\$651	\$721	\$808	\$929	\$933	\$951	5.5%
CSMC	\$151	\$225	\$230	\$212	\$210	\$341	\$328	\$418	\$456	\$492	\$469	\$539	9.3%
Shanghai Hauli	\$0	\$0	\$0	\$37	\$111	\$305	\$280	\$310	\$587	\$676	\$698	\$800	NM
XMC	\$0	\$0	\$0	\$0	\$180	\$210	\$200	\$250	\$300	\$300	\$280	\$300	NM
ASMC	\$95	\$130	\$124	\$137	\$128	\$132	\$120	\$116	\$124	\$180	\$169	\$180	3.9%
Shanghai Bellng	\$14	\$20	\$20	\$13	\$15	\$15	-	-	-	-	-	-	NM
<b>China foundry sales (US\$mn)</b>	<b>\$1,687</b>	<b>\$2,549</b>	<b>\$2,303</b>	<b>\$2,673</b>	<b>\$3,298</b>	<b>\$3,638</b>	<b>\$3,808</b>	<b>\$4,730</b>	<b>\$5,326</b>	<b>\$5,928</b>	<b>\$5,665</b>	<b>\$6,663</b>	<b>11.9%</b>
<b>YoY Growth</b>	<b>-22.2%</b>	<b>51.1%</b>	<b>-9.7%</b>	<b>16.1%</b>	<b>23.4%</b>	<b>10.3%</b>	<b>4.7%</b>	<b>24.2%</b>	<b>12.6%</b>	<b>11.3%</b>	<b>-4.4%</b>	<b>17.6%</b>	
<b>China foundry share (%)</b>	<b>8.4%</b>	<b>9.0%</b>	<b>8.0%</b>	<b>7.9%</b>	<b>8.4%</b>	<b>7.9%</b>	<b>7.8%</b>	<b>8.8%</b>	<b>9.0%</b>	<b>9.4%</b>	<b>9.2%</b>	<b>8.7%</b>	
TSMC	\$8,972	\$13,323	\$14,543	\$17,137	\$20,111	\$25,173	\$26,606	\$29,420	\$32,105	\$34,196	\$34,633	\$45,402	11.5%
GlobalFoundries	\$2,422	\$3,662	\$3,005	\$4,013	\$4,121	\$4,352	\$4,673	\$4,639	\$5,284	\$5,451	\$5,380	\$5,500	7.6%
UMC	\$2,697	\$3,810	\$3,605	\$3,587	\$3,913	\$4,219	\$4,419	\$4,593	\$4,904	\$5,028	\$4,782	\$6,013	3.6%
Samsung Foundry	\$486	\$390	\$770	\$1,295	\$3,200	\$3,339	\$2,621	\$3,700	\$4,475	\$4,721	\$4,340	\$5,859	24.1%
Japanese IDMs	\$972	\$1,095	\$992	\$940	\$954	\$1,111	\$1,261	\$1,291	\$1,289	\$1,318	\$858	\$858	-1.8%
Powerchip Logic	\$140	\$149	\$431	\$614	\$862	\$917	\$985	\$987	\$1,057	\$1,152	\$994	\$994	11.0%
TowerJazz	\$298	\$509	\$613	\$639	\$505	\$828	\$961	\$1,249	\$1,387	\$1,303	\$1,234	\$1,261	9.1%
Vanguard	\$386	\$395	\$509	\$490	\$400	\$546	\$736	\$802	\$819	\$959	\$914	\$1,098	7.6%
Dongbu	\$370	\$512	\$483	\$478	\$464	\$540	\$590	\$667	\$611	\$615	\$694	\$729	4.6%
IBM	\$383	\$500	\$545	\$634	\$495	\$519	\$280	-	-	-	-	-	NM
Magnachip	\$265	\$410	\$338	\$390	\$400	\$400	\$291	\$274	\$320	\$327	\$307	\$292	-1.2%
X-Fab	\$211	\$317	\$278	\$297	\$290	\$310	\$290	\$461	\$582	\$588	\$506	\$467	7.8%
Silterra	\$160	\$180	\$180	\$160	\$172	\$160	\$150	\$130	\$120	\$190	\$120	\$126	-4.9%
Other	\$692	\$504	\$159	\$370	\$165	\$199	\$1,221	\$1,057	\$1,077	\$1,147	\$1,181	\$1,217	28.4%
<b>Global foundry sales (US\$mn)</b>	<b>\$20,141</b>	<b>\$28,305</b>	<b>\$28,754</b>	<b>\$33,716</b>	<b>\$39,349</b>	<b>\$45,852</b>	<b>\$48,891</b>	<b>\$53,999</b>	<b>\$59,357</b>	<b>\$62,925</b>	<b>\$61,608</b>	<b>\$76,478</b>	<b>10.0%</b>
<b>YoY Growth</b>	<b>-10.8%</b>	<b>40.5%</b>	<b>1.6%</b>	<b>17.3%</b>	<b>16.7%</b>	<b>16.5%</b>	<b>6.6%</b>	<b>10.4%</b>	<b>9.9%</b>	<b>6.0%</b>	<b>-2.1%</b>	<b>24.1%</b>	

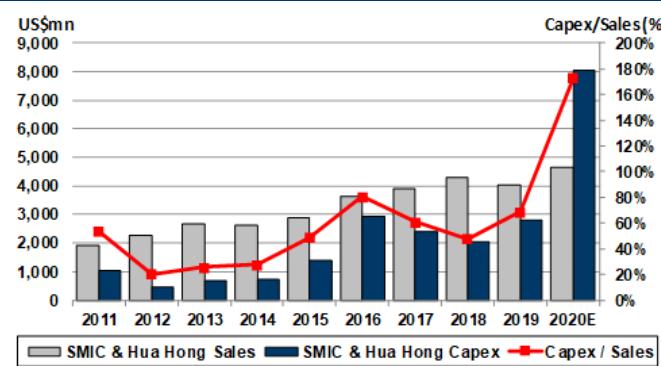
Source: Company data, Gartner, Credit Suisse estimates

## Key barriers to entry

- High capex requirements:** TSMC's capex at US\$25-28 bn in 2021 is 5-6x higher than SMIC's recent US\$5 bn levels and well above its US\$2-3 bn spending in the prior five years. Equipment cost for China's most advanced leading-edge capacity at 14nm is now US\$160 mn per 1,000 WPM capacity, limiting SMIC to 30,000 capacity additions per year at its current budget, paling in comparison to TSMC's installed 475,000 wafers per month capacity at 28nm and below. While SMIC has used its Shanghai and Beijing JVs to share the capex and initial losses, the capex, even including those JV investments, still implies that the scale gap only widens in the coming years with TSMC continuing to outspend.

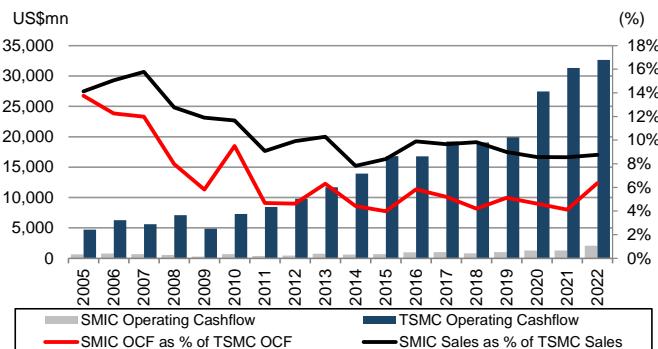
**Figure 77: China foundry share stable the past decade**

Source: Company data, Credit Suisse estimates

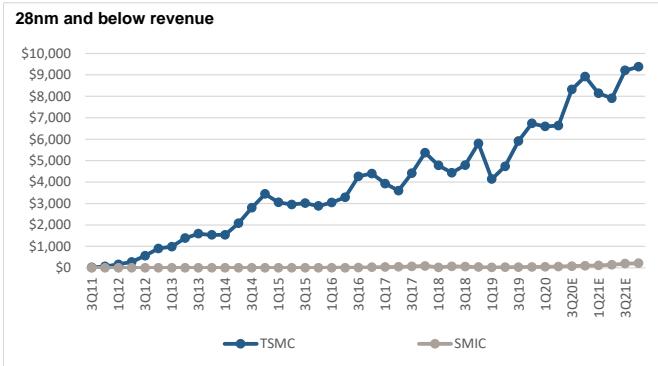
**Figure 78: China foundry capex above its sales in 2020**

Source: Company data, Credit Suisse estimates

The higher scale base also translates to a wide difference in revenues. SMIC's revenue base is still only 8% of TSMC's and is also playing out in investment capability, with operating cash flows also only 6% of TSMC's operating cash flow and capex staying around 20% of TSMC's overall capex. At a US\$5 bn budget, SMIC can add about 15,000 14nm wafers, enough to generate US\$1 bn on the advanced node, only 2.5% of TSMC's projected 2020 sales.

**Figure 79: SMIC <10% of TSMC's sales and cash flow**

Source: Company data, Credit Suisse estimates

**Figure 80: TSMC 28nm and below sales outpaces SMIC**

Source: Company data, Credit Suisse estimates

- **Capacity additions committed from the government, but not yet needed:** Contrary to memory where fabs are kept loaded to minimise unit costs, foundry requires specific wafer demand from unique customers that have qualified product, all subject to having effective and competitive capacity. SMIC has available government commitments for it to have another 100k Beijing JV 28/40nm capacity, 70k Shanghai JV 14nm capacity as well as additional 8" capacity in Tianjin. Our tracker of China capacity shows 540k WPM of capacity built out by foundries in China, out of the 1.123 mn available capacity planned, a level that would match TSMC's capacity if all built out.

**Foundries have plans on paper to double capacity to 1.1mn foundry wafers, similar to TSMC's capacity size, though this will come in phases.**

**Figure 81: China has sizeable committed capacity ramping each year**

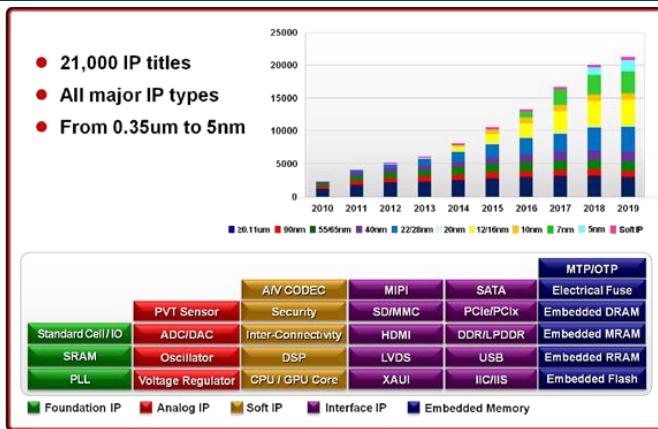
Company	Location	Wafer Size	Node	4Q17	4Q18	4Q19	4Q20	Max Capacity	Status
SMIC	Multiple Sites	8"	350-90nm	101.8	112.6	101.3	110.7	150.0	Mature
SMIC	Beijing	12"	90nm-28nm	46.0	42.0	52.0	52.0	52.0	Fully built
SMIC	Beijing 2A JV	12"	40nm	29.0	33.0	41.0	56.0	70.0	Ramping
SMIC	Beijing New Phase	12"	28nm	0.0	0.0	0.0	0.0	100.0	Announced
SMIC	Shanghai JV	12"	14nm	0.0	0.0	3.0	7.0	70.0	Ramping
<b>SMIC capacity build-out in China:</b>				<b>176.8</b>	<b>187.6</b>	<b>197.3</b>	<b>225.7</b>	<b>442.0</b>	
ASMC/GTA	Shanghai	5/6/8"	500-350nm	16.0	17.0	18.0	19.6	26.7	Mature
ASMC/GTA	Shanghai	12"	65nm BCD	0.0	0.0	0.0	3.0	50.0	Planning
CanSemi	Guangzhou	8"	180-90nm	0.0	0.0	16.0	20.0	24.0	Started 2019
CR Micro	Qongqing	8"	350-180nm	0.0	0.0	0.0	0.0	30.0	Planning
Hua Hong	Shanghai F1-F3	8"	350-90nm	74.7	77.3	79.1	80.4	90.0	Mature
Hua Hong	Wuxi F7	12"	90-65nm	0.0	0.0	10.0	20.0	80.0	Planning
Huali	Shanghai F5	12"	55-40nm	35.0	35.0	35.0	40.0	40.0	Fully built
Huali	Shanghai F6	12"	28-14nm	0.0	0.0	0.0	10.0	40.0	Ramping
Powerchip	Hefei	12"	90-65nm	0.0	6.0	15.0	25.0	40.0	Started 2018
SiEn	Qingdao	8"	350-110nm	0.0	0.0	0.0	0.0	35.6	Planning
SiEn	Qingdao	12"	90-28nm	0.0	0.0	0.0	0.0	40.0	Planning
TSMC	Nanjing	12"	16nm	0.0	10.0	10.0	20.0	80.0	Started 2Q18
UMC	Xiaman: F12X	12"	40-28nm	11.5	17.0	17.0	17.0	25.0	Ramping
XMC	Wuhan	12"	90-45nm	30.0	40.0	50.0	60.0	80.0	Ramping
<b>Other foundries capacity build out in China</b>				<b>167.2</b>	<b>202.3</b>	<b>250.1</b>	<b>315.0</b>	<b>681.2</b>	
<b>Total capacity build out in China</b>				<b>343.9</b>	<b>389.9</b>	<b>447.4</b>	<b>540.7</b>	<b>1123.2</b>	
<b>YoY capacity growth</b>				<b>13%</b>	<b>15%</b>	<b>21%</b>			

Source: Company data, Credit Suisse estimates

- **Technology gap remains high:** Technology and scale shows up as a sizeable gap both on mature and leading nodes. SMIC has done quite well to fully load 8" and its mature 12" capacity with specialty and second wave applications (fingerprint IC, smart cards, power management, image sensors, NOR flash, RF transceivers) but is still only 20% of TSMC's revenue base on these lagging nodes. On the advanced nodes, SMIC has only 10% of sales on 28nm and below nodes (pre Huawei ban in 3Q20), keeping its sales base limited in areas that account for 70% of TSMC's sales. SMIC will expand its 14nm to 15k WPM as customer orders ramp up, giving that node a chance to scale to US\$500 mn sales, though still only one-sixth the size of TSMC's 16nm capacity and not able to access the 120k capacity being built on 7nm and 50k on 5nm.

- Ecosystem development has posed a barrier:** The challenges of ramping up a new node every two years and increasingly a half node every year requires development across equipment, materials, design software (EDA), IP developers, foundry and customers, keeping an advantage for the incumbents ahead on technology. TSMC has noted a rising number of titles now approaching 21,000 IP blocks qualified on its manufacturing platform and a stepped up rise in IP qualification, architecture design and system verification. The Chinese foundries are working to put in place that ecosystem, but the size of revenue base with TSMC at US\$40 bn vs SMIC at US\$3.9 bn places a huge gap in resources committed, even with the government and IC fund backing and subsidy support.

Figure 82: TSMC qualifying a large IP pool on its process



Source: 2020 TSMC Technology Symposium

## TSMC captures a large share of the opportunity

### China IC design growth helps the foundry sector, though TSMC capturing high share

The foundry opportunity from domestic IC design companies in China has increased at a 22% CAGR to US\$12 bn, representing almost 20% of the foundry market and an opportunity for all the players. Due to its scale and leadership on advanced capacity, TSMC has grown even faster, increasing its share of China local customers from 20% in 2010 to over 70% in 2020. We estimate TSMC's China sales currently at US\$9 bn vs US\$2.6 bn for SMIC and US\$500 mn for Hua Hong.

TSMC has 70% China fabless share vs 20% for SMIC due to its technology leadership.

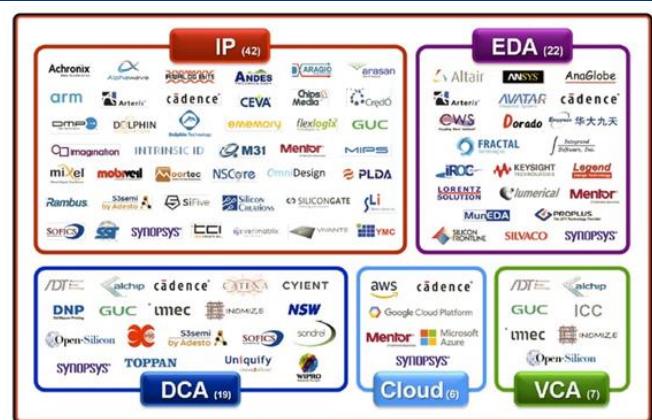
Figure 84: TSMC gaining share at the Chinese fabless



Source: Company data, Credit Suisse estimates

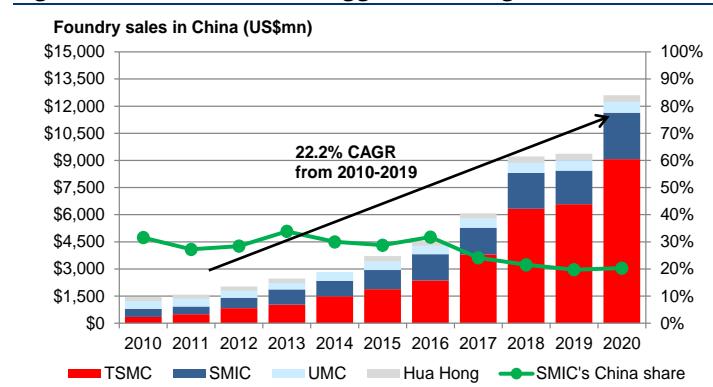
We also show the mix for foundry excluding HiSilicon each year as that has been a key driver of the foundry's China business. Excluding that customer, TSMC has 65% market share and SMIC 20% market share, with TSMC's sales at US\$4 bn and SMIC's sales at US\$1.5 bn

Figure 83: TSMC has built a wide ecosystem of partners

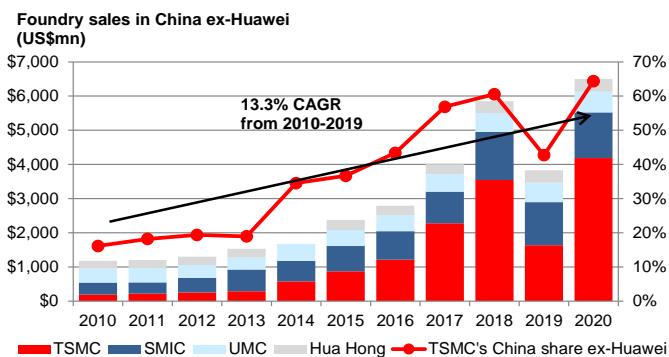


Source: 2020 TSMC Technology Symposium

Figure 85: SMIC share has lagged TSMC's gains



Source: Company data, Credit Suisse estimates

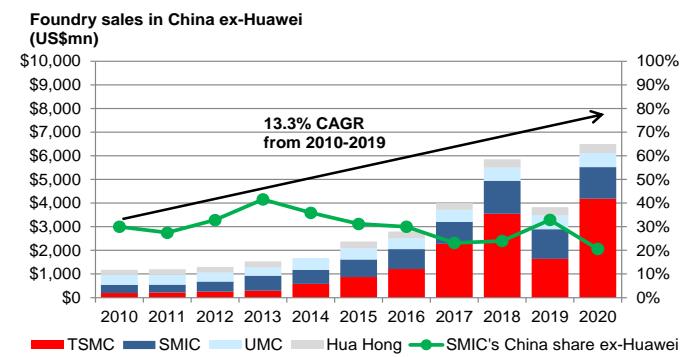
**Figure 86: TSMC share gains at China fabless ex-Huawei****TSMC also has a 12" fab to address the China opportunity**

TSMC is also building out a fab in Nanjing China in four phases. The first of four phases is capable of ramping up to 20k WPM at an initial cost of US\$3 bn. The company will also have a design service centre to support local IC design companies. The revenue contribution will be modest at only 4% of sales once built out, but can allow TSMC to stay competitive addressing local customers for its 16nm FinFET process as SMIC starts its Shanghai line for its 14nm in 4Q19. TSMC also leverages its design service companies in Taiwan to bring in China CPU and AI companies to fab on its advanced process.

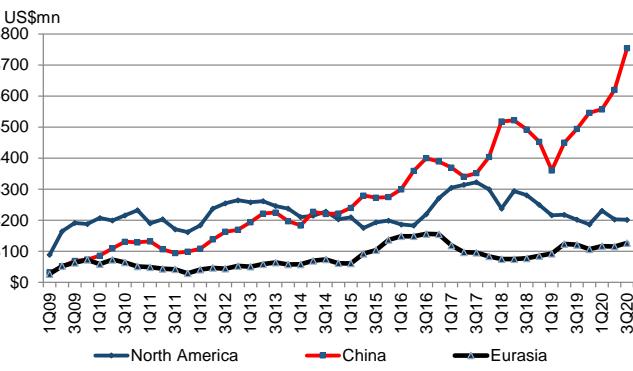
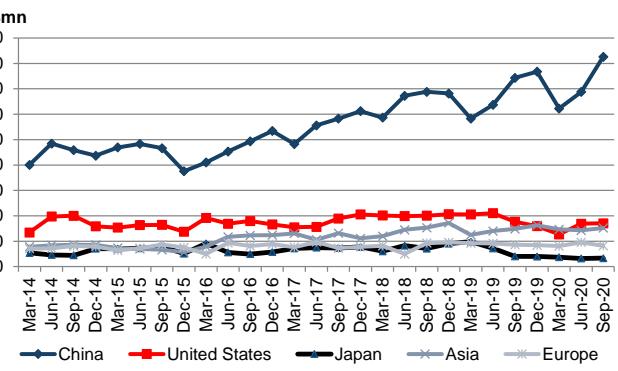
**SMIC: US restriction better than feared, though may limit its advanced foundry development.**

SMIC is in a high investment phase, reversing course from its strategy a few years back to fill its mature 12" and 8" with differentiated technology and gradually migrate to the advanced nodes. The company has leveraged Dr. Mong-Song Liang, formerly at TSMC and Samsung, to improve its foundry process and R&D capability to get from a lagging position on 28nm to a position of ramping initial 14nm and qualifying N+1 technology (around 8nm). Dr Shang-Yi Chiang ex-TSMC R&D head is also now rejoining SMIC as Vice-Chairman. Since the stepped up efforts, it is spending at a high capital intensity and R&D level and growing its ability to receive government R&D grants to advance its process towards 14nm and n+1 technology (~8nm) to target more advanced mobile and high performance computing applications.

The technology advancement, heavy capex, and state fund backing did draw the US government's attention which placed SMIC on its restricted military use list and also entity list for allegedly cooperating with the China military. The restrictions look better than feared with the company maintaining case-by-case licences on mature nodes and only presumption of denial on tools uniquely used at 10nm and below.

**Figure 87: SMIC share ex-Huawei has declined**

**SMIC's US entity list restriction looks severe only on the most advanced tools; may be a better than feared outcome unless US policy tightens further**

**Figure 88: SMIC's China volumes can grow w/legacy tools****Figure 89: Hua Hong sales rising from China customers**

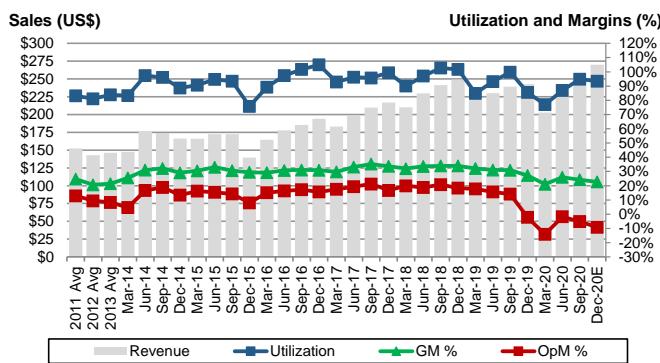
The restrictions should allow SMIC to continue its fab operations unless the US further tightens. That outcome would allow it to continue to satisfy mainstream communications, consumer, and smart home applications and capitalise on China IC design companies and some International customers seeking local China manufacturing sources. The outcome barring restrictions should still be for above industry growth and improving profitability though lacking some of the investor catalysts hoping for eventual penetration into advanced 5G, data centre and networking applications to better rival TSMC in China.

### **Hua Hong: focussed on specialty technology on mature 8"/12", privately held Huali pushing advanced technology**

China's other top foundry Hua Hong has carved out a role in China's development as a specialty foundry focussed on leveraging more mature technology on 8" and 12". The foundry achieved good scale on 8" foundry manufacturing through the merger of Grace and Hua Hong Semiconductor with differentiated specialty technology and particular capabilities both in applications using embedded flash (over 40% of sales) and in supplying domestic Chinese customers (over 50% of sales). The company's technology roadmap focusses production on a wide range of specialty applications including microcontrollers, power management, RF, smart cards, discretes and MEMS. The company has licensed Super Flash from SST, a Microchip subsidiary, and SONOS from Cypress to develop a competency in eNVM (embedded Non-Volatile Memory) used in smart cards (SIM cards, bank ICs, mobile payments, ID cards, social security cards) at 35% of sales and targeted to reach 50% of sales long term.

Hua Hong is now moving ahead more aggressively on the first 40k WPM of its new 12" fab for full tool installation by early-2021 and plans a further 40k fab for production ramp in 2022-23. Its sister company Huali also has 40k WPM capacity on 28-55nm and is also building a second advanced 12" fab with an eventual capacity for 40k for 28-14nm.

**Figure 90: Hua Hong building scale over near-term GMs**



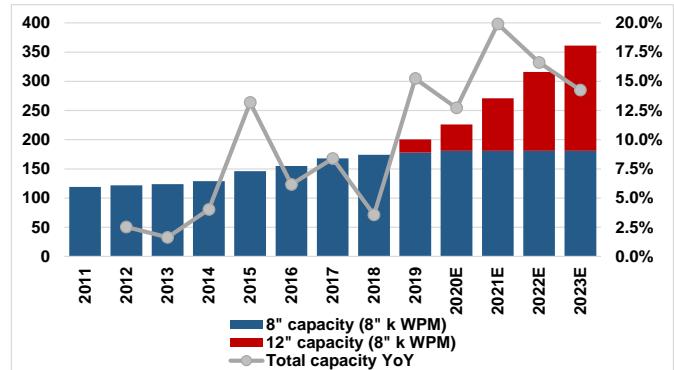
Source: Hua Hong Semiconductor

### CR Micro and other China chipmakers

**CR Micro (China Resource Microelectronics):** Headquartered in Wuxi, CR Micro is an IDM (integrated device manufacturer) and also provides foundry and OSAT (outsourced semiconductor assembly & testing) services. CR Micro operates three 6-inch production lines in Wuxi and two 8-inch production lines in Wuxi and Chongqing. The capacity of the 6-inch and 8-inch fabs reached 206,000 wafers per month (2.47 mn wafers p.a.) and 111,000 wafers per month (1.33 mn wafers p.a.) in 2019, of which Wuxi 8-inch takes 61,000 wafer per month (730,000 wafers p.a.) and Chongqing 8-inch takes 50,000 wafers per month (600k wafers p.a.). As of 3Q20, capacity of Wuxi 8-inch and Chongqing 8-inch fabs reached 62,000 wafers per month (744,000 wafer p.a.) and 61,000 wafers per month (732,000 wafers p.a.).

**Hua Hong aggressively ramping a mature 12" fab to capture growth from mature semiconductor applications (NOR flash, CIS, discretes/analog, MCUs)**

**Figure 91: Hua Hong aggressively expanding 12" capacity**



Source: Hua Hong Semiconductor

**CR Micro is an analog IDM and foundry based in Wuxi**

**Figure 92: CR Micro's wafer fabs in operation**

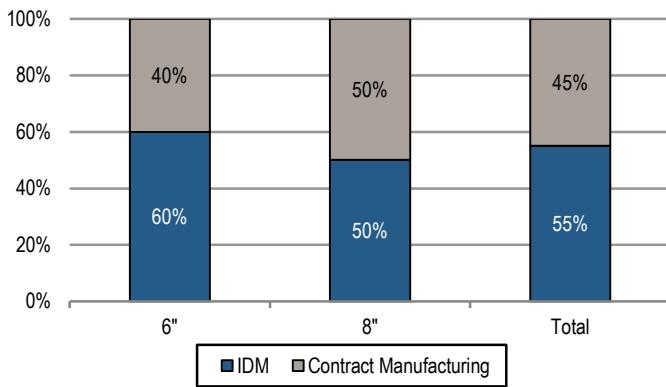
Location	Line	Process	Total capacity
Wuxi	6" x 3	Analog, BCD, MEMS, DMOS, Power Discrete, etc.	2.48mn wafer per year or 207k wafer per month
Wuxi	8"	Advance, BCD, Analog, DMOS, etc.	744k wafer per year or 62k wafer per month
Chongqing	8"	Medium- & low-voltage trench gate MOS, shield gate MOS, super junction MOS, SBD, etc.	732k wafer per year or 61k wafer per month

Source: Company data, Credit Suisse

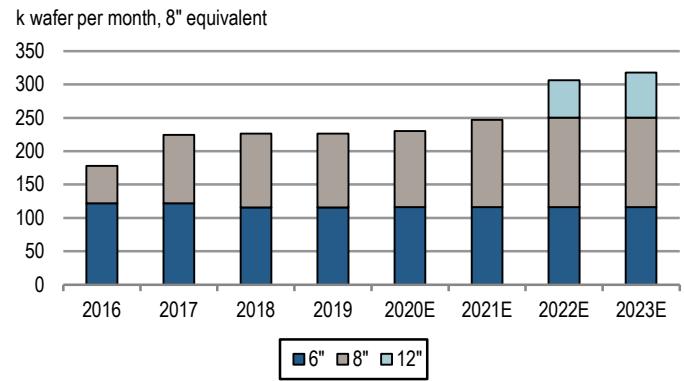
The company offers wafer fabrication service covering 1.0-0.11µm nodes for CMOS (Complementary Metal Oxide Semiconductor), DMOS (Double-diffused Metal Oxide Semiconductor), BCD (Bipolar-CMOS-DMOS), mixed-signal, high-voltage CMOS, RF (radio frequency) CMOS, bipolar, BiCMOS, NVM (Non-Volatile Memory), MOSFET, IGBT, MEMS, GaN, SiC, etc. As of now, CR Micro allocates roughly 55% of foundry capacity for its IDM (Integrated Device Manufacturing) business and 45% to the Contract Manufacturing Service business (for external customers). Key foundry customers include China IC design companies, like MEMSensing, GoerTek, AWINIC, NCE Power, Chipown, and Fuman Electronics.

We expect future capacity expansion from: (1) Wuxi 8-inch line to added capacity of 16k wafer per month for BCD and MEMS. CR Micro raised Rmb1.5 bn for this project during IPO and expects the project to kick off in 2Q 2021. (2) CR Micro is working with a few partners to build a 12-inch production line in Chongqing for power semiconductor, with capacity of 30k wafers per month and total capex of Rmb7.5 bn. It expects this new 12-inch line to ramp up production from end-2021 or 2022. CR Micro will only have minority share of the new Chongqing 12-inch fab, and the agreement between CR Micro and its partners entitles the former to operate the 12-inch fab and has priority to use the capacity for CR Micro's chip products. CR Micro may acquire more stake and consolidate the Chongqing 12-inch fab after its ramps up production and turns a profit. (3) Capacity expansion on existing Chongqing 8" line and Wuxi 6" lines to add a few thousand wafers per month through de-bottleneck. (4) Silicon Carbide 6" line to add roughly 1k wafers per month.

CR Micro's foundry business recorded revenue of Rmb2.3 bn in 2019, only 0.5% of global foundry market share. We do not expect CR Micro to pose a meaningful threat to global foundry players.

**Figure 93: CR Micro uses about 45% of total wafer capacity for contract manufacturing**

Source: Company data, Credit Suisse estimates

**Figure 94: We expect CR Micro's foundry capacity to see continued growth**

Note: 12" line might not be consolidated by CR Micro at its early stage.

Source: Company data, Credit Suisse estimates

**Huali Microelectronics (HLMC)** was founded in 2010, headquartered in Shanghai and is affiliated to Hua Hong Group. Huali is another important 12" foundry in China besides SMIC. Many China fabless rely on either Huali or SMIC or both to produce chips. After the US restrictions on SMIC in September 2020, China fabless may rely on Huali even more going

forward. Huali operates two 12-inch fabs in Shanghai with first 12" fab at 40k WPM with US\$600-700 mn sales doing mostly logic and CIS on 40-55-90nm and second fab running about 10k-15k WPM shipments and US\$200-300 mn annual sales run rate with capacity for 40k WPM, covering 28nm-14nm nodes for more advanced logic and development of FinFET transistors. Huahong Semi (1347.HK) said before it has the right to merge Huali under the major shareholder approval.

**XMC** was founded in 2006 in Wuhan and is now an affiliate of Tsinghua Unigroup. XMC operates two 12-inch fabs in Wuhan with total capacity of 135k wpm (8" equivalent), covering 90nm-45nm nodes, and focusses on NOR flash, CIS (CMOS image sensor), RF (radio frequency) and logic.

**ASMC** formerly was Shanghai Philips Semiconductor, founded in 1988, and got listed and delisted from Hong Kong Exchange in 2007 and 2019. ASMC operates three fabs of 5", 6" and 8", with total 8" equivalent capacities of 3k, 24k and 29k wafers per month. But its wafer fabrication service only covers 0.5-0.35μm nodes and power/MEMS products.

**CanSemi** was founded in December 2017 and headquartered in Guangzhou. With investment of Rmb13.5 bn, CanSemi Phase I started mass production in September 2019 and has capacity of 36k wafers per month (8-inch equivalent) for 0.18μm-90nm nodes. CanSemi Phase II is expected to launch in 2021, with capacity of 54k wafer per month (8-inch equivalent) and focussing on 90-65nm nodes.

**Nexchip (JV with an overseas company).** Nexchip was established in 2015, as a joint venture between Powerchip (5346.TWO) and Hefei Construction Investment Holdings. Powerchip now holds 41% of Nexchip, while Hefei Construction Investment Holdings and Hefei Xinping Industry Investment (also under Hefei Construction Investment Holdings) holds the rest 59%. Nexchip's Fab N1 of Phase I was completed and started mass production in 2017, and reached capacity of 20k wafers per month by end-2019 and 30k by October 2020. It is reportedly to expand to 45k by end-2021. It offers 150/110/90/55nm manufacturing service for DDIC (Display Driver IC) for TDDI used in smartphone, as well as large-sized DDI for TV/IT products by offering competitive pricing versus producing on 8" fab. It has been building its new N2 fab and will have 10k capacity next year. The N2 fab is planned to have 40k by 2024. The N2 fab will extend technology to 40nm, allowing Nexchip to deliver more diversified foundry service including DDI, MCU, power management IC and CIS. Additionally, Nexchip is planning a new N3 fab for 160k wafer capacity.

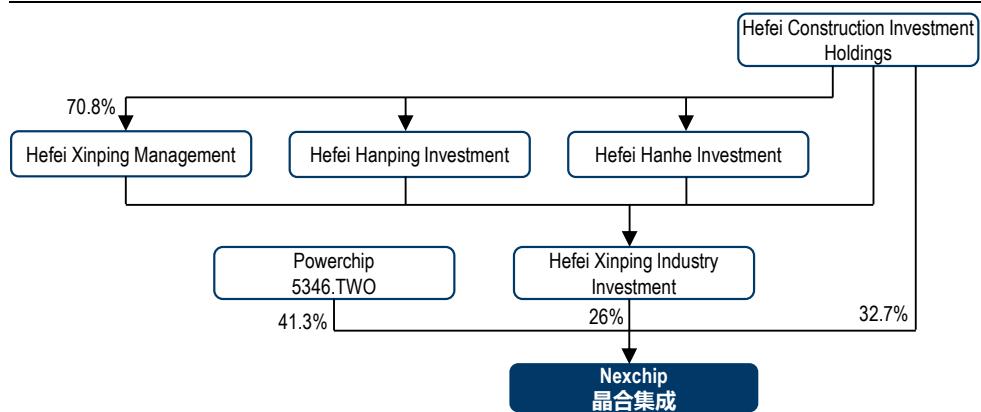
**Nexchip is a JV between Powerchip and Hefei targeting driver ICs, MCUs, CIS and analog**

**Figure 95: Comparison among CR Micro, Huali and other China chipmakers**

Company		Node						Application							Capacity in 2019			
English	Chinese	0.35-0.5μm	0.11-0.25μm	90nm	65/55nm	45nm	14-40nm	Logic	Analog	Power	Display driver IC	CMOS image sensor	Memory	Radio frequency	MEMS	6"	8"	12"
CR Micro	华润微	✓	✓					✓	✓	✓				✓	✓	116	111	
ASMC	上海先进	✓								✓					✓	24	29	
XMC	武汉新芯			✓	✓	✓		✓				✓	✓	✓				135
Huali	上海华力				✓		✓	✓	✓	✓	✓	✓	✓	✓	✓			169
CanSemi	粤芯		✓	✓				✓	✓	✓	✓	✓						36
Nexchip	晶合集成		✓	✓				✓			✓							45

Note: Capacity in k wafer per month and 8" equivalent

Source: Company data, Credit Suisse estimates

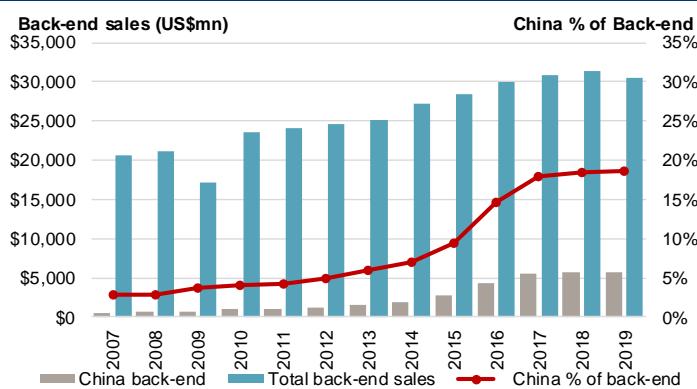
**Figure 96: Shareholding structure of Nexchip**

Source: Company data, Credit Suisse

## Back-end: turning focus towards profitability

China OSAT's global market share increased from 8% in 2014 to 17% in 2017, following JCET's acquisition of STATS ChipPAC and Tongfu's acquisition of AMD's back-end facilities. These acquisitions had quickly increased China OSAT's global presence and capabilities by adding international customers and more advanced flip chip and wafer level packaging.

**China OSAT share has increased from 8% to 17%, though bolstered by M&A in 2016**

**Figure 97: China accelerated share gains with M&A in 14-15, though now stabilising a bit**

Source: Company data, Credit Suisse estimates

In the years since, back-end market share has remained most stable as the suppliers focus on improving profitability. China OSATs grew revenue by a ~7% CAGR from Rmb4.6 bn in 2016 to Rmb6 bn in 2020, and China OSATs' global market share remained at the 17% level in 2016-20. China OSATs' market share stayed at the same level over the past five years mainly due to three reasons:

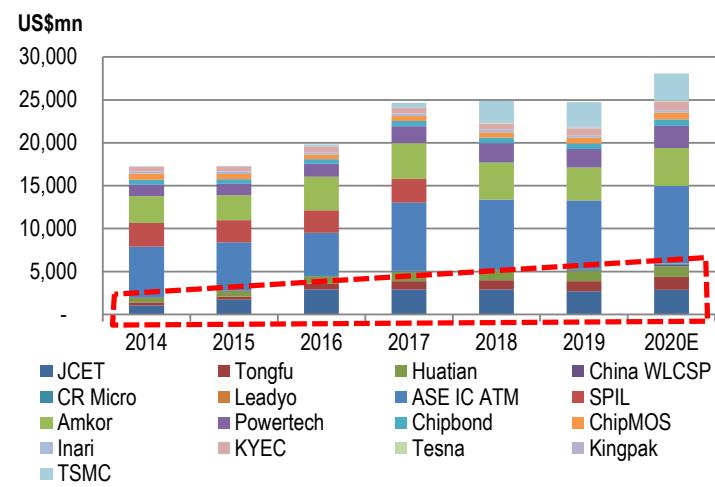
- Adversely impacted by its aggressive pricing.** In 2016-18, China OSATs were very aggressive in top line growth and thus cut prices to compete with overseas pure-play OSATs. This hurt everyone.
- TSMC share gains in advanced packaging.** China OSATs, similar to global pure-play OSATs, are behind TSMC in terms of advanced packaging and TSMC has been taking away some share of the growing advanced packaging segment in 2016-20 with its high density fan-out and its integration of high performance compute ICs on a silicon interposer.
- Execution and efficiency still lags overseas peers.** Despite improved capabilities, the major China OSATs' execution and efficiency are still behind overseas OSATs, and as a result, it is very difficult for China OSATs to gain meaningful market share away from regional OSATs, especially with the trade conflicts since 2018.

**Figure 98: Comparison of ASE-SPIL with JCET, Huatian, and Tongfu**

	US\$mn	Revenue GM OPM FCF				Top customers & revenue %
		2020E	2020E	2020E	2020E	
3711.TW	ASE	15,756	17%	8%	230	Apple 22% (including USI module revenue), HiSilicon 13% (18% pre-ban), QCOM 8%
	ASE ex-USI	8,578	21%	11%	180	Broadcom 7%, Mediatek 7%, AMD 5%, Nvidia 4%, Infineon 3%, STM 3%, NXP 3%
600584.SS	JCET	3,872	15%	6%	379	Apple, Broadcom, Huawei HiSilicon, Spreadtrum, Bitmain/Cannon, Samsung
002185.SZ	Huatian	1,300	23%	10%	-117	Gigadevice, Maxscend, On Semi, Galaxycore, Huawei
002156.SZ	Tongfu	1,596	16%	5%	-123	AMD, Mediatek, Broadcom, Huawei HiSilicon, STM, TI, NXP

Source: Company data, Credit Suisse estimates

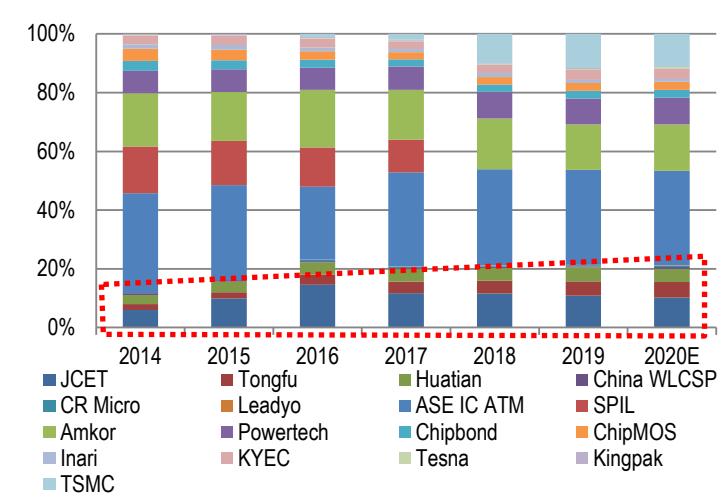
The wave of acquisitions in the 2013-15 period made the China OSATs a competitive force and source of self-sufficiency on mainstream and reasonably advanced technology (flip chip, fan-out packaging) for China. The one area of lag is still in the high-end advanced packaging, where TSMC has also emerged over the past five years by supplying the high density fan-out (InFO) process for Apple's application processor and CoWoS (silicon interposers) for advanced graphics integrating high bandwidth memory and high-end FPGAs.

**Figure 99: Post M&As in 2015-16, China OSATs grew revenue at 7% CAGR to approximately Rmb6 bn in 2020**

Source: Company data, the BLOOMBERG PROFESSIONAL™ service, Refinitiv Datastream, Credit Suisse estimates

Chinese OSATs after their aggressive M&A were initially rearing to expand capacity and gain share even at the expense of pricing and margins operating near break-even levels, helping trigger several points of gross margin erosion for the whole sector. Due to that expansion and also taking on some high dollar value but low margin SiP projects, Chinese companies have grown at a 25% CAGR (19% excluding M&A) to reach 17% market share.

After aggressive expansion in 2015-18, China OSATs observed low GM in 2016-19 due to weaker execution, pricing competition, depreciation burden and so on. This has also caused leading panel maker BOE to set up a JV with Taiwanese driver IC backend Chipbond, instead of building capacity by itself, as the driver IC backend requires specialised tools and is still under overcapacity, while end customers are very concentrated at Taiwanese fabless and Korean DDI makers keep their production mostly with Korean backend. In 2020, China OSATs changed their strategy and became more focused on improving profitability. China's localisation trend also allowed them to maintain high loading throughout 2020 without sacrificing pricing. As a result, the major China OSATs—namely JCET, Tongfu and Huatian—have generated 3-4 pp GM improvement this year. We expect China OSATs to continue to focus on profitability while improving their technology capability and management/production execution.

**Figure 100: China OSATs' global market share from 12% in 2014 to 23% in 2016, but then stay at 21-22% in 2016-20**

Source: Company data, the BLOOMBERG PROFESSIONAL™ service, Refinitiv Datastream, Credit Suisse estimates

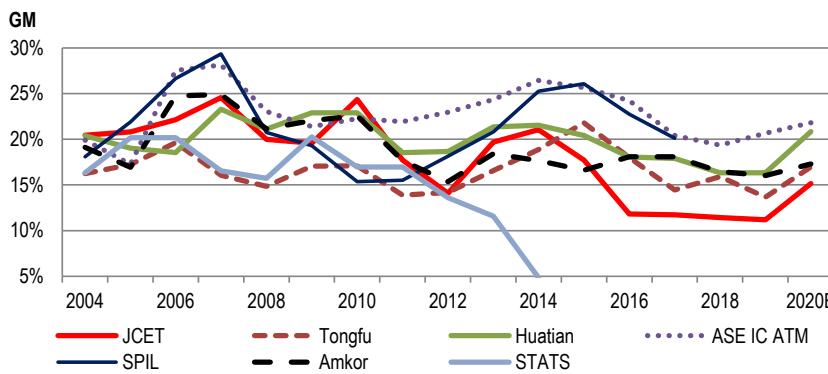
**Figure 101: China's back-end sector has grown at a 21% CAGR to reach 17% share in 2020 (+17% CAGR excluding M&A)**

Sales comparison	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	10-20 CAGR
JCET	\$343	\$347	\$535	\$582	\$703	\$830	\$1,043	\$1,713	\$2,875	\$3,540	\$3,607	\$3,393	\$3,621	\$3,647	21%
Tianshui Huatian	\$107	\$114	\$172	\$203	\$257	\$399	\$536	\$616	\$824	\$1,039	\$1,081	\$1,172	\$1,228	\$1,453	22%
Tongfu Micro	\$171	\$181	\$255	\$251	\$252	\$288	\$339	\$369	\$689	\$967	\$1,093	\$1,194	\$1,473	\$1,745	19%
<b>China back-end</b>	<b>\$621</b>	<b>\$642</b>	<b>\$962</b>	<b>\$1,035</b>	<b>\$1,213</b>	<b>\$1,517</b>	<b>\$1,918</b>	<b>\$2,698</b>	<b>\$4,388</b>	<b>\$5,545</b>	<b>\$5,781</b>	<b>\$5,760</b>	<b>\$6,323</b>	<b>\$6,845</b>	<b>21%</b>
YoY Growth	6%	3%	50%	8%	17%	25%	26%	41%	63%	26%	4%	0%	10%	8%	
China % of back-end	3%	4%	4%	4%	5%	6%	7%	10%	15%	17%	17%	17%	17%	17%	
JCET ex Stats	\$343	\$347	\$535	\$582	\$703	\$830	\$1,043	\$1,268	\$1,722	\$2,323	\$2,382	\$2,170	\$2,853	\$2,867	
Tianshui Huatian	\$107	\$114	\$172	\$203	\$257	\$399	\$536	\$616	\$824	\$1,039	\$1,081	\$1,172	\$1,228	\$1,453	
Tongfu Micro ex AMD	\$171	\$181	\$255	\$251	\$252	\$288	\$339	\$369	\$427	\$529	\$602	\$567	\$677	\$782	
<b>China organic back-end</b>	<b>\$621</b>	<b>\$642</b>	<b>\$962</b>	<b>\$1,035</b>	<b>\$1,213</b>	<b>\$1,517</b>	<b>\$1,918</b>	<b>\$2,253</b>	<b>\$2,973</b>	<b>\$3,891</b>	<b>\$4,065</b>	<b>\$3,910</b>	<b>\$4,758</b>	<b>\$5,102</b>	<b>17%</b>
YoY Growth	6%	3%	50%	8%	17%	25%	26%	17%	32%	31%	4%	-4%	22%	7%	
ASE	<b>\$3,007</b>	<b>\$2,608</b>	<b>\$3,992</b>	<b>\$4,345</b>	<b>\$4,401</b>	<b>\$4,829</b>	<b>\$5,273</b>	<b>\$4,873</b>	<b>\$4,982</b>	<b>\$8,035</b>	<b>\$8,230</b>	<b>\$8,133</b>	<b>\$9,258</b>	<b>\$9,506</b>	<b>9%</b>
YoY Growth	-2%	-13%	53%	9%	1%	10%	9%	-8%	2%	61%	2%	-1%	14%	3%	
% of back-end	14%	15%	17%	18%	18%	19%	19%	18%	17%	25%	24%	24%	25%	24%	
<b>Amkor</b>	<b>\$2,659</b>	<b>\$2,179</b>	<b>\$2,939</b>	<b>\$2,776</b>	<b>\$2,760</b>	<b>\$2,956</b>	<b>\$3,129</b>	<b>\$2,885</b>	<b>\$3,894</b>	<b>\$4,186</b>	<b>\$4,316</b>	<b>\$4,053</b>	<b>\$4,993</b>	<b>\$5,222</b>	<b>5%</b>
YoY Growth	-3%	-18%	35%	-6%	-1%	7%	6%	-8%	35%	8%	3%	-6%	23%	5%	
% of back-end	13%	13%	12%	12%	11%	12%	12%	11%	13%	13%	13%	12%	13%	13%	
SPIL	\$1,925	\$1,729	\$2,026	\$2,084	\$2,188	\$2,336	\$2,743	\$2,613	\$2,640	N/A	N/A	N/A	N/A	N/A	P/A
Powertech	\$886	\$908	\$1,202	\$1,342	\$1,407	\$1,267	\$1,321	\$1,339	\$1,500	\$1,960	\$2,258	\$2,182	\$2,468	\$2,728	7%
TSMC	\$218	\$249	\$340	\$442	\$477	\$450	\$733	\$873	\$1,115	\$1,408	\$1,838	\$2,022	\$2,237	\$2,440	21%
UTAC	\$711	\$601	\$925	\$981	\$978	\$748	\$734	\$878	\$875	\$874	\$888	\$901	\$914	\$928	0%
ChipMOS	\$466	\$362	\$527	\$555	\$612	\$589	\$699	\$677	\$622	\$604	\$610	\$642	\$681	\$751	3%
Chipbond	\$150	\$163	\$385	\$403	\$478	\$481	\$562	\$574	\$584	\$621	\$618	\$636	\$653	\$737	5%
KYEC	\$465	\$382	\$561	\$516	\$496	\$495	\$537	\$540	\$623	\$647	\$691	\$846	\$982	\$1,031	6%
J-Devices	\$498	\$523	\$549	\$576	\$532	\$825	\$923	\$822	N/A	N/A	N/A	N/A	N/A	P/A	0%
Carssem	\$370	\$275	\$394	\$360	\$356	\$350	\$336	\$360	\$378	\$384	\$389	\$395	\$401	\$407	0%
Walton	\$258	\$256	\$286	\$279	\$280	\$299	\$330	\$249	\$272	\$310	\$317	\$324	\$332	\$332	1%
Unisem	\$373	\$300	\$433	\$380	\$354	\$315	\$319	\$323	\$340	\$345	\$350	\$355	\$360	\$366	-2%
Orient Semi	\$327	\$265	\$357	\$369	\$360	\$322	\$456	\$507	\$490	\$457	\$504	\$516	\$528	\$535	4%
AOI Electronics	\$248	\$211	\$234	\$304	\$331	\$343	\$363	\$392	\$336	\$414	\$412	\$381	\$389	\$395	5%
Formosa Advanced	\$292	\$257	\$376	\$404	\$360	\$302	\$304	\$276	\$264	\$259	\$265	\$271	\$278	\$282	-3%
<b>Major Players (ex-China)</b>	<b>\$12,851</b>	<b>\$11,267</b>	<b>\$15,528</b>	<b>\$16,116</b>	<b>\$16,372</b>	<b>\$16,907</b>	<b>\$18,762</b>	<b>\$18,181</b>	<b>\$18,916</b>	<b>\$20,505</b>	<b>\$21,687</b>	<b>\$21,658</b>	<b>\$24,474</b>	<b>\$25,661</b>	<b>5%</b>
YoY Growth	0%	-12%	38%	4%	2%	3%	11%	-3%	4%	8%	6%	0%	13%	5%	
% of back-end	61%	66%	66%	67%	67%	67%	69%	67%	64%	63%	64%	64%	65%	65%	
Other suppliers	\$7,736	\$5,241	\$7,104	\$6,873	\$6,942	\$6,659	\$6,450	\$6,251	\$6,268	\$6,479	\$6,363	\$6,413	\$6,923	\$7,101	0%
YoY Growth	9%	-32%	36%	-3%	1%	-4%	-3%	-3%	0%	3%	-2%	1%	8%	3%	
<b>Total back-end sales</b>	<b>\$21,209</b>	<b>\$17,150</b>	<b>\$23,593</b>	<b>\$24,024</b>	<b>\$24,526</b>	<b>\$25,082</b>	<b>\$27,130</b>	<b>\$27,130</b>	<b>\$29,572</b>	<b>\$32,529</b>	<b>\$33,830</b>	<b>\$33,830</b>	<b>\$37,721</b>	<b>\$39,607</b>	<b>5%</b>
YoY Growth	3%	-19%	38%	2%	2%	2%	8%	0%	9%	10%	4%	0%	12%	5%	

Source: Company data, Credit Suisse estimates, (2014 revised to show the impact of JCET + Stats)

In the past year, the China suppliers became a bit more selective on bidding for SiP projects, spending on capex and more restricted from large M&A on greater national protectionism, and therefore may have more limited share gains. One key opportunity would be to continue outgrowing the industry with the emergence of more local IC design companies.

China OSAT GMs have improved over the past year with a focus on improving profitability and passing on low margin SiP projects.

**Figure 102: Three major China OSATs (JCET, Tongfu, Huatian) improving GMs in 2020**

Source: Company data, the BLOOMBERG PROFESSIONAL™ service, Credit Suisse estimates

## Memory: finally producing, not yet creating oversupply

For NAND and DRAM, the major China companies are Yangtze Memory Technologies (YMTC) for NAND, Ruili Jicheng (known as Innotron Memory in English) for DRAM and now Ingénierie which acquired ISSI a fabless specialty DRAM, SRAM, and NOR supplier. We focus attention on the mainstream DRAM and NAND flash suppliers CXMT and YMTC which are making

progress in expanding their capacities this year despite the lingering pandemic. Our check suggested YMTC NAND is making better progress than Innotron DRAM.

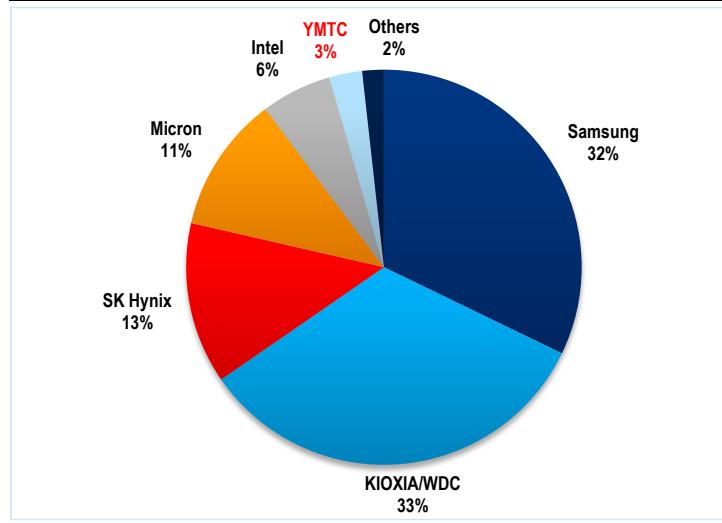
## YMTC 64L NAND into the local commercial market, 128L into mass production at year-end

YMTC has been obtaining qualifications with Chinese hardware manufacturers across applications (smartphones, PCs, servers, consumer electronics, etc.). Its 64L NAND has been adopted by Huawei's Mate 40 Smartphone, and YMTC has supplied Huawei with memory capacity of 300 mn GB (equivalent, for example, to 2.3 mn 128 GB storage devices for smartphones). [Xiaomi also completed qualification](#) of YMTC's cSSD for PC. Further, there are multiple China SSD vendors that also use YMTC's NAND flash besides YMTC's own Zhitai brand. We also believe YMTC has sampled 128 layer with yields around 70% for cards, YSB drives and SSDs. The company plans to transition to 128L and after that to 192L.

**YMTC planning mass production ramp on 128L NAND through 2021.**

Regarding its production, as of early December 2020, our [checks with semicap](#) suggested that its capacity in terms of equipment installed has reached approximately 75k wafers per month and its production output has reached 40k wafers per month. The company has plans now to ramp to 85k WPM by the end of 2021. Its yield is improving to 80-90% on 64-layer, but is still a bit unstable and around 70% on 128L in initial samples. The company would be 3% of 2020 capacity at year-end and ramping to 5% of capacity by the end of 2021 if the roll-out proceeds.

**Figure 103: Global NAND capacity by supplier—4Q20**



Source: TrendForce, Credit Suisse

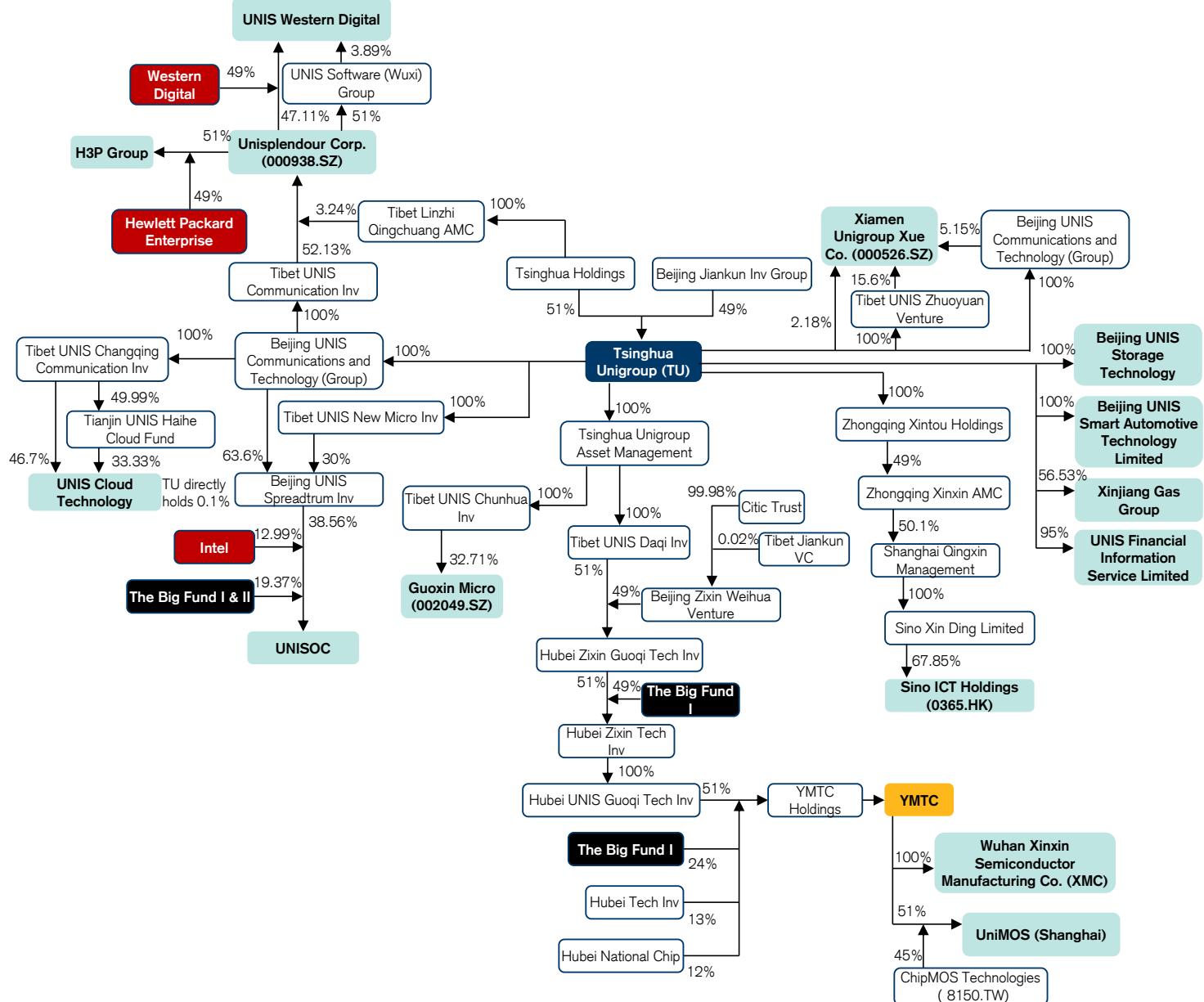
Some investors were worried that Tsinghua Unigroup's bond default may impact YMTC's expansion. Our checks with equipment suppliers suggest that in the past few months YMTC has not asked equipment suppliers to delay equipment move-in, and there is likely to be a major capacity expansion in 1H21. Given YMTC's high importance to China's semiconductor localisation ambition, if there should be any major negative event for Tsinghua Unigroup, YMTC should continue to receive support through other means as long as YMTC can continue to enhance its technology, yield and production. We expect the company to realise a restructuring that allows the NAND flash operation to continue seeing funding for expansion.

YMTC's 128L NAND is in development and for risk production in 4Q20 or 1H21. Additionally, Tsinghua Unigroup also has another project to build DRAM technology capability, while using XMC's existing facility as its DRAM pilot line. We would be more optimistic about its NAND than its DRAM.

**Figure 104: YMTC 3D NAND journey**

Year	Highlights
2014	3D NAND kicked off in XMC
2015	9L test chip validation
2016	32L test chip tape-out. YMTC founded
2017	32L product tape-out. 1st Si validation. YMTC 32L 64Gb MLC 3D NAND flash ES
2018	64L product tape-out. 32L production. 64L First silicon
2019	64L TLC NAND sampling and trial production
2020	64L expand to 50-60k and passed multiple qualifications; 128L still in development

Source: Company data, Credit Suisse

**Figure 105: Tsinghua Unigroup's group structure—YMTC is one out of many affiliates.**

Source: Company data, Credit Suisse

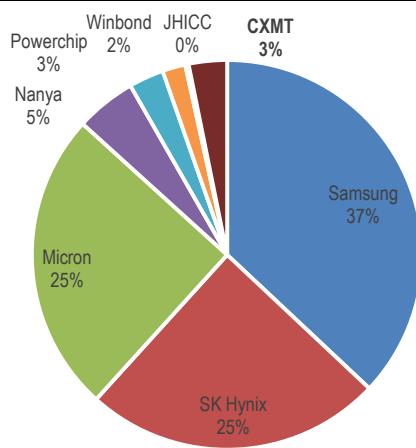
## Innotron (CXMT) 19nm DRAM slower progress

Ruili Jicheng's (Innotron Memory) DRAM project is under CXMT (Changxin Memory Technology), in which Innotron owns a 100% stake. Founded in May 2016 and headquartered in Hefei, CXMT's DRAM development leverages patents [licensed](#) from Qimonda. Qimonda is a previous global leading DRAM tech provider, the inventor of Buried Word Line, and one of the pioneers of advanced DRAM technology though it went bankrupt during the financial crisis and also due to challenges scaling the trench capacitor relative to rivals stack capacitor. CXMT said it has transferred 10 mn technical files (2.8TB of data) from Qimonda. Besides Qimonda, CXMT indicated close partnerships with the equipment makers AMAT, ASML, KLA, LAM, Tech Insights, and TEL. It also jointly released technical papers with ASML at the SPIE conference in 2019.

**CXMT** commercialising 19nm DRAM, though has lagged a bit relative to YMTC's progress on NAND flash

CXMT's 19nm DRAM expansion this year has been slower than planned. It has expanded DRAM capacity from 20k per month in 2019 to now only 40k-50k (approximately 3% of global capacity). The company once planned to further expand to 100k in 1H21, including 30k in a Beijing fab which it acquired from SMIC. But the 30k capacity in Beijing also seems uncertain now though current plans are to get to 85k capacity by the end of 2021. CXMT's DRAM qualification progress is notably behind YMTC's NAND. CMXT only qualified with a few white-box OEM customers. CXMT has 17nm in development and expects risk production from 2021. But, given the slower-than-expected progress for its 19nm DRAM, we currently stay cautious for its 17nm in 2021 and see its output only at 0.5% of total output in 4Q20.

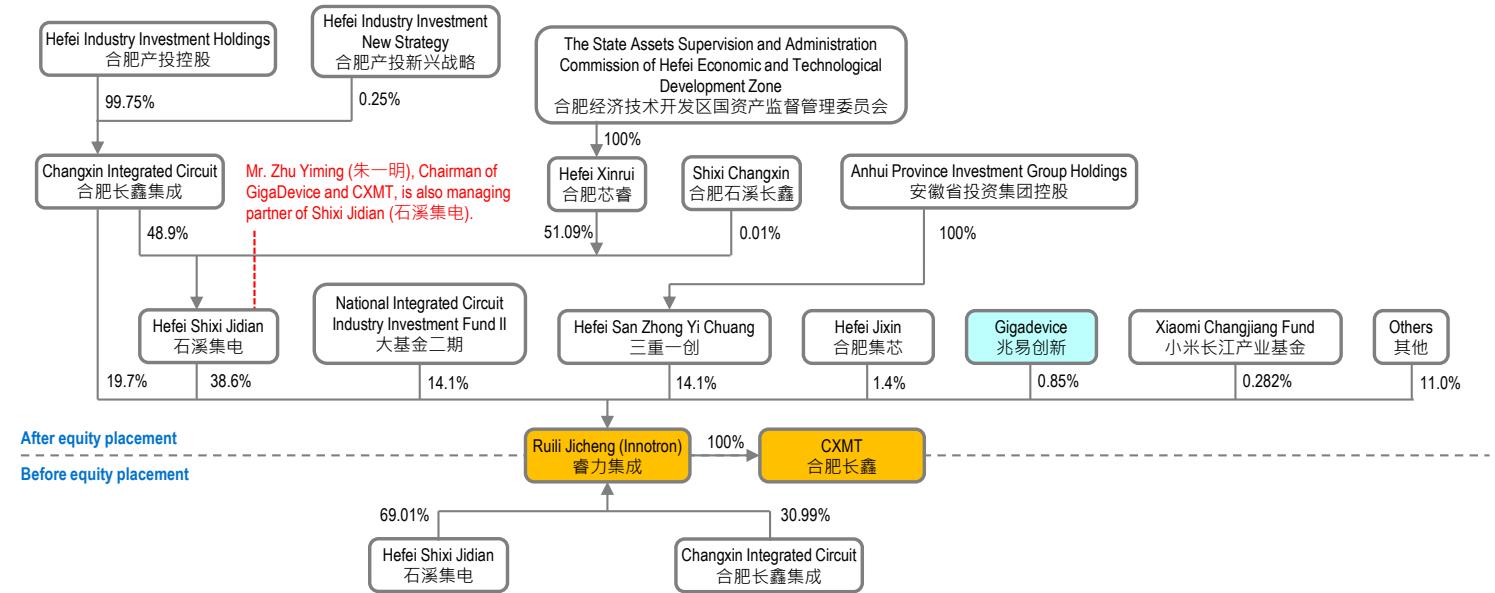
**Figure 106: Global DRAM capacity by supplier—4Q20**



Source: TrendForce, Credit Suisse

Innotron Memory had an Rmb15.6 bn equity placement in November 2020. After the Rmb15.6 bn placement, Innotron has a complicated shareholder structure as shown below.

**Figure 107: Innotron Memory shareholder structure before/after the placement**



Source: Company data, Credit Suisse

## Impact of China's memory capacity on industry supply

We see China's development in memory semiconductors impacting the NAND industry more than DRAM:

### DRAM

For DRAM, we see very little supply impact from China through 2021-22. CXMT is the producer which appears to have been assigned the task of championing China's DRAM development. Its first fab is designed for up to 120k wafers, with its current 30k wpm capacity scheduled to reach 45k by end of 2020 and 85k by end of 2021. CXMT's current process technology is based on 19nm technology, finally being applied to production after several years of capacity ramp-up delay. Additionally, only having 19 nm process node that produces 8Gb dies of DDR4 and LPDDR4 products with estimated yields of 60% puts its technology considerably behind that of the industry leaders.

YMTC and CXMT were planning 100k capacity by end of 2021 though may end up around 85k each, representing 4% of NAND and 1% of DRAM based on effective bit production

In the front of the DRAM technology curve, the leaders are already deploying EUV based production on 1z nm (1 to 2 layers), while developing 1A node process for 2021 implementation. 19nm is not a cost-competitive technology where majority of the industry's DRAM mass production is currently migrating from 1x to 1y nm. CXMT plans to transition into 17 nm (close to ~1x we think) in 2021 once the 19nm yields stabilise. Also, with limited production scale and lack of DRAM design engineers, it is unlikely CXMT can simultaneously work on various DRAM technology nodes and product architectures such as mobile, PC, Server, etc. Most likely, CXMT will likely find itself continuing to compete in the niche and consumer specialty DRAM segment which would require less advanced nodes and speed. Some penetration into local whitebox PC makers are also expected given reports of recent qualifications.

We expect the Taiwanese consumer DRAM makers would be the first in line, in terms of competitive threat—only if CXMT is successful in 17nm deployment. From CXMT's capacity impacting global supply, its current 30k wpm on 19nm nodes represents less than 0.5% of global DRAM bit supply. If it does reach 100k wpm by end of 2021 on 17nm, the bit supply ratio could reach ~1% of global production, although wafer percentage would be higher.

**Figure 108: China's YMTC progress in NAND**

	
<b>Capacity at the end of 2020</b>	<b>40K</b> (down from previous 50K)
<b>Capacity at the end of 2021</b>	<b>85K</b> (down from previous 100K)
 <b>TRENDFORCE</b> <small>around 70% to move into 128L TLC/QLC production is the primary mission now</small>	
<b>Technology as of now</b>	64L TLC products for cards, USB drives and client SSD
<b>Technology in 2021</b>	transitioning to 128L TLC/QLC and preparing to move into 192L production.
<b>TrendForce's View</b>	YMTC accounts for less than <b>2%</b> of the total NAND Flash bit supply in 2020, and its share will be around <b>4%</b> in 2021

Source: Trendforce

### NAND

Throughout 2020, YMTC's 3D NAND mass production has improved. With 40k-50k wpm expected capacity exiting 2020, the ramp-up speed has accelerated slightly following the end of the pandemic in China. Current capacity plan calls for further expansion to 85k-100k wpm by the end of 2021 and ultimately reaching 300k wpm in a few years as it builds out two more 100k WPM buildings.

The company has made some significant inroads in customer qualifications and penetrating end market devices mainly in the consumer, mobile, and client SSD products on a limited basis. Its core 64L 3D NAND TLC architecture based on Xtacking design can process independent

memory array and CMOS on the same wafer simultaneously, reducing manufacturing cycle time, and enabling stacking of memory arrays on top of periphery circuits. However, the yield rates remain challenging—at best ~80% level. We think the majority of YMTC's NAND products end up in memory cards, USB drives and some into low/mid end smartphones. The company's 2021 production goal is to move some wafer production into 128L TLC, test QLC architecture and expand further into consumer SSD segments in order to minimise losses and become more technologically competitive vs the industry leaders. YMTC has made some notable progress during 2020 advancing its products into end market consumer products with many local customers qualifying their products.

Barring any unforeseen events such as a US semi equipment export ban or any negative impact rising from the financial difficulty faced by its parent Tsinghua Unigroup, YMTC will likely become a viable producer as China's NAND champion. Current capacity represents about 2-3% of global wafer capacity and is likely to be about 5% by end-2021. However, on a bit output basis, its market share will likely be less, given its technology trails the industry leaders. We believe SK Hynix's announcement of acquiring INTC's NAND assets finally started the long-awaited NAND industry consolidation. However, scaling up of China's NAND capacity will likely delay the consolidation process if China continues to expand its NAND programme to a meaningful scale and industry leader's such as Samsung respond with more aggressive capacity additions and lower prices.

## Equipment and semiconductor materials still nascent

The global semiconductor equipment market is dominated by a few major international suppliers, including Applied Materials (the US), KLA (the US), LAM Research (the US), ASML (Europe) and Tokyo Electron (Japan). There are a few suppliers in Korea, but those mainly serve Samsung and Hynix. China has a few emerging equipment companies, including Naura, ACM Research, AMEC, and Kingstone although scale is still small compared with the global suppliers.

**China's share in semi equipment and materials is still in the low single digits**

**Figure 110: Market share for global semiconductor equipment suppliers—China share growing from a very low base**

	2019 Size (\$bn)	Incumbent equipment suppliers						Emerging China suppliers		
		ASML	Applied International	Lam Materials	KLA Research	Tencor	Tokyo Screen	AMEC	Naura	ACM
Deposition	\$12.0		7.9%	43.8%	19.1%		10.4%	1.1%	0.9%	0.1%
Lithography	\$11.7	83.3%		0.3%						
Etch	\$10.8			18.1%	44.7%		28.0%	1.1%	0.8%	
Process Control	\$6.2	4.9%		11.3%		53.6%				
Material Removal/Clean	\$3.7			18.3%	34.0%		24.1%	9.7%	0.7%	0.8%
Fab Automation	\$2.9			4.7%						0.6%
Photoresist Processing (Track)	\$2.1						91.3%	5.6%		
CMP	\$1.4			66.1%						
RTP	\$1.4			40.4%			20.3%	3.8%		1.7%
Ion Implant	\$1.2			60.0%						
Wafer Level Packaging	\$2.1					13.7%				
Total Market	\$55.5	18.1%	1.7%	18.7%	13.9%	6.5%	13.6%	3.1%	0.5%	0.5%
										0.2%

Source: Gartner, Credit Suisse

**AMEC (Advanced Micro-Fabrication Equipment Inc. China).** Founded in 2004 and headquartered in Shanghai, AMEC develops and manufactures dielectric and TSV etch tools for semiconductor manufacturers and MOCVD (Metal-Organic Chemical Vapor Deposition) tools for LED makers. Its customers include TSMC, SMIC, YMTC, Hynix, UMC, Winbond, and Sanan. AMEC's revenue reached Rmb1.9 bn in 2019, with a 47% CAGR from 2017-19 from both growth in its MOCVD's for LED and its etch, deposition and clean tools. In 9M20, it grew revenue by 21% YoY. In 2019, specialty equipment accounted for 73% of total revenue, with spare parts taking 26%. In 2018, etching equipment accounted for 40% of specialty equipment revenue, while MOCVD equipment took the rest at 60%. The company had gross margin of 30-40% in the past few years.

The following is a profile of AMEC's key equipment:

- **CCP (Capacitive Coupled Plasma) etching equipment.** AMEC has developed CPP etching equipment since 2004. For logic IC, its CCP etching equipment for 65nm-5nm nodes has been adopted by global chipmakers, including orders received for its latest 5nm equipment applied in critical procedures, according to AMEC. It is working closely with customers to develop damascene etching technology to cover 5nm and below nodes. For memory, its CCP etching tool has been adopted for 64L 3D NAND mass production. Meanwhile, AMEC is developing high depth-to-width ratio etching equipment for 128L 3D NAND.
- **ICP (Inductively Coupled Plasma) etching equipment.** It has been developing ICP etching equipment since 2012 and launched single sided equipment, Primo Nanova. The equipment has been adopted by many logic IC and memory manufacturers. Meanwhile, it is developing a next-generation ICP product for logic IC of 7nm and below nodes, 1xnm DRAM and 128L and above 3D NAND.
- **MOCVD.** AMEC started R&D for MOCVD equipment, the most critical equipment for the fabrication of LED epitaxial slice, in 2010. So far, the company's MOCVD equipment Prismo A7 has achieved a leading position in the global market of Gallium Nitride-based LED MOCVD. Besides, the company has received decent orders on DUV (Deep Ultraviolet) LED MOCVD equipment.

**Naura (Naura Technology Group).** Headquartered in Beijing, Naura was formed through the consolidation and restructuring of Beijing Sevenstar Electronics and Beijing North Microelectronics in 2016 and the group was renamed Naura in 2017. Its controlling shareholder is Beijing Electronics Holdings. Naura and its affiliates assume the country's mission to establish China's capabilities in various equipment fields, from semiconductors, new energy resources, new materials, and other fields. Naura develops a wide range of semiconductor equipment, including etching, PVD (physical vapour deposition), CVD (chemical vapour deposition), diffusion, cleaning tool, UV cure, indexer, gas measuring control, ALD (atomic layer deposition), and furnace tube. That said, the company is too ambitious in development of a wide range of tools. Insufficient R&D talent is an industry-wide problem, with no exception to Naura. Second, due to its history and management culture, Naura is more like an SOE (state-owned enterprise). Its SOE culture is tough for it to recruit and keep leading R&D researchers to develop advanced semiconductor equipment.

Naura achieved revenue of Rmb4.1 bn in 2019, with 17% CAGR in 2012-19. About 80% of its total revenue comes from electronic equipment, with about 21% from electronic components. Its 9M20 revenue grew 40% YoY. Naura's customers include YMTC, SMIC, Hua Hong, Huali, Innotron Memory, and XMC.

**ACM Research.** Founded in 1998 in Silicon Valley, ACM Research develops wet processing technology and equipment for semiconductor manufacturing. In 2006, ACM Research formed its subsidiary, ACM Research (Shanghai). ACM Research now has complete R&D, engineering and manufacturing in Shanghai. ACM Research (Shanghai) has applied for IPO in the A-share Sci-Tech Board and obtained regulatory approval.

ACM Research has top cleaning tools (SAPS, TEBO, and Tahoe), with unique megasonic clean technology already covering 50% of the US\$3 bn market, and it has also introduced silver wafer back side clean, ECP and scrubber to cover 80% of the market. It also introduced advanced packaging, copper plating and a vertical furnace product for dry clean, with two furnaces shipped already and qualified by year-end. ACM noted the new tools raise the addressable market to US\$5 bn and the goal is to double the TAM again to US\$10 bn in three years. ACM has two Shanghai facilities (36k + 100k), with a second floor established in 2Q20 for capacity to do US\$200 mn and adding a Lingjiang facility with 1 mn sq ft in initial production in late 2022.

ACM Research forecasted its 4Q revenue to increase 58% YoY and expects the strong demand to continue into 1Q21 and 2Q21. The company is in discussions with existing and new customers and sees strong demand from both groups. The future growth will be driven by better share within existing customers, penetration into new domestic/overseas customers, and also

more tools being introduced for both front-end and back-end manufacturing. For 2021, ACM also expects more business with its major overseas DRAM customer consistent with its customer's higher capex next year. For the domestic market, the company expects good demand from tier 1 and 2 chipmakers. The revenue contribution from new overseas customers may not be too meaningful yet in 2021, but they are expected to drive growth in the future.

The company has two new products in the pipeline and expects to unveil one new product in the next one to two years. The company is also open for M&A to acquire good technology to supplement its in-house development.

**Kingstone.** Founded in 2009, Kingstone is one of the major semiconductor equipment companies that Wanye has invested in. In the past, Kingstone developed an ion implant platform for photovoltaic and has been developing an ion implant platform for semiconductor manufacturing. Kingstone is seeing good progress for its ion implant platform in both domestic and overseas markets. In the domestic market, it expects solid demand from both logic and memory customers in the near term and good shipments in 2021. In the overseas market, it sees a good opportunity in its ion implant module possibly being used for a global customer's leading fabrication process in the foreseeable future. Notably, Kingstone's ion implant platform has all components from Europe and Asia. This can help reduce the risk from geopolitical tension. The company is optimistic about its growth potential with the localisation effort in the industry.

## China equipment progressing but still far behind global peers

For equipment, we estimate Chinese players are at least five to ten years behind those of global suppliers, or even longer for areas where there is not yet any volume production by Chinese companies. We expect the five- to ten-year gap to continue in the foreseeable future, given the long development and complex qualification required with chipmakers and gap in incremental learning and having a wide base of tools already installed in advanced fabrication. That said, Chinese suppliers may witness high growth in the next five years given China's strong drive for domestic replacement, which could help more established companies such as ACM Research and AMEC gain qualifications at local memory and foundries to narrow their gap vs global players, while some smaller emerging equipment companies may require a longer time to gain scale.

It is important to note that semiconductor makers are keen on steadily optimising power, performance and area, in addition to cost, which is more about bringing up production yield as much as lowering tool cost. The leading manufacturers rely on current global equipment suppliers to improve yields steadily, leveraging on years of innovation and improvement. It has been quite difficult to change suppliers unless China suppliers prove to have a huge technology advantage (less than 10% in the performance gap may not be enough of a trigger to change a supplier). The price of equipment is not a critical issue to change suppliers in the equipment market as production yield is quite an important parameter for semiconductor makers and existing vendors also have a large base of already installed and qualified tools for chip makers' existing process, making share gains take time.

## Quantifying the risk to US suppliers from deeper restrictions exporting to China

We also discuss implications for the US semiconductor equipment leaders which have seen a larger portion of their growth coming from China but also have been exposed to corrections when the US has stepped up to restrict China's vendors (Huawei/HiSilicon) or manufacturers (SMIC) access to US tools without a licence. US equipment stocks were down ~15% following the initial SMIC restriction news in September but have since more than recovered. The correction underscores the risk of stock market valuation impact if the US were to press harder on restricting tool exports to China with the threat of slowing down those projects or longer-term shifting business to overseas competitors or accelerating incentives to Chinese suppliers.

Domestic China represents ~20% of CY20 WFE (wafer fab equipment) and SMIC alone represents ~50% of CY20 China WFE, up 220% YoY with YTD spend thru C3Q of ~66% of CY20 WFE of US\$6.7 bn. SMIC provides manufacturing services from 35 to 14nm mostly to

China domestic semis (now up to 70% of sales) and is typically used as a 3rd/4th source for several US Semiconductor companies (Broadcom and TI) and a primary source for Qualcomm's power management, with a majority of its business now though going to China design houses.

We estimate the US\$10 bn of CY20 WFE for Domestic China is split about 50/50 between Foundry and Memory. A full ban on China would likely place the US\$5bn in memory WFE at risk (bullish for memory manufacturers), albeit at least a portion of the ~\$5 bn from foundry is likely to be reconstituted in other geos with that equipment spending shifting to other foundries to support real-time demand. For 2021, CS models WFE spending at US\$64-65 bn up 12% YoY from US\$57 bn in CY20 of which US\$10 bn (~15%) is domestic China, flat YoY.

**Figure 111: SMIC has risen with China domestic customers and some global accounts**

IC Design	Ticker	2019 Revenue (US\$mn)	GMs (%)	Production (75% of COGs)	SMIC Share %	SMIC Revenue (US\$mn)	% of SMIC sales
HiSilicon	Unlisted	\$14,765	50%	\$5,537	11%	\$590	18.9%
Qualcomm	QCOM.OQ	\$19,398	58%	\$6,113	7%	\$398	12.8%
Broadcom	AVGO.OQ	\$22,597	71%	\$4,915	4%	\$200	6.4%
Will Semi	603501.SS	\$1,973	27%	\$1,075	15%	\$161	5.2%
Sony Sensors	6758.JP	\$9,000	40%	\$4,050	4%	\$150	4.8%
Texas Instruments	TXN	\$14,383	65%	\$3,776	3%	\$128	4.1%
Realtek	2379.TW	\$1,967	44%	\$833	15%	\$125	4.0%
Gigadevice	603986.SS	\$464	41%	\$207	50%	\$103	3.3%
Goodix	603160.SS	\$937	60%	\$278	30%	\$84	2.7%
Fingerprint Cards	FING.B	\$166	23%	\$96	80%	\$77	2.5%
Galaxycore	Unlisted	\$527	26%	\$292	23%	\$67	2.2%
Rockchip	603893.SS	\$204	40%	\$92	41%	\$38	1.2%
Silicon Motion	SIMO	\$449	50%	\$169	20%	\$34	1.1%
Giantec	688123.SS	\$74	40%	\$33	100%	\$33	1.1%
VeriSilicon	688521.SS	\$194	40%	\$87	32%	\$28	0.9%
Dosilicon	Unlisted	\$73	15%	\$47	57%	\$27	0.9%
Bright Power Semi	688368.SS	\$126	23%	\$73	25%	\$18	0.6%
Beken	603068.SS	\$170	36%	\$81	20%	\$16	0.5%
SG Micro	300661.SZ	\$115	47%	\$46	30%	\$14	0.4%
Bestechnic	Unlisted	\$93	38%	\$43	21%	\$9	0.3%
Puya Semi	Unlisted	\$52	27%	\$28	28%	\$8	0.3%
Fullhan	300613.SZ	\$76	37%	\$36	20%	\$7	0.2%
MEMSensing	688286.SS	\$41	39%	\$19	26%	\$5	0.2%
Maxscend	300782.SZ	\$219	52%	\$78	2%	\$2	0.1%
KT Micro	Unlisted	\$22	60%	\$7	15%	\$1	0.0%
Chipsea	688595.SS	\$37	45%	\$15	3%	\$0	0.0%
Amlogic	688099.SS	\$341	34%	\$169	0%	\$0	0.0%
StarPower	603290.SS	\$113	31%	\$59	0%	\$0	0.0%
Expressif	688018.SS	\$110	47%	\$44	0%	\$0	0.0%
<b>SMIC's top customers</b>		<b>\$88,687</b>		<b>\$28,297</b>	<b>8%</b>	<b>\$2,323</b>	<b>74.5%</b>

Source: Company data, Credit Suisse estimates

Looking at the three major US semiconductor equipment leaders, KLAC, LRCX, and AMAT, China represented about 30% of sales for 1Q-3Q20, up 36% YoY and representing half of the growth for those companies. These stocks have proven to be a bigger Biden trade than expected—and are up 40-50% post-election, vs SOX/SP500 +23%/13%, after recent lows ~15-20% down from peak on news of SMIC ban.

Specifically, each of the US companies are still showing strong figures and are not sharply impacted by the initial SMIC restrictions:

**Lam Research (LRCX): China strength not inflated by pull-ins.** LRCX guided F2Q above Street with strong F1Q China and expected strong F2Q China (despite an SMIC headwind of ~\$100-150mm) that will fuel investor concern that a potential widening of export controls is driving pull-ins. However, we disagree that factor is driving the growth as more of the recent China business is also coming from international suppliers with fabs ramping in China. While China was 37% of F1Q revenue, above its 8Q average of 29%, we would note that 50% of China is multinational, with the 50% of domestic representing 14% of revenues, only modestly ahead of China's share of global production of ~11%.

**KLA (KLAC): SMIC contribution already low in C4Q.** KLAC guided F2Q (Dec) well above street on continued strength in Foundry (+29% QoQ) and China (+30% QoQ and 32% of revenue split ~60/40 domestic/multinational). While KLAC has applied for, but has not been granted, licences by the DoC BIS, we estimate that SMIC is still 1-3% of F2Q revenue guidance, albeit down from ~5% of revenue in F1Q/F4Q. The US entity list amendment recently to only presume denial on unique tools below 10nm should also allow more licences on mature tools to flow. We argue investors are still unwilling to underwrite the secularly rising cost of capacity as process complexity is now outpacing fab productivity, driving continued higher highs and higher lows for WFE.

#### **Applied Materials: memory and etch gains to be drivers over China restriction risk.**

AMAT guided F1Q well above street even after adjusting for an extra-week in F1Q and SMIC US\$100 mn headwind delaying tools awaiting a licence. While the US-China tensions (China 34% of revenue, +31% YTD) remain a headline risk and AMAT's revenue growth over several years has trailed that of LRCX/KLAC, looking into CY21 we note that with stronger growth in DRAM over NAND and AMAT's improving position in dielectric etch, the growth gap should continue to close.

#### **Quantifying the positive offsets to potential US restrictions on tools to China**

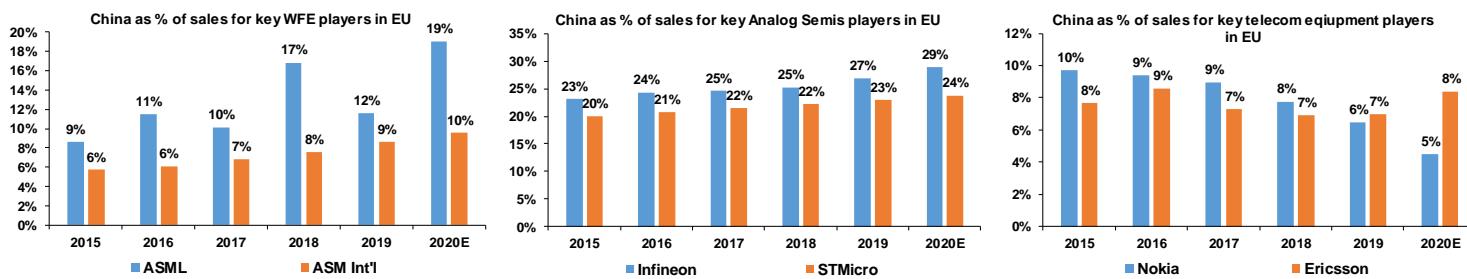
While potential China bans are a near-term risk, the need for the US and others (Japan, the EU) to build strategic domestic Semi production capacity is a significant tailwind that is being underappreciated by investors. In addition, there are no domestic or non-US substitutes for semiconductor equipment that would enable China to build fabs without the US suppliers.

China today represents ~11% of global production versus the US, the EU, and Japan at 6%, 8%, and 5%, respectively. Assuming a useful life of WFE of 5-7 years would imply a total industry installed base of WFE capacity at US\$225-275 bn. A complete ban on China would drive a supply deficit of over US\$20 bn of WFE, double of what domestic China represents in CY20. In addition, we see a trend towards regionalisation of Semiconductor production. TSMC announced an Arizona fab earlier this year with space for multiple phases like the Taiwan megafab complexes. The US Chips Act passed with the US defence bill in Dec-2020 will also provide ~US\$30 bn for domestic production, and Japan/EU have made similar overtures. Given the growing strategic importance of silicon, it would not be surprising if over the next 5-10 years, governments incentivise/mandate that some types of chips sold in a region need to be manufactured in the same region.

### **Impact to the European semiconductor sector from China**

While China is gaining market share in equipment categories, it is expanding from a very low base, still at low single-digit market share. The higher barrier equipment categories including EUV and Atomic Layer Deposition do not yet have China competition, allowing European suppliers, also with less direct US restrictions, to benefit from domestic fab investment.

**Figure 112: China growing for European Semi equipment and analog semiconductors, slightly down for telecom equipment**



Source: Company data, Credit Suisse estimates

**Wafer fab equipment: market opportunity in China outweighs some demand volatility from restrictions, also with limited risk of China substitution.** Domestic China accounts for ~US\$10 bn of WFE, which is slightly less than 20% of global demand. This US\$10 bn is roughly split 50/50 between Foundry and Memory. Within Foundry, a large part of demand comes from SMIC, which was put under export restrictions from the US government in Sep-2020. Further, SMIC was added to the US Entity List in Dec-2020, but the new restrictions seem to only presume denial on tools uniquely developed for 10nm and lower advanced nodes. The US review allows case-by-case approval on other tools, which historically means they receive licensing, implying that SMIC should be able to carry on development on its core business on 8" and mature 12" nodes through 28nm, with some possibility to even keep up the 14/12nm process development.

We summarise the China opportunity and risks for European semiconductor equipment suppliers, ASML and ASMI.

- **ASML: exposure rising in China, monopoly position on advanced EUV.** ASML has seen its China revenue exposure generally rise from 9% to 19% over the last five years. Given the big capex push from SMIC in recent quarters, we estimate its China exposure in 2020 to be slightly below 20%. ASML mainly sells Lithography tools to Chinese customers in both Foundry and Memory, where it has ~90% overall share (rest split between Canon and Nikon). But more importantly ASML has 100% share in the latest generation EUV lithography tools. Risk of China substitution remains extremely low as there are no local companies in the area of Lithography, and technology complexity should require many years to develop a home grown tool.

Even though the US government has only introduced supply chain restrictions on SMIC in the last 3-4 months, ASML has not been able to sell its EUV tool to SMIC for the last 2 years. [Press reports](#) have suggested that SMIC placed an order for an EUV tool from ASML in Apr-2019, with expectation of tool delivery by end of 2019 in order to allow SMIC to conduct R&D to advance its process to 7nm and below. ASML needs an export licence from the Dutch government in order to ship any EUV tool to customers. While ASML had applied for that licence during 2019, we believe there has been limited progress in terms of getting that licence given US pressures on the Dutch government to keep that pending order on hold awaiting licence.

- **ASM International: rising China exposure through its advanced deposition tools.** While ASMI has not provided China sales exposure since 2017, it was ~6% in 2015/16. We estimate this number may have risen to ~10% in 2020 given increasing WFE capex in China along with an increase in customer engagement over the last couple of years. ASMI mainly sells ALD and Epitaxy related tools (both in the area of Deposition) to China customers, where risk of substitution from China vendors remains low (only ~2% of share in overall Deposition market is held by Chinese companies and not on the most advanced atomic layer deposition).

## View from the Japan semiconductor equipment industry

### Leverage or opportunity from China

Over the years, all Japanese semiconductor equipment suppliers have seen an increase in their weighting of sales to China (to local Chinese makers and the Chinese bases of global players as they benefited from investment by SMIC and YMTC in 2020). SMIC was added to the US entity list in Dec-2020, but the restrictions apply only to procurement for 10nm and below processes, and the company should be able to carry on its existing fab operations unimpeded. Thus, we expect equipment suppliers to be able to continue to supply spare parts and to carry out maintenance and revamps. Since the US imposed export restrictions on SMIC in Sep-2020, Chinese foundry makers such as Huali have stepped up their investment in a bid to poach SMIC's customers, to the benefit of global equipment suppliers in 2020 and 1H 2021. However, we had noted as SMIC's operations continue, we could see excess production capacity. We anticipate a snapback decline in equipment demand from mid-2021.

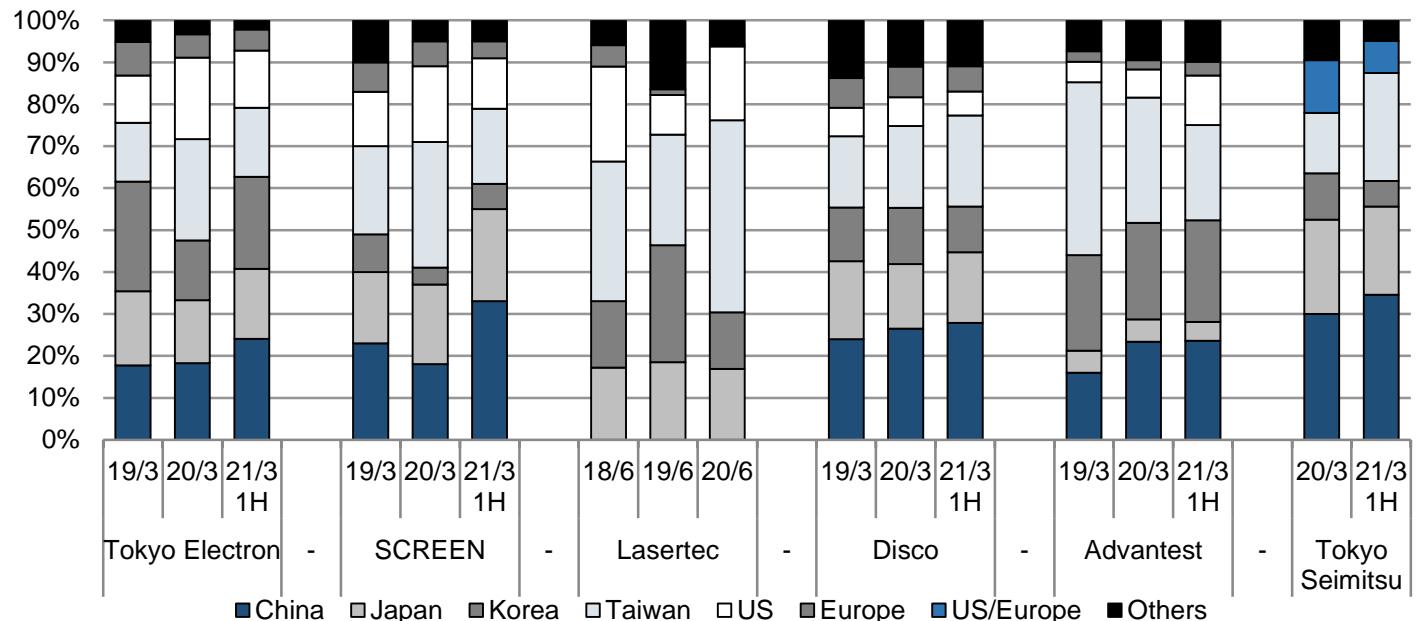
**Market opportunity for European equipment outweighs the substitution risk**

Meanwhile, among local Chinese memory makers, YMTC has started to get qualification for its products from end customers (Huawei and Xiaomi), and is implementing further capex. We think these qualifications could be politically motivated, and intend to monitor the actual trend in post-qualification demand carefully. After the imposition of export restrictions on SMIC in Sep-2020, fears that it too may become subject to restrictions appear to have prompted YMTC to bring forward its investment in 128-layer 3D NAND production capacity. We envisage pullback from this in 2H 2021. Due to technology reasons, local DRAM maker CXMT appears to have pushed back its investment plans somewhat in Oct-Dec 2020.

While investment currently remains strong, we envisage a pullback from the front-loading of demand by both foundry and memory makers in 2H 2021, and think that it will be primarily the trend in memory investment that shapes equipment demand from local Chinese makers from 2022 onwards. Investment is likely to increase if there is smooth progress on the qualification of 128-layer 3D NAND products by customers and on DRAM development.

With regards to back-end processes, we are seeing solid progress in re-building supply chains for Chinese smartphone production and in power IC-related capex. However, we see evidence of overheating in the smartphone application and identify a high risk of duplicate orders. Some Taiwanese OSATs have started selling their Chinese facilities to local Chinese companies and are investing in rebuilding their production networks outside China, while local makers have been investing within the Chinese market. While 1H 2021 could see a snapback decline from this excessively high amount of investment, we estimate that Chinese and Taiwanese investment will remain robust over the longer term.

**Figure 113: Japanese semiconductor equipment suppliers share by region (FY2018–20)**



Note : Lasertech - no disclosure of "only china" revenues. It includes in others. Tokyo Seimitsu started disclosing SPE revenues by region in FY3/20.

Source: Company data, Credit Suisse

## Potential for Japanese vendors to take share from the US suppliers in China

Currently, it is impossible to manufacture semiconductors using any process (including 90nm and other mature processes) without using US suppliers' equipment, and we think it unrealistic to attempt to build even a 45nm process line using only equipment from non-US suppliers. Japanese equipment suppliers have told us that 45nm and any more advanced process would be impossible without the US equipment, as US makers have a 100% share of some processes, including copper wiring and low-k materials. Chinese makers could possibly establish their own

90nm and other older processes by developing similar specification of the US equipment, but even this would likely take around five years to accomplish. Any semiconductors manufactured in this way could only be used in the Chinese domestic market, but this would not be an issue given that it accords with the Chinese government's aspiration to inshore all production.

METI (Japanese Ministry of Economy, Trade and Industry) could make a political decision to restrict supply to China given the closeness of Japan with the US, and we deem it likely that if US equipment suppliers are blocked from supplying to Chinese customers, some leading Japanese equipment suppliers will follow suit with their US counterparts even in the absence of any official ban in Japan. This would mean that the Chinese have to develop their own semiconductor equipment without the benefit of US or Japanese input, which we find to be an unrealistic prospect. Therefore, we do not see front-end Japanese equipment suppliers taking over the market share of the US suppliers.

For Japanese back-end equipment suppliers, we think the US-China trade friction will have little impact on assembly equipment makers since there is little competition with the US here, but as the testing process space is dominated by Advantest and Teradyne, we think Advantest is likely to take market share longer term.

## Risk of Japanese players' share loss to China vendors

We believe that Chinese equipment suppliers still only have market share for some technologically unsophisticated processes. Given the requirement that semiconductors need to be highly reliable, we see little likelihood of any significant change in the market shares of global front-end equipment suppliers over the next five years. However, Chinese equipment suppliers could increase their market share for 200 mm semiconductor fabs where Japanese equipment suppliers have not yet embarked on new equipment development due to limited potential market size.

While back-end equipment suppliers are facing competition from some local Chinese companies, there is little risk of substantial change to their market shares, with the exception of investment that runs counter to economic sense, as production yield in the assembly process has such a large impact on costs.

## Silicon wafer global competitive landscape

The wafer market is dominated by the five majors, Shin-Etsu, SUMCO, GlobalWafers, Siltronic, and SK Siltron, which collectively control over 90% of the market. Shin-Etsu Chemical and SUMCO are the two companies that have taken the lead in wafers for cutting-edge nodes. Both companies have about 30% share of this market. GlobalWafers also gained share to 18% since the acquisitions of Topsil and SunEdison in 2016, which also allows it to have a global production base and support leading edge foundries and memory makers.

**Local wafer providers aggressive on capacity plans but still at low share of production silicon wafers even in the domestic fabs**

There have been some regional players establishing joint ventures in China. Ferrotec has established a 200 mm production base in Shanghai licensing technologies from GlobalWafers since 2017. It further set up another joint venture as a sales agent for the 200 mm production base, with 60% ownership by GlobalWafers and 40% by Ferrotec. Ferrotec also has plans to build a 12" raw wafer fab to support local semiconductor demand. Additionally, RS Technologies has invested in GriTek (GRINM Semiconductor Materials) in Beijing to make 200 mm prime silicon wafers. GriTek is 45% owned by RS Technologies, 49% by GRINM, and 6% by Fujian Kuramoto.

Due to the favourable financing environment in China for semiconductor companies, regional players are trying to get their China branches listed in Sci-Tech Board. FerroTec Hangzhou Semiconductor Wafer (FTHW) used to be an affiliate of FerroTec (Japan) in China, operating wafer capacity of 200k wpm for 12" (after reaching full load), 450k wpm for 8" and 400k wpm for 6". Its 12" wafer line was launched in early-2020, and reached capacity of 30k wpm in Oct-2020. FTHW plans to achieve 12" capacity of 100k wpm by end-2020 and 200k wpm in 2021. FerroTec has finished sale of a 60% stake of FTHW to China local investors for about Rmb2 bn in Nov-2020.

Wafer Works (Shanghai), with Wafer Works Corp. in Taiwan to be its largest shareholder (48.5% stake), submitted an IPO application for the Sci-Tech Board in Jun-2020, but the company posted on Taiwan MOPS that it withdrew the application in Dec-2020. The market expects the potential reason for the IPO termination might be concerns about the company's dependency on its largest shareholder. Wafer Works (Shanghai) has 8" EPI (epitaxial) wafer capacity of 200k wpm. It previously fully relied on 8" polished wafer from Wafer Works Corp. as the raw material for its EPI wafer. Its own 8" polished wafer line with capacity of roughly 100k wpm (50% of existing EPI wafer capacity when reaching full load) launched production in 2018, and supplied polished wafer for about 10% of its EPI wafer production in 2019, with the rest still from Wafer Works Corp. The company expected to expand EPI wafer capacity and polished wafer capacity to 300k wpm and 200k wpm (two-thirds of EPI capacity), respectively, in three years with Rmb1.7 bn raised from the IPO, but fundraising uncertainties now loom as its IPO has been terminated.

**Figure 114: China silicon wafer suppliers far behind global suppliers**

China players	Market share	Global players	Market share	Asian players displace West
NSIG	~1% for 12" 1-2% for 8"	Shin-Etsu	30%	✓
Tianjin Zhonghuan Semiconductor	<3%	SUMCO	27%	✓
Hangzhou Lion Electronics	~2% for 8" <2% for 12"	GlobalWafers	18%	✓
Regional players in China	Market share	Siltronix	15%	
Ferrotec – GlobalWafers JV	5% for 8"	SK Siltron	10%	✓
GRINM Semiconductor Materials	~1% for <8"?			
JV/subsidiary of regional players to IPO in A-share Sci-Tech board	Market share			
FerroTec Hangzhou Semiconductor Wafer	~1% for 12" 2-3% for 8"			
Wafer Works (Shanghai) (IPO terminated)	<1% for 8"			

Source: Siltronix, Credit Suisse estimates

Although China has stayed aggressive in building its local semiconductor ecosystem since 2014 across foundries, IC Design, back-end and equipment/material, we believe the current progress on the raw wafer sector is limited to 6" and below, while it will take an additional 2-3 years for the technology to catch up on 8" raw wafer production and 3-5 years on 12". Chip manufacturers currently use the incumbents for large-scale volume agreements to achieve purchasing scale. As bare wafer is only 5-10% of the revenue for an 8" foundry and can be less than 1% of the revenue for an advanced 5nm wafer, leading foundries have a high hurdle to bring in a new supplier to avoid sacrificing any yield or quality loss on its fab process.

**Figure 115: 8" raw wafer capacity growth in China will add 7% of global supply by 4Q21, mainly from overseas players**

8" raw wafer capacity expansion in China (k WPM)				Planned	Planned progress			Effective
Company	Projects	Location	Investment (RMB bn)	8" capacity	End of 2019	End of 2020	End of 2021	End of 2021
AST	Chongqing	Chongqing	5	500	0	50	150	15
ChangFong	Sichuan	Sichuan	5	100	0	0	0	0
GRINM	Phase 1	Dezhou	1.8	150	0	0	30	0
Zhonghuan	Phase 1	Wuxi	10	750	0	150	300	30
ZJJRH	Quzhou	Quzhou	5	400	0	100	200	20
Ferrotec	HanZhou JV	Hanzhou	6	350	0	180	350	150
	Phase 1	Ningxia	3.1	150	0	0	0	0
	Phase 2	Ningxia	6	350	0	0	0	0
WaferWorks	Zhengzhou	Zhengzhou	5.7	200	101	150	200	200
<b>Total China - domestic</b>				<b>1,900</b>	<b>0</b>	<b>300</b>	<b>680</b>	<b>65</b>
<b>Total China - overseas</b>				<b>1,050</b>	<b>101</b>	<b>330</b>	<b>550</b>	<b>350</b>
<b>Total China</b>				<b>2,950</b>	<b>101</b>	<b>630</b>	<b>1230</b>	<b>415</b>
<b>% of global capacity</b>				<b>51%</b>	<b>2%</b>	<b>11%</b>	<b>21%</b>	<b>7%</b>

Source: Company data, Credit Suisse estimates

The local China supply chain is planning the capacity ramp schedule and made investments, although we believe most of the new 8" and 12" raw wafer capacity addition in China will still come from its overseas peers. We estimate raw wafer capacity additions in China will add 7%/2% of global 8"/12" raw wafer capacity by end-2021, already reflected in our global raw wafer supply-demand model.

Our recent update from the supply chain suggests Chinese players have been aggressive on building facilities to grow their raw wafer capacity for lifting self-sufficiency, with key local players including Zhonghuan Huanxin, NSIG and AST. Based on Zhonghuan's plan in 2019, the company planned to invest Rmb20 bn for its Yixin mega fab with a maximum of 1mn WPM 8" capacity (300-350k in fab 1, 2 and fab 3 each for phase 1) and 600k WPM 12" capacity (150-200k WPM in phase 1 and another 300-400k WPM in phase 2). The 8" capacity in Yixin fab will start sampling from 3Q19, while 12" capacity will start sampling from early 2020 to reach its target of 500k WPM 8" capacity and 150k WPM 12" capacity by end-2020. NSIG, on the other hand, only focusses on 12" raw wafer expansion and targets to have 300k WPM in its Shanghai facilities by the end of 2020 and has room for another 300k WPM.

**Figure 116: Chinese players are aggressive on 12" raw wafer supply but effective capacity will be limited**

12" raw wafer capacity expansion in China (k WPM)				Planned	Planned progress			Effective
Company	Projects	Location	Investment (RMB bn)	12" capacity	End of 2019	End of 2020	End of 2021	End of 2021
Anhui Yixin	Anhui	Anhui	3	150	0	0	0	0
	Shanghai	Shanghai	10	300	0	50	150	15
	Chongqing	Chongqing	5	50	0	0	0	0
	Chengdu	Chengdu	5	500	0	0	0	0
ChangFong	Sichuan	Sichuan	5	400	0	0	0	0
Eswin Silicon Wafer	Xian	Xian	11	500	0	0	0	0
GRINM	Phase 2	Dezhou	6.2	300	0	0	0	0
Sino Crystal Jiaxing	Phase 1	Jiaxing	6	400	0	0	0	0
	Phase 2	Jiaxing	5	600	0	0	0	0
TSI Semiconductor	Guanxi	Guanxi	20	1,200	0	0	0	0
Zing Semi	Phase 1	Shanghai	2.3	150	150	150	150	30
	Phase 2	Shanghai	4.5	450	50	150	250	15
Zhonghuan	Phase 1	Wuxi	10	150	0	20	150	15
	Phase 2	Wuxi	10	350	0	0	50	0
ZJJRH	Quzhou	Quzhou	5	150	0	0	0	0
Ferrotec	HanZhou JV	Hanzhou	6	200	0	30	30	30
	Phase 2	Ningxia	6	200	0	0	0	0
WaferWorks	Zhengzhou	Zhengzhou	5.7	200	0	10	45	45
Total China - domestic				5,650	200	370	750	75
Total China - overseas				600	0	40	75	75
Total China				6,250	200	410	825	150
% of global capacity				89%	3%	6%	12%	2%

Source: Company data, Credit Suisse estimates

The total raw wafer capacity expansion plan from Zhonghuan and NSIG could add as much as 15-20% to current global 8" and 12" capacity, respectively, if they can successfully ramp the projects, putting the industry at a risk of severe oversupply. However, we believe the production yield, technology and qualification remain the gap for local companies to compete in the global market. We would note the companies' production yield and quality on 8" raw wafers are still a few years behind their overseas peers. For 12" raw wafer plans, the companies have been pushing out the timing of qualification and production due to low yield and worsening ROI from the industry pricing erosion since 2H18.

Our feedback across the supply chain also noted that the relatively low technology reliability and limited track record of China raw wafer makers keeps them away from winning orders from major foundries, IDMs, and memory makers. For the domestic market, their raw wafers will only be used for testing purpose in the next 2-3 years, and it will take an additional few years for local players to secure sizeable 8" and 12" raw wafer orders as reliable second or third sources for their customers.

## Emerging China wafer suppliers targeting capacity expansion

For the China domestic ecosystem, wafer companies include NSIG and Tianjin Zhonghuan Semiconductor. Both are working hard to boost their product competitiveness by recruiting engineers from overseas.

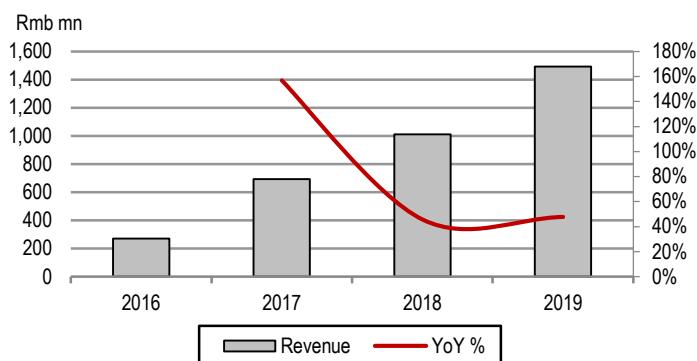
**NSIG (National Silicon Industry Group):** NSIG is formed through the consolidation of three entities, including Zing Semiconductor, Shanghai Simgui and Okmetic. The company also tried to acquire Siltronic in 2016 for technology and capacity, though it did not come through due to concerns on IP leakage and the industry was at the inflection point for pricing upturn from more balanced supply-demand following years of loss.

**NSIG has aggressive capacity plans following the merger of three emerging wafer suppliers.**

NSIG is expected to achieve its capacity plan of 200k wafers per month for 300 mm product by end-2020 vs 150k in end-2019. New tools have arrived in Shanghai and are under installation as of Sep-2020. The company suggests 300 mm capacity should see major increase in 2021. Shanghai Simgui produces <8" EPI and SOI wafers and it licenses SOI technology from SOITEC. Based in Finland, Okmetic is the seventh-largest silicon wafer supply for wafers used

in manufacturing MEMS, sensor, discrete and analog circuits. Storage device is the largest end market for NSIG's wafer, followed by logic and power IC. NSIG's consolidated revenue was Rmb694 mn/Rmb1,010 mn/Rmb1,493 mn in 2017/18/19, mainly from the sales of 8" wafers.

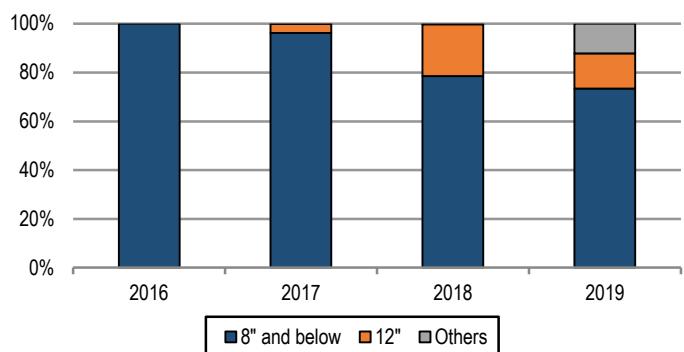
**Figure 117: NSIG revenue has been growing fast**



Source: Company data, Credit Suisse

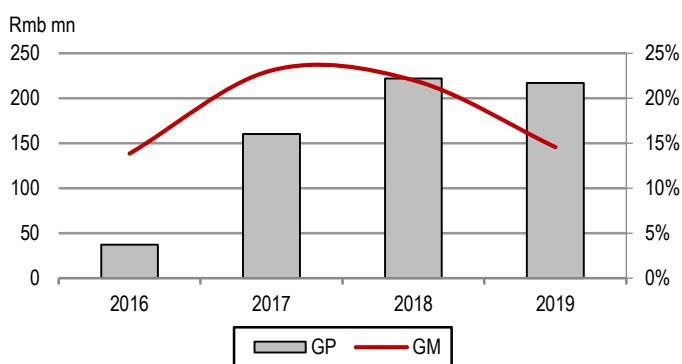
NSIG is the largest silicon wafer supplier with the strongest technical competence in Mainland China. NSIG has passed qualification for 28nm and mature nodes and 64-layer 3D NAND, with the qualification for 14nm logic IC, 19nm DRAM and 128-layer 3D NAND in progress. The company is trying to qualify with foundries outside China. NSIG still has a gap with global competitors regarding technical specifications and yield but the company is confident on its development and growth given the large demand in China and government support.

**Figure 118: More revenue contribution from 12"**



Source: Company data, Credit Suisse

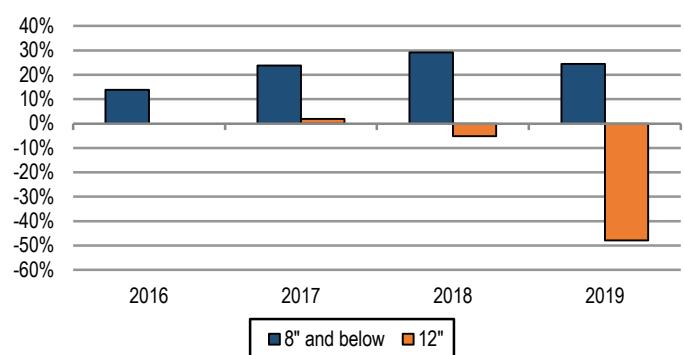
**Figure 119: Gross margin was affected by 12" ramp-up**



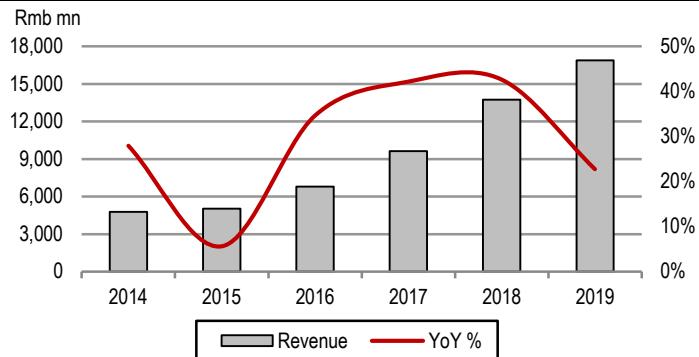
Source: Company data, Credit Suisse

**Tianjin Zhonghuan Semiconductor:** Zhonghuan is another China company with a strong ambition in producing bare wafers. The company had 300k WPM 8" raw wafer capacity in Tianjin in 2019 and targets to grow to 500k WPM in 2020. In addition to 8" raw wafer capacity, Zhonghuan targets to grow its 12" raw wafer capacity in its Yixin fab. Although the company claims its raw wafer technology and production capability have been qualified by 60 8" customers and is under qualification by 20 12" raw wafer customers, we believe most of the raw wafers it produces is still only for testing purpose and its technology and quality lag its global peers by 3-5 years. The company targets its wafer product for CIS (CMOS Image Sensor), power device, logic and memory markets.

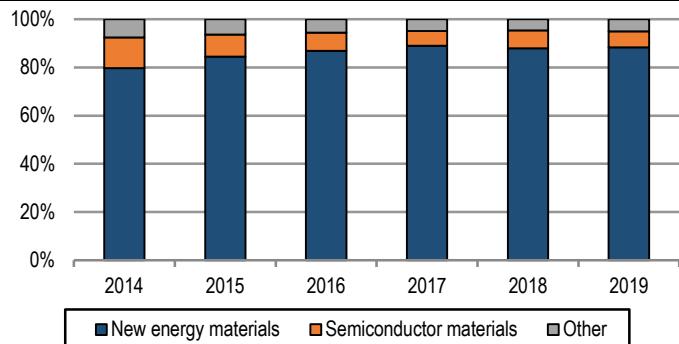
**Figure 120: 12" still has negative GM**



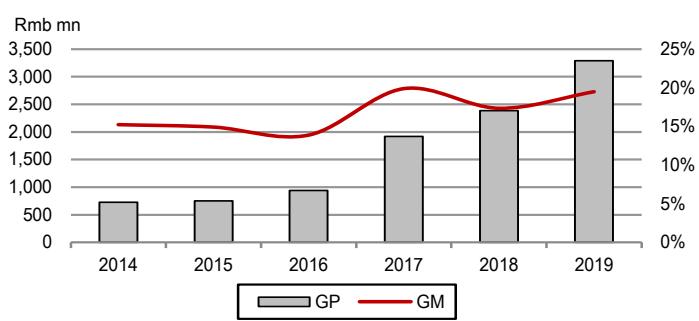
Source: Company data, Credit Suisse

**Figure 121: Zhonghuan revenue CAGR of 29% in 2014-19**

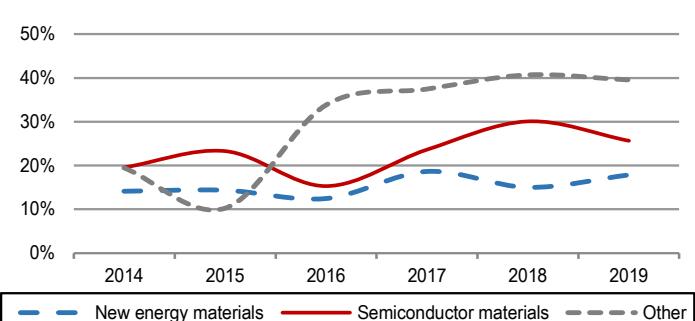
Source: Company data, Credit Suisse

**Figure 122: Majority of revenue from new energy materials**

Source: Company data, Credit Suisse

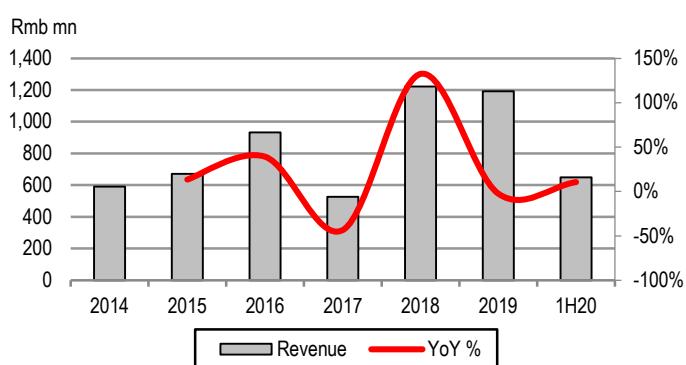
**Figure 123: Zhonghuan demonstrated improving GM**

Source: Company data, Credit Suisse

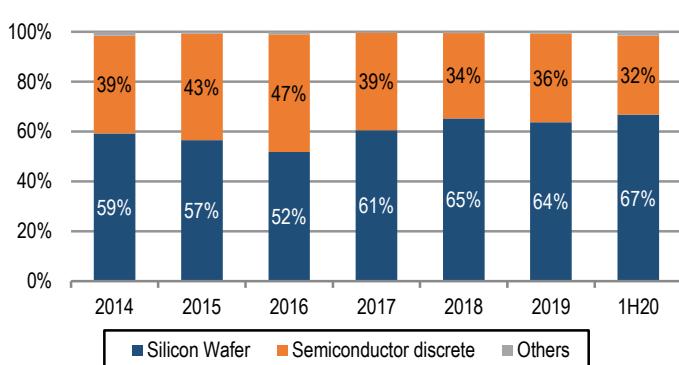
**Figure 124: Semiconductor materials GMs above new energy**

Source: Company data, Credit Suisse

**Lion Electronics.** Founded in 2002, Lion Electronics has been focussing on silicon wafer manufacturing and semiconductor discretes. It started the mass production of 6" silicon wafer in 2004 and 8" silicon epitaxial wafer in 2009. The company now is able to supply 8" single crystal ingot, polished wafer and epitaxial wafer, with capacity of 220k wpm. Major customers include On Semi, Alpha & Omega Semiconductor, Toshiba, Episil Technologies, SMIC, Huahong, and CR Micro. Besides, its 12" silicon wafer has achieved capacity of 20k wafers per month by Nov-2020 and is under qualification by SMIC, Hua Hong, CR Micro, and On Semi. Lion Electronics expects its 12" capacity to reach 150k wafers per month by end-2021. The 12" silicon wafer currently in shipment is for 90nm node with 28nm in development.

**Figure 125: Lion Electronics—15% sales CAGR from 2015-19**

Source: Company data, Credit Suisse

**Figure 126: Lion Electronics—sales from wafers and discretes**

Source: Company data, Credit Suisse

## Semiconductor chemicals: China suppliers now emerging

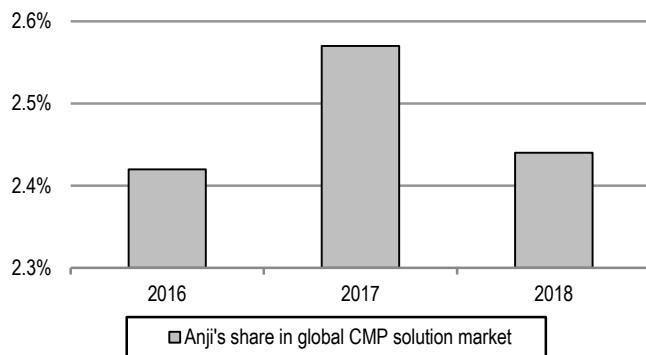
Manufacturers of semiconductor chemicals should have integrated know-how of chemistry, chemical engineering, materials and electronic engineering. China is behind global competitors on semiconductor chemicals due to the high-entry barrier with existing suppliers already qualified into a high precision process. For semiconductor photoresist, the global major suppliers are JSR, Tokyo Ohka Kogyo, Shin-Etsu, Sumitomo Chemical, Fuji Film Electronics Materials, Dow and Dongjin Semichem. The electronics gas market is dominated by Air Products, Air Liquide, Taiyo Nippon Sanso, and Praxair. For CMP (chemical mechanical polishing), the market is dominated by Cabot Microelectronics, Versum, Entegris and Fujimi. In the past few years, Chinese players have penetrated into the low- and mid-end semi chemicals market driven by the higher adoption rate at China foundries, but the high-end market is still controlled by the US, Europe, and Japan companies.

**China suppliers starting to emerge for photo resist and CMP slurries**

The following is a profile on some of the leading China chemical suppliers:

**Anji Tech:** Anji Tech was founded in 2006, and is a leading supplier in China for CMP solution and photoresist remover for wafer fabrication, advanced packaging and LED/OLED. The company's CMP solution for nodes of 130-14nm has achieved mass shipment, already qualified by many logic and memory chips, while CMP solution for 10-7nm is under R&D. Anji's customers include SMIC, YMTC (Yangtze Memory Technologies Co.), Hua Hong, CR Micro, Silan, WLCSP (China Wafer Level CSP, 603005.SS), TSMC, and UMC.

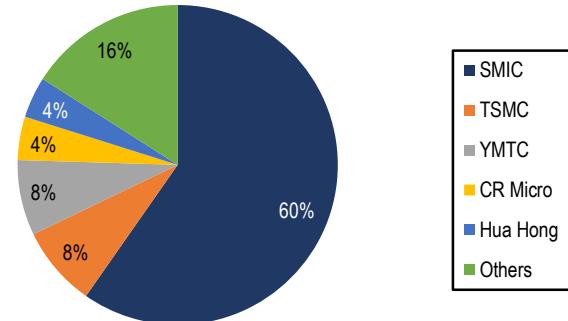
**Figure 127: Anji's CMP share has stayed 2-3% from 2016-18**



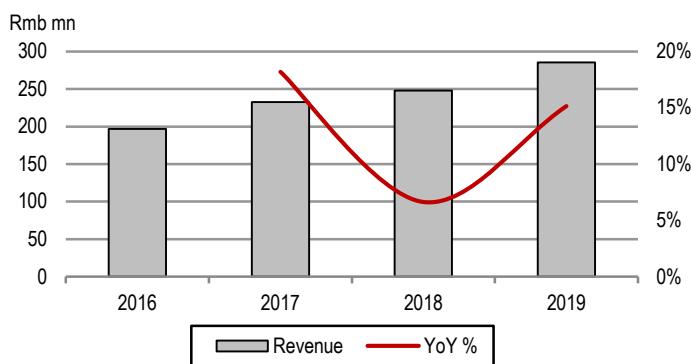
Source: Company data, Credit Suisse

The company is headquartered in Shanghai and was listed on the Shanghai Stock Exchange in 2019. It operates nine production lines for CMP solution and two lines for photoresist remover, with 80-90% sales from Mainland China. Anji Tech's revenue reached Rmb232 mn/Rmb247 mn/Rmb285 mn in 2017/18/19, with over 80% from CMP solution and the rest from photoresist remover. The company's market share in the global CMP solution market was 2-3% during 2016-18.

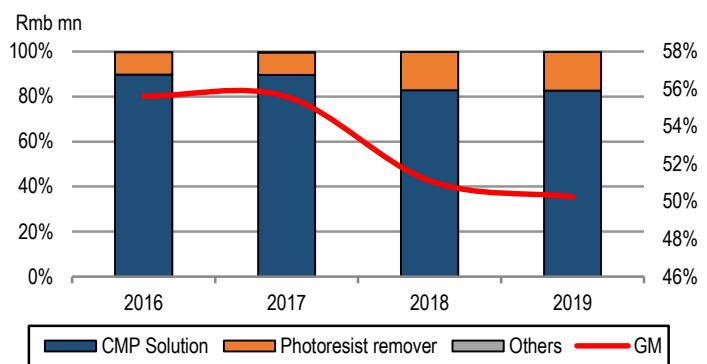
**Figure 128: Anji's customer mix in 2018**



Source: Company data, Credit Suisse

**Figure 129: Anji's revenue grew at 13% CAGR in 2017-19**

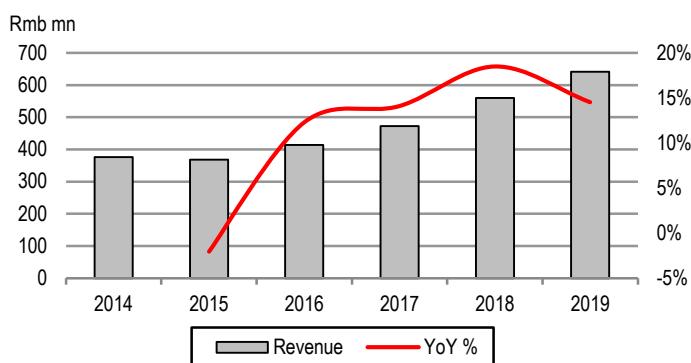
Source: Company data, Credit Suisse

**Figure 130: Anji sales from CMP slurry and resist at good GMs**

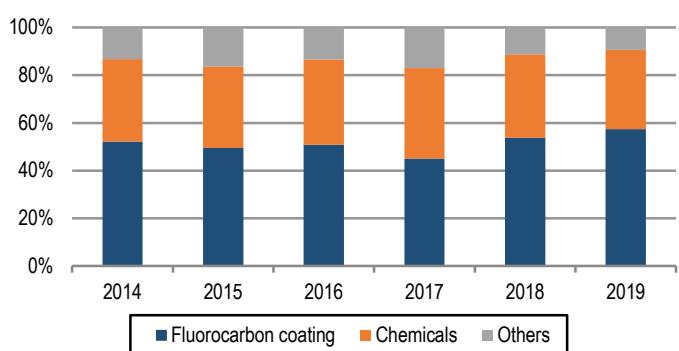
Source: Company data, Credit Suisse

**Sinyang:** Headquartered in Shanghai, Sinyang was founded in 1999 and listed on the Shenzhen Stock Exchange in 2011. The company has developed more than 140 types of electronics plating and cleaning chemical materials, widely adopted by IC fabrication, 3D advanced packaging, and IC testing. Its existing product portfolio includes plating solution/additive for Damascene copper interconnects or through-silicon (via TSV), cleaning fluid after copper/aluminium etching, silicon nitride etchant, cleaning fluid after CMP (chemical mechanical polishing), and tin plating solutions. Sinyang's revenue reached Rmb641 mn in 2019, with a CAGR of 11% in 2015-19. Chemicals contributed about one-third of revenue and 40% of gross profit in 2019, while fluorocarbon coating is another major revenue contributor.

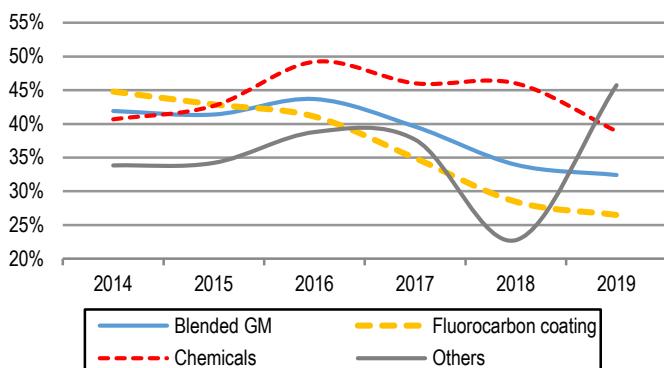
Sinyang is the only Chinese company that supplies ultrapure plating solution/additive for copper process on 90-28nm nodes. Key clients include SMIC, Hynix, CR Micro, JCET (Jiangsu Changjiang Electronics Technology CO.), Huatian Technology, and WLCSP (China Wafer Level CSP). Meanwhile, Sinyang has been developing high-end photoresist products. According to its private placement plan in Nov-2020 (Rmb815 mn raised for the photoresist project), Sinyang's KrF (Krypton Fluoride, 248nm) photoresist, primarily for 3D NAND, is expected to reach mass production in 2022, and ArF (Argon Fluoride, 193nm) should start mass production in 2023.

**Figure 131: Sinyang recorded 11% revenue CAGR in 2015-19**

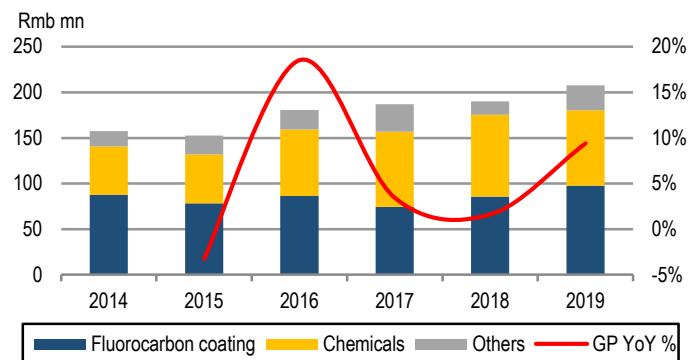
Source: Company data, Credit Suisse

**Figure 132: Sales led by fluorocarbon coating and chemicals**

Source: Company data, Credit Suisse

**Figure 133: Sinyang's chemical business records decent GM**

Source: Company data, Credit Suisse

**Figure 134: Sinyang's GP recorded 6% CAGR in 2015-19**

Source: Company data, Credit Suisse

## China's game plan to build up equipment and materials

The Chinese government, either central or provincial, does not have separate policies specifically supporting semi equipment, wafers or semi chemicals. In general, for the semiconductor industry, the IC Development Guideline is a top-level policy document. That said, it is widely recognised that domestic customers (chip manufacturers) are encouraged to adopt equipment or wafers made by China suppliers. Chinese companies across all semiconductor sub-sectors have made efforts to recruit experienced global talent to accelerate their R&D and expand their business.

For raw wafers, the China government appears to subsidise ~20% of the purchase price when China chipmakers purchase locally manufactured wafers. In addition, we believe the local government would encourage foreign raw wafer suppliers to set up fabs locally to ensure sufficient supply amid the macro uncertainty from the trade war.

For equipment, China has a strong desire to build a semiconductor production line without any US equipment. We believe it is very difficult, at least for 45nm or below. So we think China equipment suppliers have a motivation to expand their product portfolios towards the areas where the US dominates. This may trigger another implication for M&A. China equipment companies such as ACM Research and AMEC have both said they are open for M&As.

## China wafer makers unlikely to close technology gap

Although raw wafer is seen as a more commoditised product in the semiconductor supply chain, we believe local Chinese wafer makers are unlikely to be able to close the technology gap with the wafer majors and significantly boost their market share over the next 1-3 years. Given the size of the market shares commanded by Japanese, European, Taiwanese, and Korean makers, we do not envisage any noteworthy change in market share distribution. In addition, we believe raw wafer customers would not risk switching raw wafer suppliers only based on pricing, as raw wafers are essential and important for semiconductor manufacturing, while only representing a small portion of the manufacturing cost (10-15% for 8" foundries and mid-to-high-single-digits for 12" foundries). Still, as China chipmakers get up and running, growth in demand in the mature segment of the semiconductor market that does not require high-end wafers should provide business opportunities for Chinese wafer makers.

At this point, we have ascertained the following major developments, although in all four cases we understand there are unresolved technological issues:

1. **Zing Semi** is shipping 300 mm wafers to customers, but the significantly lower-than-average yield rate could be a challenge for capacity ramp-up and profit performance.
2. **RS Technologies** has hired engineers from outside and improved the technology of its 200 mm wafers, but not enough to catch up to the five market leaders.

3. **Ferrotec** has increased the competitiveness of its product by licensing technology from GlobalWafer, but appears mainly to ship test and prime wafers only to a few China chipmakers that are not particularly fussy about product quality.
4. **FTHW** would be regarded as a China wafer manufacturer after China investors acquire the 60% stake. However, since it just launched the 12" wafer production in early-2020, capacity ramp-up and customer qualification could be uncertain and take much time.

## Semiconductor chemicals need time to catch up

There are various types of semi chemicals, including photoresist, auxiliary materials for photoresist, process chemicals, electronics gas, dopants, target materials, and polishing materials. Each type of semi chemicals could include hundreds of different products, depending on the wafer fabrication process and nodes. Furthermore, fast product iteration is required for manufacturers as advanced nodes or special processes would continuously set a higher standard for semi chemicals. But so far, we have not observe the presence of Chinese players in many sub-segments of semi chemicals, while the breakthrough makers in some sub-segments still have to narrow the distance with global giants for high-end applications.

Although there are technological obstacles to solve and incumbent advantages to overcome, we admit progress has been made by China in the past few years:

1. **Anji Tech** has qualified its CMP solution for 130-14nm, while its 10-7nm products are under R&D.
2. **Sinyang's** photoresist project might deliver in the next few years, with ArF photoresist to cover 22-10nm nodes, but uncertainties remain on product quality and customer qualification.
3. **Cristal Clear Chemical** and **Nata Opto-Electronic Materials** are also developing KrF and ArF photoresist, but are away from mass production.
4. **Huate Gas** has been supplying to global major foundries/IDMs like Intel, Micron, Texas Instruments, though at a small scale.

The growing foundry capacity in China is one of the significant drivers for the development of local semi chemicals manufacturers, and SMIC is no doubt a major customer for nearly all Chinese semiconductor chemical manufacturers, following the US entity list and military end user restrictions. Future growth of China semi chemicals manufacturers may be negatively affected if the US restriction is modified further to cover legacy tools and significantly affects SMIC's normal operation.

## Rising breadth of China IC design

The China IC design market has had a steadier penetration as compared with the flat market share in foundry and M&A accelerated growth from the China OSATs. The local fabless companies are benefiting from a combination of domestic R&D and wafer subsidy support, recent desire for localised and non-US sources of technology, rise of China brands in mobile and consumer, and a gradually improving IP and engineering base of talent supplemented by foreign hires and returning Chinese engineers from overseas corporates and academia. At the policy level, China is targeting a number of high-growth areas, including mobile communications, networking, cloud computing, Internet of Things and AI/machine learning.

Our tracker of 36 top fabless companies in China reached US\$29.1 bn sales in 2020, representing 24% global fabless share of our global fabless sample of US\$120 bn sales. China fabless has been outgrowing the global average, showing a 27% CAGR since 2010 vs 7% CAGR for the Top 28 global fabless and 10% CAGR for the entire fabless sector and 4% CAGR for global semiconductor revenue.

China's fabless success was led by HiSilicon which increased sales 20x from US\$652 mn in 2010 to US\$13.2 bn in 2020 and is now restricted from fabricating chips without foundries receiving a licence to use US equipment in the fabs. Stripping out HiSilicon, China's fabless growth is a still solid +22% CAGR, with its share still rising from 4% to 15%.

**Randy Abrams, CFA**

886 2 2715 6366

randy.abrams@credit-suisse.com

**Chaolien Tseng**

852 2101 6795

chaolien.tseng@credit-suisse.com

**John W. Pitzer**

1 212 538 4610

john.pitzer@credit-suisse.com

**Achal Sultania**

44 20 7883 6884

achal.sultania@credit-suisse.com

**Haas Liu**

886 2 2715 6365

haas.liu@credit-suisse.com

**China fabless has grown by 20x to US\$13.2 bn in 2020 at a 27% CAGR to 22% share, though 15% share excluding Huawei's HiSilicon**

**Figure 135: China's IC design growing at a 27% CAGR to take 24% market share in 2020 (15% ex-HiSilicon)**

China IC Design Companies	2013 revenue	2014 revenue	2015 revenue	2016 revenue	2017 revenue	2018 revenue	2019 revenue	2020 revenue	CAGR 2010-20	Major products
Shenzhen HiSilicon Technologies	\$2,120	\$2,950	\$3,299	\$3,881	\$4,640	\$6,742	\$11,287	\$13,175	35%	Networking/Set-tops
Will Semi	\$1,596	\$1,595	\$1,489	\$1,530	\$1,732	\$1,917	\$2,061	\$3,017	18%	Image Sensors
Bitmain	\$0	\$0	\$137	\$278	\$2,518	\$4,268	\$1,280	\$1,921	NM	Cryptocurrency mining machine
Spreadtrum Communications	\$1,050	\$1,110	\$1,640	\$1,866	\$1,587	\$1,104	\$1,233	\$1,418	15%	Mobile processors
Goodix	\$102	\$127	\$167	\$448	\$545	\$563	\$937	\$1,040	NM	Fingerprint ICs
CEC Huada Electronic Design	\$169	\$183	\$504	\$507	\$514	\$869	\$782	\$860	28%	Smart card ICs
ZTE Microelectronics	\$45	\$470	\$520	\$829	\$907	\$883	\$725	\$775	NM	Networking / Wireless
GigaDevice Semiconductor	\$96	\$93	\$110	\$224	\$301	\$340	\$464	\$676	NM	NOR Flash Memory
Hangzhou Silan Microelectronics	\$263	\$263	\$305	\$357	\$407	\$457	\$450	\$533	NM	Communications ASICs
Tongfang Guoxin	\$142	\$180	\$197	\$213	\$272	\$370	\$496	\$458	NM	Smart card / ASIC
Maxscend	NA	\$7	\$18	\$58	\$88	\$85	\$219	\$413	NM	Acquired Omvision
Tatwah Smartech Co Ltd	\$90	\$127	\$219	\$526	\$514	\$436	\$330	\$393	NM	RFID chips
Yangzhou Yangjie Electronic Technology Co Ltd	\$0	\$104	\$132	\$179	\$218	\$280	\$290	\$355	NM	Discretes
BYD Microelectronics	\$105	\$275	\$345	\$424	\$403	\$383	\$364	\$346	NM	Image Sensor / fingerprint
NavInfo	\$141	\$170	\$237	\$238	\$321	\$322	\$334	\$300	19%	Smart card ICs
Amlogic	\$80	\$100	\$115	\$132	\$152	\$197	\$175	\$295	23%	Consumer / Tablet SoC
Wuhan Tianyu Information Industry Co Ltd	\$206	\$218	\$234	\$245	\$286	\$362	\$320	\$283	22%	Smart cards
Shenzhen Microgate Technology Co Ltd	\$26	\$36	\$107	\$261	\$214	\$253	\$262	\$273	NM	Surveillance
Montage	\$100	\$150	\$200	\$220	\$225	\$254	\$251	\$273	NM	Memory interface design
Leadcore Technology	\$152	\$115	\$218	\$228	\$235	\$242	\$250	\$257	8%	Mobile processors
Jilin Sino-Microelectronics Co Ltd	\$202	\$199	\$205	\$210	\$243	\$258	\$239	\$251	4%	Power/Analog
Suzhou Good-Ark Electronics Co Ltd	\$132	\$149	\$128	\$178	\$275	\$285	\$286	\$226	6%	Discretes
Fuzhou Rockchip Electronics	\$216	\$152	\$152	\$191	\$179	\$182	\$203	\$211	14%	Tablet/audio processors
Allwinner Technology	\$246	\$185	\$181	\$187	\$179	\$206	\$212	\$187	NM	Tablet/audio processors
SG Micro Corp	\$0	\$0	\$12	\$0	\$79	\$87	\$114	\$145	NM	Power Semis/Foundry
Sino Wealth Electronic Ltd	\$55	\$60	\$65	\$78	\$102	\$115	\$121	\$142	NM	MCUs
Shanghai Bellng Co Ltd	\$95	\$76	\$77	\$77	\$83	\$119	\$127	\$137	5%	Consumer ICs
Jiangsu Jiejie Microelectronics Co Ltd	\$0	\$0	\$0	\$0	\$64	\$81	\$97	\$127	NM	Discretes
Canaa Inc	\$0	\$0	\$7	\$48	\$195	\$416	\$203	\$120	NM	AI / bitcoin
Ingenic Semiconductor Co Ltd	\$15	\$9	\$11	\$17	\$27	\$39	\$49	\$110	23%	Smart cards
Datang Microelectronics Technology	\$151	\$131	\$146	\$135	\$150	\$151	\$82	\$94	2%	Smart card ICs
Espressif Systems Shanghai Co Ltd	\$0	\$0	\$0	\$0	\$0	\$37	\$62	\$92	NM	Connectivity
Shanghai Fullhan Microelectronics Co Ltd	\$0	\$0	\$0	\$0	\$67	\$62	\$75	\$88	NM	MCUs
Giantec Semiconductor Corp	\$0	\$0	\$0	\$0	\$0	\$13	\$39	\$68	NM	Contactless
Nationz Technologies Inc	\$70	\$69	\$89	\$106	\$103	\$92	\$57	\$53	-6%	Industrial ICs
RDA Microelectronics	\$380	\$339	In SPRD	NM	Connectivity and RF					
<b>China Fabless</b>	<b>\$8,046</b>	<b>\$9,642</b>	<b>\$11,266</b>	<b>\$13,868</b>	<b>\$17,826</b>	<b>\$22,468</b>	<b>\$24,476</b>	<b>\$29,111</b>	<b>27%</b>	
<b>YoY Growth</b>	<b>43%</b>	<b>20%</b>	<b>17%</b>	<b>23%</b>	<b>29%</b>	<b>26%</b>	<b>9%</b>	<b>19%</b>		
<b>Top China fabless market share</b>	<b>11.8%</b>	<b>12.8%</b>	<b>15.3%</b>	<b>17.4%</b>	<b>19.2%</b>	<b>21.7%</b>	<b>23.6%</b>	<b>24.2%</b>		
<b>China Fabless ex-HiSilicon</b>	<b>\$5,926</b>	<b>\$6,692</b>	<b>\$7,968</b>	<b>\$9,988</b>	<b>\$13,186</b>	<b>\$15,725</b>	<b>\$13,189</b>	<b>\$15,936</b>	<b>22%</b>	
<b>YoY Growth</b>	<b>33%</b>	<b>13%</b>	<b>19%</b>	<b>25%</b>	<b>32%</b>	<b>19%</b>	<b>-16%</b>	<b>21%</b>		
<b>China fabless share ex-HiSilicon</b>	<b>9.0%</b>	<b>9.2%</b>	<b>11.3%</b>	<b>13.2%</b>	<b>15.0%</b>	<b>16.3%</b>	<b>14.3%</b>	<b>14.9%</b>		

Source: Gartner, PwC, Credit Suisse estimates

The global fabless suppliers have still maintained above-industry growth despite the rise of China fabless, keeping a 7% CAGR vs 4% for global semiconductors. Fabless companies leveraging advanced and specialty foundry have been able to keep focus on R&D and chip design tailored to high growth applications in networking, mobile, IoT and consumer. Fabless traditionally lacked much leverage to longer product cycle markets in industrial, aerospace/

**Global fabless has still maintained a 7% CAGR vs 4% for global semiconductors**

defence, medical and automotive, though it will target those areas more as they require more advanced processing, sensing and communications.

**Figure 136: Overseas design companies maintaining a 7% growth CAGR the past decade**

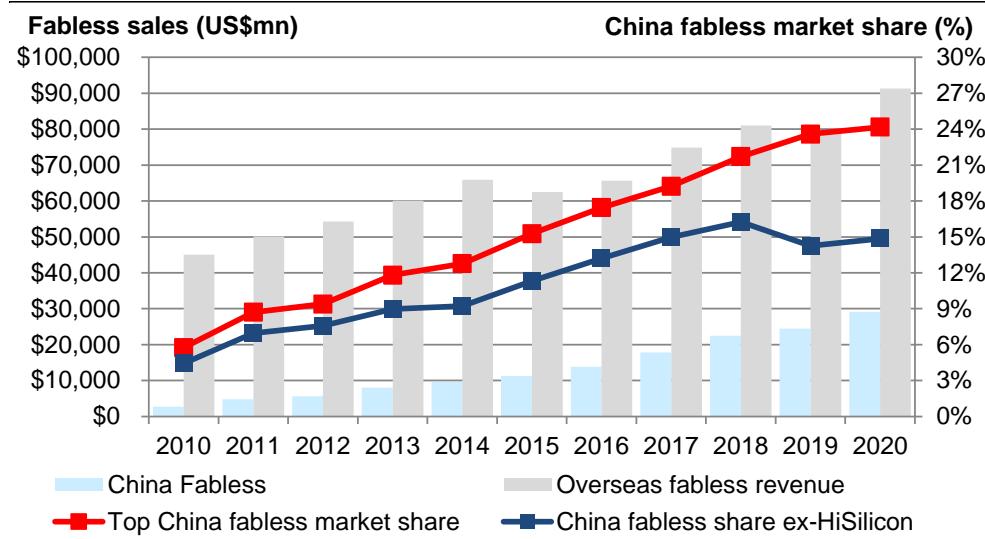
Overseas IC Design Companies	2013 revenue	2014 revenue	2015 revenue	2016 revenue	2017 revenue	2018 revenue	2019 revenue	2020 revenue	CAGR 2010-20	Major products
Broadcom	\$8,305	\$8,388	\$8,472	\$13,292	\$17,665	\$20,029	\$17,297	\$18,321	10%	Networking/Broadband
QCOM QCT	\$17,211	\$19,291	\$16,008	\$15,415	\$17,029	\$16,581	\$16,208	\$18,227	10%	Mobile Processors
NVIDIA	\$4,118	\$4,646	\$4,982	\$6,750	\$9,474	\$11,546	\$10,986	\$15,364	15%	Graphics
Mediatek	\$4,586	\$7,030	\$6,718	\$8,549	\$7,832	\$7,902	\$7,972	\$10,643	11%	Mobile/Digital Home
AMD	\$5,481	\$5,668	\$4,111	\$4,272	\$5,253	\$6,475	\$6,731	\$8,898	3%	Processors/Graphics
Xilinx	\$2,256	\$2,485	\$2,447	\$2,334	\$2,485	\$2,661	\$3,215	\$3,367	6%	Programmable Logic
Marvell	\$3,169	\$3,404	\$3,707	\$2,726	\$2,393	\$2,416	\$2,866	\$2,699	0%	Networking/Connectivity
Realtek	\$950	\$1,032	\$1,000	\$1,207	\$1,371	\$1,521	\$1,967	\$2,600	14%	Networking/IoT
Novatek	\$1,397	\$1,784	\$1,602	\$1,416	\$1,548	\$1,820	\$2,084	\$2,598	8%	Driver ICs/Display
Phison	\$1,083	\$1,012	\$1,129	\$1,391	\$1,271	\$1,296	\$1,361	\$1,429	4%	Memory Controllers
Synaptics	\$948	\$948	\$1,703	\$1,667	\$1,718	\$1,630	\$1,472	\$1,334	8%	Touch
Dialog	\$901	\$1,159	\$1,356	\$1,198	\$1,353	\$1,444	\$1,444	\$1,318	16%	Power management
Silicon Lab	\$580	\$621	\$645	\$698	\$769	\$868	\$838	\$850	6%	MCUs/Networking
Himax	\$771	\$841	\$692	\$803	\$685	\$724	\$672	\$812	2%	Display Drivers
Silicon Motion	\$225	\$289	\$361	\$556	\$523	\$530	\$449	\$517	15%	Memory controllers
ELAN	\$258	\$232	\$197	\$205	\$223	\$268	\$323	\$480	10%	MCUs/Touch
Lattice	\$333	\$366	\$411	\$427	\$386	\$399	\$404	\$400	3%	FPGAs
FocalTech	\$315	\$0	\$229	\$179	\$158	\$136	\$312	\$398	8%	Display Drivers
Global Mixed-Mode	\$131	\$121	\$105	\$117	\$120	\$142	\$193	\$230	4%	Analog
Asmedia	\$40	\$47	\$47	\$65	\$91	\$118	\$128	\$218	27%	Logic I/O
EGIS	\$3	\$1	\$16	\$53	\$144	\$188	\$197	\$207	NM	Fingerprint
Holtek	\$121	\$111	\$110	\$118	\$126	\$138	\$156	\$172	3%	MCUs
PixArt Imagine	\$132	\$76	\$63	\$68	\$106	\$139	\$146	\$153	2%	MCUs/Bluetooth
Sunplus	\$105	\$79	\$81	\$61	\$42	\$39	\$41	\$43	-14%	MCUs
Pixelworks	\$48	\$61	\$60	\$53	\$81	\$77	\$69	\$42	-5%	Consumer
Altera	\$1,733	\$1,932	\$1,971	\$2,010	\$2,050	\$1,948	\$1,753	In Intel	NM	Programmable Logic
Avago	\$2,520	\$4,269	\$4,300	In BRCM	NM	RF/Storage/Networking				
LSI (Acquired by Avago)	\$2,370	In Avago	In Avago	In BRCM	NM	Storage/Networking				
<b>Top overseas fabless</b>	<b>\$60,089</b>	<b>\$65,892</b>	<b>\$62,523</b>	<b>\$65,630</b>	<b>\$74,894</b>	<b>\$81,035</b>	<b>\$79,283</b>	<b>\$91,320</b>	<b>7%</b>	
YoY Growth	11%	10%	-5%	5%	14%	8%	-2%	15%		
<b>Top overseas fabless market share</b>	<b>88.2%</b>	<b>87.2%</b>	<b>84.7%</b>	<b>82.6%</b>	<b>80.8%</b>	<b>78.3%</b>	<b>76.4%</b>	<b>75.8%</b>		
China top fabless	\$8,046	\$9,642	\$11,266	\$13,868	\$17,826	\$22,468	\$24,476	\$29,111	27%	
Overseas fabless revenue	\$60,089	\$65,892	\$62,523	\$65,630	\$74,894	\$81,035	\$79,283	\$91,320	7%	
<b>Fabless Revenue</b>	<b>\$68,135</b>	<b>\$75,535</b>	<b>\$73,789</b>	<b>\$79,498</b>	<b>\$92,720</b>	<b>\$103,502</b>	<b>\$103,760</b>	<b>\$120,431</b>	<b>10%</b>	
YoY Growth	14%	11%	-2%	8%	17%	12%	0%	16%		
<b>Semiconductor Revenue</b>	<b>\$305,584</b>	<b>\$335,744</b>	<b>\$333,568</b>	<b>\$336,027</b>	<b>\$408,999</b>	<b>\$465,529</b>	<b>\$406,957</b>	<b>\$435,444</b>	<b>4%</b>	
YoY Growth	5%	10%	-1%	1%	22%	14%	-13%	7%		

Source: Gartner, PwC, Credit Suisse estimates

## IC design traction varies by application

China has consistently outgrown the global industry in the past decade, although at a 15% market share in fabless excluding HiSilicon and with no major established IDMs combining manufacturing and design, the success and market penetration is still highly variable by application, with a number of semiconductor categories seeing still small China player share.

**Figure 137: China IC design share to 24%, though only 15% ex-HiSilicon**



Source: Company data, Credit Suisse estimates

We highlight the fabless design categories seeing relatively higher market traction and areas with more limited success to date for the China suppliers.

#### **Areas with reasonable success for Chinese companies**

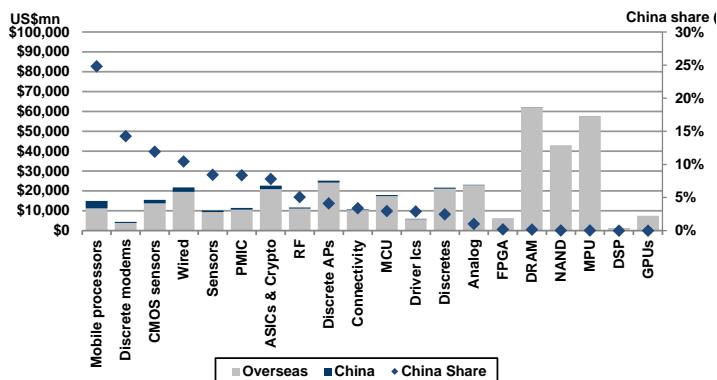
- **Mobile communications.** IC design in China was led, up until the US restriction, by Huawei's chip division HiSilicon, which alone represents 45% of China's fabless sales. HiSilicon pre-restriction supplied 80% of Huawei's smartphones, including being in the first wave of 5nm customers at TSMC, along with Apple. Huawei has also internalised its RF transceiver, low-end power amplifier and connectivity chipsets to offer a more complete bill of materials.  
Elsewhere in mobile chipsets, UniSOC (formerly Spreadtrum) has lagged in 4G after developing a competitive presence in 2G/3G, although it is still pushing ahead with commercialising its 12nm modem in 1H20 and developing its first 5G SoC on TSMC's 6nm by the end of 2020. UniSOC also acquired RDA, which gives it capability in connectivity and RF. Beyond these mobile chipset providers, China has developed a competitive footprint in other mobile peripherals including CMOS image sensors (Will Semiconductor, GalaxyCore), fingerprint IC (Goodix, Silead, Fortsense) and RF (Vanchip, Maxscend).
- **Networking.** HiSilicon also led China's networking IC sector with internal supply to Huawei's base stations and infrastructure, including its own high-end ASIC which is displacing some of the FPGA content. ZTE Microelectronics and Datang have also emerged as infrastructure suppliers to their parent companies, and Montage has developed a leading memory interface solution for cloud computing systems.
- **Consumer electronics.** Lower entry barriers for mature high volume consumer products have also enabled entry of a number of Chinese designers, including several application processor suppliers that initially reached a high volume on tablets and are currently moving into connected audio and video and IoT applications, including Rockchip, Allwinner, Actions, AM Logic, Ingenic, Zhuhai JieLi and Bestechnic.
- **Crypto-currency/AI inference.** China's local IC design companies, including Bitmain, Canaan and eBang, commanded 95%+ of the crypto-currency ASIC market. The companies, along with start-ups Cambricon and Illuvatar, are currently using their processing and low power design capability and software algorithm work in crypto-currency into AI inference processors for smart buildings, smart home, and smart city applications.
- **Flash memory.** China has worked with several sources of IP for flash memory. Gigadevice produces NOR flash and NAND flash through SMIC and Huali. YMTC is also developing 3D NAND flash by leveraging multiple international chipmakers' NAND flash IPs. Integrated Silicon Solution Inc (ISSI) is also being acquired by Ingenic. These together will bring China's capacity in flash memory. YMTC also has recently showcased a 128-layer sample for its own SSD for mass production by the end of 2020 and plans to double capacity to 85-100k WPM capacity by year-end. ChangXin (CXMT) has also been sampling its 19nm DRAM and ramping up its production in 2020-21, to ramp to 85k WPM capacity by end of 2021.
- **Smart card ICs.** China is developing its local smart card IC vendors to embed flash on a secure card for use in transportation, social security/National ID cards, and financial IC cards. The company has qualified six vendors for mobile payments, including Tongfang Guoxin, Datang, Huada, NationZ, and Hua Hong IC.

Despite success in these high volume markets in mobile, networking and consumer, China is still a small player in a number of strategic and high value areas in the industry, with low-single-digit share in a number of critical semiconductor categories including microprocessors, graphics processors, microcontrollers, programmable logic, MEMS sensors, analog, automotive components, memory, storage ICs and display drivers.

**China's share is still low in a number of large chip segments including processors, analog, graphics and sensors**

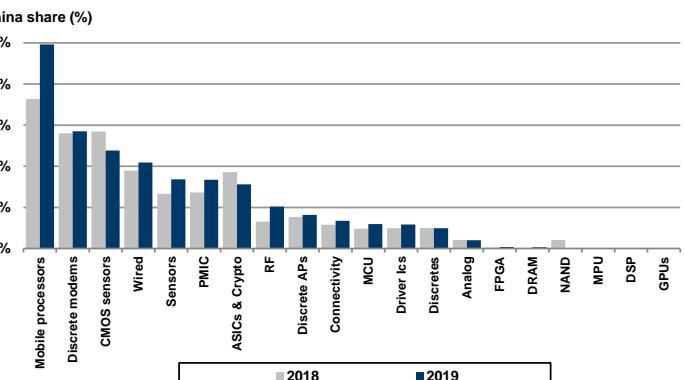
We estimate that these markets where China has less than 5% market share represent about US\$333 bn of sales, and 75% of the semiconductor industry for China to target through building up its in-house teams and supplementing with hiring overseas talent, M&A or equity stakes to accelerate development.

**Figure 138: China IC design share higher in Comm-ICs**



Source: Gartner, company data, Credit Suisse estimates

**Figure 139: China IC design gained 70 bp share to 3.9% in 2019**



Source: Gartner, company data, Credit Suisse estimates

### Areas where Chinese companies still lag

- **CPU: dominated by Intel and AMD, though ARM solutions emerging.** The processor market is dominated by Intel and AMD, with their x86 architecture as the basis for running the PC and server operating systems. China's opportunity in the core processor is to leverage ARM's core for servers tailored to China domestic applications. Huawei's Kunpeng server chipset is the highest performing ARM core and was targeting to be a solution to mitigate the impact from its ban on receiving US technology. We also are witnessing Phytium's ARM based PC CPU seeing traction at SOEs in China as a home grown alternative to Intel-AMD based systems. Zhaoxin has also licensed the x86 core as a JV with Via and the Shanghai Municipal Government for a home-grown processor based on Intel's well-established x86 instruction set for compute. Loongson is also targeting MIPS 64 bit CPUs for general purpose computing.
- **FPGA: Xilinx and Altera/Intel lead.** Xilinx and Altera have over 80% market share, followed by Microchip (acquired Microsemi/Actel) and Lattice each with about 5% market share, and a negligible share for the Chinese players. The FPGA market has higher barriers due to the software platforms used to programme the FPGAs and now increasing amount of embedded IP and requirement to manufacture high-end FPGAs at large die size (more difficult to use) on advanced technology nodes. Several Chinese players including Gowin, Fudan Micro, Unigroup Guoxin and Huada are developing FPGAs.
- **Analog/discretes: Chinese design houses focussing initially on high volume IT products and discretes.** China is following the route of Taiwan analog companies a decade prior by focussing on high volume IT markets, initially in computing, mobile, consumer/IoT, display and LEDs, and later focussing on auto/industrial. China has several emerging companies including SG Micro, Jilin Sino-Microelectronics, Silan, and Silergy and ZTE's Microelectronics (SaneChips) that are gaining traction and growing both as lower cost alternatives for global companies or a local source domestically in China. In standard products, Wingtech's purchase of Nexperia's standard products group also gives it a high position in discrete.
- **Graphics: barriers high, a couple of Chinese design houses trying to address.** Graphics has had high barriers as both Nvidia and AMD have built their GPUs as platforms for gaming, in close collaboration with the leading game developers and in extensive marketing to build up the consumer base for their systems. Graphics require a long design cycle, large die size, complex architecture and advanced manufacturing, and marketing capabilities, raising the barriers to entry. China has a couple of IC design companies

working on graphics, including Jingjia Micro, developing a high performance GPU starting with 28nm (vs Nvidia on 12nm and AMD on 7nm). Zhaoxin has also integrated Via's GPU technology for an integrated processing unit with graphics.

**Figure 140: China's 2019 market share growing from a low base in most categories**

Market	18 (US\$)	19 (US\$)	Overseas players	2018	2019	Chinese players	2018	2019	Market	18 (US\$)	19 (US\$)	Overseas players	2018	2019	Chinese players	2018	2019
DRAM	99,872	62,170	Samsung Electronics	42.8%	43.3%	YMTC	<1%	<1%	Sensors	10,489	10,127	Robert Bosch	14.2%	14.1%	Goertek	3%	5%
			SK hynix	29.5%	28.1%	CXMT	<1%	<1%				Infineon Technologies	8.0%	7.8%	Goodix	4%	3%
			Micron Technology	22.9%	23.5%	Fujian Jinhua	<1%	<1%				STMicroelectronics	6.0%	5.9%	Silan	<1%	<1%
			Nanya Technology	2.8%	2.7%							TDK	5.0%	5.1%	Shanghai Bellinc	<1%	<1%
			<b>Overseas subtotal:</b>	<b>98.0%</b>	<b>97.5%</b>	<b>Chinese subtotal:</b>	<b>&lt;1%</b>	<b>&lt;1%</b>				Knowles	4.5%	4.6%	Yangtze	<1%	<1%
			<b>Chinese subtotal:</b>	<b>&lt;1%</b>	<b>&lt;1%</b>							<b>Overseas subtotal:</b>	<b>37.8%</b>	<b>37.6%</b>	<b>Chinese subtotal:</b>	<b>&lt;8%</b>	<b>&lt;9%</b>
NAND	57,951	42,628	Samsung Electronics	37.8%	36.8%	YMTC	<1%	<1%	Mobile Processor	14,829	14,928	Qualcomm	54.1%	45.0%	HiSilicon	14%	22%
			Kioxia	14.6%	18.2%	GigaDevice	<1%	<1%				Samsung Electronics	13.9%	16.2%	UniSOC	4%	3%
			Western Digital	15.5%	14.4%	ISSI / Ingenic	<1%	<1%				MediaTek	13.8%	14.0%	Allwinner	<1%	<1%
			Micron Technology	11.1%	12.7%							<b>Overseas subtotal:</b>	<b>81.8%</b>	<b>75.2%</b>	<b>Chinese subtotal:</b>	<b>&lt;19%</b>	<b>&lt;26%</b>
			SK hynix	11.0%	9.7%												
			Intel	4.1%	7.2%							Nvidia	81.1%	80.7%	Jingjia Micro	<1%	<1%
MPUs	54,151	57,481	Toshiba	4.9%	0.0%							AMD	18.1%	18.3%	Zhaoxin	<1%	<1%
			<b>Overseas subtotal:</b>	<b>98.9%</b>	<b>99.0%</b>	<b>Chinese subtotal:</b>	<b>&lt;1%</b>	<b>&lt;1%</b>				<b>Overseas subtotal:</b>	<b>99.0%</b>	<b>99.0%</b>	<b>Chinese subtotal:</b>	<b>&lt;1%</b>	<b>&lt;1%</b>
			Intel	91.4%	90.0%	HiSilicon	<1%	<1%				Broadcom	22.3%	20.9%	HiSilicon	2%	3%
			AMD	5.2%	7.0%	Cambrionix	<1%	<1%				Qualcomm	18.5%	17.5%	UniSOC	<1%	<1%
			NXP	0.8%	0.8%	Alibaba	<1%	<1%				MediaTek	7.1%	7.4%	Maxscend	<1%	<1%
			Marvell	0.4%	0.7%	Montage	<1%	<1%				NXP	5.4%	6.3%	Goodix	<1%	<1%
MCUs	19,211	17,867	Texas Instruments	0.5%	0.4%	Eeasy Tech	<1%	<1%				Realtek	3.8%	4.7%	Will Semi	<1%	<1%
			<b>Overseas subtotal:</b>	<b>98.4%</b>	<b>98.9%</b>	<b>Chinese subtotal:</b>	<b>&lt;1%</b>	<b>&lt;1%</b>				<b>Overseas subtotal:</b>	<b>57.1%</b>	<b>56.9%</b>	<b>Chinese subtotal:</b>	<b>&lt;3%</b>	<b>&lt;4%</b>
			Renesas Electronics	18.0%	18.7%	CEC Huada	1%	1%				Broadcom	36.3%	35.7%	HiSilicon	7%	8%
			NXP	17.3%	17.3%	Gigadvice	<1%	<1%				Marvell Technology	8.4%	8.0%	Sanchip	1%	2%
			Microchip Technology	14.0%	13.8%	Unigroup Guoxin	<1%	1%				Intel	5.0%	5.1%	Montage	1%	1%
			STMicroelectronics	12.0%	11.8%	SinoWealth	<1%	<1%				Realtek Semiconductor	3.0%	4.3%	Microchip Technology	3.3%	3.5%
DSP	1,453	1,279	Infineon Technologies	9.0%	9.1%	Silan	<1%	<1%				<b>Overseas subtotal:</b>	<b>56.0%</b>	<b>56.6%</b>	<b>Chinese subtotal:</b>	<b>&lt;10%</b>	<b>&lt;11%</b>
			Texas Instruments	43.8%	39.6%							Skyworks Solutions	22.3%	19.0%	HiSilicon	2%	2%
			NXP	23.6%	25.3%							Qorvo	17.3%	17.7%	Maxscend	1%	2%
			Analog Devices	22.2%	22.4%							Qualcomm	14.8%	14.8%	Xinyi Semi	<1%	<1%
			<b>Overseas subtotal:</b>	<b>89.6%</b>	<b>87.4%</b>	<b>Chinese subtotal:</b>	<b>&lt;1%</b>	<b>&lt;1%</b>				Murata Manufacturing	11.9%	10.7%	Smarter Micro	<1%	<1%
												NXP	5.2%	4.7%	UniChip	<1%	<1%
FPGA	5,683	5,975	Xilinx	51.1%	54.1%	Unigroup Guoxin	<1%	<1%				<b>Overseas subtotal:</b>	<b>75.9%</b>	<b>73.4%</b>	<b>Chinese subtotal:</b>	<b>&lt;4%</b>	<b>&lt;6%</b>
			Intel	35.8%	32.1%	Fudan Micro	<1%	<1%				Texas Instruments	15.3%	14.7%	HiSilicon	3%	4%
			Microchip Technology	5.2%	6.3%	Huada	<1%	<1%				Dialog Semiconductor	9.2%	8.8%	Silergy	3%	3%
			Lattice Semiconductor	5.0%	4.9%	Gowin	<1%	<1%				Qualcomm	9.5%	8.2%	SG Micro	<1%	<1%
			<b>Overseas subtotal:</b>	<b>97.1%</b>	<b>97.4%</b>	<b>Chinese subtotal:</b>	<b>&lt;1%</b>	<b>&lt;1%</b>				STMicroelectronics	7.4%	7.3%	Shanghai Bellinc	<1%	<1%
												<b>Overseas subtotal:</b>	<b>48.0%</b>	<b>45.7%</b>	<b>Chinese subtotal:</b>	<b>&lt;10%</b>	<b>&lt;10%</b>
Driver IC	6,060	5,878	Samsung Electronics	26.6%	24.2%	Huada	<1%	<1%	RF	11,831	11,677	Intel	24.8%	25.7%	Bitmain	4%	2%
			Novatek	16.4%	17.4%	SinoWealth	<1%	<1%				STMicroelectronics	4.5%	4.8%	HiSilicon	4%	4%
			Silicon Works	10.0%	10.3%	Solomon Systech	<1%	<1%				Cirrus Logic	3.9%	4.4%	Montage	1%	1%
			Himax Technologies	9.7%	9.0%	Chipone	<1%	<1%				<b>Overseas subtotal:</b>	<b>44.3%</b>	<b>46.6%</b>	<b>Chinese subtotal:</b>	<b>&lt;15%</b>	<b>&lt;15%</b>
			Raydium	5.7%	7.3%							Apple	28.0%	31.7%	Amlogic	2%	2%
			<b>Overseas subtotal:</b>	<b>68.5%</b>	<b>68.2%</b>	<b>Chinese subtotal:</b>	<b>&lt;2%</b>	<b>&lt;3%</b>				MediaTek	13.5%	13.8%		1%	1%
Analog	24,401	23,014	Texas Instruments	29.2%	29.2%							Broadcom	7.6%	7.2%			
			Analog Devices	20.1%	20.1%							Nvidia	5.3%	5.3%			
			Maxim Integrated	4.6%	4.2%							AMD	6.9%	4.2%			
			ON Semiconductor	4.1%	4.0%							NXP	3.1%	3.1%			
			Renesas Electronics	2.1%	3.1%							<b>Overseas subtotal:</b>	<b>64.4%</b>	<b>65.2%</b>	<b>Chinese subtotal:</b>	<b>&lt;5%</b>	<b>&lt;5%</b>
			STMicroelectronics	2.9%	2.9%							Intel	39.4%	44.0%	HiSilicon	5%	7%
Discretes	22,731	21,608	<b>Overseas subtotal:</b>	<b>52.8%</b>	<b>51.8%</b>	<b>Chinese subtotal:</b>	<b>&lt;3%</b>	<b>&lt;2%</b>	Discrete AP	25,264	25,180	Qualcomm	37.1%	32.5%	UniSoC	9%	6%
			Sony	46.8%	52.0%	Will Semiconductor	12%	9%				MediaTek	6.1%	4.6%	<b>Overseas subtotal:</b>	<b>82.6%</b>	<b>81.0%</b>
			Samsung Electronics	21.0%	19.5%	Galaxycore	3%	3%				Broadcom	7.6%	7.2%	<b>Chinese subtotal:</b>	<b>&lt;15%</b>	<b>&lt;15%</b>
			ON Semiconductor	5.7%	4.4%	BYD Micro	<1%	<1%				Nvidia	5.3%	4.2%			
			SK Hynix	2.4%	3.8%	SmartSens	<1%	<1%				AMD	6.9%	4.2%			
			<b>Overseas subtotal:</b>	<b>76.0%</b>	<b>79.6%</b>	<b>Chinese subtotal:</b>	<b>15%</b>	<b>16%</b>				NXP	3.1%	3.1%			

Source: Gartner, Company data, Credit Suisse estimates

#### ■ **MCU: a broad fragmented market dominated by global IDMs makes penetration slow.**

China has a low single-digit share in the MCU market dominated by global IDMs including Renesas, NXP, Microchip, STM, TI and Infineon. The MCU customer base is in thousands and relies on a large catalog of products and takes time to build up. China has multiple MCU suppliers including Gigadvice, Ingenc, Sinowalth, Silan, Datang and Huada and can use Hua Hong/SMIC's embedded flash capability. MCU companies can target the large domestic Chinese market looking for a domestic source and also some of the higher volume markets, such as home appliances and toys.

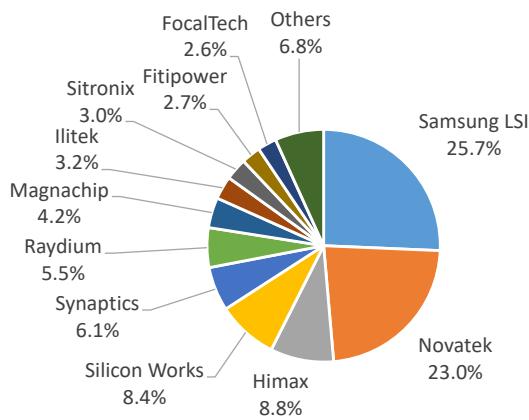
#### ■ **RF: advanced specialty technology requires an experienced team.** RF design is

increasingly complex supporting multiple bands across 2G-5G, integration of multiple components and use of specialty compound semiconductor materials requiring experienced radio frequency chip designers. China's RF suppliers (HiSilicon, RDA, Maxscend, Vanchip) are now competitive in 2G through 4G with discrete solutions and trying to build up module integration capabilities. The supply chain will also rely on Murata (PA filters) and Taiyo Yuden (BAW filters) to mitigate risk of the US technology exposure.

■ **Display drivers.** Taiwan and Korea lead in driver ICs with established position from years of supplying their domestic panel makers. Market share is led by long-time suppliers Novatek, Himax, Synaptics, FocalTech, Magnachip and Samsung's internal division. China does have a few suppliers seeking entry for LCD driver IC including SinoWealth, Galaxycore, Solomon Systech, Chipone, though it lags in capacity support (at times tight on 8"), technology development (shifting to higher resolution, ability to develop peripheral chips, power consumption, and colour accuracy), and panel makers' confidence relative to the established suppliers with a large purchasing scale and design advantage, as driver IC only accounts for 3-5% of BOM for large-sized panels and 10-15% for smartphone panel.

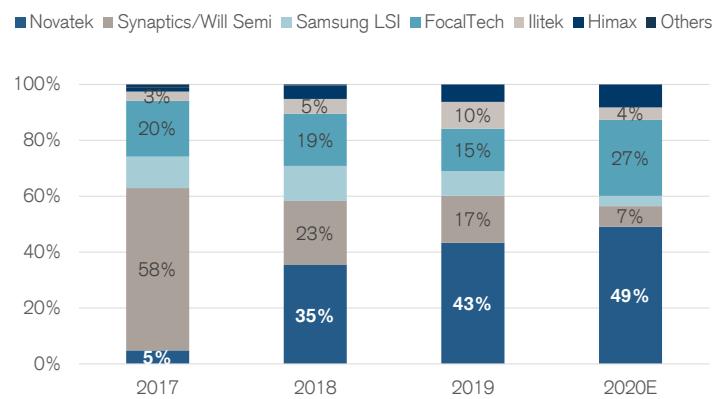
As a result of its scale and technology gap in driver ICs, M&A seems to be an easier route for Chinese companies to enter the driver IC space. In late-2019, Will Semi announced it would acquire Synaptics' smartphone TDDI business and finally enter into the market, although its market share has been shrinking amid the transition. Another M&A case in 2020 was Ilitek, which used to be Mediatek's subsidiary and suppliers TDDI and some large-sized DDI, which was sold to a consortium including PE funds, Chinese panel makers, and smartphone makers. For the OLED driver IC, the market is dominated by companies such as Novatek, Raydium, and Siliconworks although several Chinese start-ups including Eswin, Sheng He, Viewtrix, SD Micro target the space. However, the China suppliers' focus is more on the wearable and smartphone repair market, while progress on entering into rigid and flexible OLED panel makers by these new start-ups and even tier two fabless in Taiwan remains slow due to lags in technology development for higher-resolution design and higher development cost for 40nm/28nm process node.

**Figure 141: Korean and Taiwanese companies dominate the display driver IC market (1H20)**



Source: Omdia, Company data, Credit Suisse estimates

**Figure 142: Novatek has higher allocation for TDDI at leading Chinese smartphone brands and IDH**



Source: Company data, Credit Suisse estimates

## China also has a large pool of IC design start-ups

We present an industry map of over 120 China IC design companies by chip and applications. In fact, now there are already over 2,000 IC design companies in China. On the one hand, the high number of IC design companies suggests a bubble in formation. Over the next few years, the large number of companies with less technology capabilities may incur a price war to the detriment of industry fundamentals to capture some market share in MCU, analog/discrete, audio and smart home/connectivity applications. But, on the other hand, China's appetite for semiconductor would facilitate local talent training and enterprises' access to the capital market. Also, the industry's history has shown that solid IC companies can emerge and grow from bubbles. Given China market's large size and with the continued localisation trend, we expect at least one-to-two companies from each category to stand out over the next decade and gradually build more comparable capabilities to compete with the global IC design companies.

**China has over 2,000 local IC design companies, leading to an eventual consolidation of several new leaders to emerge**

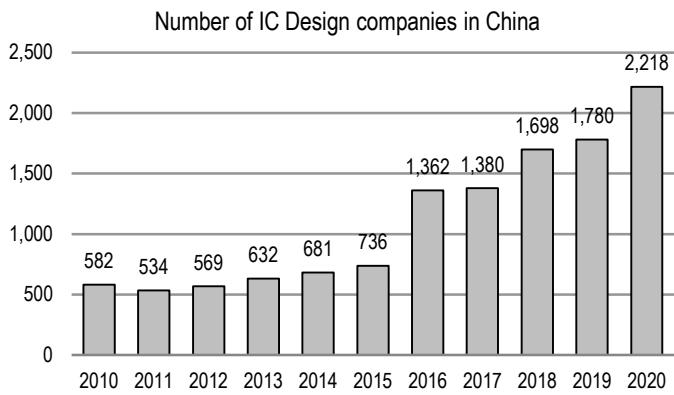
**Figure 143: Map of China IC design companies**

Mobile processor	Ticker	MCU	Ticker	Memory	Ticker	Power, MOSFET, IGBT
Huawei HiSilicon	Private	Gigadevice	603986	Gigadevice	603986	Huawei HiSilicon
UNISOC (Unigroup Spreadtrum-RDA)	Private	Ingenic	300223	Innotron / CXMT	Private	SG Micro
Allwinner	300458	Unigroup Guoxin Microelectronics	002049	YMTC / XMC (Tsinghua Unigroup)	Private	StarPower Semi
Rockchip	603892	SinoWealth	300327	Ingenic / ISSI	300223	Silan
Leadcore	Private	Silan	600460	Giatec	688123	Shanghai Bellng
ASR Micro	Private	Goodix	603160	Fujian Jinhua	Private	Nexperia / Wingtech
Pinecone (Xiaomi)	1810 HK	Datang Microelectronics	Private	Reliance Memory (JV of Rambus and Gigadevice)	Private	CR Micro
Sanechips (ZTE Microelectronics)	Private	Huada Semiconductor	Private	Unigroup Guoxin Microelectronics	002049	Silergy
<b>PC/server CPU</b>	<b>Ticker</b>	<b>Giatec</b>	688123	<b>Memory interface chip &amp; PCIe retimer</b>	<b>Ticker</b>	<b>Will Semi</b>
Phytium	Private	BYD Microelectronics (within BYD)	1211 HK	Montage Technology	688008	Yangjie
Huawei HiSilicon	Private	Yi-xin	Private	<b>SSD/eMMC controller</b>	Jiangsu JieJie Microelectronics	300623
Hygon	Private	MindMotion	Private	Huawei HiSilicon	Private	BYD Microelectronics (within BYD)
Loongson	Private	WinnerMicro	Private	Goke Microelectronics	300672	Wuxi NCE Power
Sunway	Private	<b>Fingerprint sensor &amp; touch controller</b>	Jiangsu Huacun Electronic Technology	Private	Good-ARK	002079
Zhaoxin	Private	Goodix	603160	Tsinghua Dera	Private	Zhuzhou CRRC Times Electric's semi entity
<b>Cloud, Server, NPU, AI</b>	<b>Gigadevice (Silead)</b>	<b>603986</b>	<b>SinoChip Semiconductors</b>	<b>Private</b>	<b>3898 HK</b>	
Huawei HiSilicon	Private	Fortsense	Private	Yeestor	Private	Sino-Microelectronics
Cambricon	Private	Betterlife	835288	StoreArt	Private	3Peak Inc
Montage Technology	688008	Chipone	Private	Konsemi	Private	Superchip (Fine Made Electronics)
Alibaba	BABA	BYD Microelectronics (within BYD)	1211 HK	<b>Audio, video, surveillance, image processing</b>	Chipown	688508
Eeasy Tech	Private	<b>CIS / ToF sensor</b>	Huawei HiSilicon	Private	ETEK	Private
Huaxintong	Private	Omnivision / Will Semi	603501	Fullhan	300613	UNISOC (Unigroup Spreadtrum-RDA)
Big Fish (Xiaomi)	1810 HK	Galaxy core	Private	Goke Microelectronics	300672	Huada Semiconductor
ThinkForce	Private	BYD Microelectronics (within BYD)	1211 HK	Rockchip	603892	SAIC Infineon Automotive Power Module
Iluvatar	Private	SmartSens	Private	Dahua	002236	ETASolutions Co.,
<b>FPGA</b>	<b>Silicon Integrated</b>	<b>Private</b>	<b>Bestechnic</b>	<b>688608</b>	<b>Leshan Radio</b>	
Gowin	Private	Goodix	603160	Beken	603068	Beijing Zhisi Microelectronics
Fudan Micro	1385 HK	<b>DDI (Display driver IC)</b>	Zhuhai Jiel	Private	Sanechips (ZTE Microelectronics)	Private
Unigroup Guoxin Microelectronics	002049	SinoWealth	300327	Eeasy Tech	Private	Changzhou Galaxy Century Microelectronics
Anlogic	Private	Solomon Systech	2878 HK	Vimicro	Private	WeEn Semiconductor
Hercules Microelectronics	Private	Will Semi	603501	Artosyn	Private	Jiangsu CAS-IGBT Technology
Huada Semiconductor	Private	Galaxy core	Private	YITU	Private	Beijing Yandong Microelectronics
DeePhi (Acquired by Xilinx)	XLNX	Chipone	Private	Horizon Robotics	Private	Chipone
<b>CPU</b>	<b>Wi-Fi, BLE connectivity</b>	<b>Private</b>	<b>Sanechips (ZTE Microelectronics)</b>	<b>Private</b>	<b>RF switch, LNA, PA</b>	
Phytium	Private	Huawei HiSilicon	Private	Ingenic	300223	Maxscend
Zhaoxin	Private	UNISOC (Unigroup Spreadtrum-RDA)	Private	Goodix	603160	Huawei HiSilicon
HiSilicon	Private	Espressif Systems	688018	CCVUI	Private	Vanchip
Loongson	Private	Beken	603068	Analogix (Display Port, Tcon, ASIC)	Private	UniChip (Will Semi's subsidiary)
Hygon	Private	Winner Micro	Private	<b>IC for bank card, sim card, security card</b>	Sanechips (ZTE Microelectronics)	Private
Sunway	Private	Goodix	603160	Nationz Technologies	300077	Xinyi Semi
<b>GPU</b>	<b>Siflower</b>	<b>Private</b>	<b>Unigroup Guoxin Microelectronics</b>	<b>Private</b>	<b>002049</b>	
Jingjia Micro	300474	Era Semi	Private	Shanghai Fudan	1385 HK	Smarter Micro
Zhaoxin	Private	Tianyi Hexin	Private	Huada Semiconductor	Private	ChipBetter
<b>Automotive</b>	<b>Xinyi Semi</b>	<b>Private</b>	<b>LED driver, MEMS sensor, discrete</b>	<b>OnMicro</b>	<b>Private</b>	
NavInfo / AutoChip	002405	Amlogic	688099	Silan	600460	Lansus
BYD Microelectronics (within BYD)	1211 HK	<b>Drone, robot SoC</b>	Shanghai Bellng	Private	600171	Jiamei Xinxin (CanaanTek)
Wingtech	600745	Artosyn	Private	Yangjie	300373	Awinic
Goodix	603160	<b>Cryptocurrency ASIC</b>	STB	Private	Espressif Systems	688018
Will Semi	603501	Bitmain	Private	Goke Microelectronics	300672	RadRock
Horizon Robotics	Private	Canaan	CAN	Amlogic	688099	Private
Huawei HiSilicon	Private	Ebang Communication	Private	Avalink	Private	Private
Sanechips (ZTE Microelectronics)	Private	<b>Aerospace, satellite IC</b>	Sanechips (ZTE Microelectronics)	Private	Private	Private
Allystar	Private	Orbita	300053	Private	Private	Private
Yi-xin	Private	UniStrong	002383	Private	Private	Private

Source: Company data, Credit Suisse

We profile in more depth China's opportunities and efforts to penetrate RF, CPU and AI/HPC as high profile and significant markets for domestic fabless.

**Figure 144: China's great semi policy supports have driven many IC design start-ups or large China companies to set up IC design subsidiaries**



Source: China Semiconductor Industry Association, Credit Suisse

## China RF to grow its tiny market share

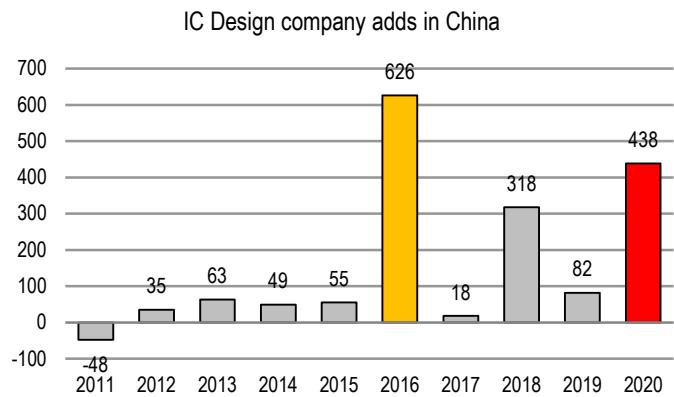
While we expect the top global five RF suppliers (Qorvo, Skyworks, Broadcom, Qualcomm and Murata) to continue their high market share in the next few years, we also expect capable Chinese RF companies to substantially grow their currently very tiny market share driven by the strong import substitution trend in China, and more importantly, with China RF suppliers' expanding technology capabilities. Among the existing over ten China RF suppliers, our checks suggest that Maxscend, Vanchip and UNISOC are the relatively more capable ones, while Lansus also claims it has developed 5G RF front-end (RF FE) (LPAMiF, LFEM, and PAMiF and PA) and has increased its wafer-start at Taiwanese foundry partners for customer qualification. The other China RF suppliers have shorter histories, smaller engineer teams, less proven records with major OEMs or fewer high-end RF FE chips.

**Figure 146: China RF FE suppliers—driven by the Chinese government's push for a domestic semi supply chain, there are various Chinese companies developing semiconductors over the past few years**

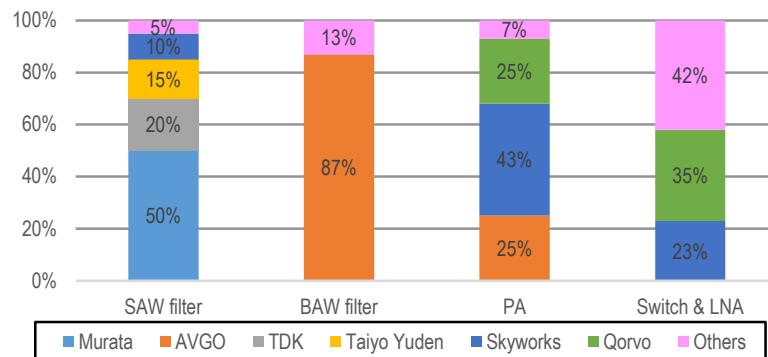
	Maxscend	Vanchip (MediaTek)	Huawei HiSilicon	UNISOC	OnMicro (Huntersun)	Will Semi	Etra Semi	RadRock	Kangxi
Switch	卓胜微	唯捷创芯	华为海思	紫光展锐	昂瑞微 (中科汉天下)	韦尔半导体	宜确半导体	锐石创芯	康希通信
LNA	x		x	x	x	x	x	x	x
PA	x	x	x	x	x		x	x	x
Filter	x	x	x	x					
Module	x	x	x	x	x			x	x
	Lansus	China UniChip	Smarter Micro	CanaanTek	Microgate	Deqing Huaying	Shoulder	Sunway	Cai Qin
Switch	飞骧科技	中普微	慧智微电子	迦美信芯	麦捷微科技	德清华莹	好达电子	信维通信	灿勤科技
LNA	x			x					
PA	x	x	x		x	x	x	x	x
Filter									
Module	x	x		x					

Source: Company data, Credit Suisse

**Figure 145: 438 IC design companies were established in 2020**



Source: China Semiconductor Industry Association, Credit Suisse

**Figure 147: Global RFFE market share by major RF components**

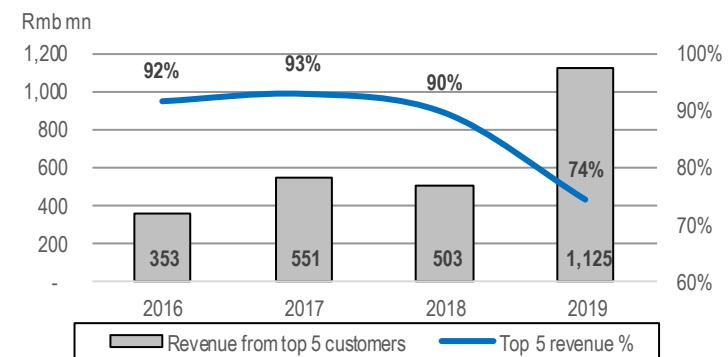
Source: Company data, Credit Suisse estimates

**Maxscend: Proven track record for product expansion.** Established in 2006 and headquartered in Wuxi, China, Maxscend is the only radio frequency front-end (RF FE) IC design (fabless) company in A-share (IPO in 2019). It develops various RF front-end chips and modules, including switch, LNA, antenna tuner, filter, and PA (Power Amplifier). Maxscend supplies RF chips to the global top five Android OEMs in China and overseas. International customers include Samsung, Qualcomm and Korean module supplier WiPAM. Chinese customers include Xiaomi, Huawei, vivo, OPPO, Lenovo, ZTE, and TCL.

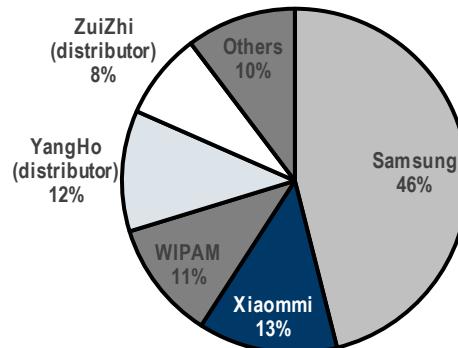
Maxscend's technology portfolio includes RF CMOS (complementary metal oxide semiconductor), RF SOI (silicon on insulator), SiGe (silicon germanium) and GaAs (gallium arsenide) and it can customise solutions based on customer requirements. Maxscend continues developing new products to expand its technology portfolio beyond switch, LNA and tuner. It launched multiple SAW (Surface Acoustic Wave) filters in 2019, including GPS filter, Wi-Fi filter, and LTE filter, and has begun shipments in 1H20. It has also introduced Wi-Fi PA and began shipping Wi-Fi FEM (PA + switch + LNA) in 1H20. Besides Wi-Fi FEM, it also developed other RF modules and will begin volume production this year, including DiFEM (Diversity Receive Front-End Module), LFEM (LNA Integrated FEM), and LNA (Low Noise Amplifier) bank. All the cellular and Wi-Fi modules use Maxscend's own switch, LNA, filter and PA chips.

According to our checks, the new Wi-Fi FEM has been adopted by routers and module customers for IoT applications. The company's LNA portfolio covers both low-cost CMOS (Complementary Metal Oxide Semiconductor) and high-performance SiGe (silicon germanium). Further, Maxscend's RF chips have been used by global major Android OEMs for their flagship models and also mainstream models.

Maxscend is raising Rmb3 bn through a private placement, including Rmb1.4 bn to build high-end filter capacity and Rmb0.8 bn to build base station RF capacity. Both projects are expected to take five years to build, depending on market demand and technology development.

**Figure 148: Maxscend – 74% of 2019 sales from top 5 clients**

Source: Company data, Credit Suisse

**Figure 149: Maxscend revenue by customer – 2018**

Source: Company data, Credit Suisse

**Figure 150: Maxscend continues to expand its product portfolio beyond switch and LNA. New products in 2019-20 will deliver meaningful growth in 2020-23. High-end filters, PA and high-end modules to fuel further growth beyond 2023**

RF FE						Non-RF
Switch	LNA	Filter	PA	Module	Antenna tuner	Low-power Bluetooth MCU
Cellular switch	GPS / GNSS LNA	LTE SAW filter	Wi-Fi AC PA	DfEM	Impedance tuner	Connectivity MCU for smart city, surveillance, smart meter
Wi-Fi Switch	Cellular signal LNA	GPS SAW filter	Wi-Fi AX PA	LFEM	Aperture tuner	
Antenna tuning switch	TV signal LNA	Wi-Fi SAW filter	Cellular PA	LNA bank		Bluetooth audio IC
Integrated switch-LNA	FM signal LNA	RX SAW filter		WiFi & connectivity module		
(Maxscend has over 300 switches for diff spec.)						
Font color note						
Black: product shipping since prior to 2018						
Green: product shipping from 2019-2020						
Red: product in R&D						
LTE Duplexer						
TX SAW						
WLAN filter						
PAMiD						
LTE MMBB						

Source: Company data, Credit Suisse

**Vanchip = Vanchip + Airoha (Mediatek).** Established in 2010, Vanchip is one of the earlier RF front-end IC design companies in China. It began volume shipments from 2012 and the power amplifier is its major product. Over the past few years, Vanchip and Airoha (MediaTek's subsidiary) faced fierce price competition in the low-end PA market in China and both were not making reasonable profits as RF fabless suppliers.

In Apr-2019, Mediatek invested in Vanchip and MediaTek's Vice Chairman Ching-Jiang Hsieh took the position of Vanchip's Chairman. MediaTek then encouraged Airoha's customers to use Vanchip's PA, while Airoha shifted focus to other non-PA chip products including the audio SoC. Our channel check suggested that currently Vanchip should be the largest PA supplier among Chinese suppliers with a position into many of the top China smartphone brands.

**UNISOC: Total 5G solution supplier.** UNISOC, formerly known as Spreadtrum, is a major IC design (fabless) company in China, focussing on 5G and AI. Its product portfolio covers mobile SoC (System on Chip), baseband processor, AI chip, and RFFE (RF Front-End). The company had gained a solid RF capability acquiring former US listed company, RDA, which brought with it power amplifier, Bluetooth, FM and a baseband solution. Together with RDA, UNISOC now has over 5,000 employees, with over 90% working on R&D, and 17 R&D centres globally.

UNISOC is the first Chinese company to launch its 5G RFFE total solution on 9 November, integrating transmitting and receive modules. Further, the PAs (Power Amplifier) included in its RFFE solution are 100% self-designed. UNISOC launched its 5G PA in 2020 and has overcome challenges such as the high transmitting power requirement for 5G. Additionally, the company relies partly on external suppliers for its filter, as its current filter products cannot cover all the massive 5G frequency bands. UNISOC suggested its 5G RFFE products have been adopted by various smartphone customers, including Nokia smartphone (through its ODM FIH Mobile), Huawei, TCL, Transsion, Chino-E, Meizu, China Mobile and Hisense.

**Huawei: A pure customer now.** Huawei's semiconductor entity, HiSilicon, was a major treat to both international and Chinese RF FE suppliers. Between 2018 and early 2020, while Huawei adopted external RF chips, HiSilicon also very aggressively developed RF chips for

**China's emerging RF suppliers include Maxscend, Vanchip, UniSOC and several smaller suppliers**

Huawei. But the US ban on Huawei (restricting foundries globally with any US equipment from producing wafers for Huawei) totally limited the future potential for HiSilicon. Prior to 15 May 2020, there was still a gray area as to whether foundries globally with US equipment can produce wafers for Huawei. But the regulatory announcement on 15 May 2020 gave clear instructions that this is not allowed. Without the US ban, it is highly possible that Huawei would use more HiSilicon's RF chips going forward, limiting growth potential for international and Chinese RF suppliers. With this US ban, Huawei's smartphone, base station, TV, IoT businesses have to use external RF chips. Furthermore, as a result of the restriction, China OEMs also want to help develop their domestic chip supply chain, thereby creating an even more favourable growth environment for China IC design companies.

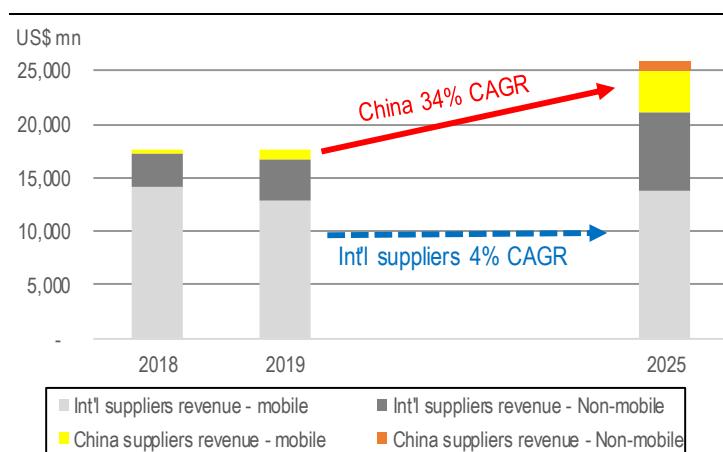
**CanaanTek: One of the emerging start-ups with switch and tuner expertise.** CanaanTek, founded in 2014, is a Chinese RF supplier and shipped more than 50 mn chips per month by 2017, according to the company. Its products cover RF switch, RF SOI antenna tuner, LNA (Lower Noise Amplifier), and LNA Bank for cellular and GPS. CanaanTek has used 110RFSOI technology in volume and has 55RFSOI in development. The company has developed advanced and low-cost switches for 4G on the Mediatek and Qualcomm platforms and also a 5G NR switch and antenna tuner using the domestic foundry and back-end suppliers. Its CEO Wenhai Ni has been with the company since 2008 with prior background at Intersil, RFMD, Comlent (TD-SCDMA supplier) and Orange Coast Semiconductor (GPS and Digital TV tuner supplier)

**Lansus: a new entrant in RFFE.** Lansus was spun off from Nationz Technologies' Power Amplifiers Department in 2015, focussing on the development of RF solutions including PA, switch, and RFFE modules. It started 5G RFFE development from 2018 and claims it has developed China's first 5G RFFE (LPAMiF, LFEM, and PAMiF, and PA) in June 2000 for n77+n79 band with the production at local foundry Sanan. Based on our supply chain checks, Lansus has increased its 4G/5G wafer-start at Taiwanese foundries since late-4Q20, on top of Sanan, targeting to complete the customer qualification and ramp up its output in 2021.

## China RF suppliers to grow their tiny market share

We expect China RF suppliers to grow in both mobile RF and non-mobile RF segments, driven by China's strong localisation trend, China smartphone OEMs' over 50% global share, and China fabless' technology advancement. In the mobile RF market, we estimate China RF suppliers to grow market share from 5-6% in 2019 to 22% by 2025E. In the non-mobile RF market (infrastructure, automotive, defence, incremental IoT, new connected vehicles), we estimate China RF suppliers to grow from nearly 0% share in 2019 to 11% by 2025E.

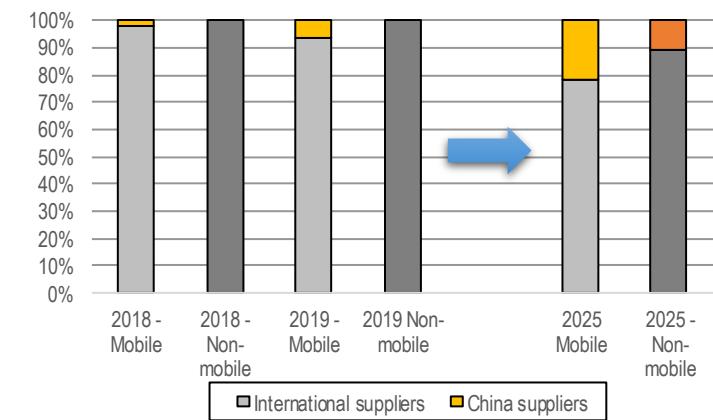
**Figure 151: Global mobile and non-mobile RF market**



Source: Credit Suisse estimates

We believe the 22% share for the mobile and 11% share for the non-mobile market is achievable by 2025. In the smartphone market, seven out of top 10 OEMs are Chinese

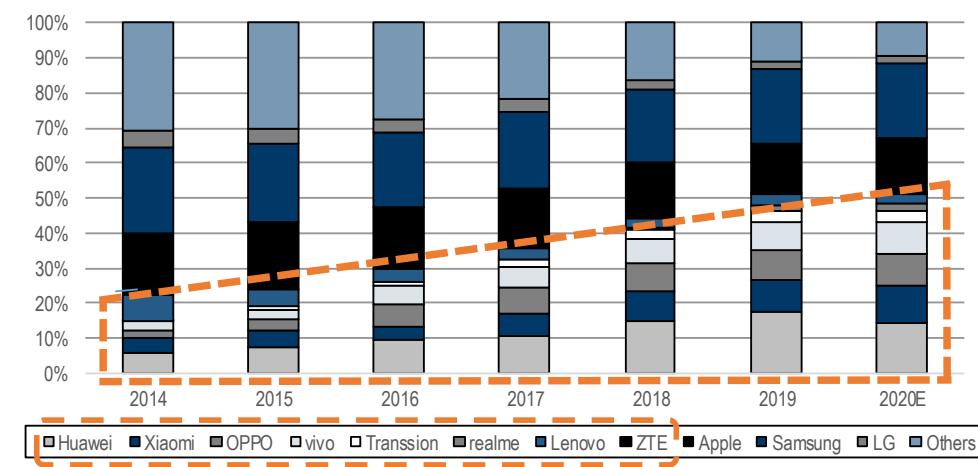
**Figure 152: Global mobile and non-mobile RF markets—China vs international RF suppliers market share estimates**



Source: Credit Suisse estimates

companies and they have over 50% global market share. In the base station market, Huawei and ZTE together have about 35-40% share globally. In the automotive market, 20-25% vehicles are made by China auto makers. Furthermore, China has a more open environment for autonomous cars. Regarding IoT, China is the largest region by user base and has a decent number of well-known brands from smartphone, TV and home appliance OEMs.

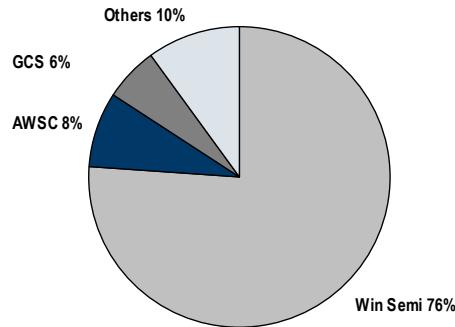
**Figure 153: Global smartphone market share—China top eight OEMs' increased market share from 45% in 2018 to 51% in 2019**



Source: IDC, Credit Suisse estimates

We believe the rise of Chinese RF fabless will be positive for Taiwanese PA foundries such as VPEC (epiwafer), Win Semi (wafer processing), and AWSC (wafer processing). VPEC has a long history with Chinese fabless by supplying epi wafers to Win Semi and Sanan. As Win Semi's capacity has been occupied by HiSilicon since 2H19, it has worked with its customers to diversify into AWSC. We believe VPEC has the most diversified customer base among the foundries as it also supplies epi wafer for leading IDMs (Avago, Skyworks, and Qorvo) into flagship smartphones. It recently saw good momentum of epi wafer for 4G/5G RF PA from Qorvo and Chinese RF fabless, which can support further RF localisation. [For Win Semi, we also believe](#) it could be a beneficiary of China's RF localisation as it has the greatest foundry capacity and technology, as well as it has a proven track record working with IDM and China fabless customers like HiSilicon. Nevertheless, it will face some revenue gap post the Huawei/HiSilicon ban, but longer term could still benefit from the rising RF production by Chinese fabless.

**Figure 154: Win Semi dominates compound semi foundry space with 76% market share in 2019**



Source: Company data, Credit Suisse

**Figure 155: VPEC has a more diversified customer base than the wafer foundries**

Primary epiwafer supplier	Wafer processing	
Avago	VPEC	Win Semi
Skyworks	IQE	In-house and AWSC
Qorvo	VPEC	In-house
Qualcomm	Shifting from Win Semi to VPEC	Win Semi, adding AWSC
Murata	Win Semi	Win Semi
Others	Win Semi and VPEC	Win Semi, AWSC, and Sanan

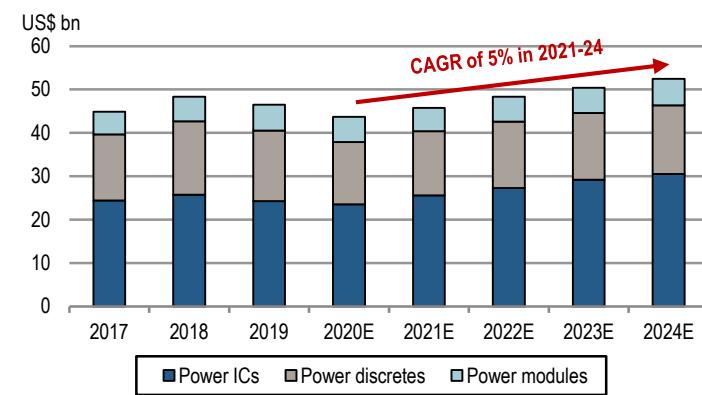
Source: Company data, Credit Suisse

## Power semi market dominated by global giants, but China players growing their penetration

We profiled China's semiconductors market opportunities in the power semiconductor market in our recent [initiation report](#) on CR Microelectronics and highlight the key implications for China's emergence and for the existing global incumbents. Power semiconductors are the core component for any power system (or electronic device), designed with a unique architecture to handle high voltage and large current without damage. Its primary function is to regulate electrical parameters, such as AC/DC, voltage, current and frequency, to ensure appropriate power supply. Power semiconductors play an irreplaceable role in diverse applications including vehicles and industrial devices, converter/rectifier/transducer in grids, electricity stabiliser for home appliances and commercial equipment.

In 2019, the power semiconductor market reached US\$46 bn, accounting for about 10% of the global semiconductor market value, with 52% from PMIC and 48% from discrete and module, according to OMDIA. Automotive has already been the largest end-market for power discrete & module, accounting for about 22%, followed by industrial.

**Figure 156: OMDIA expects global power semiconductor market to grow at a CAGR of 5% in 2021-24E**



Source: OMDIA, Credit Suisse

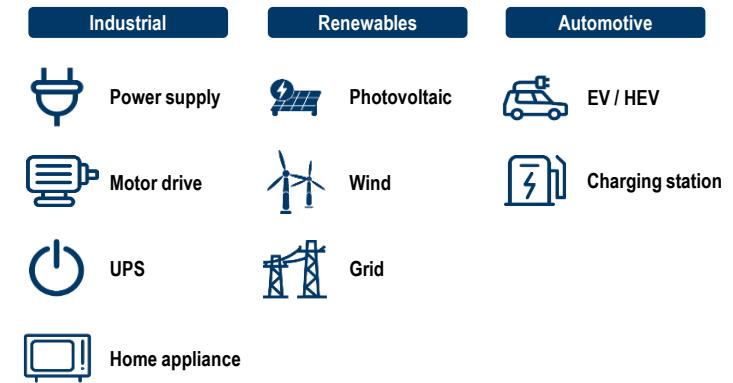
As power semi products require advanced designs and complex processes to achieve stable performance under high-voltage, large-current and high-frequency conditions, the major global suppliers manufacturers have accumulated rich experience and comprehensive knowledge of every aspect of the manufacturing process to succeed in the market. Meanwhile, the IDM business model, requiring continuous heavy capital input in the power semi world, also set barriers for new and small players. Additionally, for many devices, power semi accounts for a very small portion of the device's BoM (and often below 1%), so device manufacturers are often reluctant to change power semi suppliers.

Thanks to the first mover advantage and long-term commitment, global giants in Europe, the US, and Japan are dominating the power semi market. Infineon from Germany, ON Semiconductor from the US, and STMicroelectronics from Switzerland are the top three suppliers globally, while Japanese manufacturers, Mitsubishi and Fuji Electric, also have demonstrated strong track record for IGBT-based products. For PMIC, only Texas Instrument is the top vendor with nearly 15-20% share of global PMIC. In contrast, due to late development and lack of technology reserve, manufacturers in China have not established a strong presence in power semi. There is still a gap in their size and technological advancement with the global giants.

### Import substitution from US tension and domestic demand

Similar to other ICs, the emerging power semi suppliers need customers' willingness to test their ICs, discrete and modules in end-devices, use small volumes, and then gradually adopt high volume. The feedback from customers is critical for manufacturers to further improve their

**Figure 157: Yole expects power semiconductor growth to be driven by industrial, renewables, and automotive**



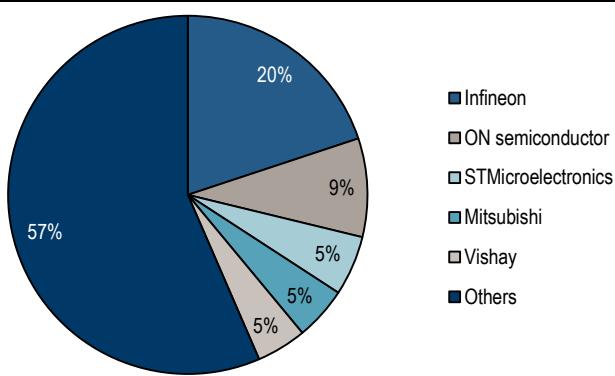
Source: Yole, Credit Suisse

products. However, considering the performance and reliability of power semi are of make-or-break nature to any end product, like industrial inverter and EV, OEMs were reluctant to test and use power semi from new suppliers prior to 2018. This could explain China's power semi suppliers' low market share as they are much younger and less mature than global peers.

The ecosystem in China is experiencing a fundamental change from the US-China trade war. The US bans on ZTE, Huawei and SMIC are making Chinese OEMs more anxious about the security of supply chain and they are very willing to adopt China-made or China-designed power semi products. And the import substitution momentum has been even stronger in 2020 than it was in 2018-19, and China power semi manufacturers are receiving an unprecedented welcome from downstream customers across consumer, mobile, home appliance, industrial, and automotive markets. More importantly, China OEMs are sharing next-generation product design with local manufacturers and involving them in the early stages of product development, which should accelerate growth of China power semi companies and products.

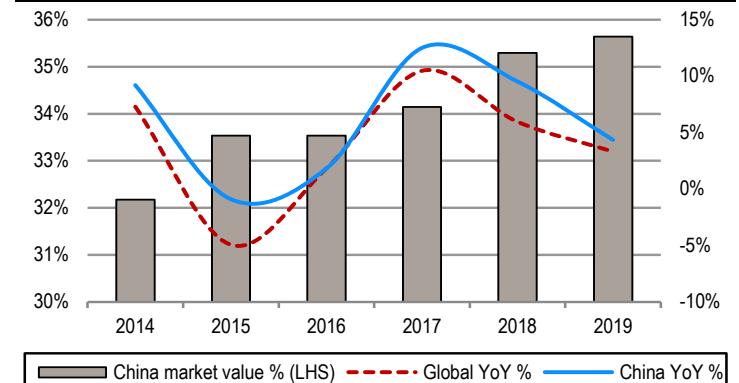
The China market at one-third of global demand with faster growth is accelerating China's power semi ecosystem development. China is leading the world's EV and solar markets, which will constitute the majority of incremental power semi demand in the next decade. The local market provides a strong base for the emerging Chinese companies to grow their market share.

**Figure 158: Global power semiconductor led by global players**



Source: IHS Markit, Infineon, Credit Suisse (2018 market share)

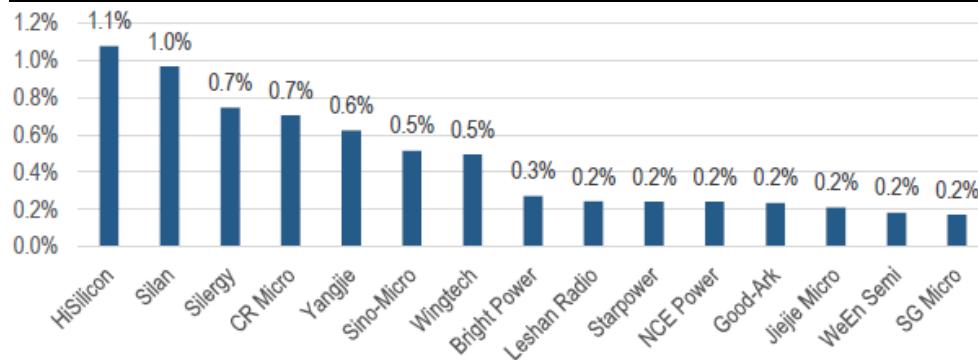
**Figure 159: China the largest market for power ICs**



Source: IHS Markit, CR Micro IPO prospectus, Credit Suisse

Our conversations with China OEMs suggest that although high-end products still rely heavily on overseas chip suppliers, China manufacturers can supply abundant mainstream power semi discrete and modules besides ICs. The total revenue of major China power semi companies accounts for 7-8% of the global market share in 2019, while CR Micro's market shares among major China suppliers and in the global power semi market were 12% and 0.7%, respectively.

**Figure 160: China's top 15 power IC suppliers have only 7% global market share**



Source: Company data, Gartner, Credit Suisse estimates

CR Micro is one of China's top five power semi suppliers besides Huawei Silicon, Silan, Silergy, and Yangjie. Also, CR Micro is one of few China suppliers which have established a comprehensive product portfolio. We believe CR Micro's established technologies, especially in MOSFET, should help it to grow with China's ecosystem in the next few years as technological moat in power semi is hard to break, and CR Micro is continuously reinforcing its technology capabilities and that helps create its moat vs many emerging, smaller China suppliers.

**Figure 161: China power semiconductor suppliers—CR Micro has the most comprehensive product portfolio**

Company		CR Micro	Starpower	BYD	Silan	Sino-Micro	Yangjie	Nexperia - Wingtech	Zhuzhou CRRC Times
Chinese name		华润微	斯达半导	比亚迪	士兰微	华微电子	扬杰科技	安世半导体 - 闻泰	株洲中车时代
Discrete	MOSFET	√		√	√	√	√	√	
	IGBT	√	√	√	√	√	√	√	√
	IPM	√	√		√	√	√	√	
	Diode	√			√	√	√	√	√
Power IC	AC/DC	√		√	√				
	DC/DC	√		√	√				
	PMIC	√		√	√				
	Driver IC	√		√	√	√		√	
	Audio power amplifier	√			√				
Company		NCE Power	Silergy	SG Micro	Bright Power	Jiejie Micro	Chipown	ETEK	Good-Ark
Chinese name		新洁能	矽力杰	圣邦微	晶丰明源	捷捷微电子	芯朋微	力芯微	苏州固锝
Discrete	MOSFET	√			√	√			√
	IGBT	√				√			
	IPM				√				
	Diode								√
Power IC	AC/DC		√	√	√	√	√		
	DC/DC		√	√	√		√	√	
	PMIC		√	√	√	√	√	√	
	Driver IC		√	√	√		√	√	
	Audio power amplifier		√	√				√	

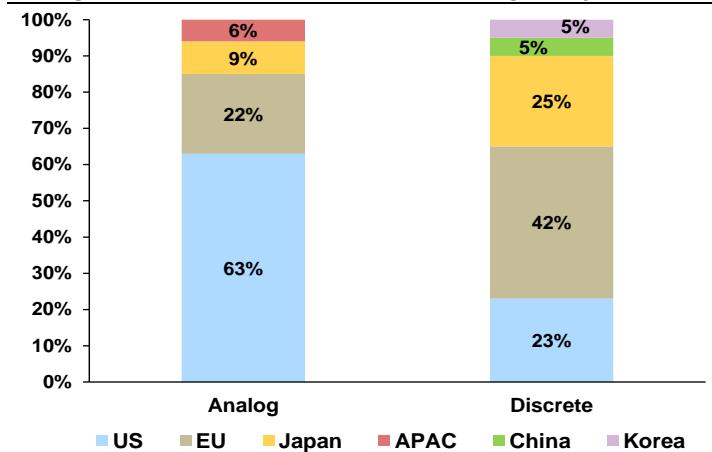
Source: Company data, Credit Suisse estimates

### Overseas implications from China's ramp in power ICs

The Auto and Industrial semiconductor market are two areas where key overseas semiconductor companies like Infineon and STMicro have higher exposure. Auto semiconductors globally were a US\$41 bn market in 2019, accounting for ~10% of the overall market, while Industrial semiconductors were around US\$45 bn in size.

**China industrial/auto growing, still outweighing local China player inroads**

**Figure 162: European vendors have 22% revenue share in the Analog market and 42% in Discrete market globally**



Source: SIA, Credit Suisse

We still view the fragmented customer base in industrial, deep product catalogue, long qualification and stringent quality requirements in automotive, and lower price sensitivity in these segments slowing penetration for China players in the overseas broad markets, although localisation in China for domestic suppliers from import substitution could happen faster. In this field of analog and discrete semiconductors, China is focussing on high volume IT markets initially in computing, mobile, consumer/IoT, display and LEDs, with plans to expand later into auto/industrial, similar to the approach adopted by Taiwan analog companies in the last decade.

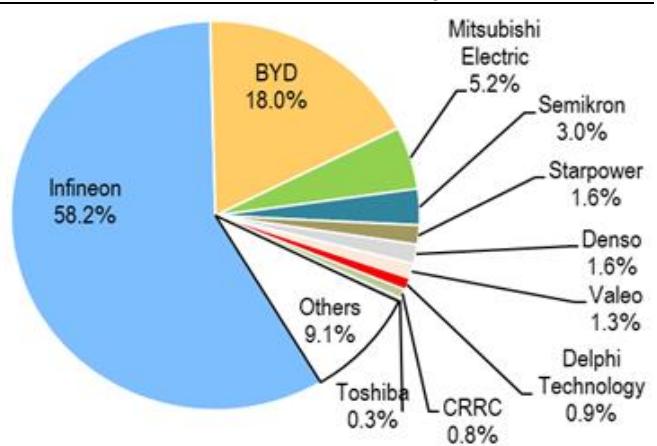
■ **Infineon: China exposure expanding from rising industrial and its strong EV position.** IFX's exposure to China has risen from 23% in 2015 to close to 30% now, driven by China gaining a bigger proportion of global car sales and rising domestic industrial productivity. IFX's main products for the China market are power and sensor related chips going into the automotive, industrial drives, renewables (solar and wind), high speed rail, and consumer electronics end-markets.

IFX has been a market leader for supplying IGBT chips in the global auto market for xEV models. The company has also enjoyed a particularly high share in China over the last few years, with 55-60% market share in 2019. A couple of local Chinese companies have made inroads in this market (BYD 18% share helped by its vertically integrated approach, and Starpower 2% share, which still remains low). During 2020, BYD established a new business unit named 'BYD Semiconductor' for power semiconductor, intelligent control, intelligent sensor and optoelectronic semiconductor, by combining BYD Microelectronics, Ningbo BYD Semiconductor, Guangdong BYD Energy Saving Technology and BYD's (Huizhou) intelligent photo-electricity, LED light source and LED application business into a new group.

■ **STMicroelectronics: power discretes and modules growing, albeit smaller than Infineon's footprint.** While IFX holds a leading position in the power discretes and modules market with 19% share, STM holds the third position with 6% share. From the figure below, no local China player is in the top vendors despite high levels of market share fragmentation in this segment (top 9 players here cumulatively account for ~55% share).

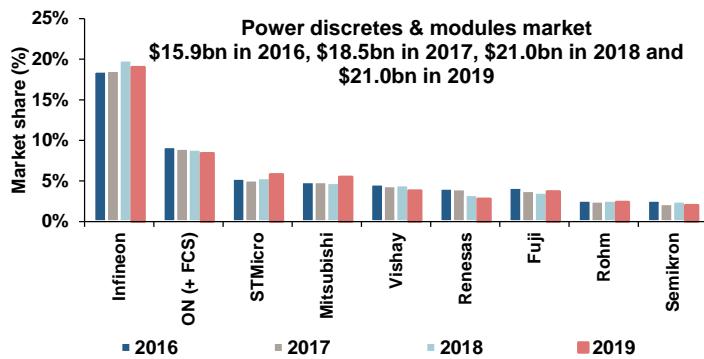
Similarly, if we just look at the Power MOSFET market, again IFX is a clear market leader with 25% share, with STM holding on to #3 position (10% share). Again this market is dominated by the EU, the US, and Japan, with Nexperia being the only Chinese company in the top vendor list, and only a part of the list with Nexperia formed when a group of China investors bought NXP's Standard Products group in 2016/17.

**Figure 163: IGBT market share for China NEV (2019)—IFX clear leader; BYD/Starpower are the two key local suppliers**



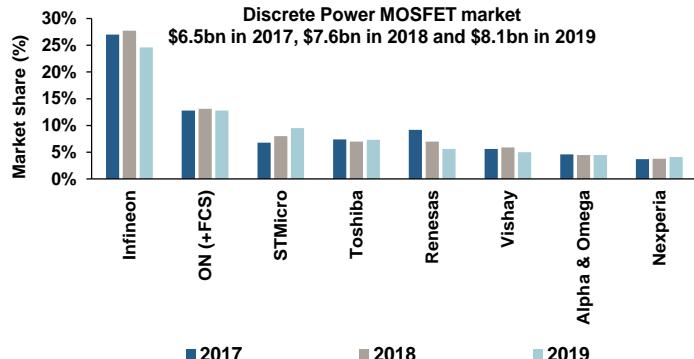
Source: Credit Suisse (China Auto Research team)

**Figure 164: IFX holds #1 (19% share) and STM #3 (6% share) in the US\$21 bn global Power discretes and modules market**



Source: Infineon slides (based on Omdia), Credit Suisse

**Figure 165: Within that, IFX holds #1 (25% share) and STM #3 (10% share) in the US\$8 bn global Power MOSFET market**



Source: Infineon slides (based on Omdia), Credit Suisse

## CPU localisation a priority for the China government

China has also been actively building its own operating system and processors to try and control the IT ecosystem and also enhance national security under the HGJ project (core electronic devices, high-end generic chips and basic software) during the 11th five-year plan. The pace of the development has modestly accelerated after Microsoft blacked out the Windows system on a wide range of the PCs in China with pirated software in 2009 and the leak of the US PRISM programme by Edward Snowden in 2014. However, China's progress was still slow due to a lack of technology knowledge and capability in the semiconductor industry, given the build-up of the software ecosystem takes a lot of time.

The inflection point was a series of moves by the US government with regards to China, including (1) limiting China's supercomputing system's access to Intel's most advanced Xeon chipsets on the concern of national security in 2015, (2) adding ZTE on the entity list in 2016, (3) adding Huawei and its affiliates on the entity list in 2019 and full ban on the access to US technology in 2020, (4) stopping ASML from shipping EUV tools to SMIC, (5) requiring AMD to end support for its CPU JV with its China partner Hygon, and (6) most recently the US military use and entity list restrictions on SMIC. The US government's restrictions on the access to advanced technology added the urgency the Chinese government needed to ramp up its semiconductor ecosystem more aggressively, with CPU replacement for government PC/NB and servers becoming a priority.

## Emerging China CPU players

There are six notable China CPU IC design companies emerging with solutions, including Phytium, Zhaoxin, HiSilicon, Hygon, Loongson, and Sunway, while Montage also offers a 'localised' version of Intel's server CPU. Despite the lack of clear evidence of any of these China CPU developers' technologies leading (or at least close to) global players (mainly Intel, AMD or ARM solutions from Marvell and Amazon), China's localisation ambition sets a favourable and decent environment for them to grow from a very low base. Among them, we think Phytium has a better position in the public sector (government agencies, SOEs), while Montage's Jintide® server platform is well positioned to grow in the private (commercial) server sector.

## CPU localisation a priority for the China government

Phytium, Zhaoxin, HiSilicon, Hygon, Loongson and Sunway all developing CPU offerings in China; Montage also tailoring Intel's server platform for the local market

**Figure 166: Other China CPU IC design companies**

<b>China CPU fabless</b>	<b>Phytium</b>	<b>Zhaoxin</b>	<b>HiSilicon</b>	<b>Hygon</b>	<b>Loongson</b>	<b>Sunway</b>
	飞腾	兆芯	海思	海光	龙芯	申威
Shareholders	China Great Wall, CEC Group	Shanghai Zhaoxin (VIA + Shanghai government)	Huawei	Sugon, AMD, Hygon	Institute of Computing Technology, Chinese Academy of Sciences	Wuxi Jiangnan Institute of Computing Technology
Architecture	ARM v8	x86	ARM v8	x86	MIPS64	Sunway 64
PC CPU	FT2000/4	KX-6000	Kunpeng 920s	3185	3A4000	SW1621
Tech spec	2.0GHz Quad core 64 bit	2.0GHz Quad core 64 bit	2.0GHz Quad / Octa 64 bit	3.2GHz 8 cores 64 bit	2.0GHz Quad core 64 bit	2.0GHz 16 core 64 bit
Manufacturing node	16nm	16nm	7nm	14nm	28nm	40nm
Server CPU	S2500	KH-30000	Kunpeng 920	7185	3B4000	SW26010
Tech spec	2.2GHz 64 cores 64 bit	3.0GHz Octa cores 64 bit	2.5GHz 64 cores 64 bit	2.0GHz 32 cores 64 bit	2.0GHz Quad core 64 bit	1.45GHz 260 cores 64 bit
Manufacturing node	16nm	16nm	7nm	14nm	28nm	28nm
IC design partner	Alchip, EE2	VIA	NA	AMD	NA	NA
Ecosystem support	Strong	Strong	Strong	Strong	Limited	Limited
Security	High	High	High	High	High	High
China technology control	Medium-High	Low	Medium-High	Low	High	High

Source: Company data, cnBeta, Anandtech, HKEPC, Credit Suisse

**Figure 167: China CPU fabless ecosystem partners—all are working closely with Chinese companies across industries to promote their CPU solutions**

China CPU fabless	Phytium	Zhaoxin	HiSilicon	Hygon	Loongson	Sunway
	飞腾	兆芯	海思	海光	龙芯	申威
Server	Lenovo, Inspur, Unishy, Chaoyue, Sugon, Tsinghua Tongfang, Changhong, Power Leader, Nginetech, Cloud Kirin, Wanfang Electronics, Bitland, Weibu, LDX, Great Wall, etc.	Lenovo, Tsinghua Tongfang, Donghai Computer, Master, Inspur, Power Leader, Ruijie, etc.	Huawei, Changhong, 100 Trust, EASTCOM, Unishy, Xiangjiang Kunpeng, Tsinghua Tongfang, Power Leader, Huanghe, Hai Xia Xing Yun, Digital China, etc.	Sugon, Jinpin, etc.	100 Trust, Lenovo, Chaoyue, Gooxi, Teamsun Info, Inspur, Sugon, Tsinghua Tongfang, Super Red, Wuzhou, Zishan Longlin, Founder, Power Leader, etc.	Wuzhou, CETC, CyanCloud, Power Leader, TTY, CAHD, Cloud Kirin, etc.
Desktop/Notebook	Great Wall, Lenovo, Inspur, Chaoyue, Bitland, Haier, Unishy, Tsinghua Tongfang, Sugon, Hisense, AOC, IPASON, Embed Way, Sakway, LDX, etc.	Lenovo, Tsinghua Tongfang, Donghai Computer, Vention, IPASON, HP, IP30-Technology, Biens, etc.	Huawei, 100 Trust, Tsinghua Tongfang, Power Leader, Tsinghua Tongfang, Changhong, Centrium, Huanghe, Xiangjiang Kunpeng, Digital China, etc.		Tsinghua Tongfang, 100 Trust, Power Leader, Chaoyue, Founder, GEIT, Haier, Inspur, Lenovo, HIK VISION, Ningmei, IPASON, RUIJIE, 3nod, Centerm, Sugon, Wuzhou, Taiii, etc.	CyanCloud, External Asia, etc.
All/security/industrial devices	Caffee, Intellifusion, Baidu, Cambricon, Tensor Flow, Bitmain, Venustech, Westone, TOPSEC, NSFOCUS, Sangfor, HBC, NEUSOFT, Securityunion, Victory-idea, TIPTOP, Dahua, HIK VISION, etc.	Syan, DAS-Security, HICO, eFound, Learsun, Centerm, SIXUNITED, Westone, Hillstone, EISO, WUZHOU, CVTE, etc.	Huawei Fusion Storage, Huawei GaussDB, Huawei CloudLink, DSCOM, Starwarp, etc.		Maipu, Westone, Bdcom, Unishy, ZEEGO, AERODEV Network, EmbedWay, Shenzhou Huian, Sansec, Sugon, etc.	
Operating system	Kylin, CentOS, Ubuntu, Debian, Fedora, ReWorks, JARI, VxWorks, SylixOS, UOS, etc.	Ubuntu, iSoft, NeoKylin, NFS China, Windows, CentOS, UOS, etc.	CentOS, Ubuntu, NeoKylin, Deepin, iSoft, Asianux, BC Linux, Openeuler, UOS, etc.	Windows, NeoKylin, UOS, CentOS, Ubuntu, Deepin, etc.	Loongnix, NeoKylin, Deepin, iSoft, Kylinsec, UOS, etc.	UOS, iSoft, NeoKylin, Red Flag, Deepin, etc.
Software/cloud service/end user	Foxit, Kingsoft, Thunisoft, Sougou, Meitu, Tencent, Kingdee, Firefox, Scutech, Haitai, Pushtiem, HKB, Weaver, Aliyun, ZTE, UCLOUD, EASTED, KVM, etc.	Windows Office, WPS, OpenGL, Direct3D, Foxit, Lanxum, Haitai, 360, DHC, Neusoft, Tiduyun, YOZO Soft, Windows softwares, Big Data Center of Shanghai Government, People's Bank of China, Bank of Shanghai, China Pacific Insurance, Shanghai Metro, etc.	Sangfor, Sandstone, Tong Tech, Asian Info, Chinac.com, Easy Stack, Tech Education, Beiming Software, Mixlinker, Chanjet, Kingdee, Super Map, SIPM, Paratera, Information2, Joyware, China Telecom, DCITS, ThuniSoft, Audaque, NetEase, Haitong Securities, NC Cloud, etc.	China Telecom, Windows softwares, etc.	WPS, YOZOSOFT, Foxit, Suwell, Smplayer, Meitu, 360 Security Browser, Tencent, Alibaba, Kingsoft, Inspur, etc.	Red Flag, Standard Software, Dameng, GBASE, Kingbase, etc.

Source: Company data, Sina, cnBeta, DSCom, Sohu, Credit Suisse

**Montage: Localised solution for Intel server CPU.** Montage has been working with Tsinghua University and Intel to develop Jintide® server platform since 2016, consisting of Jintide® server CPU and Montage's memory solution. Jintide® server CPU is based on Intel's latest generation Xeon server CPU die (x86 architecture), with Montage's security chips integrated to achieve functions of PrC (Pre-Check) and DSC (Dynamic Security Check, developed by Tsinghua University).

Montage launched the first Jintide® server solution in 2018 through collaboration with Lenovo and Byosoft. In Aug-2020, they launched the second-generation Jintide® server platform based on newer Intel processors. According to Montage, its server platform has been adopted by many server vendors to develop a series of high-performance servers with real-time security monitoring functions in the areas of government affairs systems, transportation systems, financial organisations and high-tech enterprises. Server OEMs that have qualified Jintide® server platform include Lenovo, New H3C Technology Co., Powerleader, Inspur, and SuperCloud (a subsidiary of China Greatwall Technology Group). Montage is working closely with China server OEMs for the mass commercialisation of its Jintide® server platform.

Intel invested in Montage in 2005-06 and remains the No. 2 top shareholder as of now. Montage signed an MOU (memorandum of understanding) and cooperation agreement with Intel in Sep-2015 and Jan-2016, respectively, deciding to develop an integrated server platform based on Intel's x86 architecture and specifying items like division of work, ownership and protection of intellectual properties, etc. Montage will have the Jintide® brand, patent and revenue. Montage will pay royalty to Tsinghua University. In 2017, Intel, as the CPU partner of Jintide®, signed another agreement to offer Montage R&D subsidy of US\$2.1 mn. Additionally,

Montage will purchase CPU from Intel based on normal business practice, according to their announcement on related party transactions.

**Figure 168: Montage's Jintide server platform products**

Product type	Product	Description
Jintide Server CPU	Jintide Server CPU	x86 processor with PrC (Pre-check) and DSC (Dynamic Security Check) technologies
Hybrid Security Memory Module	HSDIMM® (Hybrid Security DIMM)	Based on JEDEC DDR4 LRDIMM architecture, HSDIMM® is designed with Montage proprietary Mont-ICMT® technology to provide real-time tracing on both command/address and data to enhance data security in servers.
	HSDIMM®-Lite (Hybrid Security DIMM-Lite)	HSDIMM®-Lite is an RDIMM type security DIMM based on JEDEC DDR4 RDIMM architecture. This type of DIMM has a built-in Security Authorization Management (SAM) mechanism to enable command/address tracing and data protection for memory systems.

Source: Company data, Credit Suisse

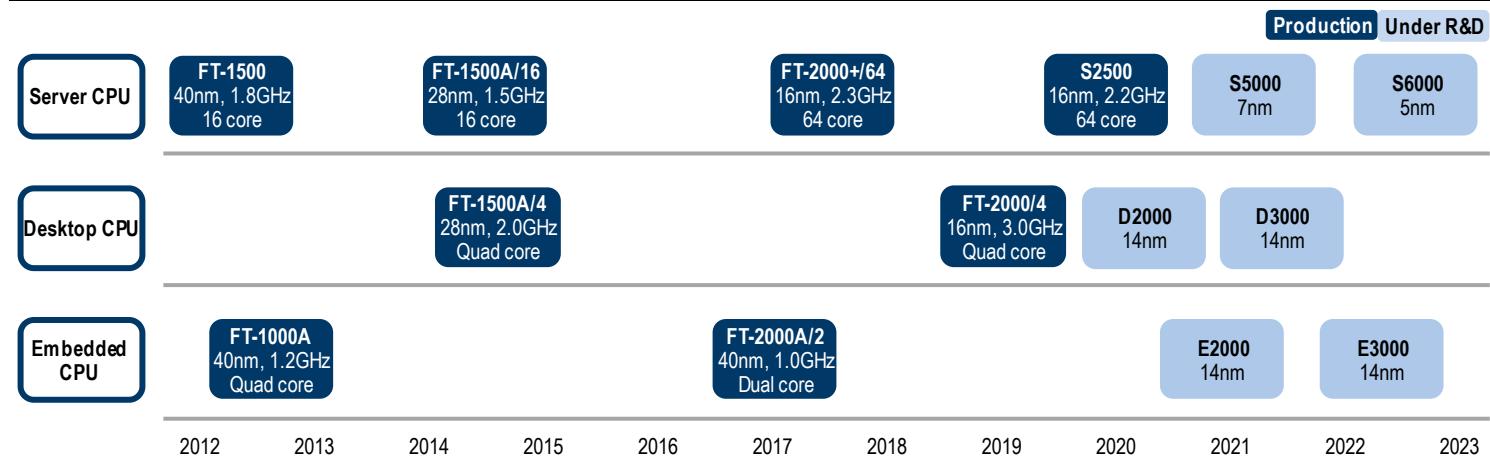
**Phytium: Rising ARM-based CPU fabless.** Headquartered in Tianjin, Phytium Technology was founded in 2014. Before that, its founding team focussed on independent CPU development at the National University of Defense Technology since 1999. China Greatwall Technology Group, a Chinese major state-owned server manufacturer, became Phytium's dominant shareholder with 35% of the stake after it acquired Phytium's shares from Zhenhua Electronics and Huada Semiconductor in 2019.

Phytium tried x86, Epic and SPARC (Scalable Processor Architecture) architectures and released two SPARC-based commercial chips, FT-1000 and FT-1500, in its early years. Due to the inherent weakness of the SPARC ecosystem, Phytium switched to the ARM architecture in 2011. Phytium's latest mass production server CPU FT-2000+/64 (16nm process by TSMC, 2.3GHz and 64 cores) was launched in 2017, with performance claiming to be close to Intel's Xeon E5 launched in 2014. Its latest desktop CPU FT-2000/4 was launched in Sep-2019, with 16nm process, 3.0GHz and quad cores.

Phytium expects its CPU production of all product lines to exceed 3 mn units in 2020 and has ambitious growth plans, restructuring product lines into S series server CPU, D series desktop CPU and E series embedded CPU. Phytium's new generation server CPU S2500 (formerly known as FT-2500) was launched in Jul-2020 and is expected to achieve mass delivery in 4Q20, with 16nm, 2.2GHz and 64 cores. Its new multi-chip package support will allow customers to create 128- to 512-core system to achieve multiplied increase of server's computing capability. Phytium's server CPU is scheduled to upgrade to 7nm process (S5000) in 3Q21 and to 5nm process (S6000) in 2022. Furthermore, our check suggests its 2021 production plan may increase nearly fourfold.

With continued technological innovation and the company's strong ambition, Phytium should be a force to be reckoned with in the China CPU market. Phytium can leverage its major shareholder's server business to accelerate its penetration into the China server market, especially government and SOE. However, due to the inherent concern of the ARM ecosystem supporting legacy PC applications as well as x86, Phytium may have difficulties expanding into the commercial world.

TSMC is currently its major foundry partner and it relies on Alchip, an IC design service provider, to complete its processor design. It has plans to use SMIC for newer processors, but it is uncertain whether this plan will still go through following the US restrictions on SMIC's access to advanced tools.

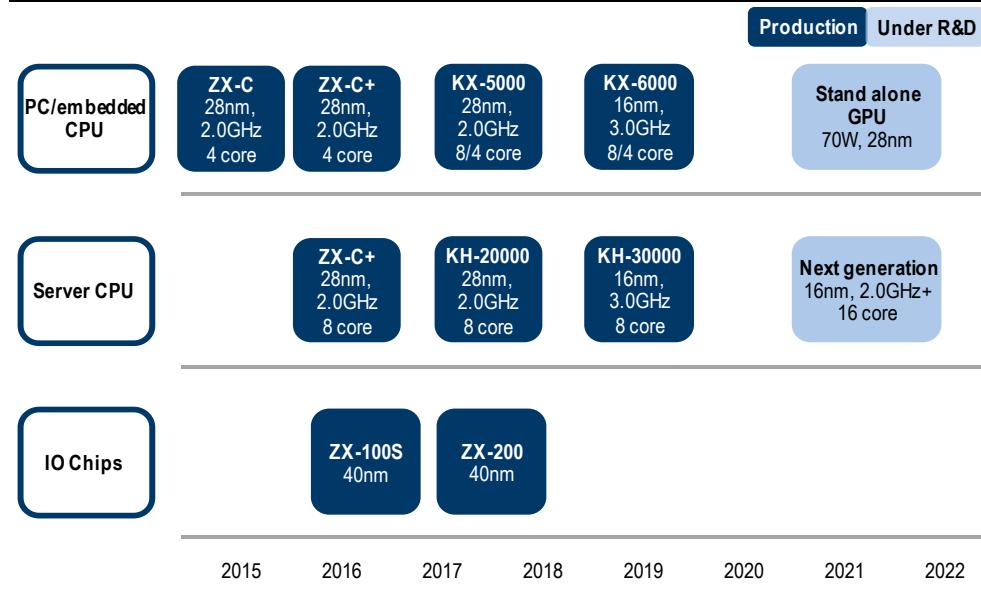
**Figure 169: Phytium CPU roadmap**

Source: Company data, cnBeta, Sina, Credit Suisse

**Zaoxin: Domestic x86 player.** Headquartered in Shanghai, Zaoxin Semiconductor was founded in 2013 and is China's first homegrown x86 CPU company. Shanghai Lianhe Investment, a subsidiary of Shanghai SASAC (State-owned Assets Supervision and Administration Commission of the State Council), holds 85.2% of Zaoxin's total stake, while VIA Taiwan holds the remaining 14.8%. Zaoxin obtained its x86 licence from VIA in 2013, and VIA announced in Oct-2020 that it would sell additional x86 IP to Zaoxin. Now Zaoxin operates three product lines of PC/embedded CPU, server CPU and IO chips.

Zaoxin's latest PC/Server CPUs were launched in Q2019 using TSMC's 16nm process and offering 3.0GHz performance through up to 8 cores. The performance was claimed to be close to Intel's Gen7 i5 desktop CPU launched in 2016. It plans to launch the next generation server CPU, with 16nm process, 2.0GHz+ and 16 cores, and standalone GPU, with 28nm process, in 2021.

**Zaoxin is the only x86 player in China, other than Montage**

**Figure 170: Zaoxin CPU roadmap**

Source: Company data, Credit Suisse

Zaoxin has made progress in government applications and SOEs, breaking into the supply chain of the Big Data Centre of the Shanghai Government, People's Bank of China, Bank of Shanghai, China Pacific Insurance, and Shanghai Metro among others. Thanks to the highly compatible x86 architecture, we expect Zaoxin to continue enhancing its market share in the government and SOE sector while at the same time stepping into the commercial server world.

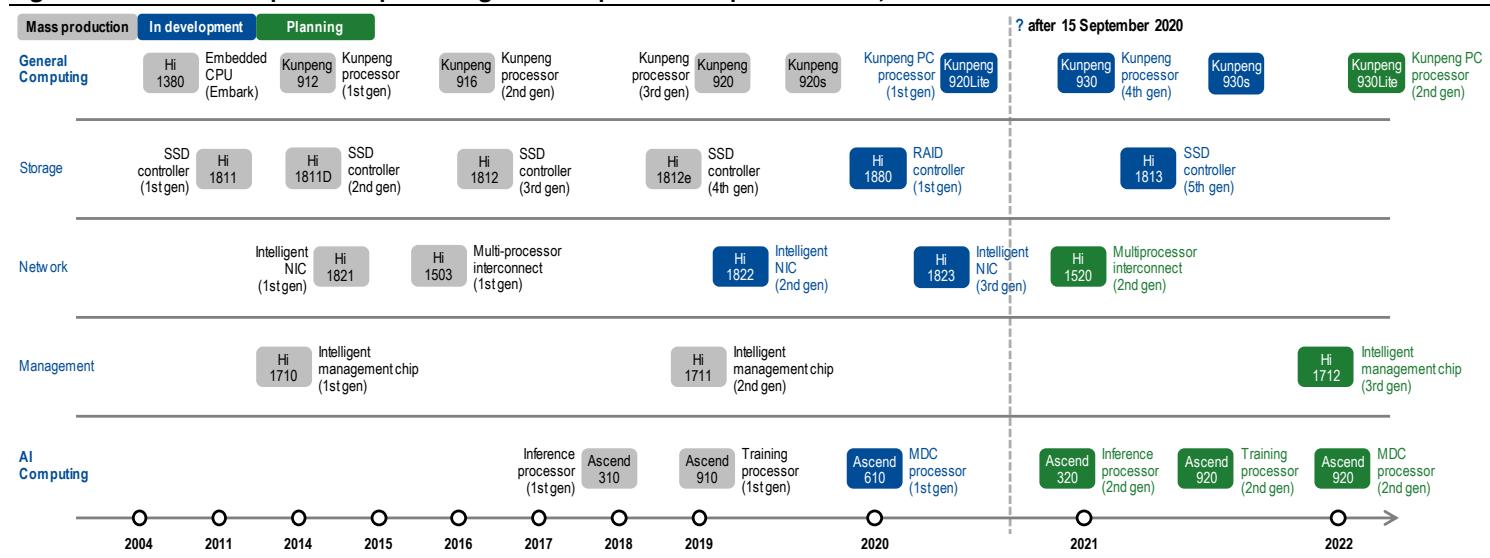
One potential risk is that VIA's x86 licence expired in Apr-2018, which means Zhaoxin does not have access to Intel's x86 instruction set extensions published after Apr-2018. However, it normally takes years for new instruction set extensions to achieve wide adoption with the divergence between Intel and AMD on x86 instruction set architecture, even prolonging the process. Meanwhile, the release of new x86 instruction set extensions is decelerating, with only one extension published after 2017 (vs five published in 2013 and three published in 2014). As such, we do not expect Zhaoxin's CPU business to be significantly impacted in the next 5-10 years. Zhaoxin will have to develop its own x86 instruction set extensions in the longer term.

### **Huawei HiSilicon: Shining but its lifetime limited without the US restriction relief**

HiSilicon's server CPU was once believed to be the most high-performance ARM-based CPU. HiSilicon's server CPU has evolved into second-generation Kunpeng 920, launched in Jan-2019 using TSMC's 7nm process, 2.5GHz and 64 cores. The Kunpeng 920, 25% higher computing capacity and 30% lower power dissipation than industry benchmark, was once believed to be the strongest ARM-based CPU at that time. The ARM community placed great expectations on Kunpeng as a potential major breakthrough in the traditionally x86-dominated server CPU market. What's more, Kunpeng has put great efforts into establishing a mature ecosystem, with over 150 partners already in the Kunpeng Partnership Program including many commercial cloud service and software providers.

But the US restrictions on Huawei (inclusion in the Entity List and then restricting foundries globally with any US technology to produce wafers for Huawei) virtually limits all future potential for HiSilicon. Huawei's and HiSilicon's ecosystem partners have submitted applications to the US government to apply for a licence to continue to supply Huawei or HiSilicon, but until now the restrictions have not been lifted.

**Figure 171: Huawei chip roadmap—strong and comprehensive product lines, but unclear future**



Source: Company data, Credit Suisse

**Hygon: Inclusion into Entity List limits future growth.** Hygon Information Technology Corp. was founded in 2014. Its controlling shareholder is Dawning Information Industry (Sugon), which increased its holding to 36.4% by acquiring 10.9% from CD Industrial Investment and CDHT Investment in 2018.

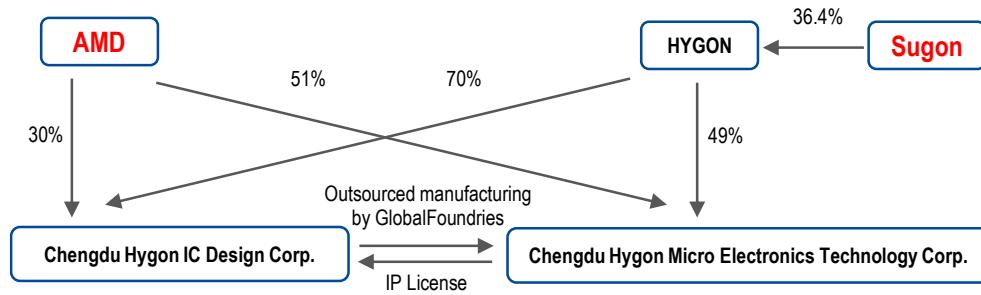
In 2016, Hygon obtained a Zen1 CPU IP Licence from AMD (x86) and designed the Hygon 7185 CPU with 14nm process, 2.0GHz and 32 cores claiming similar fixed-point but worse floating-point computing capacities compared with AMD's original Zen 1 CPU. In 2020, Hygon made progress in commercialisation by breaking into China Telecom's procurement list.

**Hygon's upside is largely limited with its shareholder included in the Entity List.**

However, Hygon and its controlling shareholder Sugon were added into US's Entities List in Jun-2019, which prohibits Hygon from obtaining a further licence from AMD. Since AMD

retained the core CPU design and manufacturing technology through a complex JV structure (as shown in the chart below), it would be very hard for Hygon to upgrade the fundamental CPU architecture without AMD's help. We expect Hygon to be able to continue launching CPUs based on existing AMD IP licence and benefit from a mature x86 ecosystem and import substitution. But the lack of product iteration might gradually erode Hygon's competitiveness in the server market which has continuous technology advancement.

**Figure 172: AMD employed complex JV structure to retain core CPU design and manufacturing technology**

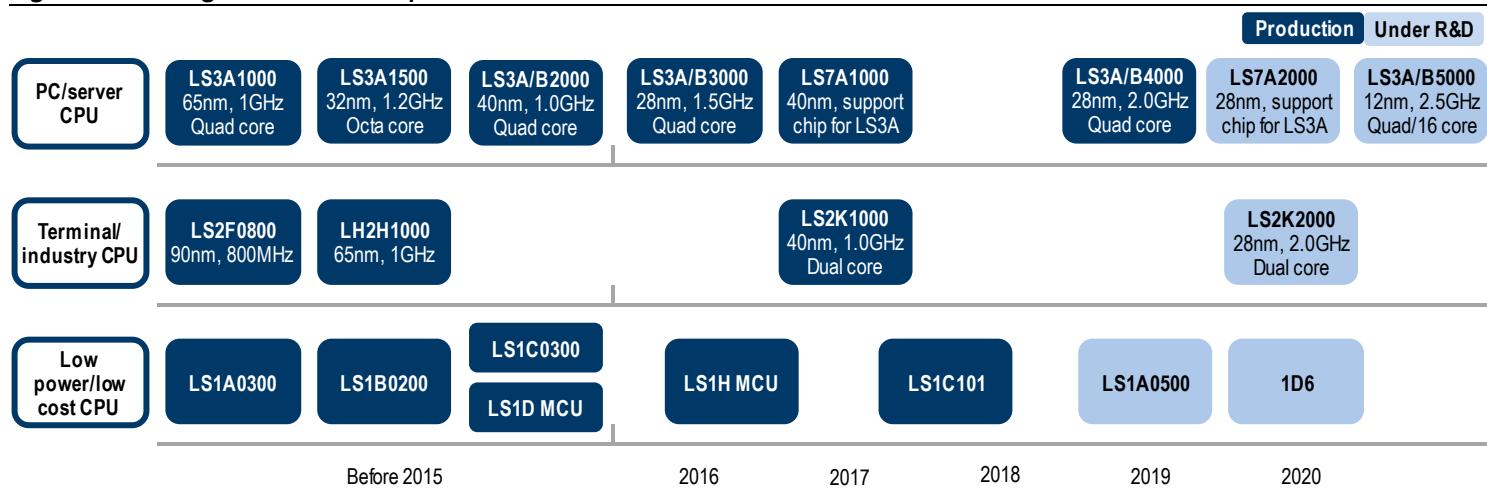


Source: Company data, Credit Suisse

**Loongson: Player in the alternative industrial compute segments.** Loongson is the first self-independent high-performance general processor in China, developed by the Institute of Computing Technology, Chinese Academy of Sciences (CAS) in 2001. The Beijing Government and CAS jointly established the Loongson Technology Corp. in 2010 to facilitate the commercialisation of Loongson chips. During 2010-14, Loongson chips were mainly employed in the industry control system. After 2014, Loongson has gradually expanded its business into small- and middle-sized server and data system. Loongson now holds three product lines: Loongson 1 Series low power/low cost CPU, Loongson 2 Series terminal/industry CPU and Loongson 3 Series PC/Server CPU, with chip shipment achieving 500k in 2019.

Loongson's latest PC/Server CPU, LS3A4000 and LS3B4000, was launched in Dec-2019, with 28nm process, 2.0GHz and quad cores. LS3A/B4000 demonstrates doubled fixed- and floating-point calculation capacity compared to the previous generation LS3A/B3000. However, Loongson still has to work hard to chase Intel and AMD since the performance of LS3A/B4000 is close to that of AMD's 28nm Excavator launched in 2015.

**Figure 173: Loongson CPU roadmap**



Source: Company data, Credit Suisse

Loongson announced that its next generation PC/Server CPU LS3A/B5000 is already on pipeline and should release in 2021, with a more advanced 12nm process, 2.5GHz and up to 16 cores. We expect Loongson to narrow its distance with global competitors and strengthen its

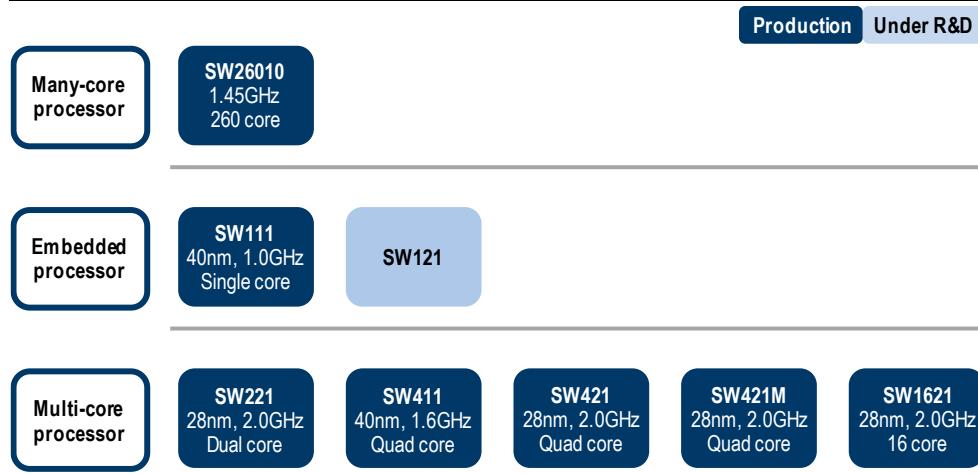
**Loongson may have a niche positioning in the government and SOE server market**

appearance in the Chinese government and SOE server market, thanks to the import substitution trend and long-term endeavour for commercialisation. However, with MIPS architecture, Loongson may have difficulty blending into the global mainstream server ecosystem and capturing customers in the commercial world.

**Sunway: Still far from commercialisation.** Sunway's CPU series was firstly developed by Jiangnan Institute of Computing Technology in 2006, and Chengdu Sunway Technology Corp. was founded in 2016. Sunway now has three product lines: many-core processor (1.45GHz, 260 cores), embedded processor (40nm, 1.0GHz, single core) and multi-core processor (28nm, 2.0GHz, up to 16 cores).

Sunway's many-core CPU is intended for super computers, like Sunway Taihulight, while multi-core CPU is largely applied in government and military sectors. We rarely observe commercial server/PC based on Sunway CPUs. Like Loongson, the unique Sunway64 architecture prevents Sunway CPU from finding enough compatible partners. The existing ecosystem of Sunway is far from mature compared to other China CPU fabless. We think Sunway still has a long way to go for commercialisation.

**Figure 174: Sunway CPU roadmap**



Source: Company data, Credit Suisse

## China CPU import substitution in public sectors initially

The private PC/NB processor market should still be dominated by Intel and AMD, with their highly-compatible x86 architecture and advanced performance for consumer-level products. The problems of compatibility (ARM-architecture) and performance (China x86 players lagging Intel/AMD) would make it hard to convince individual or enterprise users to buy China-designed PCs/NB CPUs. But in the public sectors (government and SOEs), PC/NB might be forced to used China-designed CPU for political or security purpose.

The China server market has about 30%/70% public/private sectors. The 30% public sector includes government organisations/agencies and government-controlled entities. For this 30% public sector, Phytium has much better positioning as its parent company, China Greatwall Technology Group, is a major SOE in China. For the 70% private sector (or commercial market where procurement decisions are largely based on commercial/technology factors), we believe Montage's Jintide® server platform has better opportunities mainly because Jintide® server platform is based on x86/Intel processors. Montage's Jintide® server platform provides a 'localisation' option for the China server market with Intel processors (thus, no pain for server OEM/customers to switch to Montage) and also domestically developed real-time security monitoring and memory protection technology.

We also believe that Intel, which invested in Montage in 2005-06 and remains the #2 top shareholder today, is supportive of Montage's Jintide® server platform in China. Though Montage has not signed any long-term procurement contract with Intel so far, we believe Intel is

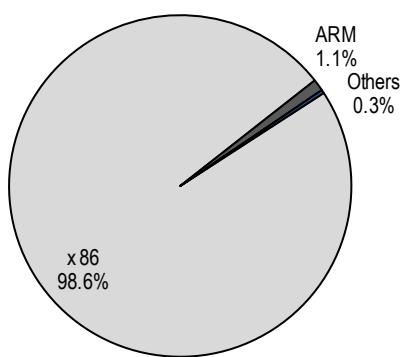
supportive of Montage's Jintide® server platform in China. The higher market share Jintide® secures, the more market share Intel secures against AMD/Phytium/Huawei.

**Figure 175: China x86 server market revenue by industry—we assume the majority of the highlighted sectors below belong to the public sector**

Rmb mn	2018E	2019E	2020E	% of total
Internet	21,300	24,870	28,840	33%
Government	12,400	14,300	16,400	19%
Telecom	7,190	8,108	9,026	10%
Education	4,850	5,290	5,740	6%
Manufacturing	4,523	4,886	5,249	6%
Transportation	2,852	3,200	3,648	4%
Electricity	2,177	2,414	2,651	3%
Healthcare	2,051	2,332	2,613	3%
Bank	1,880	2,140	2,420	3%
Securities and other financials	1,877	2,064	2,251	3%
Insurance	1,736	1,922	2,108	2%
Others	1,780	1,932	2,084	2%
Logistics	1,258	1,396	1,544	2%
Oil	1,126	1,262	1,398	2%
Retails	879	978	1,077	1%
Scientific research	842	944	1,046	1%
Coal and other energy	419	462	505	1%
<b>Total</b>	<b>69,140</b>	<b>78,500</b>	<b>88,600</b>	<b>100%</b>
Public sector (government, education, bank, insurance, securities and other)	22,743	25,716	28,919	
Public sector % of total	33%	33%	33%	

Source: Company data, CCID Consulting, Credit Suisse

**Figure 176: ARM only had 1.1% of Asia (ex. Japan) server CPU market in 1Q20, quite small compared to x86**

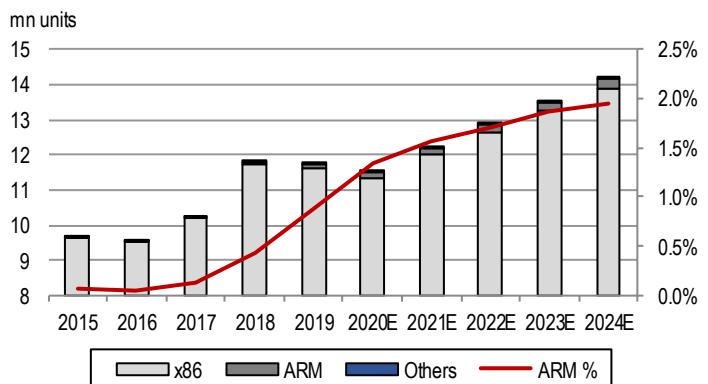


Source: IDC, Credit Suisse

## China CPU demand to grow the next few years

Local CPU makers should ramp as chipsets and operating system designed by local fabless mature and as the Chinese government adopts more semiconductors it has more control on design. According to IDC, demand from the Chinese government and large enterprise market

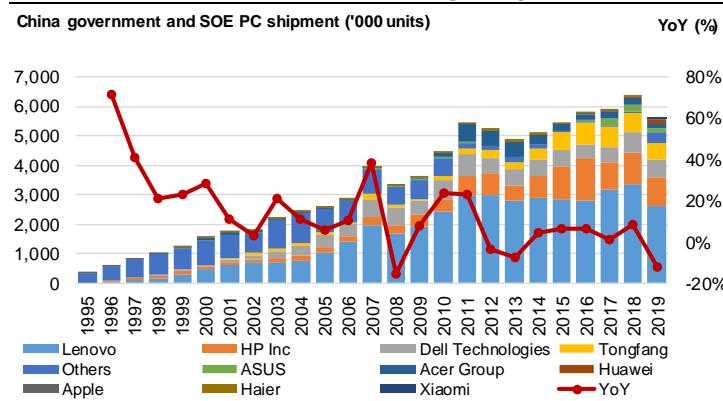
**Figure 177: Global server market should retain growth momentum in 2020-14 with x86 still to be mainstream**



Source: IDC, Credit Suisse

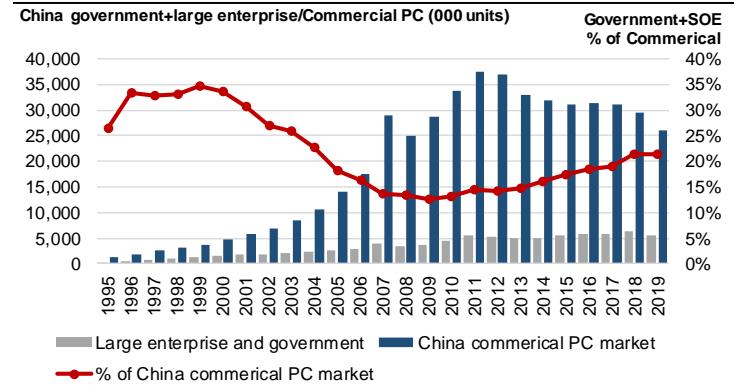
has been at 6 mn units annual run rate in the past few years. Local brands have been picking up share in the government and large companies' procurement which they have been testing the operating system on since 2014, with Tongfang growing from 5% in 2013 to 10% in 2019, while other brands have also been emerging from 0% to 3-4% in 2018-19.

**Figure 178: China government and SOE PC shipment at 6 mn unit annual run rate, with local brands gaining share**



Source: IDC, Credit Suisse estimates

**Figure 179: China government and SOE represent 20% of domestic commercial PC market**



Source: IDC, Credit Suisse estimates

According to the China government's statistics in the past few years, there are 7 mn civil servants in China and 30 mn employees in SOE, putting the total addressable market of the local CPU fabless at 37 mn units in the next few years and could penetrate into the domestic commercial market at 25 mn annual shipment run rate in the long term with government encouragement.

#### Phytium leading its local peers on technology roadmap and ecosystem

Among the major CPU fabless in China, Loongson has led the market, shipping 800k CPUs in 2019 while Phytium claimed it has built ~1 mn chipsets by the end of 2019. We believe Phytium (permanent licence from ARM), Loongson (MIPS architecture) and Sunway (Alpha architecture) have better opportunities in the government and SOEs, with higher technology control compared with Zhaoxin (x86 architecture), Hygon (the US entity list) and Kunpeng (banned by the US government along with Huawei and focus more on commercial market).

**Phytium shipped over 1 mn CPU chipsets in 2019 and targets to double to 2 mn in 2020.**

**Figure 180: Phytium's PC CPU already gets qualification by local supply chain**



Source: Phytium

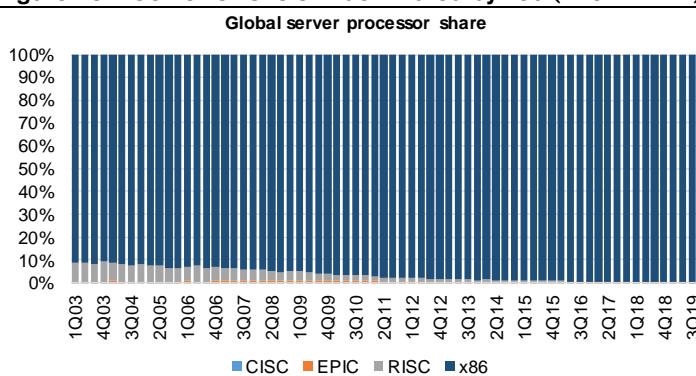
Compared with Loongson only migrating to SMIC's 12nm in 2020 and Sunway on 28nm, Phytium at TSMC should see better performance and power improvement on 16nm for its chipset launched in 2019 and 7nm chipset for launch in 2022. Phytium also has an advantage over Loongson and Sunway on ecosystem support from ARM on the documentation and essential task use for the civil servants and workers in SOEs in China. ARM's architecture for PC/NB is also more mature now with Qualcomm already launching a PC processor based on

ARM core in 2018, while Apple will also replace Intel's x86 processor in its next generation Macbook. We believe Phytium's technology roadmap, support from Alchip in the back-end design, TSMC on manufacturing in the leading edge nodes and ARM on the ecosystem should benefit from the first wave of import substitution in China's PC market.

## Server import substitution at a milder pace

The server CPU market has long been dominated by x86 architecture, with Intel holding 95%+ market share supported by the strong performance of its chipsets. We believe x86 architecture-based processors will continue to be the mainstream solution for the server market in the next several years, with AMD gaining share at the expense of Intel. For China fabless development, although some chipsets have been introduced from Loongson, Phytium, Sunway and Kunpeng, and the Chinese government also listed the solutions from these suppliers in their procurement directory in 2018, the adoption rate is still low as the performance, power consumption and stability are still not comparable with the solutions provided by overseas players.

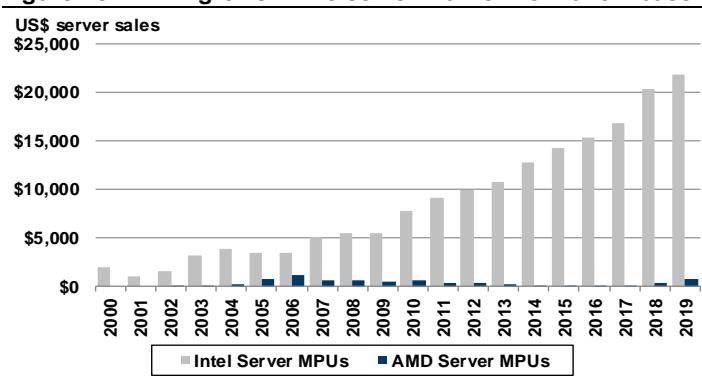
**Figure 181: Server CPU is still dominated by x86 (Intel + AMD)**



Source: IDC, Credit Suisse estimates

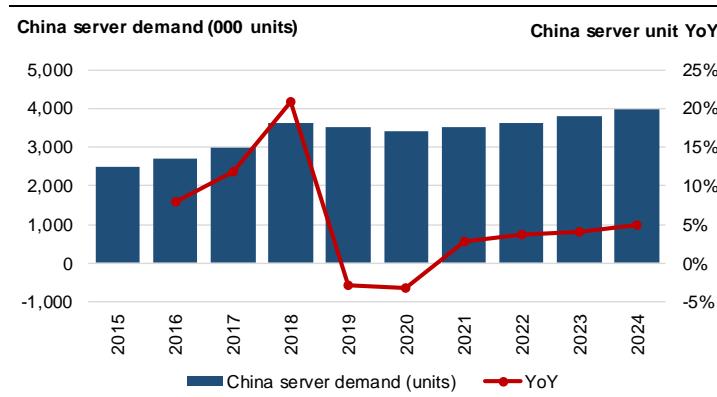
Chinese vendors' share in the global server market reached ~30% in 2019, mainly supported by their share gains in an outgrowing domestic market and modest growth outside China mostly from Lenovo's acquisition of IBM's x86 business in 2015. We believe local suppliers' continued share gains in the China domestic market should continue to be the trend supported by government policy on high technology applications given national security concern.

**Figure 182: AMD grows in the server market from a low base**



Source: Company data, Credit Suisse estimates

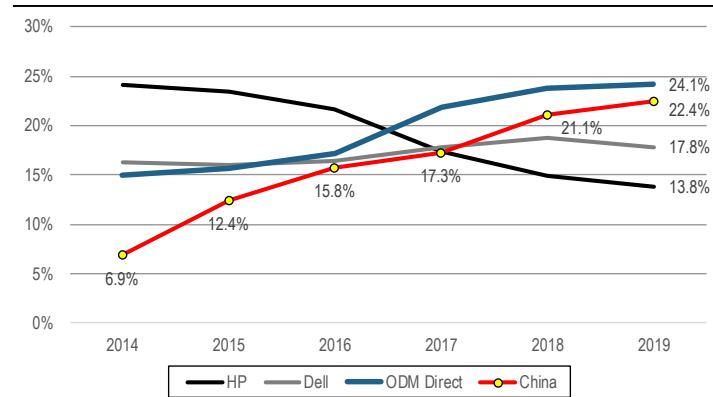
**Figure 183: China domestic server demand should reaccelerate**



Source: IDC, Credit Suisse estimates

In the Made-In-China 2025 initiative, the Chinese government disclosed its plans for global market share of domestically produced high-performance computers/servers to reach 30%, while domestic market share should reach 60% by 2020, and the shares to reach 40% and 80% by 2025, respectively. It also aimed to have domestically made high-end servers to

**Figure 184: China players gain share with fast domestic growth**



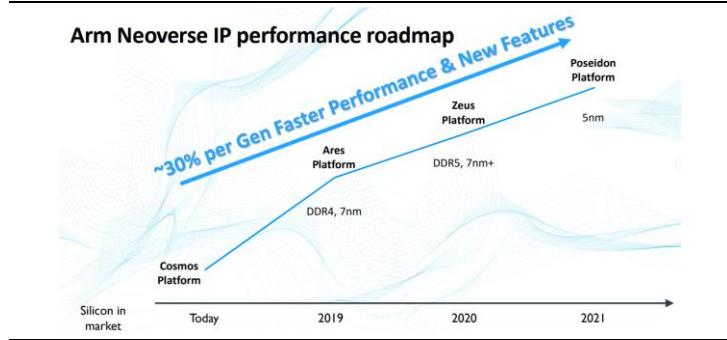
Source: IDC, Credit Suisse estimates

represent over 50% of the domestic market; and servers with domestically produced CPU to reach above 30% of the domestic market.

Despite a still meaningful gap between x86 vs other architectures when comparing power performance and ecosystem, with most of the leading local suppliers (e.g., Sugon and Inspur) still expecting to roll out new products along with Intel and AMD's roadmap for commercial use in 2020-21, we believe the servers shipped to government could be the first wave of demand adopting CPUs developed by local fabless.

The noteworthy developments by Chinese players recently would be Kunpeng's launch of its Kunpeng 920 server CPU manufactured on TSMC's 7nm and adopted in Huawei's Taishan servers for Huawei's cloud platform, providing 30% higher performance or 20% less power consumption. Amazon earlier this year also introduced Graviton2 based on ARM Neoverse core for its AWS cloud service business. This could suggest that server processors based on ARM architecture may be adopted for commercial use following the company's aggressive push on the server addressable market in the past 6-7 years.

**Figure 185: ARM's Neoverse IP improves its server platform**



Source: ARM

Although the performance still needs time to be proved, we believe it could be a positive signal for Phytium as the company has also been developing server CPU for seven years, with first generation FT-1500 launched in 2014, FT-2000 in 2016 and an upgraded version FT-2000+ tape out in 2017. The company targets to launch FT-2500/64 chipset on 7nm for the server market in 2H20. At the company's ecosystem conference in late 2019, multiple partners announced plans to build data centres based on Phytium's 64 core CPU solutions including financial and network security. For the commercial market, Tencent Cloud also announced the introduction of a platform based on Phytium's CPU, while Baidu also announced it would build a solution integrating Phytium's CPU with its cloud AI chipset Kunlun.

Based on our estimate, the government server demand in China could represent 20-30% of total shipment in the domestic market, implying a 600k server unit annual run rate opportunity for local server suppliers. According to IDC, global server processor demand will grow from 27 mn units in 2019 to 36 mn units in 2024. With China representing 25-30% of the global server market and demand from local government and data sensitive industries (e.g., telecom and finance) representing 30-35% of domestic demand, we estimate the server processor market could grow to 3 mn units for local fabless to capture the first wave demand.

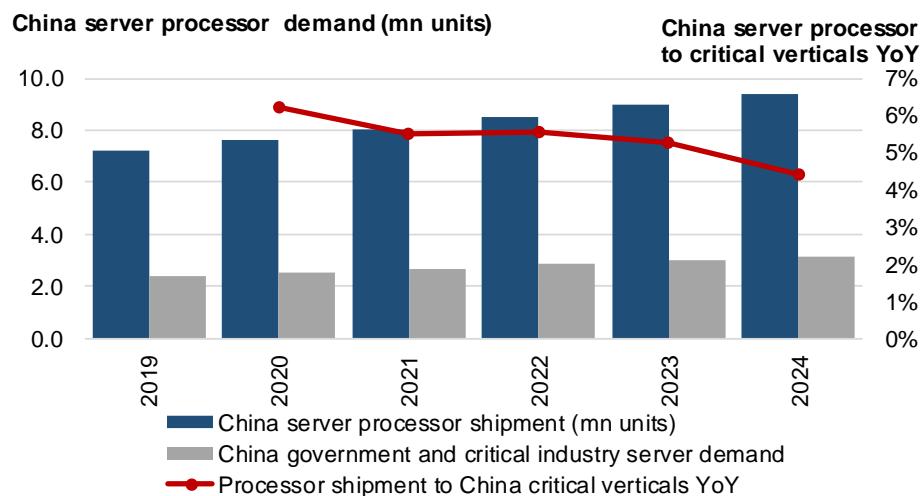
**Figure 186: Phytium growing its domestic server ecosystem**



Source: Phytium

**China's domestic market represents a 600k server unit opportunity.**

**Figure 187: China's server demand from government and SOE should be the second wave application China's CPU fabless penetrates**



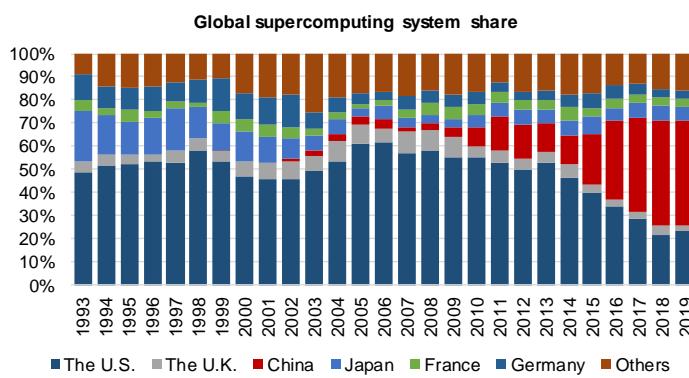
Source: IDC, Credit Suisse estimates

## China fabless making progress on supercomputing

Although China has been fast developing its super computing system for scientific use, with its unit share among the global top 500 supercomputing systems growing from 0% in 2000 to 8% in 2010 and 46% in late 2019, most of the critical semiconductor components are still from Intel for CPU and AMD/Nvidia for accelerator. However, since 2015, the US government has stopped Intel from shipping its Xeon products to Chinese supercomputing institutions due to concerns about their use in nuclear tests. Since the restriction, China has been gaining in supercomputing system share, but the computing share has been unchanged, suggesting limited system level performance improvement compared with overseas peers.

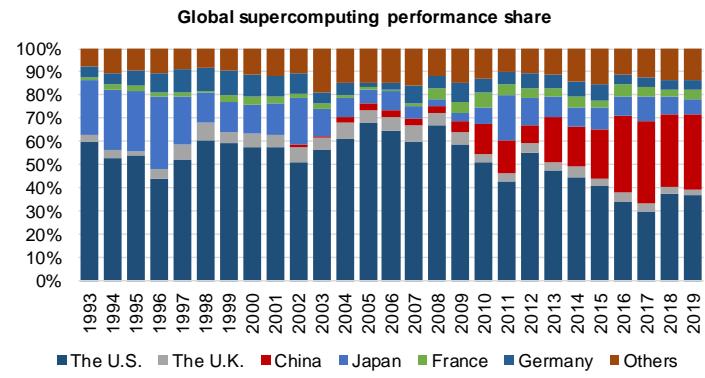
**China's domestic supercomputers had 46% share in late 2019, though now Intel's Xeon's is getting limited access in new projects.**

**Figure 188: China continues to grow system share...**



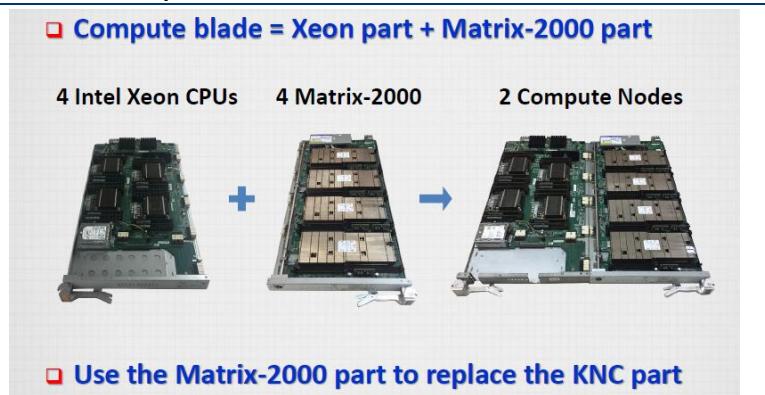
Source: Top500.org, Credit Suisse

**Figure 189: ...but its performance share has been stagnant**



Source: Top500.org, Credit Suisse

To replace solutions provided by overseas suppliers, China local institutions have been working on developing their own supercomputing CPU and accelerator based on different architecture since 2015, with the three major ones including Loongson (MIPS), Sunway (ALPHA) and Phytium (ARM). The China National University of Defense and Technology developed the Matrix-2000 accelerator on 28nm which replaced Intel's Xeon PHY chipset and was deployed in the Tianhe-2A supercomputing system in the National Supercomputing Centre of Guangzhou since 2017. The company also has been working with Tianhe for the network interconnect design since 2012, adopted in the Tianhe-1 and Tianhe-2 supercomputer. The company subsequently developed Matrix-2000+ accelerator on 16nm in 2017 for the Tianhe-3 prototype.

**Figure 190: Tianhe-2A replaced Intel Xeon PHY with its own Matrix-2000 accelerator**

Source: Tianhe-2A

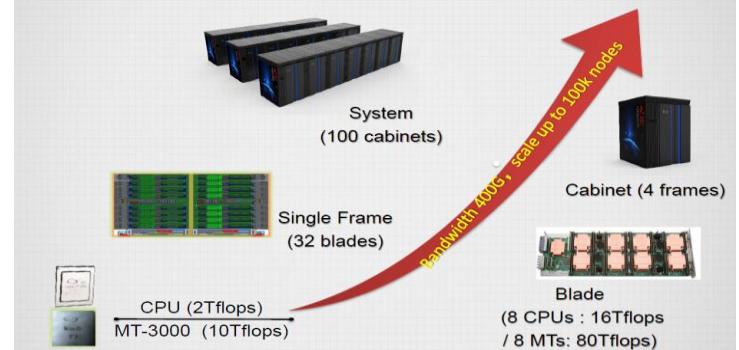
The China National University of Defense and Technology developed the Matrix-2000 accelerator on 28nm which replaced Intel's Xen PHY chipset, and along with Phytium's FT-2000 CPU for some computing nodes have been deployed in Tianhe-2A supercomputing system in the National Supercomputing Centre of Guangzhou since 2017.

The institution subsequently developed Matrix-2000+ accelerator on 16nm in 2017 for the Tianhe-3 prototype. The company has also long been adopting the network interconnect it develops in the Tianhe supercomputer since 2012. With a strong relationship with NUDT, Phytium's FT-2000+/64 processor was also adopted in some nodes in the Tianhe-3 prototype. Based on the schedule, the Tianhe-3 supercomputer should be introduced in 2021 adopting Phytium's FT-2500/64 CPU and NUDT's MX-3000 accelerator.

**Figure 191: Supercomputing migrating to exascale computing power**

• Aurora (ANL) 2021 <ul style="list-style-type: none"> <li>Cray/Intel</li> <li>Sapphire Rapids + Ponte Vecchio</li> </ul>	• Tianhe-3 (NSC Tianjin) 2020 <ul style="list-style-type: none"> <li>NUDT</li> <li>ARM-based? + MT-3000 + 400Gb/s</li> </ul>
• Frontier (ORNL) 2021 <ul style="list-style-type: none"> <li>Cray/AMD</li> <li>EPYC + Radeon</li> </ul>	• Shuguang (NSC Shanghai) 2021? <ul style="list-style-type: none"> <li>Sugon</li> <li>Licensed AMD EPYC clone</li> <li>Liquid immersion</li> </ul>
• El Capitan (LLNL) 2022 <ul style="list-style-type: none"> <li>Cray</li> </ul>	• Sunway? (NSC Jinan) 2021? <ul style="list-style-type: none"> <li>ShenWei (256C)</li> <li>No accelerator</li> </ul>
• LUMI (CSC Finland) 2020	• Fugaku (RIKEN) 2021 <ul style="list-style-type: none"> <li>Fujitsu</li> <li>A64FX (ARM)</li> </ul>
• Leonardo (CINECA Italy) 2020	
• MareNostrum 5 (BSC Spain) 2020	
• 1 <sup>st</sup> Gen ARM/RISC-V 2021	
• 3 exascale with 2 <sup>nd</sup> Gen 2023	

Source: UNSW

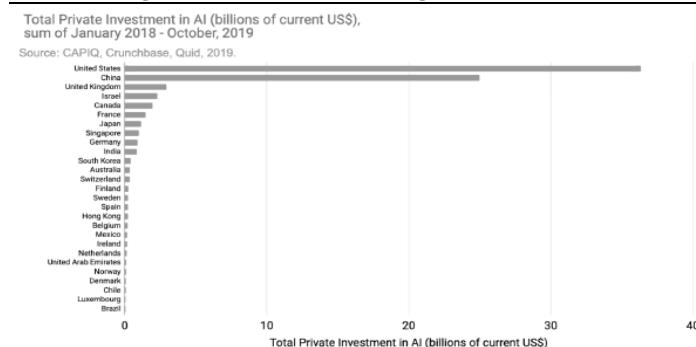
**Figure 192: Tianhe-3 could adopt Phytium's FT-3000 CPU along with the MT-3000 accelerator developed by NUDT**

Source: Tianhe-3

## AI investment also accelerating since 2014

China is also putting a huge focus on AI, with local fabless trying to capitalise both on inference and training workloads and on custom ASICs to handle local applications of AI. The global investment by AI start-ups on semiconductor has grown by 450%, from US\$0.5 bn in 2015 to US\$2-3 bn in 2019, as more and more companies try to customise their chipsets solutions and improve the AI performance and power consumption.

**Figure 193: Most of the AI investment are in the US and China, representing 75-80% of total funding**



Source: Stanford University

The AI chipset development is still fragmented due to a wide range of industry use cases, with 326 companies in China alone in 2019, according to ChinaVenture Institute. For China, the investment in algorithm, computing system and semiconductor technology reached US\$3 bn from 2014-19, representing 5.6% of total US\$51 bn investment made in China AI start-ups during the period, according to ChinaVenture Institution. At 5-6% of total AI investment, we expect the investment in AI semiconductor to continue to grow.

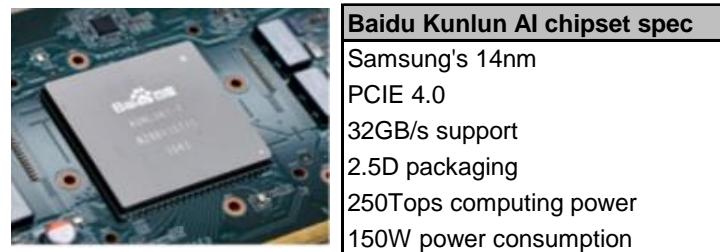
We highlight major AI chip start-ups, with most projects spanning from core to edge computing for AI training, inference and other applications. Within that list, China has a number of fabless with solutions including Cabricon, DeepcreateIC, Horizon Robotics, IntelliGo, Intengine, Lynxi, SenseTime, Thinkforce, Tsinghua Thinker and Unisound. Many of these chip suppliers are using TSMC due to its widest base of EDA and IP support, particularly on 16nm and below technologies. Some of these suppliers are now migrating to 7nm where TSMC is the primary option using the Taiwan-based design service companies.

Beyond the start-ups, China internet companies have also been expanding their chipset design capability to develop custom ASICs for their high performance workloads and AI applications:

- **Alibaba** set up T-Head as its IC design business and already developed Hanguang 800/900 series chipsets for AI inference on TSMC's 12nm and 7nm, respectively.
- **Baidu** has developed its Kunlun chipset using Samsung for edge and cloud AI computing.
- **Tencent** in March started its fabless subsidiary to develop AI applications.

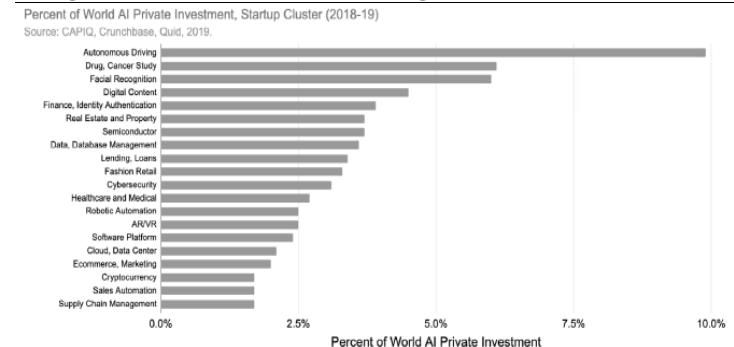
With AI training and inferencing taking time and cost, it is important not only the algorithm and design of the chipset is optimised, but also critical to use advanced manufacturing technology for further performance improvement and lower power consumption. For TSMC, we believe the high share in both start-ups and system companies shows the company's strong technology capability and should support it to capture the opportunity in the fast growing AI market.

**Figure 195: Baidu's Kunlun AI chipset on Samsung's 14nm**



Source: Baidu

**Figure 194: Autonomous driving, drug research and facial recognition are most popular among AI investments**



Source: Stanford University

**TSMC supplies many of the leading AI start-ups developing solutions**

**Figure 196: Alibaba's T-Head Hanguang 800 on TSMC's 12nm**



Source: T-Head

**Figure 197: A number of start-ups in China and globally targeting AI chip development, TSMC leading in fabrication**

Start-ups	Key focus area	Country	Foundry	Most advanced node	Tech investors
AlMotive	Semiconductor chipset and software for automated driving	Hungary	GlobalFoundries	22nm FD-SOI	Cisco, Samsung
Blaise	Vision processing chips	US	TSMC	28nm HPC	Denso, Samsung
BrainChip	Neuromorphic SoC (Akida) that can be function as an SoC or integrated into ASIC	Australia	TSMC	28nm	Listed
Cambriion	Device and cloud processors for AI	China	TSMC	7nm	Alibaba, TCL
Cerebras	Systems Specialized chip for deep-learning applications	US	TSMC	16nm	NA
Deep Vision	Low-power silicon architecture for computer vision	US	TSMC	28nm HPC	NA
DeepcreatIC	Heterogeneous neuromorphic chips	China	SMIC	40nm	NA
Deephi	Compressed CNN networks and processors	China	TSMC	7nm	Xilinx
DinoPlus	High-performance and ultra-low latency AI chipsets for 5G/edge computing	US	NM	NM	NA
Enflame	Cloud-based deep learning chips for AI training platforms	China	GlobalFoundries	12nm LP	Tencent, SummiView
Esperanto	Massive array of RISC-V cores	US	TSMC	7nm	Western Digital
GrAI Matter Labs	AI chipsets designed for ultra-low latency and low power processing at the edge	France	TSMC	28nm	NA
Graphcore	Graph-oriented processors for deep learning	UK	TSMC	16nm	Dell
Groq	Google spinout working on deep learning chip	US	NM	14nm	NA
Habana Labs	Programmable deep learning accelerators for data center training and inference	Israel	TSMC	7nm	Intel
Hailo	Specialized deep learning microprocessor	Israel	NM	NM	NEC
Horizon Robotics	Chipsets and solutions for smart Home, automotive and public safety	China	TSMC	16nm	SK Hynix
IntelliGo	Hardware and software for image and speech processing	China	NM	NM	Mediatek
Intengine Tech	AI chips for embedded system for edge computing	China	NM	NM	NA
Kneron	NPU that accelerates neural network models making possible applications (e.g. face detection and gesture control) in embedded devices	US	TSMC	16nm	Alibaba, Himax, Qualcomm
Lightmatter	Programmable photonic to accelerate critical operations in deep neural networks	US	NM	NM	Alphabet
Lynxi	Brain-like computing chip for high performance computing	China	NM	28nm	NA
Mythic	Ultra-low power neural networking inference chips based on flash+analog+digital	US	Fujitsu	40nm	Lam Research, Micron, Softbank
Novumind	AI for IoT	US	TSMC	7nm	NA
Preferred Networks	Real time data analytics and chipset solutions with deep learning library	Japan	TSMC	12nm	Hitachi, Fanuc
Reduced Energy Microsystems	Chipset solutions for deep learning and machine vision with low power consumption	US	GlobalFoundries	22nm FD-SOI	NA
SambaNova	Reconfigurable Array platform for matrix arithmetic for AI applications	US	NM	NM	Google, Intel
SenseTime	Chipset solutions for computer vision	China	NM	NM	Softbank, Singtel, Qualcomm, Alibaba
SiMA.ai	Machine Learning SoC platform for high performance and low power consumption	US	NM	NM	Dell
Syntiant	Customized analog neural networks	US	NM	40nm ULP	Amazon, Microsoft, Intel
TensorTorrent	Deep learning processor for faster training and adaptability to future algorithms	Canada	GlobalFoundries	12nm	NA
Thinkforce	AI chips for edge computing	China	NM	NM	NA
Tsinghua Thinker	Low power AI chips for edge computing	China	TSMC	65nm LP	Tsinghua VC
Unisound	Chipsets for AI-based speech and text capability	China	TSMC	28nm	Qihoo
Vathys	Chipset design for deep learning supercomputers	US	NM	NM	NA
Wave Computing	ASIC solutions for deep learning computers	US	TSMC	7nm	Samsung
Xanadu	Quantum photonic processors	Canada	NM	NM	NA

Source: Company data, Credit Suisse estimates

## Competitive landscape for Design Services

The design service capability and capacity, IP portfolio, success rate, supply chain relationship, target applications and technology/IP support are the important factors when customers choose the service provider. We compare the competitiveness for the major companies including Global Unichip, Alchip and Faraday in Taiwan in China as below.

**Figure 198: Performance, technology and target application comparison for major IC design service companies**

IC design service company	Global Unichip	Alchip	Faraday
Ticker	3443.TW	3661.TW	3035.TW
Revenue (US\$m)	\$346	\$140	\$172
GMs	27.5%	35.6%	44.6%
OpMs	6.5%	10.0%	7.5%
Headcounts	759	404	882
Service	Front/back-end design, IP	Front/back-end design, IP	Back-end design
Technology support	65nm and above: 30% 40nm: 13% 28nm: 37% 16nm: 16% 7nm and below: 4%	55nm and above: 4% 40nm: 6% 28nm: 29% 20/16nm: 33% 12/7nm: 27%	0.25um: 0-5% 0.18-0.11um: 35-40% 90-55nm: 20-25% 40nm: 15% 28nm and below: 20-25%
Targeted applications	Computer: 43% Consumer: 34% Communication: 11% Others: 12%	HPC: 59% Network: 14% Niche: 18% Consumer: 9%	Industrial: 30-35% AloT: 30-35% Communication: 20% PC: 10-15% Others: 0-5%
Foundry partners	TSMC (100%)	TSMC (~100%), Samsung, SMIC, GlobalFoundries	UMC (70-75%), Samsung (20-25%)

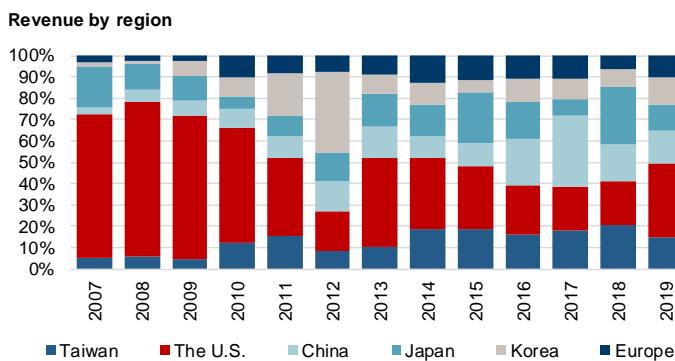
Source: Company data, Credit Suisse estimates

**Global Unichip:** The company is the largest IC Design service company in Taiwan providing both front-end and back-end IC design service with its customers, with revenue having reached

NT\$10bn in 2019 at 33% GMs. The company generates 70%+ revenue from 28nm with a target on the computing (44% of its sales) and consumer applications (33% of its sales).

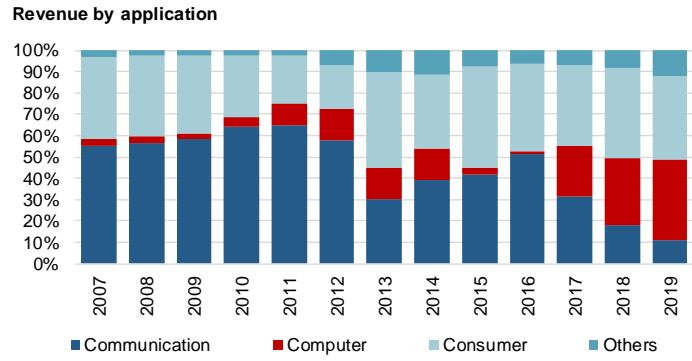
Compared with high exposure in China for Faraday and Alchip, Global Unichip's is more diversified, with the US and Taiwan contributing 50% of its sales. As one of TSMC's subsidiaries, the company gets support from TSMC on the IP library and manufacturing even during supply tightness in advanced nodes. Global Unichip is also leading on the technology development among its Taiwan peers with 5nm silicon verified by the end of last year.

**Figure 199: Global Unichip's revenue by region**



Source: Company data, Credit Suisse estimates

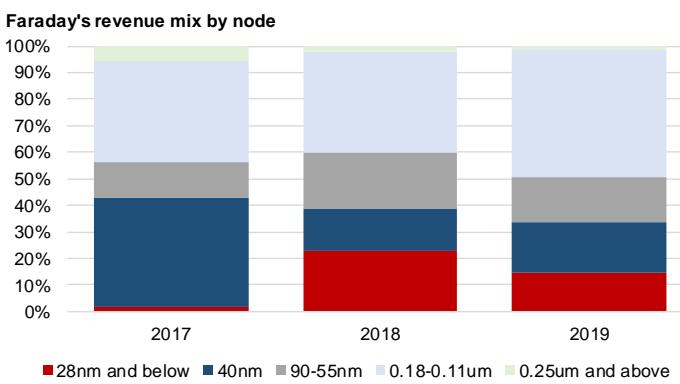
**Figure 200: Global Unichip's revenue by application**



Source: Company data, Credit Suisse estimates

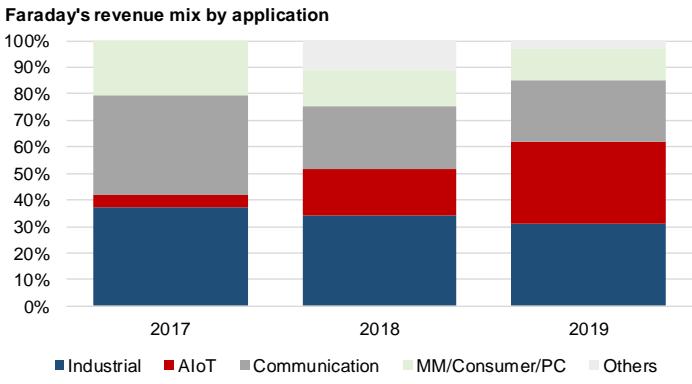
**Faraday:** The company is a spin-off from UMC, with NT\$5.3 bn revenue and 50% GMs in 2019. Although the company has started partnership with Samsung foundry for advanced nodes, with its main partnership with UMC, it is lagging on technology development and revenue growth in the past few years (sales have been flat since 2017) and has a different product mix compared with its peers. Faraday's revenue from 28nm and below only contributes 16% of its sales and 35% from 40-90nm and 46% on 8". On product mix, given limited access to the advanced nodes for HPC and mobile related applications, the company has higher exposure in AIoT (44% of its sales) and industrial (22% of sales) applications, with key revenue drivers in 2019 including printer, projector, POS machine, smart meter and medical applications.

**Figure 201: Faraday's revenue by node**



Source: Company data, Credit Suisse estimates

**Figure 202: Faraday's revenue by application**

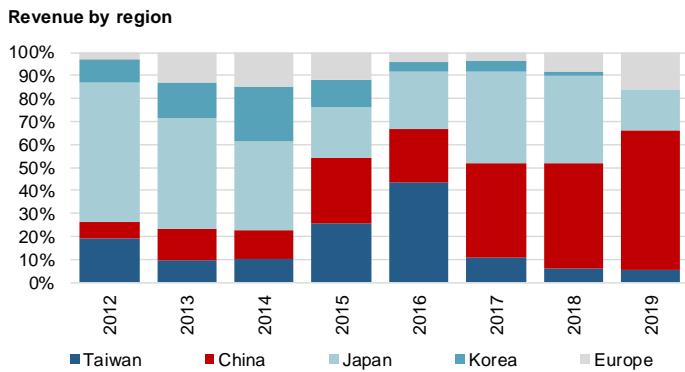


Source: Company data, Credit Suisse estimates

**Alchip:** Alchip was founded in 2003 by a group of semiconductor veterans to focus on leading edge ASIC and SoC design, with revenue reaching NT\$4.3 bn in 2019 at 37% GMs. With its strategy to put resources on HPC and AI projects, Alchip generates 26% revenue from 12/7nm, 53% from 20/16nm and 11% from 28nm. The company also has the highest China exposure among major Taiwan IC design service companies at 60% as it is designing CPU and AI chipsets for its China customers mainly for government projects. In addition to China, the

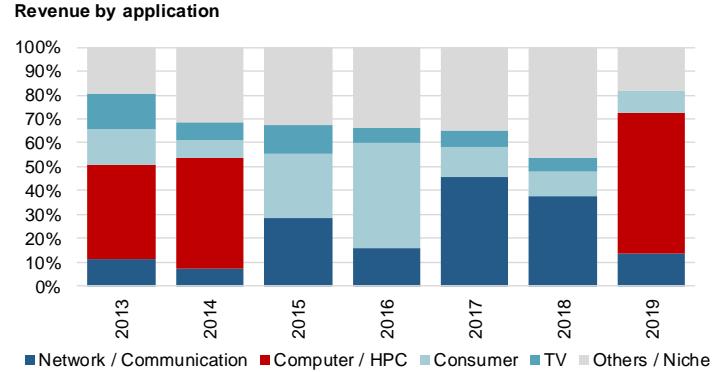
company is also aggressively working with the US internet companies for ASIC design opportunities and recently won a game console project from its Japan customer.

**Figure 203: Alchip's revenue by region**



Source: Company data, Credit Suisse estimates

**Figure 204: Alchip's revenue by application**



Source: Company data, Credit Suisse estimates

## IC stocks leveraged to China's development

China's localisation and advancement of its semiconductor industry has been a rising investment theme over the past six years since it introduced its National Guideline in 2014 but it has only accelerated in the past couple of years due to rising US tensions, accelerated domestic support, and a growing local tech capital market. Over the past year the theme evolved as US resistance to this advancement picked up and also created some pitfalls to the Huawei supply chain and for SMIC. With the change in US administration now tending towards a potentially more predictable activity, there is still a resolve by China to build up its supply chain, and we expect the investment theme to continue.

We view China's semiconductor industry will continue to make progress and grow though at an uneven pace and mixed profitability during the investment phase, also with some initial opportunities in more price sensitive segments of the market. We highlight companies in each subsector we view are best placed for growth from the local ecosystem, though many have re-rated and now have a high valuation in anticipation of years of above-market growth.

We view the best placed stocks for China's ecosystem rise in foundry to be (TSMC, SMIC and Hua Hong), back-end (ASMP, Huatian and Tongfu), IC Design (Mediatek, Will Semi, and Maxscend), and equipment, still the US suppliers AMAT, KLAC and Lam as arm's merchants given high barriers.

**Best placed stocks for China's industry development include TSMC, SMIC, Hua Hong, ASMP, Huatian, Tongfu, Mediatek, Will Semi, Maxscend, AMAT, KLAC, and Lam.**

**Figure 205: IC stocks leveraged to China's development**

Company	Ticker	Local Price 1/19/2021	Mkt Cap (US\$mn)	Ent. Value (US\$mn)	P/E Multiple (x) 2020	P/E Multiple (x) 2021	EV/EBITDA (x) 2020	EV/EBITDA (x) 2021	EV/Sales (x) 2020	EV/Sales (x) 2021	P/B Multiple (x) 2020	P/B Multiple (x) 2021	ROE 2020	ROE 2021
<b>Foundries</b>														
TSMC	2330.TW	\$627.00	\$580,344	\$519,867	31.4	29.9	17.6	15.4	11.8	10.6	8.8	7.6	28.0	30.0
SMIC Hong Kong	0981.HK	\$29.60	\$22,742	\$16,579	54.1	79.0	9.7	9.4	3.9	3.8	2.1	2.0	3.8	2.5
SMIC Shanghai	668981.SS	\$62.46	\$24,243	\$18,640	125.5	183.4	10.9	10.5	4.4	4.3	4.8	4.7	3.8	2.5
Hua Hong	1347.HK	\$48.50	\$8,119	\$8,305	98.9	65.5	34.8	15.8	8.7	7.0	3.5	3.4	3.5	5.1
Win Semi	3105.TWO	\$445.00	\$6,736	\$6,130	27.4	29.6	15.8	15.6	7.3	7.1	6.0	5.7	22.0	24.0
<b>Foundry Median:</b>					<b>54.1</b>	<b>65.5</b>	<b>15.8</b>	<b>15.4</b>	<b>7.3</b>	<b>7.0</b>	<b>4.8</b>	<b>4.7</b>	<b>3.8</b>	<b>5.1</b>
<b>Foundry Mean:</b>					<b>67.5</b>	<b>77.5</b>	<b>17.8</b>	<b>13.3</b>	<b>7.2</b>	<b>6.5</b>	<b>5.0</b>	<b>4.7</b>	<b>12.2</b>	<b>12.9</b>
<b>Equipment Companies</b>														
Advantest	6857.T	\$9,140.00	\$17,231	\$15,570	33.8	36.7	27.0	24.5	6.0	6.0	7.8	6.8	23.1	18.6
Applied Materials	AMAT	\$103.14	\$94,196	\$94,293	24.8	21.4	21.4	17.8	5.5	4.8	9.0	6.5	36.3	30.4
ASM Int'l	ASMI.AS	\$213.20	\$7,225	\$6,846	36.1	29.0	18.3	16.6	6.3	5.7	5.5	5.2	15.5	18.2
ASM Pacific	0522.HK	\$117.00	\$6,200	\$5,945	54.0	20.6	29.4	12.7	2.8	2.5	4.2	3.8	7.8	18.3
ASML	ASML	\$437.60	\$183,572	\$182,360	56.5	47.1	43.4	37.4	13.6	12.2	13.1	12.4	23.2	26.4
DISCO	6146.T	\$37,600.00	\$13,022	\$12,180	48.9	47.8	29.4	28.0	9.0	8.7	6.0	5.7	12.3	11.9
KLA	KLAC	\$304.13	\$46,976	\$48,465	29.4	24.4	24.1	17.4	8.3	7.6	17.9	13.1	60.9	53.8
Lam Research	LRCX	\$547.53	\$78,849	\$77,961	34.5	24.9	27.6	19.1	7.8	6.0	15.8	10.4	45.7	41.9
SCREEN	7735.T	\$8,860.00	\$3,976	\$4,075	82.5	29.1	20.7	13.1	1.4	1.5	2.4	2.2	2.9	7.6
Tokyo Electron	8035.T	\$44,130.00	\$65,963	\$213,962	37.7	43.9	24.3	26.5	5.8	6.1	8.5	7.6	22.6	17.4
<b>Equipment Median:</b>					<b>36.9</b>	<b>29.0</b>	<b>25.7</b>	<b>18.5</b>	<b>6.2</b>	<b>6.0</b>	<b>8.2</b>	<b>6.7</b>	<b>22.9</b>	<b>18.4</b>
<b>Equipment Mean:</b>					<b>43.8</b>	<b>32.5</b>	<b>26.6</b>	<b>21.3</b>	<b>6.6</b>	<b>6.1</b>	<b>9.0</b>	<b>7.4</b>	<b>25.0</b>	<b>24.4</b>
<b>Back-end Companies</b>														
Tianshui Huatian	002185.SZ	\$16.05	\$6,778	\$6,520	63.4	38.4	20.0	15.0	5.4	4.2	5.4	4.8	7.9	9.9
Tongfu Micro	002156.SZ	\$29.38	\$6,018	\$6,500	87.3	55.8	20.4	16.6	3.9	3.2	4.1	3.8	5.9	8.7
<b>Back-end Median:</b>					<b>75.3</b>	<b>47.1</b>	<b>20.2</b>	<b>15.8</b>	<b>4.6</b>	<b>3.7</b>	<b>4.7</b>	<b>4.3</b>	<b>6.9</b>	<b>9.3</b>
<b>Back-end Mean:</b>					<b>75.3</b>	<b>47.1</b>	<b>20.2</b>	<b>15.8</b>	<b>4.6</b>	<b>3.7</b>	<b>4.7</b>	<b>4.3</b>	<b>6.9</b>	<b>9.3</b>
<b>IDM &amp; Fabless</b>														
Mediatek	2454.TW	\$879.00	\$49,890	\$40,978	35.0	25.3	24.3	17.7	3.5	2.9	3.9	3.6	11.2	14.4
Will Semi	603501.SS	\$314.89	\$42,106	\$42,106	101.9	52.3	73.1	39.9	13.8	10.1	24.0	15.9	23.6	30.5
Maxscend	300782.SZ	\$660.00	\$18,310	\$18,148	117.9	89.1	104.8	77.2	42.5	31.3	45.7	31.3	39.1	37.5
Analog Devices	ADI.OQ	\$157.75	\$58,286	\$62,375	32.2	27.4	25.3	21.6	11.1	9.9	4.9	4.9	15.4	16.2
Texas Instruments	TXN.OQ	\$169.19	\$155,307	\$156,866	32.0	29.3	27.1	24.3	11.2	10.4	17.9	13.9	55.7	47.2
<b>IDM &amp; Fabless Median:</b>					<b>35.0</b>	<b>29.3</b>	<b>27.1</b>	<b>24.3</b>	<b>11.2</b>	<b>10.1</b>	<b>17.9</b>	<b>13.9</b>	<b>23.6</b>	<b>30.5</b>
<b>IDM &amp; Fabless Mean:</b>					<b>63.8</b>	<b>44.7</b>	<b>50.9</b>	<b>36.1</b>	<b>16.4</b>	<b>12.9</b>	<b>19.3</b>	<b>13.9</b>	<b>29.0</b>	<b>29.1</b>
<b>EDA &amp; IC design service</b>														
Alchip	3661.TW	\$847.00	\$1,875	\$1,620	62.6	37.3	23.5	16.4	7.0	4.3	13.3	11.5	21.2	30.7
Synopsys	SNPS	\$258.92	\$39,623	\$38,515	46.7	41.1	33.5	28.7	10.5	9.6	8.1	7.1	19.2	17.1
Cadence	CDNS	\$134.64	\$37,555	\$36,803	49.9	46.9	38.2	34.4	13.9	13.0	14.8	11.8	29.6	24.6
<b>EDA &amp; IC design service Median:</b>					<b>49.9</b>	<b>41.1</b>	<b>33.5</b>	<b>28.7</b>	<b>10.5</b>	<b>9.6</b>	<b>13.3</b>	<b>11.5</b>	<b>21.2</b>	<b>24.6</b>
<b>EDA &amp; IC design service Mean:</b>					<b>53.1</b>	<b>41.8</b>	<b>31.7</b>	<b>26.5</b>	<b>10.4</b>	<b>9.0</b>	<b>12.0</b>	<b>10.1</b>	<b>23.3</b>	<b>24.2</b>

Note: Priced as at 19-Jan-2021. Source: Company data, Credit Suisse estimates

## Foundry: TSMC offers leverage on advanced technology, SMIC/Hua Hong for the local IC suppliers

- **TSMC.** TSMC is best placed in China with leading 59% sector share and even higher 65% market share among fabless even excluding HiSilicon. The foundry has a five-year process technology lead over China's leader SMIC also now requiring licensing for the US advanced tools in addition to largest capex and R&D for process development and capacity scale. The company's process lead gives it access to China's faster growing IC design sector and share gains into any areas requiring advanced silicon including 5G smartphones, networking, graphics, AI training and CPUs.
- **SMIC.** We recently upgraded SMIC to Neutral as the US entity list looks better than anticipated as it only presumes denial for advanced US equipment uniquely required below 10nm. That restriction would still allow SMIC to maintain existing operations and most of its sales addressing the mainstream mobile, smart home and consumer markets. SMIC should see accelerating local business and as the largest China domestic foundry may also see a higher multiple from its leverage to the China domestic customers.
- **Hua Hong.** We view Hua Hong as placed for growth with its strategy to develop mature 8" and 12" technology for high volume mainstream applications including analog/discretes, MCUs, smart cards, CIS, NOR flash and mature logic. The company has also maintained a good relationship to date with the US authorities, with a Commerce Department Validated End User licence requiring annual audits.
- **Win Semi.** We view Win Semi as a key beneficiary of China's RF localisation as Win Semi is the largest compound semi foundry globally with 75%+ market share, and has a strong track record of supplying foundry service to Avago, Qualcomm, and HiSilicon. Post the Huawei/HiSilicon restriction, we believe it will aim to regain its allocation at the Chinese RF fabless to offset the revenue shortfall, although we think near term there will still be a gap on its cellular revenue as the ramp up of Chinese RF fabless will take a few years.

## Back-end: Huatian and Tongfu our preferred picks for share gains in China; Advantest, ASM Pacific and Disco in equipment

- **Advantest.** The company had a market share of ~55% in 2019. The weighting of sales to China rose from 16% in FY3/19 to 24% in 1H FY3/21. Due to the US-China trade friction, local Chinese OSATs seem to be starting to place more orders with Advantest than its US competitor Teradyne. Going forward, Advantest stands to benefit from the progress in developing original Chinese processors, application processes, and other semiconductors.
- **ASM Pacific.** ASM Pacific has leading back-end (58% revenue) and SMT equipment businesses (42% revenue), with 50% of its sales from mainland China. The company should see good growth from local OSATs aiming to take share in the domestic market and moving into more advanced wafer level, flip chip and system in package technology. The SMT business should also see some opportunities continuing from a partially decoupled supply chain requiring more localised manufacturing investment in more geographies.
- **Disco.** The company continues to benefit from in-shoring assembly processes in the Chinese domestic market. The weighting of sales to China rose from 24% in FY3/19 to 28% in 1H FY3/21. Notwithstanding the short-term risk of duplicate orders, the company has market shares of over 80% in dicers/grinders. Moving forward, growing investment in the Chinese market would boost the company's growth.
- **Huatian.** Huatian earned 52% of total revenue from mainland China in 1H20 vs 38% in 2017. As the third largest pure-play OSAT in China, we expect Huatian to capture the demand from China fabless, gaining share in the domestic market as well as industry-wide OSAT supply tightness. The current industry-wide supply tightness also presents a good

opportunity for Huatian's revenue and margin expansion. It has raised prices for multiple services in late 2020 and the new pricing should reflect in better revenue/margin this year. Besides, the development of China NAND flash companies (YMTC and Longsys) might present another upside to Huatian, though a very small revenue contribution so far.

- **Tongfu.** As the second-largest pure-play OSAT in China, Tongfu works with many domestic customers, such as CPUs (Phytium, Zhaoxin and Loongson), DRAM (Innotron Memory) and many other fabless (UniSOC, Maxscend, Gigadevice, Will Semi, and so on). We expect revenue from these Chinese companies to grow as a result of China's localisation ambition. Mediatek is another growth driver, with China to grow non-US sources and better demand from mobile and various smart home devices/IoT applications. Lastly, AMD should remain as the major growth driver in the next 2-3 years and Tongfu should continue to grow with AMD's share gains in CPU/GPU besides higher content value for more advanced processors. DDI is another new revenue driver besides DRAM, and Tongfu has been working with multiple domestic and international DDI fabless customers to ramp up its DDI capacity.

## **IC design: Mediatek benefitting from China OEM's 5G push, Will Semi and Maxscend from localisation**

- **Mediatek.** Mediatek is in a good position both in 5G and non-mobile to capture high OEM share competing against its US rival, Qualcomm, in the local market as domestic substitution continues to grow non-US sources. Even in the absence of localisation gains, Mediatek has built a competitive position in the mainstream mobile market and is growing into more non-mobile categories including IoT connectivity, networking, analog, ASICs and multimedia TV/set-top ICs.
- **Will Semiconductor.** Mobile CIS should remain the key revenue driver in 2021, followed by automotive. Mobile CIS growth is driven by (1) its share gain in the main camera segment within ex-Samsung Android market from 2-3% in 2019 or 13-14% in 2020 to 19%/21% in 2021-22E, (2) overall Android recovery mid-to-high-single digit in 2021, and (3) pixel upgrades for main camera allowing Will Semi to earn US\$1-2 content value per phone. The automotive business (nearly 10% revenue) should also recover in 2021 with (1) recovering vehicle sales, (2) more cameras in new car design, and (3) higher complexity for new cameras. Will Semi has 20-25% share in the global automotive CIS market and is gaining share within China auto makers.
- **Maxscend.** Maxscend's growth is driven by its switch/LNA share gains at Vivo and OPPO, and more importantly, share gains on cellular modules and Wi-Fi PA modules across all Android OEMs and Wi-Fi/IoT device makers. Organically Maxscend should grow with rising 5G penetration globally and higher RF content per box over the next 2-4 years. The company is also penetrating automotive and base station, but the revenue contribution remains very small currently given the fast-growing, high revenue base mobile business.
- **Alchip.** Alchip is an IC design service company with a focus on projects, including HPC and AI, on the advanced nodes. We believe the company's sales should see 30% CAGR from 2019-22 on growing China CPU demand in PC and server, growing content in the supercomputing system on 7nm for its China customer and more HPC and AI projects from its China and US start-up and system company customers.

## **Equipment: Leading US/Japan suppliers offer best leverage to China's capex investment**

- **Applied Materials.** AMAT has a good market share across the semiconductor equipment space and a long history supplying China's domestic suppliers. AMAT guided F1Q well-above Street even after adjusting for an extra week in F1Q and SMIC ~US\$100 mn headwind. While the US-China tensions (34% of revenue, +31% YTD) remain a headline risk and AMAT revenue growth over several years has trailed LRCX/KLAC, we note

looking into CY21, with expected stronger growth in DRAM over NAND and AMAT's improving position in dielectric etch, the growth gap should continue to close.

- **KLA.** KLA is a leading process control supplier with high barriers in the category that should ensure its central position in China fab investments and work to bring up yields and process on par with overseas competitors. KLAC guided F2Q well above Street on continued strength of Foundry (+29% QoQ) and China (+30% QoQ and 32% of revenue split ~60/40 domestic/multinational). While KLAC has applied for but has not been granted licences by the DoC BIS, we estimate that SMIC is still 1-3% of F2Q revenue guidance, down from ~5% of revenue in F1Q/F4Q. We argue investors are still unwilling to underwrite the secularly rising cost of capacity as process complexity is now outpacing fab productivity driving continued higher highs and higher lows for WFE.
- **Lam Research.** Lam is still well positioned for China domestic demand with its strong position in etch and deposition. LRCX guided F2Q above Street with strong F1Q China and expected strong F2Q China (despite an SMIC headwind of ~US\$100-150 mn) that will fuel investor concern that a potential widening of export controls is driving pull-ins. However, we disagree: while China is 37% of F1Q revenue vs 8Q average of 29%, we note that 50% of China is multinational, with the 50% domestic representing 14% of revenue, only modestly ahead of China's share of global production of ~11%.
- **SCREEN.** Because the company has an edge among logic/foundry companies, it stands to benefit if foundries, in particular, step up their investment. In 1H FY3/21, the weighting of sales to China rose to 33% (18% in FY3/20) due to investment by SMIC. There may be some short-term impact on capex from SMIC being placed on the US entity list. However, SCREEN should benefit if investment in mature processes supports in-shoring logic in the Chinese domestic market increases.
- **Tokyo Electron.** We think that Tokyo Electron will benefit significantly if memory investment in the Chinese domestic market increases although the company does not anticipate any particular boost to market share for the US makers from the fallout from the US-China trade friction. It assumes sales growth purely in line with capex by local Chinese makers. Sales to China accounted for 17% of the total for Tokyo Electron in FY3/19 and 24% in 1H FY3/21.

# China semiconductor company tear sheets

We present tear sheets for 22 major China semiconductor companies across IC design, IP, equipment, chipmakers and OSAT.

**Figure 206: Summary list of companies in this tear sheet section**

	Company	Ticker	Market Cap (US\$ mn)	Sector
1	ACM Research	ACMR	1,376	Equipment
2	AMEC	688012.SS	12,765	Equipment
3	Amlogic	688099.SS	5,221	IC Design
4	Anji Technology	688019.SS	2,481	Materials
5	Bestehnici	688608.SS	6,830	IC Design
6	CR Micro	688396.SS	12,289	IDM/Foundry
7	Gigadevice	603986.SS	14,815	IC Design
8	Goodix	603160.SS	10,769	IC Design
9	Huahong Semi	1347.HK	7,439	Foundry
10	Huatian	002185.SZ	5,840	OSAT
11	JCET	600584.SS	9,571	OSAT
12	Maxscend	300782.SZ	16,391	IC Design
13	Montage	688008.SS	15,633	IC Design
14	NAURA	002371.SZ	12,205	Equipment
15	NSIG	688126.SS	12,553	Materials
16	Sanan	600703.SS	18,709	Others
17	Shanghai Sinyang	300236.SZ	2,191	Materials
18	Shanghai Wanye	600641.SS	2,574	Equipment
19	SMIC	0981.HK	15,571	Foundry
20	Tongfu	002156.SZ	5,301	OSAT
21	Will Semi	603501.SS	30,243	IC Design

Source: Refinitiv, Credit Suisse estimates

**Chaolien Tseng**  
852 2101 6795  
chaolien.tseng@credit-suisse.com  
**Randy Abrams, CFA**  
886 2 2715 6366  
randy.abrams@credit-suisse.com  
**Kyna Wong**  
852 2101 6950  
kyna.wong@credit-suisse.com

# ACM Research (Shanghai) (ACMR.OQ, Not Covered)

## Overview/product mix

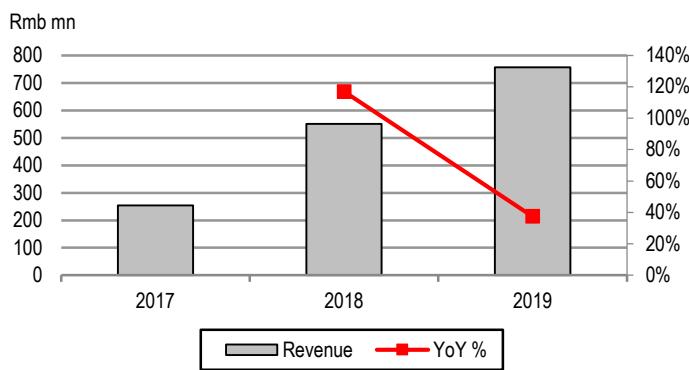
Founded in 1998 in Silicon Valley, ACM Research develops wet processing technology and equipment for semiconductor manufacturing. In 2005, ACM Research established its subsidiary, ACM Research (Shanghai). ACM Research now has complete R&D, engineering and manufacturing in Shanghai. ACM Research (Shanghai) has applied for an IPO on the A-share Sci-Tech Board and obtained regulatory approval. It should begin trading soon in 1H20.

**ACM has 3% market share in wafer clean semiconductor equipment**

ACM Research (Shanghai) focusses on semi cleaning, semi electroplating and advanced packaging wet processing tools, each accounting for 83%, 10% and 5% of the company's total revenue in 2019. Within semi cleaning tools, the company only shipped single wafer cleaning tools in 2017-18, and started to ship wet bench cleaning tools and single wafer/wet bench cleaning tools in 2019. Single wafer, wet bench, and single wafer/wet bench cleaning tools accounted for 88%, 8%, and 4% of its total cleaning tools revenue in 2019.

ACM Research (Shanghai) has shipped equipment to foundries/IDMs (Hynix, HLMC, YMTC, SMIC, and CXMT), OSATs (JCET, Tongfu, and Nepes) and silicon wafer manufacturers (Zingsemi, Lion Electronics, Wafer Works, and Phonix Silicon). The company has achieved revenue of Rmb757 mn in 2019, with 73% CAGR in 2018-19. Shipments of its semi cleaning tool, semi electroplating tool, and advanced packaging wet processing tool reached 26, 4 and 7 in 2019, vs 11, 0, 7 in 2017.

**Figure 207: ACM Research (Shanghai) registered solid growth**



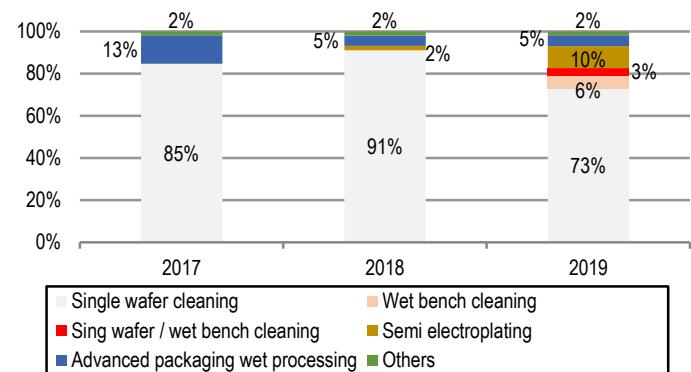
Source: Company data, Credit Suisse

## Business drivers

ACM Research's cleaning technology includes:

- **Space Alternated Phase Shift (SAPS).** The SAPS technology employs alternative phases of megasonic waves in the gap between a megasonic transducer and the wafer. It can move or tilt the transducer while the wafer rotates, enabling megasonic energy to be delivered uniformly across all points on the wafer to remove random defects much more effectively and completely. The SAPS technology has demonstrated advanced wafer cleaning capabilities for 10nm node and even beyond.
- **Timely Energised Bubble Oscillation (TEBO).** The TEBO technology is able to provide complete wafer-wide cleaning with little or no damage for advanced devices. It has demonstrated high particle removal efficiency on 1X nm patterned wafers, and can be applied to even smaller process nodes and for 3D device structures like FinFET and 3D NAND.
- **Tahoe.** The Tahoe technology employs a two-step approach combining first wet bench cleaning and then single-wafer cleaning. It has demonstrated a similar level of cleaning performance as single-wafer cleaning for nodes below 28nm, but at the same time reduces chemical use and minimises waste.

**Figure 208: ACMR's revenue mix by different equipment**



Source: Company data, Credit Suisse

**Total addressable market expanding with new products.** ACM Research has top cleaning tools (SAPS, TEBO, and Tahoe) with unique megasonic cleaning technology already covering 50% of the US\$3 bn cleaning market, and has also introduced backside cleaning and scrubber to cover 80% of the market (30% more). It also introduced advanced packaging tools, ECP (electro-copper plating) and a vertical furnace product for dry clean, with two furnaces shipped already and qualified by end-2020. Management suggests the new tools raise the addressable market to US\$5 bn and the goal is to double the TAM again to US\$10 bn in three years. The R&D portion of revenue is 11-13% with about one-third for new products. The company has two new products in the pipeline and expects to unveil one new product in the next one to two years. It is also open to M&A, to acquire good technology to supplement in-house development.

**Growing customer base.** ACM's first tool shipped to SK Hynix (megasonic cleaning) from 45nm and now up to 20 process steps and helping in yield improvement on 1X/1Y/1Z DRAM and was 20% of 2019 revenue. Chinese customers include: YMTC: 29% of 2019 sales, HLMC: 27% of 2019, SMIC, CXMT (first tools in 4Q19), JCET and Tongfu (back-end 10% of sales) as well as two new domestic analog/power IC customers buying a range of tools for 2H20 shipment. The company sees multi-year expansion for SMIC (if no restrictions)/Hua Hong/Huali, YMTC, and CXMT, as well as new product penetration. It is approaching three second-tier domestic customers and expects orders from 2021, with exact revenue recognition subject to delivery timing and acceptance. For the overseas market, management indicated it has ongoing projects with multiple customers in both North America and Taiwan. The company is also expanding service, with experienced engineers in China used to install the first tool at a customer's fab and provide on-going service. Its international engineering team expansion will progress with rising sales and customer requirements for service.

**Market share targets.** ACM covers 25% of the China market and aims to expand to 50%. Outside China, its goal is to get to 25-30%. Competition is DNS, Tokyo Electron, Lam Research and local Korean players (Simes supplying Samsung) and Naura.

## Near-term trends

ACM Research (Shanghai)'s parent company, ACM Research (ACMR.OO), holding 91.7% stake of ACM Research (Shanghai) in December 2020, reported revenue/NI of US\$48 mn and US\$13 mn in 3Q20, up 43% and 111% YoY. ACM Research's GMs came down from 49.6% in 2Q to 42.7% in 3Q, due to a change in product mix, with tools in their portfolio ranging from 40% to 50% and causing the quarter to quarter margin fluctuation.

On 5 Jan ACM announced its full-year 2020 sales would reach US\$153-155mn, +42-44% YoY at the upper end of its guidance provided on the 3Q20 results. It also guided 2021 sales to US\$205-230 mn, up 32-50% YoY due to solid growth from its top 4 China customers and Korean memory maker, higher contribution from two new analog customers, and growth from new tools including Tahoe, semi critical cleaning tools and its furnace products. Long term, management expects a GM of 40-45%, which should allow it to sustain a 10-15% R&D and S&M for still solid operating margins.

**Figure 209: Balance sheet summary**

Balance Sheet (Rmb mn)	2018	2019	YoY	3 year avg	+/- Avg
Cash and Investments	96	440	359%	194	246
Debt	65	97	50%	65	32
Net debt	-31	-343	n/a	-129	-214
<b>Net debt/share</b>	<b>-0.15</b>	<b>-0.88</b>	<b>n/a</b>	<b>-0.36</b>	<b>-0.52</b>
Accts. receivable	174	210	21%	160	49
<b>DSO</b>	<b>114</b>	<b>100</b>	<b>-14</b>	<b>117</b>	<b>-18</b>
Inventory	264	307	16%	236	72
<b>Inventory days</b>	<b>310</b>	<b>266</b>	<b>-43</b>	<b>308</b>	<b>-41</b>
Accts. payable days	221	124	-96	190	-66
<b>Cash conversion days</b>	<b>203</b>	<b>242</b>	<b>40</b>	<b>235</b>	<b>7</b>
SH Equity	145	830	472%	341	489
<b>Book value/share</b>	<b>0.7</b>	<b>2.1</b>	<b>1.4</b>	<b>1.0</b>	<b>1.1</b>

Source: Company data, WIND, Credit Suisse

**Figure 210: Financial metrics summary**

Rmb mn	Years		
	2017	2018	2019
Sales	254	550	757
QoQ/YoY	n/a	117%	38%
Gross profit	113	243	342
<b>GM %</b>	<b>45%</b>	<b>44%</b>	<b>45%</b>
R&D	52	79	99
SG&A	58	81	116
Op income	3	83	127
<b>OPM %</b>	<b>1%</b>	<b>15%</b>	<b>17%</b>
Financing cost (net)	2	-3	-4
Net income	11	93	135
<b>Net margin %</b>	<b>4%</b>	<b>17%</b>	<b>18%</b>
Shares	213	213	390
<b>EPS (Rmb)</b>	<b>0.05</b>	<b>0.43</b>	<b>0.35</b>

Source: Company data, WIND, Credit Suisse

# AMEC (688012.SS, Not Covered)

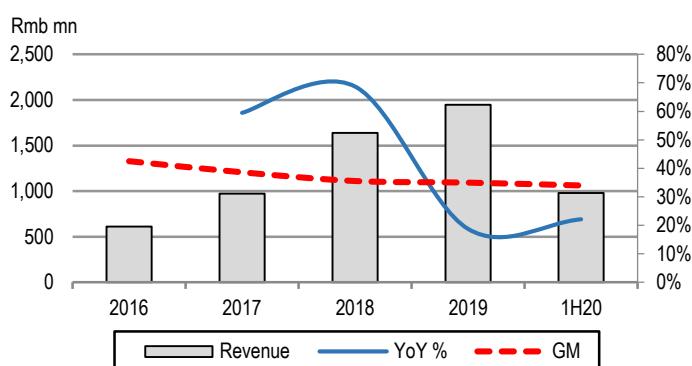
## Overview/product mix

Founded in 2014 and headquartered in Shanghai, AMEC (Advanced Micro-Fabrication Equipment Inc.) is a leading micro-fabrication equipment company in China. It focusses on plasma etching, deep silicon etching, and MOCVD (Metal-Organic Chemical Vapour Deposition) equipment. AMEC's equipment has been adopted in several fields like IC, advanced packaging, LED, MEMS. Key clients include SMIC, TSMC, Hynix, UMC, Winbond, YMTC and Sanan.

**AMEC is a China equipment supplier in etch, deposition and LED MOCVDs**

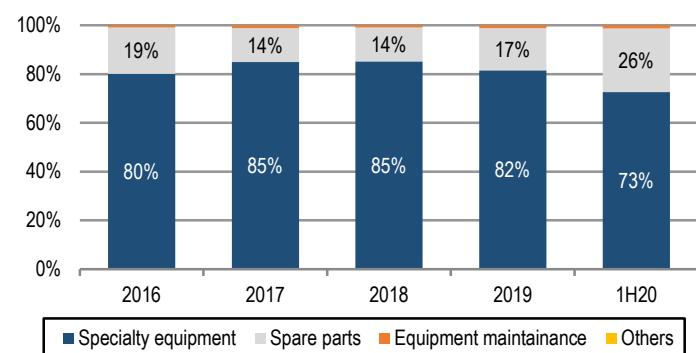
AMEC's revenue reached Rmb1.9 bn in 2019, (2017-19 CAGR: 47%). In 2019, specialty equipment accounted for 73% of total revenue, with spare parts taking 26%. In 2018, etching equipment accounted for 40% of specialty equipment revenue, while MOCVD equipment took the other 60%. The company had gross margin of 30-40% in the past few years.

**Figure 211: AMEC recorded 47% CAGR in 2017-19**



Source: Company data, Credit Suisse

**Figure 212: AMEC's revenue mix**



Source: Company data, Credit Suisse

## Business drivers

**CCP (Capacitive Coupled Plasma) etching equipment.** AMEC has been developing CCP etching equipment since 2004. For logic IC, its CCP etching equipment for 65nm-5nm nodes has been adopted by many global customers, including orders received for its latest 5nm equipment applied in critical procedures for wafer fabrication. AMEC is working closely with customers to develop Damascus etching technology to cover 5nm and below nodes. For memory, its CCP etching equipment has been adopted for mass production of 64-layer 3D NAND. It is also developing high depth-to-width etching equipment for 128-layer 3D NAND.

**ICP (Inductively Coupled Plasma) etching equipment.** AMEC has been developing ICP etching equipment since 2012 and launched single sided equipment, Primo nanova. The equipment has been adopted by many logic IC and memory manufacturers. Meanwhile, it is developing a next-generation ICP product for logic IC of 7nm and below nodes, 1Xnm DRAM and 128-layer and above 3D NAND.

**MOCVD (Metal-Organic CVD).** AMEC started R&D for MOCVD equipment, the most critical equipment for the fabrication of LED epitaxial slice, in 2010. So far, its MOCVD Prismo A7 has achieved leading position in the global market of Gallium Nitride-based LED MOCVD. Besides, it has received decent orders on DUV (Deep Ultraviolet) LED MOCVD equipment.

## Near-term trends

AMEC reported 3Q20 revenue of Rmb498 mn, down 12% QoQ, while GM grew 2 pp QoQ to 36%. Opex increased 8% QoQ, dragging down OPM to -1%. However, AMEC recorded fair value gain from an investment of Rmb155 mn in 3Q20, partly offset by the negative impact from decreased revenue and higher opex ratio. As such, AMEC grew its 3Q20 NI 70% QoQ to Rmb158 mn.

## Valuation

At the current price of Rmb150.2, AMEC has a market cap of Rmb80.3 bn and trades at 256x/198x consensus 2020/21E EPS and 19.6x/17.7x consensus 2020/21E BPS. It has maintained a healthy balance sheet, with net cash accounting for 64% of total equity and net cash per share of Rmb4.88 vs the 4-year average of Rmb1.34. Free cash flow (FCF) was – Rmb523 mn / -Rmb307 mn in 2017/18, while it turned positive in 2019, to Rmb212 mn.

**Figure 213: Balance sheet summary**

Balance Sheet (Rmb mn)	3Q20 (A)	2Q20	Diff %	4 year avg	+/- Avg
Cash and Investments	2,644	2,266	17%	880	1,764
Debt	34	35	-4%	229	-195
Net debt	-2,610	-2,231	17%	-651	-1,959
<b>Net debt/share</b>	<b>-4.88</b>	<b>-4.17</b>	<b>-0.71</b>	<b>-1.34</b>	<b>-3.54</b>
Accts. receivable	331	337	-2%	401	-70
<b>DSO</b>	<b>60</b>	<b>54</b>	<b>6</b>	<b>124</b>	<b>-64</b>
Inventory	1,200	1,145	5%	890	311
<b>Inventory days</b>	<b>342</b>	<b>276</b>	<b>66</b>	<b>403</b>	<b>-62</b>
Accts. payable days	113	92	21	158	-45
<b>Cash conversion days</b>	<b>288</b>	<b>237</b>	<b>51</b>	<b>369</b>	<b>-80</b>
SH Equity	4,101	3,882	6%	1,316	2,785
<b>Book value/share</b>	<b>7.7</b>	<b>7.3</b>	<b>0.4</b>	<b>2.7</b>	<b>5.0</b>

Source: Company data, WIND, Credit Suisse

**Figure 214: Financial metrics summary**

Ticker	688012.SS	Current price (Rmb)	150.2
Stock connect %	0.0%	52-wk range (Rmb)	65-285.1
Share outstanding (mn)	535	Mkt cap (Rmb mn)	80,342
Daily trad vol-6m avg (mn)	4.6	<b>Perf.</b>	<b>1M</b> <b>3M</b> <b>12M</b>
Daily trad vol-6m avg (Rmb mn)	810	Absolute	-1% -24% 131%
Free floatn (%)	45.9%	Relative	-3% -23% 115%
<b>Year</b>	<b>2016</b>	<b>2017</b>	<b>2018</b>
<b>Revenue (Rmb mn)</b>	<b>610</b>	<b>972</b>	<b>1,639</b>
YoY	n/a	59.5%	68.7%
Gross profit (Rmb mn)	259	375	582
<b>GM (%)</b>	<b>43%</b>	<b>39%</b>	<b>36%</b>
Operating profit (Rmb mn)	-233	70	110
<b>OPM (%)</b>	<b>-38%</b>	<b>7%</b>	<b>7%</b>
Net profit (Rmb mn)	-239	30	91
<b>EPS (Rmb)</b>	<b>-0.19</b>	<b>0.02</b>	<b>0.20</b>
EPS growth (%)	n/a	n/a	1111.3%
P/E (x)	-790	9,098	751
Dividend yield (%)	0.0%	0.0%	0.0%
P/B (x)	-197.0	1,514.2	34.2
ROE (%)	27%	11%	4%
			5% 8%

Note: P/E and P/B in 9M20 column are based on 2020E consensus EPS and BPS.

Source: Company data, WIND, Credit Suisse

# Amlogic (688099.SS, Not Covered)

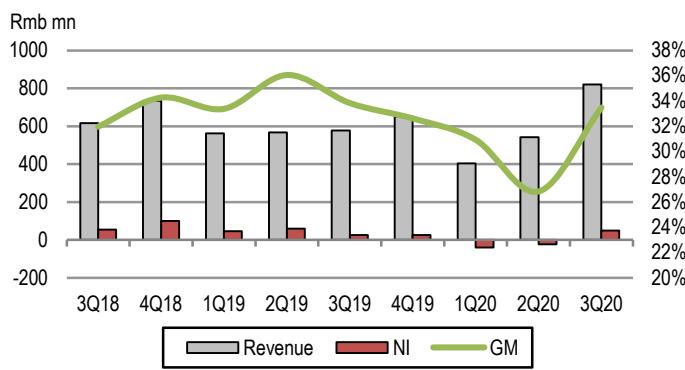
## Overview/product mix

Amlogic is an IC design (fabless) company in China supplying SoC (system on chip) for set-top box (STB), smart TV and AI video/audio terminals. It also produces Wi-Fi and Bluetooth chips since 2020. Amlogic was listed on the A-share Sci-Tech Board in August 2019. The company's SoC integrates CPU, GPU, AI processor, DSP (Digital Signal Processor), ISP (Image Signal Processor), Display controller, network interface, I/O (Input/Output), etc. Key customers include Xiaomi, TCL, Skyworth, ZTE, Alibaba, Baidu, and Haier.

Amlogic's revenue reached Rmb2.4 bn in 2019, with 27% CAGR in 2017-19. Among all its businesses, smart set-top box chip accounted for 53% of total revenue and 58% of total gross profit in 2019. Besides, Amlogic's smart TV chip business has been ramping up quickly, accounting for 37% and 30% of total revenue and gross profit in 2019.

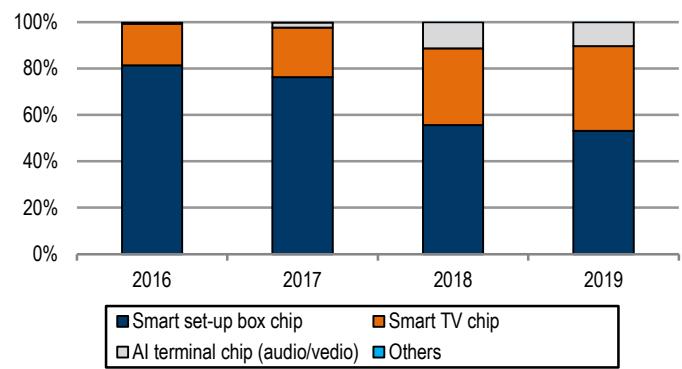
**AM Logic is a China SoC supplier for consumer multimedia products.**

**Figure 215: Quarterly revenue, NI and GM**



Source: Company data, WIND, Credit Suisse

**Figure 216: Revenue mix**



Source: Company data, WIND, Credit Suisse

## Business drivers

**12nm migration.** 12nm accounted for 37% of total revenue in 9M20 and over 40% in 3Q20.

12nm yield continues improving, according to management. Amlogic uses TSMC for wafer fabrication and JCET/Huatian for back-end service. Management expects more 12nm wafer capacity to be available in 2021.

**STB market share in China.** The company shipped 48 mn STB chips globally in 2019, including over 30 mn to China customers for the domestic market, while the annual STB shipment in China is about 60-80 mn units in the past few years, according to management. This implies 38-50% STB market share for Amlogic in China in 2019. Globally, STB shipments are around 300-400 mn units annually, implying Amlogic having 5-7% share in the overseas market. Additionally, the company shipped 27 mn Smart TV chips in 2019 globally. Total Smart TV shipments were 47 mn units in China in 2019. Also, global smart TV shipments are around 200-250 mn units annually. This implies it has 11-14% global TV SoC market share. Additionally, Xiaomi is Amlogic's largest customer for Smart TV. Xiaomi shipped around 10 mn Smart TVs in 2019, ~80-90% of which adopted Amlogic's SoC, according to management.

**Growth in the overseas market.** As Amlogic has achieved good market share in China, management indicated more efforts for overseas expansion. The company's SoCs have been qualified by Android TV Operating System (OS), Amazon TV OS, adopted by devices like Google Home Hub & Chromecast and Amazon Fire TV & Fire TV Cube, and are under qualification for Roku TV OS. Management suggests Amlogic can continue to improve product performance, client service and cost efficiency to compete in the overseas market currently dominated by MediaTek and Broadcom.

**Product expansion.** Amlogic has developed Wi-Fi and Bluetooth chips to support its main STB/TV/audio/video processors, allowing the company to provide a total solution to customers. Further, it has been working with tier 1 automotive suppliers to develop SoCs for in-vehicle infotainment systems.

## Near-term trends

**3Q GM recovery driven by higher overseas mix.** Amlogic's GM declined from 33.9% in 2019 to 28.6% in 1H20 due to the migration from 28nm to 12nm (initially lower yield). In 3Q20, GM improved to 33.5%, driven by higher overseas revenue. Management suggested overseas customers have higher spec requirements and are less price sensitive. Revenue from overseas has increased from one-third in 2019 to ~50% in 1H20 and ~60% in 9M20.

**Demand near-term.** After a strong 3Q (revenue +51% QoQ, +42% YoY), the company observes solid demand continuing into 4Q across product lines and across domestic/overseas markets, and expects 4Q20 to continue YoY growth. The scale of growth depends on foundry supply, as the company also observed foundry supply tightness issue.

## Valuation

Amlogic, at the current price of Rmb73.8, has market cap of Rmb30.3 bn and trades at 348x/76.6x consensus 2020/21E EPS and 10.6x/9.3x consensus 2020/21E BPS. The company has maintained a healthy balance sheet, with net cash accounting for 87% of total equity and net cash per share of Rmb5.87 vs the four-year average of Rmb2.14. Free cash flow (FCF) turned positive, to Rmb129 mn, in 2019 after being negative in 2017-18.

**Figure 217: Balance sheet summary**

Balance Sheet (Rmb mn)	3Q20 (A)	2Q20	Diff %	4 year avg	+/- Avg
Cash and Investments	2,540	2,203	15%	771	1,769
Debt	126	127	-1%	28	97
Net debt	-2,414	-2,076	16%	-743	-1,671
<b>Net debt/share</b>	<b>-5.87</b>	<b>-5.05</b>	<b>-0.82</b>	<b>-2.14</b>	<b>-3.73</b>
Accts. receivable	223	123	81%	172	51
<b>DSO</b>	<b>25</b>	<b>20</b>	<b>4</b>	<b>31</b>	<b>-6</b>
Inventory	225	395	-43%	349	-124
<b>Inventory days</b>	<b>37</b>	<b>90</b>	<b>-52</b>	<b>96</b>	<b>-59</b>
Accts. payable days	36	34	2	50	-14
<b>Cash conversion days</b>	<b>25</b>	<b>76</b>	<b>-51</b>	<b>77</b>	<b>-52</b>
SH equity	2,782	2,720	2%	1,243	1,539
<b>Book value/share</b>	<b>6.8</b>	<b>6.6</b>	<b>0.2</b>	<b>3.7</b>	<b>3.0</b>

Source: Company data, WIND, Credit Suisse

**Figure 218: Financial metrics summary**

Ticker	688099.SH	Current price (Rmb)			73.8
Stock connect %	0.0%	52-wk range (Rmb)			42.8-85.9
Share outstanding (mn)	411	Mkt cap (Rmb mn)			30,349
Daily trad vol-6m avg (mn)	3.1	Perf.	1M	3M	12M
Daily trad vol-6m avg (Rmb m)	197	Absolute	5%	41%	49%
Free floatn (%)	51.5%	Relative	4%	42%	33%
Year	2016	2017	2018	2019	9M20
<b>Revenue (Rmb mn)</b>	<b>1,150</b>	<b>1,690</b>	<b>2,369</b>	<b>2,358</b>	<b>1,765</b>
YoY	n/a	47.1%	40.1%	-0.5%	3.4%
Gross profit (Rmb mn)	362	595	825	800	545
<b>GM (%)</b>	<b>32%</b>	<b>35%</b>	<b>35%</b>	<b>34%</b>	<b>31%</b>
Operating profit (Rmb mn)	74	132	312	180	-2
<b>OPM (%)</b>	<b>6%</b>	<b>8%</b>	<b>13%</b>	<b>8%</b>	<b>0%</b>
Net profit (Rmb mn)	73	78	283	158	-13
<b>EPS (Rmb)</b>	<b>0.00</b>	<b>0.21</b>	<b>0.76</b>	<b>0.41</b>	<b>-0.03</b>
EPS growth (%)	n/a	n/a	261.9%	-46.1%	-109.3%
P/E (x)	n/a	352	97	180	348
Dividend yield (%)	0.0%	0.0%	0.0%	0.2%	n/a
P/B (x)	25.3	32.9	24.4	10.8	10.6
ROE (%)	33%	9%	25%	6%	3%

Note: P/E and P/B in 9M20 column are based on 2020E consensus EPS and BPS.

Source: Company data, WIND, Credit Suisse

# Anji Technology (688019.SS, Not Covered)

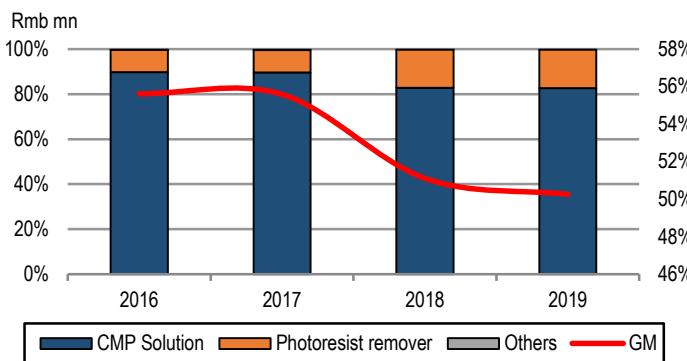
## Overview/product mix

Anji Tech was founded in 2006, and is a leading supplier, in China, of CMP solution and photoresist remover for wafer fabrication, advanced packaging and LED/OLED. The company's CMP solution for nodes of 130-14nm has achieved mass shipment, already qualified by many logic and memory chips, while CMP solution for 10-7nm is under R&D. Anji's customers include SMIC, YMTC (Yangtze memory Technologies Co.), Hua Hong, CR Micro, Silan, WLCSP (China Wafer Level CSP, 603005.SS), TSMC, and UMC.

**Anji Technology is a supplier of CMP semiconductor slurry and photoresist removal.**

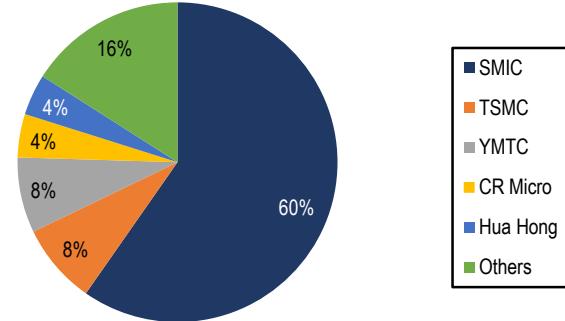
The company is headquartered in Shanghai and listed on the Shanghai Stock Exchange in 2019. It operates nine production lines for CMP and two lines for photoresist remover, with 80-90% sales from mainland China. Anji Tech's revenue reached Rmb232 mn, Rmb247 mn and Rmb285 mn in 2017-19, with over 80% from CMP and the rest from photoresist remover. The company's market share in global CMP solution market was 2-3% during 2016-18.

**Figure 219: Anji's revenue mix in 2016-19**



Source: Company data, Credit Suisse

**Figure 220: Anji's customer mix in 2018**



Source: Company data, Credit Suisse

## Business drivers

Anji suggests lockdowns caused by COVID-19 affected international logistics and accelerated the import substitution for semi chemicals in China. The company's strategy is to focus on the development of its products on advanced nodes to meet the increasing import substitution demand from China foundries.

**CMP solution:** Anji only took 2.4-2.5% global market share in 2018. The company is developing CMP solution for 10-7nm nodes, at the same time investing more sales efforts on products for 130-14nm nodes. Besides, Anji's Tungsten CMP solution for logic and memory products is under customer qualification.

**Photoresist remover:** The company is developing photoresist remover for 14nm node, with products for 28nm node under customer qualification.

## Near-term trends

Anji grew its revenue by 23% QoQ to Rmb117 mn in 3Q20, with GM staying at 56%. Although increased operating expense dragged down OPM, fair value gain from investment offset the high opex and drove 3Q NI up 146% QoQ to Rmb64 mn, with net margin up 27pp to 55%.

## Valuation

Anji, at the current price of Rmb309.7, has market cap of Rmb16.4 bn and trades at 126x/105x consensus 2020-21E EPS and 14.3x/12.6x consensus 2020-21E BPS. The company has maintained a healthy balance sheet, with net cash accounting for 37% of total

equity by 3Q20 and net cash per share of Rmb7.01 vs the 4-year average of Rmb4.73. Free cash flow in 2017-2019 was -Rmb8 mn, Rmb23 mn and -Rmb9 mn.

**Figure 221: Cash flow statement summary**

Rmb mn	2017	2018	2019	3 year avg
Revenue	232	248	285	255
Capex	39	14	42	32
<b>Capex/revenue (%)</b>	<b>17%</b>	<b>6%</b>	<b>15%</b>	<b>12%</b>
Depr and amort	9	11	10	10
<b>Depr/revenue (%)</b>	<b>4%</b>	<b>5%</b>	<b>4%</b>	<b>4%</b>
Operating cash flow	27	60	85	57
<b>Free cash flow</b>	<b>-8</b>	<b>23</b>	<b>-9</b>	<b>2</b>
FCF and dividend yield	2017	2018	2019	3 year avg
FCF/share (Rmb)	-0.21	0.58	-0.18	0.07
FCF yield (%)	-0.1%	0.2%	-0.1%	0.0%
<b>FCF/EV (%)</b>	<b>-0.1%</b>	<b>0.1%</b>	<b>-0.1%</b>	<b>0.0%</b>
Dividend per share (Rmb)	0.00	0.00	0.38	0.13
Dividend payout (%)	0%	0%	26%	9%
<b>Dividend yield (%)</b>	<b>0.0%</b>	<b>0.0%</b>	<b>0.1%</b>	<b>0.0%</b>

Source: Company data, WIND, Credit Suisse

**Figure 222: Balance sheet summary**

Balance Sheet (Rmb mn)	3Q20 (A)	2Q20	Diff %	4 year avg	+/- Avg
Cash and Investments	392	389	1%	220	172
Debt	20	0	n/a	0	20
Net debt	-372	-389	-4%	-220	-152
<b>Net debt/share</b>	<b>-7.01</b>	<b>-7.33</b>	<b>0.32</b>	<b>-4.73</b>	<b>-2.28</b>
Accts. receivable	89	73	22%	49	39
<b>DSO</b>	<b>68</b>	<b>68</b>	<b>0</b>	<b>74</b>	<b>-6</b>
Inventory	84	83	1%	65	19
<b>Inventory days</b>	<b>146</b>	<b>178</b>	<b>-32</b>	<b>206</b>	<b>-60</b>
Accts. payable days	30	45	-14	66	-35
<b>Cash conversion days</b>	<b>184</b>	<b>202</b>	<b>-18</b>	<b>214</b>	<b>-31</b>
SH Equity	996	920	8%	450	546
<b>Book value/share</b>	<b>18.7</b>	<b>17.3</b>	<b>1.4</b>	<b>9.9</b>	<b>8.9</b>

Source: Company data, WIND, Credit Suisse

**Figure 223: Financial metrics summary**

Ticker	688019.SS	Current price (Rmb)	309.7
Stock connect %	0.0%	52-wk range (Rmb)	106.4-489.6
Share outstanding (mn)	53	Mkt cap (Rmb mn)	16,446
Daily trad vol-6m avg (mn)	1.2	Perf. 1M 3M 12M	
Daily trad vol-6m avg (Rmb m)	313	Absolute	6% -18% 175%
Free floatn (%)	56.3%	Relative	5% -18% 159%
Year	2016	2017	2018
Revenue (Rmb mn)	197	232	248
YoY	n/a	18.2%	6.6%
Gross profit (Rmb mn)	109	129	127
GM (%)	56%	56%	51%
Operating profit (Rmb mn)	35	43	36
OPM (%)	18%	18%	14%
Net profit (Rmb mn)	37	40	45
EPS (Rmb)	0.00	1.00	1.13
EPS growth (%)	n/a	n/a	13.0%
P/E (x)	n/a	310	274
Dividend yield (%)	0.0%	0.0%	0.0%
P/B (x)	47.1	40.9	35.6
ROE (%)	14%	13%	13%
		7%	13%

Note: P/E and P/B in 9M20 column are based on 2020E consensus EPS and BPS.

Source: Company data, WIND, Credit Suisse

# Bestechnic (688608.SS, Not Covered)

## Overview/product mix

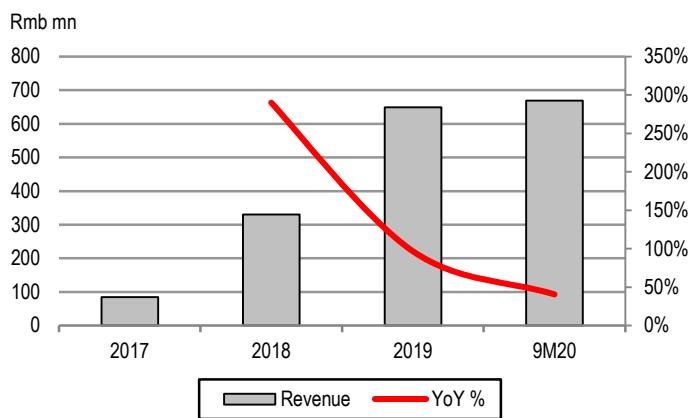
Founded in 2005 and headquartered in Shanghai, Bestechnic is an IC design (fabless) company supplying audio SoC (system-on-chip) for TWS and other applications. The company has obtained regulatory approval to list in A-share Sci-Tech Board in the near term.

**Bestechnic supplies audio SoCs for the TWS market.**

Counterpoint Research forecasts TWS shipment to have an 80% CAGR in 2019-22.

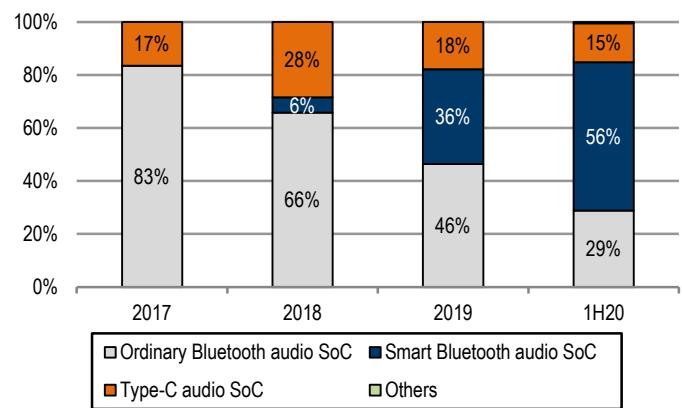
Bestechnic's customers include Huawei, Samsung, OPPO, Xiaomi, Google, Alibaba, Baidu, Sony, Harman, Skullcandy, Edifier, JBL, and 1MORE. Management suggested it has the No. 1 market share in the non-Apple TWS market. OPPO, Xiaomi and Alibaba account for 13.9%, 13.33% and 0.38% revenue in 1H20. The company is applying for a licence to supply Huawei.

**Figure 224: Bestechnic registered 177% revenue CAGR in 2018-19**



Source: Company data, Credit Suisse estimates

**Figure 225: Bluetooth audio SoC accounts for nearly 70% of Bestechnic's revenue in 1H20**



Source: Company data, Credit Suisse estimates

Bestechnic currently uses 28nm and 40nm. Its major foundry partners are TSMC and SMIC. In 1H20, 59% wafer purchase was from TSMC and 41% from SMIC, vs 71% from TSMC and 29% from SMIC in 2019. Its major OSAT partners are JCET and Forehope Electronic (Ningbo). For back-end, its audio SoC mainly uses QFN (quad-flat no-leads) and BGA (ball grid array).

After 97% revenue growth in 2019, it further grew revenue by 40% in 9M20. In 1H20, it recorded 56% revenue from smart Bluetooth audio SoC, 29% from normal Bluetooth audio SoC, and 15% from type-C audio SoC. For 2021, the company expects growth across all three product lines.

## Business drivers

Bestechnic suggested it is one of the early fabless companies supplying single-chip ANC (active noise cancellation) solution in the non-Apple market. Currently, in the TWS market, the mainstream solution remains two separate chips for ANC and Bluetooth. Bestechnic believes its single-chip solution offers a better choice in terms of power consumption, cost structure and form factor for customers. Its second-generation smart Bluetooth audio SoC, supporting new LE (low energy) audio standard and dual-mode Bluetooth 5.2, will begin volume production by end-2020. Besides TWS, it is also working towards smart watch, smart speaker and smart home devices. Alibaba's Tmall Genie has adopted its AIoT SoC.

Bestechnic expects further share gains going forward, especially in audio customers (non-smartphone brands) and in the low-end segment. It plans to provide cost-effective solutions to expand share in the low-end segment. The major competitors in the audio SoC market are Qualcomm and Mediatek, with better scale and wider product portfolios. Other competitors include Realtek, Beken, Zhuhai Jieli, Synaptics, Cirrus Logic, and Huawei (HiSilicon).

## Near-term trends

Bestechnic recorded 9M20 revenue of Rmb669 mn, up 40% YoY, while 9M20 GM grew 3 pp YoY to 41% and 9M20 net profit increased 165% YoY to RMB117 mn. The company has a healthy balance sheet, with net cash accounting for 83% of total equity and net cash per share of Rmb6.01 vs the three-year average of Rmb6.82. Bestechnic recorded free cash flow of -Rmb35 mn and -Rmb22 mn in 2018-19.

The company has been approved to be listed on the Sci-Tech Board, with issuance price of Rmb162.07, but the first trading date is pending announcement. The issuance price implies 89x/38x 2020/21 consensus P/E or 2.5x/2.4x 2020/21 consensus P/B.

**Figure 226: Financial summary**

Rmb mn	2017	2018	2019	3Q20
Sales	85	330	649	331
QoQ/YoY	n/a	290%	97%	n/a
Gross profit	33	119	245	135
<b>GM %</b>	<b>39%</b>	<b>36%</b>	<b>38%</b>	<b>41%</b>
R&D	45	87	132	45
SG&A	129	31	55	16
Op income	-141	1	58	74
<b>OPM %</b>	<b>-167%</b>	<b>0%</b>	<b>9%</b>	<b>22%</b>
Financing cost (net)	2	-2	-1	6
Net income	-144	2	67	68
<b>Net margin %</b>	<b>-170%</b>	<b>1%</b>	<b>10%</b>	<b>21%</b>
Shares	8	9	90	90
<b>EPS (Rmb)</b>	<b>-3.05</b>	<b>0.03</b>	<b>0.83</b>	<b>0.76</b>

Source: Company data, WIND, Credit Suisse

**Figure 227: Balance sheet summary**

Balance Sheet (Rmb mn)	2019	3Q20	Diff %	3 year avg	+/- Avg
Cash and Inv estments	418	543	30%	183	360
Debt	0	2	n/a	0	2
Net debt	-418	-541	29%	-183	-358
<b>Net debt/share</b>	<b>-4.65</b>	<b>-6.01</b>	<b>-1.36</b>	<b>-6.82</b>	<b>0.81</b>
Accts. receivable	10	36	250%	13	23
<b>DSO</b>	<b>6</b>	<b>10</b>	<b>4</b>	<b>15</b>	<b>-6</b>
Inventory	152	161	6%	87	74
<b>Inventory days</b>	<b>135</b>	<b>74</b>	<b>-62</b>	<b>148</b>	<b>-74</b>
Accts. payable days	72	52	-20	142	-90
<b>Cash conversion days</b>	<b>69</b>	<b>32</b>	<b>-38</b>	<b>21</b>	<b>10</b>
SH Equity	522	651	25%	230	421
<b>Book value/share</b>	<b>5.8</b>	<b>7.2</b>	<b>1.4</b>	<b>8.6</b>	<b>-1.3</b>

Source: Company data, WIND, Credit Suisse

**Figure 228: Financial metrics summary**

Financial Statement (Rmb mn)	2017	2018	2019	9M20
<b>Revenue</b>	<b>85</b>	<b>330</b>	<b>649</b>	<b>669</b>
YoY	n/a	290.2%	96.6%	40.4%
Gross profit	33	119	245	276
<b>GM (%)</b>	<b>39%</b>	<b>36%</b>	<b>38%</b>	<b>41%</b>
Operating profit	-141	1	58	104
<b>OPM (%)</b>	<b>-167%</b>	<b>0%</b>	<b>9%</b>	<b>16%</b>
Net profit	-144	2	67	117
<b>EPS (Rmb)</b>	<b>-3.05</b>	<b>0.03</b>	<b>0.83</b>	<b>1.30</b>
EPS growth (%)	n/a	n/a	2987.8%	129.3%
P/E (x)	-53	6,003	194	89
BPS (Rmb)	6.9	13.0	5.8	7.2
P/B (x)	23.5	12.4	27.9	2.5
ROE (%)	-270%	2%	13%	29%

Note: P/E and P/B are based on issuance price of Rmb162.07 and 2020E consensus EPS/BPS for 9M20 column.

Source: Company data, WIND, Credit Suisse

# CR Micro (688396.SS, Outperform)

## Overview/product mix

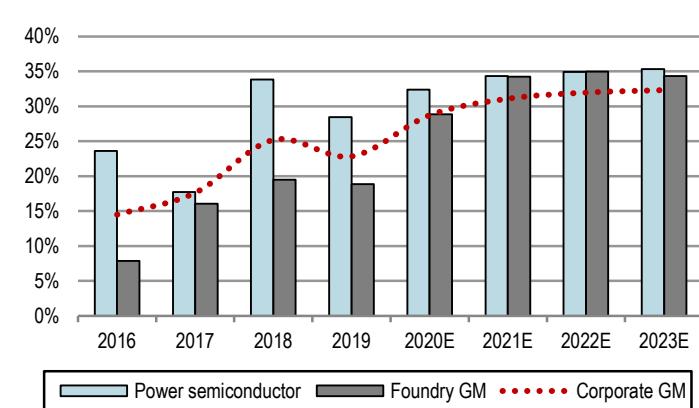
Headquartered in Wuxi and listed in February 2020, China Resources Microelectronics (CR Micro) is an IDM (integrated device manufacturer) with its own wafer fabs for its chip product ('Product & Solution' business), and it also provides contract manufacturing services to external IC design fabless companies ('Contract Manufacturing Service' business). Its Product & Solution business accounted for 44% revenue in 2019, and the Contract Manufacturing business for 56%.

**CR Micro is an analog IDM and foundry.**

The major products for its Product & Solution business include power semiconductor (90% of Product & Solution business revenue), sensors (6%), MCUs (4%). For the Contract Manufacturing business, foundry accounts for 71% of revenue, OSAT (outsourced semiconductor assembly & testing) 25%, and masks and others 4%.

Also, China does not have any IDM with scale, and major global power semi IC design companies are all IDMs. So CR Micro set its strategy to develop its Product & Solution business as the primary focus (with power semi being the main driver), and it aims to become a major IDM in China over the next five years.

**Figure 229: CR Micro's gross margin performance**



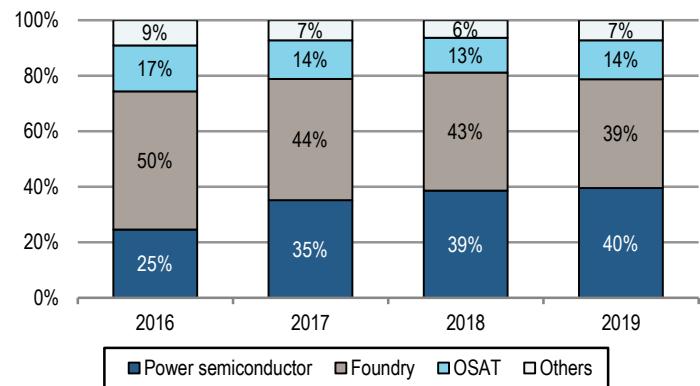
Source: Company data, Credit Suisse estimates

## Business drivers

MOSFET is CR Micro's major product in the power semiconductor business, accounting for over two-thirds of revenue in 1H20. MOSFET revenue grew by 21% YoY to Rmb858 mn and it estimates full-year MOSFET revenue to grow by 20%. Management further expects to continue the 20% MOSFET growth into 2021. According to the third-party research institution, OMEDIA, CR Micro now has approximately 7% share in China's MOSFET market. CR Micro aims to expand its share to 20-30% within the next five years.

While China's import substitution momentum is one of the drivers, MOSFET is also partly driven by the industry's organic demand growth and also due to COVID-19. As MOSFET is currently not within the scope of any US restrictions, Chinese companies can still procure MOSFET from US suppliers; but COVID-19 resulted in supply and logistics issues for US MOSFET manufacturers and this created opportunities for Chinese MOSFET companies such as CR Micro. Also, the industry is observing organic demand growth across communication (5G), industrial and automotive applications due to more devices or more complexity in terms of power design.

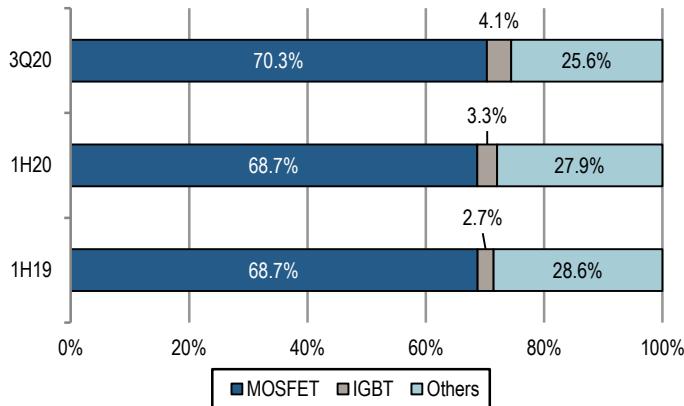
**Figure 230: Power semiconductor business is expected to expand its share in CR Micro's total revenue**



Source: Company data, Credit Suisse estimates

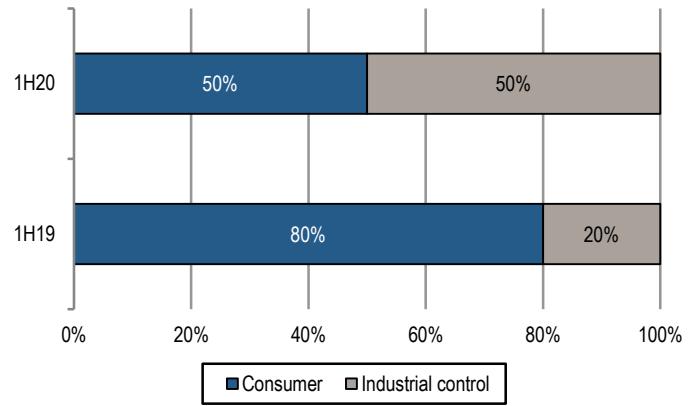
Additionally, CR Micro is ambitious to expand its IGBT business. According to management, its IGBT business grew by approximately 45% in 2019 and around 50% in 1H20, and accounts for 3.3%/4.1% of power semiconductor revenue in 1H20 and 3Q20.

**Figure 231: MOSFET accounts for more than two-thirds of power semiconductor revenue**



Source: Company data, Credit Suisse estimates

**Figure 232: Increasing revenue % from industrial control, reflecting strong technology capabilities**



Source: Company data, Credit Suisse estimates

CR Micro operates three 6-inch production lines in Wuxi and two 8-inch production lines in Wuxi and Chongqing. The capacity of the 6-inch and 8-inch fabs reached 206,000 wafers per month (2.47 mn per year) and 111,000 wafers per month (1.33 mn per year) in 2019, of which Wuxi 8-inch takes 61,000 wafers per month (730,000 per year) and Chongqing 8-inch takes 50,000 wafers per month (600,000 per year). As of 3Q20, capacity of Wuxi 8-inch and Chongqing 8-inch fabs reached 62,000 wafers per month (744,000 per year) and 61,000 wafers per month (730,000 per year).

The company offers wafer fabrication service covering 1.0-0.11µm nodes for CMOS (Complementary Metal Oxide Semiconductor), DMOS (Double-diffused Metal Oxide Semiconductor), BCD (Bipolar-CMOS-DMOS), mixed-signal, high-voltage CMOS, RF (radio frequency) CMOS, bipolar, BiCMOS, NVM (Non-Volatile Memory), MOSFET, IGBT, MEMS, GaN, SiC, etc. As of now, CR Micro allocates roughly 55% of foundry capacity to its Product & Solution business (for its own chip products) and 45% to the Contract Manufacturing Service business (for external customers). Key foundry customers include major China IC design companies like MEMSensing, GoerTek, AWINIC, NCE Power, Chipown, Fuman Electronics etc.

We expect future capacity expansion from: (1) Wuxi 8-inch line to added capacity of 16k wafers per month for BCD and MEMS. CR Micro raised Rmb1.5 bn for this project during the IPO and expects the project to kick off in 2021. (2) CR Micro is working with a few partners to build a 12-inch production line in Chongqing for power semiconductor, with capacity of 30k wafers per month and total capex of Rmb7.5 bn. It expects this new 12-inch line to ramp up production from 2022. CR Micro will only have minority share of the new Chongqing 12-inch fab, and the agreement between CR Micro and its partners entitles CR Micro to operate the 12-inch fab and have priority to use the capacity for CR Micro's chip products. CR Micro may acquire more stake and consolidate the Chongqing 12-inch fab after it ramps up production and turns to profit. (3) Capacity expansion on the existing Chongqing 8" line and Wuxi 6" lines to add a few thousand wafers per month through de-bottlenecking. (4) Silicon Carbide 6" line to add roughly 1k wafers per month.

**Figure 233: CR Micro's wafer fabs in operation**

Location	Line	Process	Total capacity
Wuxi	6" x 3	Analog, BCD, MEMS, DMOS, Power Discrete, etc.	2.48mn wafer per year or 207k wafer per month
Wuxi	8"	Advance, BCD, Analog, DMOS, etc.	744k wafer per year or 62k wafer per month
Chongqing	8"	Medium- & low-voltage trench gate MOS, shield gate MOS, super junction MOS, SBD, etc.	732k wafer per year or 61k wafer per month

Source: Company data, Credit Suisse

## Near-term trends

3Q20 revenue grew 9% QoQ to Rmb1.8 bn, with GM up 1 pp to 30%. 3Q20 NI was roughly flat due to increased opex. CR Micro suggests high order visibility that strong demand might carry into 1Q20, with 4Q20 utilisation rate to reach even higher. The company is negotiating order prices with customers and might raise prices for contract manufacturing services following Taiwan foundries.

**Figure 234: 3Q19-3Q20 and 2016-2019 financial summary**

Rmb mn	Quarters					Years			
	3Q19	4Q19	1Q20	2Q20	3Q20	2016	2017	2018	2019
Sales	1,492	1,611	1,382	1,681	1,826	4,397	5,876	6,271	5,743
QoQ/YoY	3%	8%	-14%	22%	9%	n/a	34%	7%	-8%
Gross profit	379	387	344	492	539	637	1,035	1,581	1,311
<b>GM %</b>	<b>25%</b>	<b>24%</b>	<b>25%</b>	<b>29%</b>	<b>30%</b>	<b>14%</b>	<b>18%</b>	<b>25%</b>	<b>23%</b>
R&D	127	139	107	120	144	346	447	450	483
SG&A	152	160	126	108	157	410	581	584	555
Op income	100	88	112	263	238	-119	7	546	274
<b>OPM %</b>	<b>7%</b>	<b>5%</b>	<b>8%</b>	<b>16%</b>	<b>13%</b>	<b>-3%</b>	<b>0%</b>	<b>9%</b>	<b>5%</b>
Financing cost (net)	17	-3	7	-16	-39	31	-5	0	31
Net income	105	131	114	289	284	-303	70	429	401
<b>Net margin %</b>	<b>7%</b>	<b>8%</b>	<b>8%</b>	<b>17%</b>	<b>16%</b>	<b>-7%</b>	<b>1%</b>	<b>7%</b>	<b>7%</b>
Shares	830	830	1,130	1,130	1,130	830	830	830	830
<b>EPS (Rmb)</b>	<b>0.12</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.24</b>	<b>-0.34</b>	<b>0.08</b>	<b>0.49</b>	<b>0.46</b>

Source: Company data, WIND, Credit Suisse

## Valuation

CR Micro, at the current price of Rmb55.1, has market cap of Rmb67 bn and trades at 70x/56x consensus 2020/21E EPS and 8.3x/7.4x consensus 2020/21E BPS. The company has maintained a healthy balance sheet, with net cash accounting for 49% of total equity and net cash per share of Rmb4.94 vs the four.-year average of Rmb0.36. CR Micro registered strong free cash flow of Rmb562 mn, Rmb723 mn and Rmb652 mn in 2017-19.

**Figure 235: Balance sheet summary**

Balance Sheet (Rmb mn)	3Q20 (A)	2Q20	Diff %	4 year avg	+/- Avg
Cash and Investments	7,090	6,691	6%	1,414	5,676
Debt	1,502	1,512	-1%	1,119	383
Net debt	-5,588	-5,179	8%	-295	-5,293
<b>Net debt/share</b>	<b>-4.94</b>	<b>-4.58</b>	<b>-0.36</b>	<b>-0.36</b>	<b>-4.59</b>
Accts. receivable	2,083	1,121	86%	1,129	954
<b>DSO</b>	<b>103</b>	<b>60</b>	<b>43</b>	<b>74</b>	<b>28</b>
Inventory	1,282	1,176	9%	954	328
<b>Inventory days</b>	<b>90</b>	<b>89</b>	<b>1</b>	<b>77</b>	<b>13</b>
Accts. payable days	104	66	38	67	37
<b>Cash conversion days</b>	<b>89</b>	<b>83</b>	<b>6</b>	<b>85</b>	<b>4</b>
SH Equity	10,225	10,036	2%	4,030	6,195
<b>Book value/share</b>	<b>9.0</b>	<b>8.9</b>	<b>0.2</b>	<b>4.9</b>	<b>4.2</b>

Source: Company data, WIND, Credit Suisse

**Figure 236: Financial metrics summary**

Ticker	688396.SS	Current price (Rmb)	55.1
Stock connect %	0.0%	52-wk range (Rmb)	32.4-63.5
Share outstanding (mn)	1,216	Mkt cap (Rmb mn)	66,973
Daily trad vol-6m avg (mn)	22.2	Perf.	1M 3M 12M
Daily trad vol-6m avg (Rmb mn)	1,045	Absolute	13% 8% n/a
Free floatn (%)	20.5%	Relative	10% 9% n/a
Year	2016	2017	2018
Revenue (Rmb mn)	4,397	5,876	6,271
YoY	n/a	33.6%	6.7%
Gross profit (Rmb mn)	637	1,035	1,581
GM (%)	14%	18%	25%
Operating profit (Rmb mn)	-119	7	546
OPM (%)	-3%	0%	9%
Net profit (Rmb mn)	-303	70	429
EPS (Rmb)	-0.34	0.08	0.49
EPS growth (%)	n/a	-123.2%	510.8%
P/E (x)	-160	689	113
Dividend yield (%)	0.0%	0.0%	0.0%
P/B (x)	17.8	12.6	11.7
ROE (%)	-11%	2%	10%
		7%	9%

Note: P/E and P/B in 9M20 column are based on 2020E consensus EPS and BPS.

Source: Company data, WIND, Credit Suisse

**Figure 237: Cash flow statement summary**

Rmb mn	2017	2018	2019	3 year avg
Revenue	5,876	6,271	5,743	5,963
Capex	571	544	612	576
<b>Capex/revenue (%)</b>	<b>10%</b>	<b>9%</b>	<b>11%</b>	<b>10%</b>
Depr and amort	1,372	953	709	1,011
<b>Depr/revenue (%)</b>	<b>23%</b>	<b>15%</b>	<b>12%</b>	<b>17%</b>
Operating cash flow	1,667	1,482	576	1,242
<b>Free cash flow</b>	<b>562</b>	<b>723</b>	<b>652</b>	<b>645</b>
FCF and dividend yield	2017	2018	2019	3 year avg
FCF/share (Rmb)	0.68	0.87	0.79	0.78
FCF yield (%)	1.2%	1.6%	1.4%	1.4%
<b>FCF/EV (%)</b>	<b>0.9%</b>	<b>1.2%</b>	<b>1.1%</b>	<b>1.0%</b>
Dividend per share (Rmb)	0.00	0.00	0.03	0.01
Dividend payout (%)	0%	0%	7%	2%
<b>Dividend yield (%)</b>	<b>0.0%</b>	<b>0.0%</b>	<b>0.1%</b>	<b>0.0%</b>

Source: Company data, WIND, Credit Suisse

# Gigadevice (603986.SS, Neutral)

## Overview/product mix

Headquartered in Beijing, Gigadevice is a Chinese IC design (fabless) company developing NOR Flash, SLC NAND Flash, MCU (Microcontroller Unit), fingerprint sensor, etc. Gigadevice is the third-largest NOR Flash supplier in the world and third-largest MCU supplier in China. Silead, affiliated to Gigadevice, is the fourth-largest touch IC supplier and third-largest fingerprint sensor supplier globally in 2018. The company currently sells DRAM products for CXMT and has been developing its own DRAM technology.

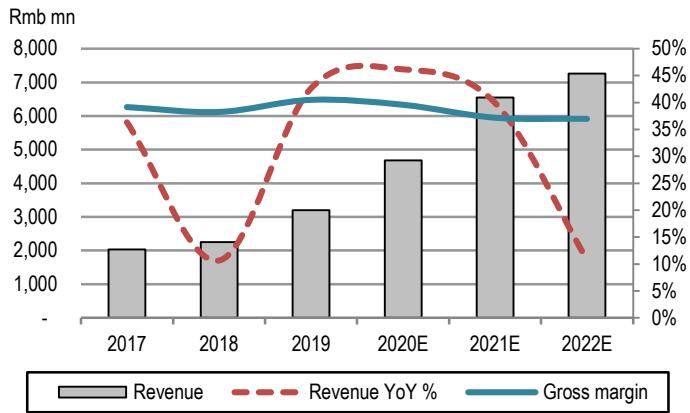
Gigadevice's products have been widely adopted by consumer electronics, IoT terminals, PC and peripherals, communication devices, medical equipment, automotive electronics, etc. The fast development of TWS (True Wireless Stereo) & other wearables, 5G base station, ADAS (Advanced Driver Assistance Systems), and IoT applications (like intelligent meter) has been driving NOR Flash demand in the past few years.

The chairman, Mr Zhu Yiming, aged 48, founded Gigadevice in 2005. Mr Zhu is also the chairman and CEO of Innotron Memory since July 2018. Before Gigadevice, Mr Zhu worked as Project Manager at Monolithic System Technologies and Senior Engineer at iPolicy Networks. He got his master's in electronic engineering from State University of New York at Stony Brook.

Gigadevice has about half of its wafer supply from SMIC, while Huali is another important supplier for about half of its NOR flash wafer. It also uses TSMC and UMC for MCU, but volumes are still small currently. In 2020, we estimate NOR flash to account for 71% of the company's total revenue, while EMMC/EMCP/SLC NAND and MCU account for 3% and 11%.

**Gigadevice is a supplier of NOR flash, MCUs and SLC NAN**

**Figure 238: Gigadevice's revenue and gross margin**



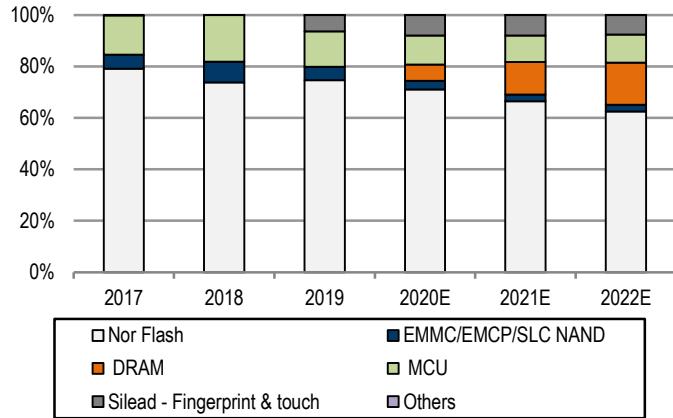
Source: Company data, Credit Suisse estimates

## Business drivers

**NOR flash.** With the continued strong demand from TWS and a wide variety of consumer/industrial IoT devices, we expect strong NOR flash demand to continue into 1H21. Also, Industrial IoT in China could be a major growth driver in the near few years, for both NOR flash and MCU. The industry is waiting for China's new policy to upgrade water meters, electricity meters, and gas meters, and the new smart meters will use 128Mb NOR flash vs no NOR flash in the past. The company is also promoting its NOR flash products for 5G base station and automotive applications. The automotive NOR flash business is growing fast, but from a very low base, so currently the automotive contribution remains small.

**MCU.** Gigadevice has observed strong MCU demand since 1Q20 and expects this to continue into 1H21. As a result of the industry-wide supply shortage, the company also noted longer

**Figure 239: NOR flash accounts for over 70% of total revenue in 2020E**



Source: Company data, Credit Suisse estimates

lead time for MCU, extending from 2-3 months to 4 months or even longer now. Consumer electronics MCU remains the largest segment, but industrial MCU is growing faster. The company is also developing automotive MCUs.

**Fingerprint.** Its optical fingerprint business has also observed better momentum recently and the company expects growing volumes with major China OEMs. It is also migrating its fingerprint from 8" to 12". We believe currently its optical fingerprint sensing solution is still behind Goodix but the gap is smaller vs 2018-19, and as a result, it should gain better orders in 2021 within China Android OEMs. Nevertheless, the optical fingerprint sensor pricing has dropped very fast in 2020 and we expect the fast ASP erosion to continue into 2021.

**Capacity.** We expect Gigadevice to maintain its plan to increase its wafer capacity by 20% or more in 2021. The SMIC restriction remains a risk (see [our summary](#) of 24 China fabless' exposure to SMIC), but Gigadevice should gradually increase its wafer output at Hua Hong's Wuxi 12" fab in 2021. Also, SMIC is still working hard to find non-US equipment suppliers and equipment not within the restriction scope to try to maintain its 8" and mature 12" production in the next few years.

**DRAM and CXMT.** Gigadevice has two businesses with CXMT. Gigadevice sells CXMT's DRAM. At the same time, Gigadevice is developing its DRAM technology and CXMT will be Gigadevice's foundry in the future. Revenue from selling CXMT's DRAM kicked off from 2Q20. Also, Gigadevice is on schedule to unveil its first 19nm DRAM next year, and will first target industrial application.

## Near-term trends

Management suggested 3Q20 demand was strong across NOR flash, MCU and fingerprint sensors. Gigadevice expects the demand to remain strong in 4Q20 and is optimistic about 2021, with improving demand from consumer, industrial and auto.

**Figure 240: 3Q19-3Q20 and 2016-2019 financial summary**

Rmb mn	Quarters					Years			
	3Q19	4Q19	1Q20	2Q20	3Q20	2016	2017	2018	2019
Sales	1,002	999	805	852	1,516	1,489	2,030	2,246	3,203
QoQ/YoY	34%	0%	-19%	6%	78%	25%	36%	11%	43%
Gross profit	406	436	330	343	618	398	795	859	1,298
<b>GM %</b>	<b>41%</b>	<b>44%</b>	<b>41%</b>	<b>40%</b>	<b>41%</b>	<b>27%</b>	<b>39%</b>	<b>38%</b>	<b>41%</b>
R&D	103	120	106	116	119	0	0	208	363
SG&A	89	112	82	85	147	247	335	215	318
Op income	215	205	142	142	352	151	460	436	617
<b>OPM %</b>	<b>21%</b>	<b>20%</b>	<b>18%</b>	<b>17%</b>	<b>23%</b>	<b>10%</b>	<b>23%</b>	<b>19%</b>	<b>19%</b>
Financing cost (net)	-38	15	-22	-3	49	-25	27	-24	-26
Net income	262	157	168	195	310	176	397	405	607
<b>Net margin %</b>	<b>26%</b>	<b>16%</b>	<b>21%</b>	<b>23%</b>	<b>20%</b>	<b>12%</b>	<b>20%</b>	<b>18%</b>	<b>19%</b>
Shares	321	321	321	471	472	100	203	285	321
<b>EPS (Rmb)</b>	<b>0.87</b>	<b>0.49</b>	<b>0.53</b>	<b>0.28</b>	<b>0.00</b>	<b>2.12</b>	<b>1.99</b>	<b>1.44</b>	<b>2.02</b>

Source: Company data, WIND, Credit Suisse

## Valuation

Gigadevice, at the current price of Rmb216, has a market cap of Rmb100 bn and trades at 106x/78x 2020/21 CSe EPS and 9.4x/8.4x 2020/21 CSe BPS. We rate Gigadevice NEUTRAL with a target price of Rmb191 on 64x 2021E EPS. Gigadevice has a healthy balance sheet, with net cash accounting for 69% of total equity and net cash per share of Rmb15.39 vs the six-year average of Rmb4.62. Gigadevice recorded free cash flow (FCF) of Rmb28 mn, Rmb155 mn and Rmb451 mn in 2017-19.

**Figure 241: Balance sheet summary**

Balance Sheet (Rmb mn)	3Q20 (A)	2Q20	Diff %	6 year avg	+/- Avg
Cash and Investments	7,344	6,891	7%	844	6,500
Debt	85	87	-2%	102	-17
Net debt	-7,259	-6,804	7%	-742	-6,518
<b>Net debt/share</b>	<b>-15.39</b>	<b>-14.45</b>	<b>-0.94</b>	<b>-4.62</b>	<b>-10.77</b>
Accts. receivable	464	172	169%	121	343
<b>DSO</b>	<b>28</b>	<b>18</b>	<b>9</b>	<b>26</b>	<b>1</b>
Inventory	705	917	-23%	449	256
<b>Inventory days</b>	<b>71</b>	<b>162</b>	<b>-91</b>	<b>131</b>	<b>-60</b>
Accts. payable days	45	68	-22	75	-30
<b>Cash conversion days</b>	<b>53</b>	<b>113</b>	<b>-60</b>	<b>82</b>	<b>-29</b>
SH Equity	10,478	10,100	4%	1,858	8,619
<b>Book value/share</b>	<b>22.2</b>	<b>21.5</b>	<b>0.8</b>	<b>9.6</b>	<b>12.6</b>

Source: Company data, WIND, Credit Suisse

**Figure 242: Financial metrics summary**

Ticker	603986.SS	Current price (Rmb)	216.0		
Stock connect %	0.0%	52-wk range (Rmb)	130-304		
Share outstanding (mn)	472	Mkt cap (Rmb mn)	100,447		
Daily trad vol-6m avg (mn)	10.0	Perf.	1M 3M 12M		
Daily trad vol-6m avg (Rmb r	2,387	Absolute	4% 6% 55%		
Free floatn (%)	88.6%	Relative	0% 4% 37%		
Year	2016	2017	2018	2019	9M20
<b>Revenue (Rmb mn)</b>	<b>1,489</b>	<b>2,030</b>	<b>2,246</b>	<b>3,203</b>	<b>3,174</b>
YoY	25.3%	36.3%	10.6%	42.6%	44.0%
Gross profit (Rmb mn)	398	795	859	1,298	1,291
<b>GM (%)</b>	<b>27%</b>	<b>39%</b>	<b>38%</b>	<b>41%</b>	<b>41%</b>
Operating profit (Rmb mn)	151	460	436	617	637
<b>OPM (%)</b>	<b>10%</b>	<b>23%</b>	<b>19%</b>	<b>19%</b>	<b>20%</b>
Net profit (Rmb mn)	176	397	405	607	673
<b>EPS (Rmb)</b>	<b>2.12</b>	<b>1.99</b>	<b>1.44</b>	<b>2.02</b>	<b>1.47</b>
EPS growth (%)	1.0%	-6.1%	-27.6%	40.3%	-3.9%
P/E (x)	102	109	150	107	105
Dividend yield (%)	0.2%	0.2%	0.1%	0.2%	n/a
P/B (x)	16.9	24.9	32.4	13.3	12.4
ROE (%)	14%	23%	21%	12%	9%

Note: P/E and P/B in 9M20 column are based on 2020E consensus EPS and BPS.

Source: Company data, WIND, Credit Suisse

Source: Company data, WIND, Credit Suisse

**Figure 243: Cash flow statement summary**

Rmb mn	2013	2014	2015	2016	2017	2018	2019	7 year avg
Revenue	789	947	1,189	1,489	2,030	2,246	3,203	1,699
Capex	29	18	41	79	233	297	277	139
<b>Capex/revenue (%)</b>	<b>4%</b>	<b>2%</b>	<b>3%</b>	<b>5%</b>	<b>11%</b>	<b>13%</b>	<b>9%</b>	<b>7%</b>
Depr and amort	17	20	24	29	39	62	110	43
<b>Depr/revenue (%)</b>	<b>2%</b>	<b>2%</b>	<b>2%</b>	<b>2%</b>	<b>2%</b>	<b>3%</b>	<b>3%</b>	<b>2%</b>
Operating cash flow	100	95	217	84	198	620	967	326
<b>Free cash flow</b>	<b>19</b>	<b>26</b>	<b>97</b>	<b>-3</b>	<b>28</b>	<b>155</b>	<b>451</b>	<b>110</b>
FCF and dividend yield	2013	2014	2015	2016	2017	2018	2019	7 year avg
FCF/share (Rmb)	0.26	0.35	1.29	-0.03	0.14	0.54	1.40	0.56
FCF yield (%)	0.1%	0.2%	0.6%	0.0%	0.1%	0.3%	0.7%	0.3%
<b>FCF/EV (%)</b>	<b>0.0%</b>	<b>0.0%</b>	<b>0.1%</b>	<b>0.0%</b>	<b>0.0%</b>	<b>0.2%</b>	<b>0.5%</b>	<b>0.1%</b>
Dividend per share (Rmb)	0.00	0.00	0.00	0.53	0.39	0.29	0.38	0.23
Dividend payout (%)	0%	0%	0%	25%	20%	20%	19%	12%
<b>Dividend yield (%)</b>	<b>0.0%</b>	<b>0.0%</b>	<b>0.0%</b>	<b>0.2%</b>	<b>0.2%</b>	<b>0.1%</b>	<b>0.2%</b>	<b>0.1%</b>

Source: Company data, WIND, Credit Suisse

# Goodix (603160.SS, Underperform)

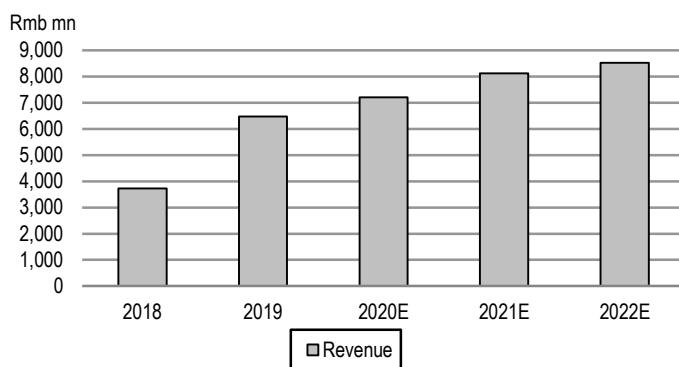
## Overview/product mix

Headquartered in Shenzhen, Goodix is a leading Chinese IC design company developing fingerprint solution and human interface technologies, founded in 2002 and listed on the A-share board in 2016. Goodix has the largest share in the global under-display fingerprint market (competitors include Silead affiliated to Gigadevice, Egis, Novatek, among others). Key customers include Huawei, Oppo, Vivo, Xiaomi, ZTE, Samsung, LG, among others. Goodix uses TSMC as its main foundry partner, and also uses SMIC and Dongbu.

**Goodix is a leading fingerprint and touch IC supplier.**

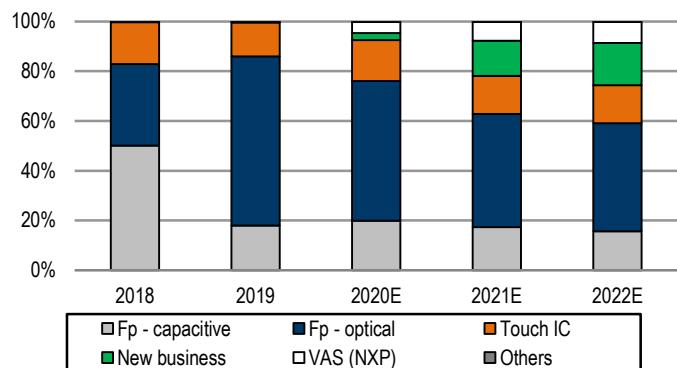
Goodix achieved revenue of Rmb6.5 bn in 2019, with 28% CAGR in 2017-19, and we expect 8% revenue CAGR in 2020-22 going forward. The company earned 86% of its total revenue from fingerprint sensor and 14% from touch IC in 2019. Within fingerprint, we estimate 21% revenue from capacitive sensor and the remaining 79% from under-display optical sensor. After consolidating the VAS (Voice and Audio Solutions) business from NXP in February 2020, Goodix has expanded its product portfolio into audio solutions and IoT (Internet of Things) applications. Besides, the company has expanded its R&D team headcount from 1,175 in 1H19 to 1,729 by 1H20 (91% of total employee headcount), and is actively developing new products like ToF (time of flight) sensor and CIS (CMOS image sensor). We expect revenue contribution from VAS and new business might achieve 9% and 18% of revenue in 2022.

**Figure 244: We expect modest top-line growth for Goodix**



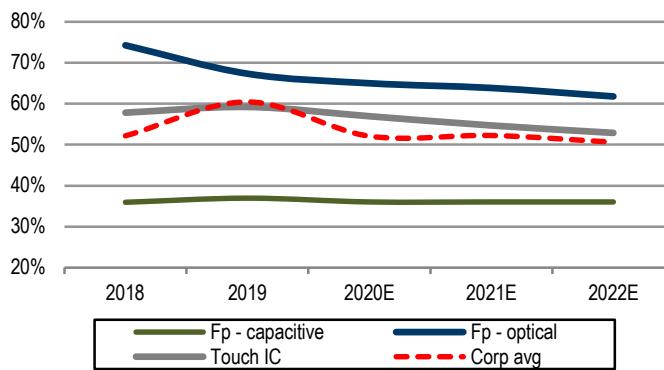
Source: Company data, Credit Suisse estimates

**Figure 245: Goodix's new business should gradually increase revenue contribution**



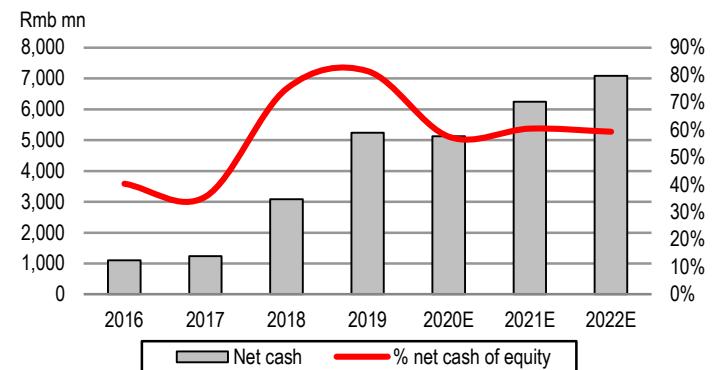
Source: Company data, Credit Suisse estimates

**Figure 246: Goodix's GM might face downside pressure due to competition**



Source: Company data, Credit Suisse estimates

**Figure 247: Goodix has a rich net cash position**



Source: Company data, Credit Suisse estimates

## Business drivers

**Pressure on fingerprint sensor price should last into 2021.** From the Android end-market demand perspective (our Asian tech strategist expects Android shipment to recover from 1.08 bn in 2020 to 1.17 bn in 2021, up 8% YoY), we think the industry and Goodix are likely to reach bottom. However, given there are more than five suppliers in the market, we expect price erosion for lens-type optical sensors might inevitably continue into 2021. For ultra-thin sensor, the company is making good progress to improve cost structure and expects GM to approach the corporate average eventually, but we stay cautious about the adoption rate of ultra-thin sensor in 2021 as its higher cost might not match improvement in user experience.

**A more diversified future growth, but R&D effort and time are needed.** Goodix works closely with major smartphone OEMs for these OEMs' various wearable and home devices with Goodix solutions for heart rate/blood oxygen sensors, in-ear detection, voice/audio, and lower-power Bluetooth. Revenue for IoT/VAS (voice audio solution) has increased to high-single-digit percentage in 3Q20. Additionally, Goodix has increased R&D efforts on CIS and may hit the market with high-pixel CIS in 2H21. In the long run, automotive may be the next vertical that management keeps a close eye on. Besides, the company's ToF solution with own sensor and algorithm has been promoted to OEMs. Android OEMs are waiting for real applications from the iOS camp before adopting ToF.

## Near-term trends

Goodix reported 3Q20 revenue grew 21% QoQ to Rmb2.1 bn, due to some customer(s)' chip inventory build, but GM dropped 0.7 pp QoQ to 52.1%, due to unfavourable product mix. Inventory reduced 15% QoQ to Rmb685 mn, or 63 inventory days (a healthy level).

Goodix's latest pricing for fingerprint is now close to its peers; this should help secure its volume growth in China besides share gains in the overseas market. Management is optimistic about revenue /GM outlook in 4Q, and 4Q may be a flattish quarter QoQ, but the risk of inventory correction due to the Android camp's overbooking remains in 1H21 if global end-demand recovers very slowly.

**Figure 248: 3Q19-3Q20 and 2016-2019 financial summary**

Rmb mn	Quarters					Years			
	3Q19	4Q19	1Q20	2Q20	3Q20	2016	2017	2018	2019
Sales	1,792	1,795	1,351	1,706	2,072	3,079	3,682	3,721	6,473
QoQ/YoY	8%	0%	-25%	26%	21%	175%	20%	1%	74%
Gross profit	1,089	1,039	678	900	1,079	1,452	1,735	1,942	3,910
<b>GM %</b>	<b>61%</b>	<b>58%</b>	<b>50%</b>	<b>53%</b>	<b>52%</b>	<b>47%</b>	<b>47%</b>	<b>52%</b>	<b>60%</b>
R&D	263	359	413	422	455	0	0	838	1,079
SG&A	184	200	150	183	247	538	912	447	728
Op income	642	480	115	295	377	914	823	657	2,103
<b>OPM %</b>	<b>36%</b>	<b>27%</b>	<b>9%</b>	<b>17%</b>	<b>18%</b>	<b>30%</b>	<b>22%</b>	<b>18%</b>	<b>32%</b>
Financing cost (net)	-4	1	-16	-3	-15	5	-14	-1	-6
Net income	695	605	205	393	503	857	887	742	2,317
<b>Net margin %</b>	<b>39%</b>	<b>34%</b>	<b>15%</b>	<b>23%</b>	<b>24%</b>	<b>28%</b>	<b>24%</b>	<b>20%</b>	<b>36%</b>
Shares	456	456	456	457	458	445	454	457	456
<b>EPS (Rmb)</b>	<b>1.55</b>	<b>1.35</b>	<b>0.44</b>	<b>0.88</b>	<b>0.00</b>	<b>2.10</b>	<b>1.95</b>	<b>1.65</b>	<b>5.17</b>

Source: Company data, WIND, Credit Suisse

## Valuation

At the current price of Rmb158.7, Goodix has a market cap of Rmb72.7 bn and trades at 47.3x/43.0x 2020/21 CSe EPS and 8.3x/7.1x 2020/21 CSe BPS. We rate Goodix UNDERPERFORM with a target price of Rmb152 based on 39x 2021E EPS. The 39x is its historical P/E on forward consensus EPS and at 45% discount to A-share fabless. Goodix has a healthy balance sheet, with net cash accounting for 46% of total equity and net cash per

share of Rmb7.51 vs the six-year average of Rmb3.75. Goodix recorded strong free cash flow of Rmb831 mn, Rmb549 mn and Rmb2.1 bn in 2017-19.

**Figure 249: Balance sheet summary**

Balance Sheet (Rmb mn)	3Q20 (A)	2Q20	Diff %	6 year avg	+/- Avg
Cash and Investments	3,712	3,974	-7%	1,546	2,166
Debt	275	250	10%	0	275
Net debt	-3,437	-3,724	-8%	-1,546	-1,891
<b>Net debt/share</b>	<b>-7.51</b>	<b>-8.15</b>	<b>0.64</b>	<b>-3.75</b>	<b>-3.75</b>
Accts. receivable	1,354	725	87%	761	593
<b>DSO</b>	<b>59</b>	<b>38</b>	<b>21</b>	<b>96</b>	<b>-37</b>
Inventory	685	808	-15%	349	336
<b>Inventory days</b>	<b>62</b>	<b>90</b>	<b>-28</b>	<b>98</b>	<b>-36</b>
Accts. payable days	40	52	-12	72	-32
<b>Cash conversion days</b>	<b>81</b>	<b>76</b>	<b>4</b>	<b>122</b>	<b>-41</b>
SH Equity	7,443	6,855	9%	3,139	4,304
<b>Book value/share</b>	<b>16.3</b>	<b>15.0</b>	<b>1.3</b>	<b>7.5</b>	<b>8.7</b>

Source: Company data, WIND, Credit Suisse

**Figure 250: Financial metrics summary**

Ticker	603160.SS	Current price (Rmb)	158.7		
Stock connect %	0.0%	52-wk range (Rmb)	155.9-372		
Share outstanding (mn)	458	Mkt cap (Rmb mn)	72,627		
Daily trad vol-6m avg (mn)	5.3	Perf. 1M 3M 12M			
Daily trad vol-6m avg (Rmb mn)	1,221	Absolute -11% -2% -27%			
Free floatn (%)	99.0%	Relative -13% -5% -40%			
Rmb mn	2016	2017	2018	2019	9M20
<b>Revenue</b>	<b>3,079</b>	<b>3,682</b>	<b>3,721</b>	<b>6,473</b>	<b>5,128</b>
YoY	175.0%	19.6%	1.1%	74.0%	9.6%
Gross profit	1,452	1,735	1,942	3,910	2,657
<b>GM (%)</b>	<b>47%</b>	<b>47%</b>	<b>52%</b>	<b>60%</b>	<b>52%</b>
Operating profit	914	823	657	2,103	788
<b>OPM (%)</b>	<b>30%</b>	<b>22%</b>	<b>18%</b>	<b>32%</b>	<b>15%</b>
Net profit	857	887	742	2,317	1,100
<b>EPS (Rmb)</b>	<b>2.10</b>	<b>1.95</b>	<b>1.65</b>	<b>5.17</b>	<b>2.44</b>
EPS growth (%)	122.0%	-7.1%	-15.4%	213.3%	-36.1%
P/E (x)	76	81	96	31	45
Dividend yield (%)	0.3%	0.4%	0.3%	0.5%	n/a
P/B (x)	25.8	20.7	17.6	11.2	9.0
ROE (%)	31%	25%	18%	36%	22%

Note: P/E and P/B in 9M20 column are based on 2020E consensus EPS and BPS.

Source: Company data, WIND, Credit Suisse

**Figure 251: Cash flow statement summary**

Rmb mn	2013	2014	2015	2016	2017	2018	2019	7 year avg
Revenue	686	854	1,120	3,079	3,682	3,721	6,473	2,802
Capex	139	73	34	28	71	363	499	172
<b>Capex/revenue (%)</b>	<b>20%</b>	<b>9%</b>	<b>3%</b>	<b>1%</b>	<b>2%</b>	<b>10%</b>	<b>8%</b>	<b>7%</b>
Depr and amort	3	8	13	21	27	36	85	28
<b>Depr/revenue (%)</b>	<b>0%</b>	<b>1%</b>	<b>1%</b>	<b>1%</b>	<b>1%</b>	<b>1%</b>	<b>1%</b>	
Operating cash flow	252	335	228	-182	1,100	1,232	2,880	835
<b>Free cash flow</b>	<b>89</b>	<b>221</b>	<b>159</b>	<b>-302</b>	<b>831</b>	<b>549</b>	<b>2,113</b>	<b>523</b>
FCF and dividend yield	2013	2014	2015	2016	2017	2018	2019	7 year avg
FCF/share (Rmb)	0.54	1.34	0.40	-0.68	1.83	1.20	4.64	1.32
FCF yield (%)	0.3%	0.8%	0.3%	-0.4%	1.2%	0.8%	2.9%	0.8%
<b>FCF/EV (%)</b>	<b>0.1%</b>	<b>0.3%</b>	<b>0.2%</b>	<b>-0.4%</b>	<b>1.2%</b>	<b>0.8%</b>	<b>3.0%</b>	<b>0.8%</b>
Dividend per share (Rmb)	0.00	0.00	0.00	0.40	0.60	0.50	0.80	0.33
Dividend payout (%)	0%	0%	0%	19%	31%	30%	15%	14%
<b>Dividend yield (%)</b>	<b>0.0%</b>	<b>0.0%</b>	<b>0.0%</b>	<b>0.3%</b>	<b>0.4%</b>	<b>0.3%</b>	<b>0.5%</b>	<b>0.2%</b>

Source: Company data, WIND, Credit Suisse

# Huahong Semi (1347.HK, Neutral)

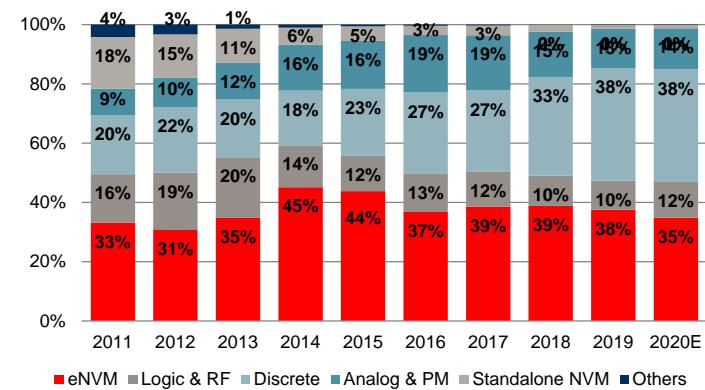
## Overview/product mix

Hua Hong is one of the initial semiconductor foundries in China, formed from the 2013 merger of two early China companies: Hua Hong NEC, started in 1997 as a JV between Shanghai Hua Hong and NEC, and Grace Semiconductor, started in 2000. The foundry had its Hong Kong IPO in October 2014 and now has three 8" fabs in Shanghai with 178k WPM capacity and a 12" fab in Wuxi ramping from 20k to 40k WPM capacity by early 2021.

The foundry focusses on mature semiconductor processes, with its 8" foundry producing from 350nm to 90nm and its 12" foundry on 90/65/55nm while its privately held sister company—HLMC, with same parent, Shanghai Alliance—focusses on advanced 12" on 40nm-14nm through its 40k 12" fab and ramping second 40k 12" fab. Hua Hong's application mix is conducive to legacy technology, including embedded flash products used in smart cards, SIM cards and MCUs (35% of YTD sales), analog and discretes (52% of YTD sales), logic and RF (12% of YTD sales) and other products including standalone flash (3% of YTD sales). The company serves as a strong local foundry for emerging domestic China fabless (65% of 3Q20 sales) and global customers looking for a local supply base or high-quality, low-cost foundry.

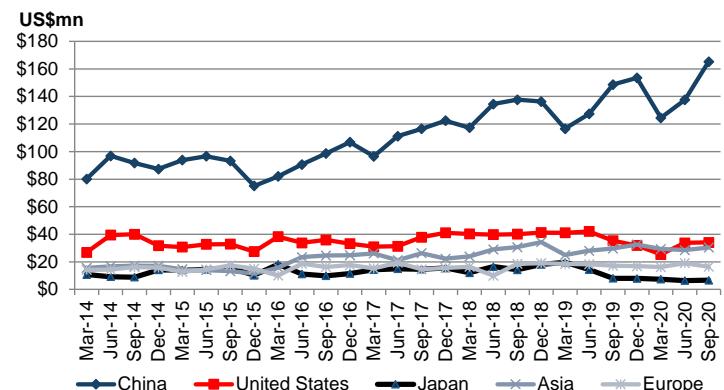
**Hua Hong is China's #2 foundry focussed on mature 12" and 8" semiconductor products.**

**Figure 252: Hua Hong sales led by embedded flash/discretes**



Source: Company data, Credit Suisse estimates

**Figure 253: Emerging China customers driving growth**



Source: Company data, Credit Suisse estimates

Management has pulled in its 12" ramp of its first phase by a year, with 20k available now and reaching 40k WPM (wafers per month) capacity installed by early 2021, ahead of its initial expectation for a 2020 completion. Hua Hong is evaluating the second phase 40k for two instalments, with 20k planned to start orders by 2H21 for production availability in 2022. The first phase cost was US\$2.5 bn including US\$1.7 bn for tools, but with site and shell built-out, the second phase may need ~US\$1.3-1.5 bn capex. For spending, 2020 capex will be US\$1.2 bn for 12" and US\$150 mn for 8", and 2021 could finish the first phase with US\$200-300 mn, add US\$300-400mn to start the new phase, plus some amount for on-going 8" maintenance and upgrades.

## Business drivers

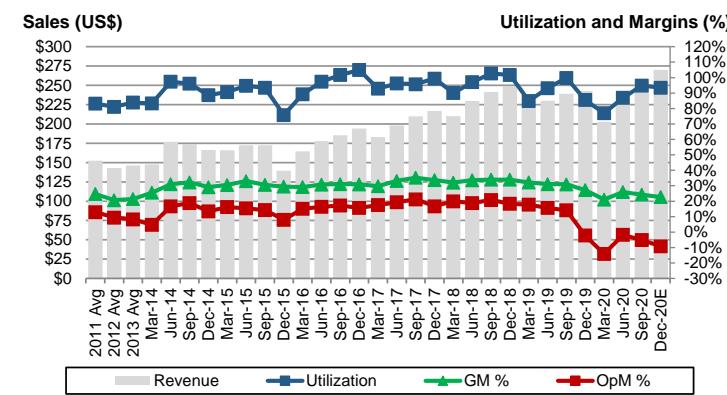
**Strong business momentum.** Hua Hong is upbeat on its sales momentum, with 2H20 picking up well as China recovers well from COVID-19 and volumes pick up from import substitution by China customers (60% of sales) improving their capability and also outsourcing by international customers (40% of mix). Sales momentum is being led by power discretes which are strong for all applications with higher-voltage IGBT growing 30%+ for the year and MCUs growing 15-20% for the year. The other main areas of logic and RF, analog and power management have also recovered well.

**12" product platforms driving a fast shipment ramp.** Hua Hong has six platforms in the ramp phase: (1) Logic and RF on 55/65nm; (2) CMOS image sensors (CIS) at about 50% of

initial shipments; (3) power discretes including MOSFETs, but prioritising 12" for high voltage IGBTs/Superjunction MOSFETs for lighting, home electronics, server power, smart meter, industrial motor, fast chargers, and EV/automotive; (4) embedded flash including smart cards, SIM cards and MCUs; (5) NOR flash with 90nm 32Mb now and upgrading to 55nm; and (6) BCD power management, including with some international customers. Shipments were 6-7k/month in 2Q20, doubling in 3Q20, and expected to approach 20k by end-2020 and 25-30k by end-2021. Management targets being EBITDA positive by end-2020 and P&L breakeven around 25-30k depending on mix. Phase 2 with lower capex costs is projected to provide the scale to be more profitable.

**Localisation still on-going.** Hua Hong still sees China customers supporting 60%+ of sales but is also seeing steady business with international customers and targeting a few new projects at overseas customers that look promising at an early stage. The company has a VEU (validated end-user) licence with the US Commerce Department with annual renewal allowing equipment procurement without a licence on each purchase. The company has sourced 20% of its Wuxi 12" fab tools from local suppliers on more of the basic steps though not yet commercialising local China bare wafer suppliers until the quality is assured at the level of its overseas supply from leaders. China is providing good support including the JV structure for Wuxi, some development subsidies and tax holiday which offers the first five years tax free on Wuxi plus half the tax rate in the following five years.

**Figure 254: Hua Hong sales ramp, but Wuxi 12" impacts GMs**



Source: Company data, Credit Suisse estimates

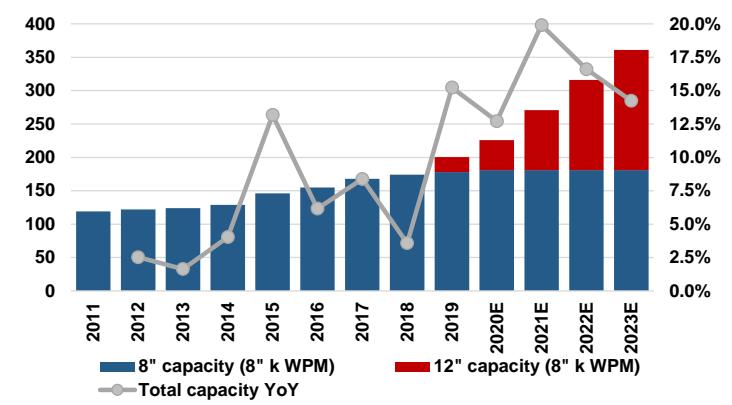
## Near-term trends

3Q20 sales were US\$253 mn, up 12% QoQ, above guidance for +5% QoQ (US\$236 mn) and CS +6% from growth in IGBT, MCU and CIS for its China customers. The Wuxi ramp dropped GMs from 26.0% in 2Q20 to 24.2% in 3Q20 (vs 22-24% guidance), lowering OpMs to -5.1%.

4Q20 sales were guided up 6.3% QoQ to US\$269 mn, above CS/street US\$257 mn, which should put full year 2020 sales up 2% YoY, saving a decline similar to last year's flat performance. On ramping depreciation, GMs were conservatively guided to decline to 21-23%, below CS/street's 23.7%/22.5%.

Capex is now targeted at US\$1.4 bn in 2020, and we estimate US\$740 mn in 2021 on Wuxi Phase 1/2 and 8" upgrades, driving depreciation to US\$211/305 mn and keeping blended GMs in the low-20s and modest profitability due to non-operating income.

**Figure 255: Hua Hong planning an aggressive 12" expansion**



Source: Company data, Credit Suisse estimates

**Figure 256: 3Q19-4Q20 and 2018-2021E financial summary**

	Sep-19	Dec-19	Mar-20	Jun-20	Sep-20	Dec-20E		2018	2019	2020E	2021E	2022E
	3Q	4Q	1Q	2Q	3Q	4Q						
<b>TOTAL SALES</b>	<b>\$239.0</b>	<b>\$242.8</b>	<b>\$202.9</b>	<b>\$225.4</b>	<b>\$253.0</b>	<b>\$270.1</b>		<b>930.3</b>	<b>932.6</b>	<b>951.2</b>	<b>1205.9</b>	<b>1436.3</b>
QoQ	3.9%	1.6%	-16.4%	11.1%	12.3%	6.7%		15.1%	0.2%	2.0%	26.8%	19.1%
YoY	-0.9%	-2.5%	-8.1%	-2.0%	5.9%	11.2%		311.2	282.5	223.8	286.7	319.6
<b>GROSS PROFIT</b>	<b>74.0</b>	<b>66.0</b>	<b>42.7</b>	<b>58.5</b>	<b>61.3</b>	<b>61.3</b>		<b>33.4%</b>	<b>30.3%</b>	<b>23.5%</b>	<b>23.8%</b>	<b>22.3%</b>
GM (%)	31.0%	27.2%	21.1%	26.0%	24.2%	22.7%		56.0	68.6	109.6	115.5	114.6
Research & Development (Net)	16.2	24.3	24.5	24.9	28.6	31.5		7.8	8.8	7.5	6.9	7.1
Selling and Distribution	1.9	2.9	2.3	1.9	1.6	1.7		66.4	101.2	177.0	129.6	121.5
Administrative	22.1	44.2	44.6	35.7	43.9	52.7		<b>181.1</b>	<b>103.8</b>	<b>-70.3</b>	<b>34.7</b>	<b>76.4</b>
<b>OPERATING INCOME</b>	<b>33.8</b>	<b>(5.3)</b>	<b>(28.7)</b>	<b>(4.0)</b>	<b>(12.9)</b>	<b>(24.6)</b>		<b>19.5%</b>	<b>11.1%</b>	<b>-7.4%</b>	<b>2.9%</b>	<b>5.3%</b>
OpM (%)	14.2%	-2.2%	-14.2%	-1.8%	-5.1%	-9.1%		<b>221.1</b>	<b>181.6</b>	<b>12.5</b>	<b>110.7</b>	<b>152.4</b>
<b>PRETAX INCOME</b>	<b>57.3</b>	<b>18.8</b>	<b>(8.7)</b>	<b>8.0</b>	<b>11.1</b>	<b>2.1</b>		23.8%	19.5%	1.3%	9.2%	10.6%
(% of sales)	24.0%	7.7%	-4.3%	3.5%	4.4%	0.8%		<b>185.6</b>	<b>155.0</b>	<b>6.9</b>	<b>94.1</b>	<b>129.6</b>
<b>NET INCOME - GAAP</b>	<b>44.4</b>	<b>14.0</b>	<b>2.7</b>	<b>1.3</b>	<b>1.1</b>	<b>1.7</b>		20.0%	16.6%	0.7%	7.8%	9.0%
(% of sales)	18.6%	5.8%	1.4%	0.6%	0.4%	0.6%		-2.5	7.3	76.0	32.2	6.1
Minority interest	0.8	12.2	17.6	16.6	16.6	25.3		<b>183.2</b>	<b>162.2</b>	<b>82.9</b>	<b>126.4</b>	<b>135.7</b>
<b>Net income attributed to parent</b>	<b>45.2</b>	<b>26.2</b>	<b>20.3</b>	<b>17.8</b>	<b>17.7</b>	<b>27.0</b>		<b>\$0.17</b>	<b>\$0.13</b>	<b>\$0.06</b>	<b>\$0.10</b>	<b>\$0.10</b>
<b>GAAP EPS (US\$)</b>	<b>\$0.03</b>	<b>\$0.02</b>	<b>\$0.02</b>	<b>\$0.01</b>	<b>\$0.01</b>	<b>\$0.02</b>		<b>\$1.31</b>	<b>\$0.97</b>	<b>\$0.49</b>	<b>\$0.74</b>	<b>\$0.79</b>
<b>GAAP EPS (HK\$)</b>	<b>\$0.27</b>	<b>\$0.16</b>	<b>\$0.12</b>	<b>\$0.11</b>	<b>\$0.10</b>	<b>\$0.16</b>						

Source: Company data, WIND, Credit Suisse

## Valuation

Hua Hong, at the current price of HK\$33.2 has a market capitalisation of US\$7.7 bn and trades at 92.7x/61.4x 2020/21 CSe EPS and 3.2x 2020e BV/share. We rate Hua Hong Neutral with a TP of HK\$28 based on 2x P/B, at the high end of its range with the market rerating for China semiconductors and Hua Hong delivering on its growth targets.

The stock has ramped to an even higher premium recently on potential upside following the US restriction of SMIC and potential for that action to also accelerate China IC companies' localisation of their foundry and design-in of Hua Hong's fabless customers at local system companies. The US restriction on SMIC though only presumes denial on advanced tools below 10nm, with mature tools on case-by-case (usually meaning approved), potentially limiting the upside opportunity for Hua Hong though some customers may still diversify to reduce this risk.

**Figure 257: Hua Hong cash flow statement summary**

Annual (US\$mn)	2016	2017	2018	2019	2020E	2021E	2022E
Revenue	\$721.4	\$808.1	\$930.3	\$932.6	\$951.2	\$1,205.9	\$1,436.3
Capital Spending	\$172.6	\$135.8	\$238.6	\$922.3	\$1,410.0	\$740.0	\$740.0
<b>Capex/Revenue</b>	<b>23.9%</b>	<b>16.8%</b>	<b>25.6%</b>	<b>98.9%</b>	<b>148.2%</b>	<b>61.4%</b>	<b>51.5%</b>
Dep and Amort	\$85.1	\$104.6	\$119.9	\$128.7	\$224.5	\$425.3	\$507.2
<b>Depr/Revenue</b>	<b>11.8%</b>	<b>12.9%</b>	<b>12.9%</b>	<b>13.8%</b>	<b>23.6%</b>	<b>35.3%</b>	<b>35.3%</b>
FCF/EV	1.2%	4.0%	1.2%	-17.4%	-23.4%	-3.7%	-1.2%
<b>FCF Yield (%)</b>	<b>1.0%</b>	<b>3.2%</b>	<b>0.9%</b>	<b>-16.2%</b>	<b>-25.0%</b>	<b>-4.2%</b>	<b>-1.4%</b>

Source: Company data, WIND, Credit Suisse

**Figure 258: Balance sheet summary**

<b>US\$mn</b>	<b>Sep-20 Actual</b>	<b>Jun-20 Actual</b>	<b>QoQ % Change</b>
Cash & Equivalents	\$716.8	\$699.7	2%
Other Investments	\$212.8	\$289.4	-26%
Interest bearing debt	\$261.0	\$40.2	-\$220.8
<b>Net Cash</b>	<b>\$668.6</b>	<b>\$948.9</b>	<b>-30%</b>
Inventory	\$205.2	\$176.9	16%
<b>Inventory Days</b>	<b>75</b>	<b>75</b>	<b>0</b>
A/P	\$486.4	\$414.9	17%
<b>Payable Days</b>	<b>232</b>	<b>227</b>	<b>5</b>
<b>Cash Conversion Days</b>	<b>-88</b>	<b>-70</b>	<b>-18</b>
SH Equity (BV)	\$3,121.1	\$2,704.3	15%
<b>Book Value / Share (HK\$)</b>	<b>\$13.41</b>	<b>\$14.31</b>	<b>-\$0.90</b>

Source: Company data, WIND, Credit Suisse

**Figure 259: Financial metrics summary**

<b>Ticker</b>	<b>1347.HK</b>	<b>Current Price (HK\$)</b>	<b>33.20</b>		
			<b>59.7%</b>	<b>52-wk range (HK\$)</b>	<b>12.7-47.3</b>
Qfii holding (%)	59.7%	52-wk range (HK\$)	12.7-47.3		
Shares outstanding (mn)	1,310.1	Mkt cap (US\$mn)	7,597		
Net cash (US\$mn)	-\$132	Perf. (%)	<b>1M</b>	<b>3M</b>	<b>12M</b>
Daily trad val-6m avg (US\$mn)	1,439	Absolute	21.5	69.0	156.5
Free Float (%)	78.2%	Relative	7.4	38.5	94.1
<hr/>					
<b>Financial metrics</b>	<b>2017</b>	<b>2018</b>	<b>2019</b>	<b>2020</b>	<b>2021</b>
<b>Revenues (US\$ mn)</b>	<b>\$808</b>	<b>\$930</b>	<b>\$933</b>	<b>\$951</b>	<b>\$1,206</b>
YoY Growth (%)	12.0%	15.1%	0.2%	2.0%	26.8%
Gross profit (US\$mn)	\$267	\$311	\$282	\$224	\$287
<b>GM (%)</b>	<b>33.1%</b>	<b>33.4%</b>	<b>30.3%</b>	<b>23.5%</b>	<b>23.8%</b>
Operating profit (US\$mn)	\$151	\$181	\$104	(\$70)	\$35
<b>OPM (%)</b>	<b>18.7%</b>	<b>19.5%</b>	<b>11.1%</b>	<b>-7.4%</b>	<b>2.9%</b>
EBITDA (US\$mn)	\$302	\$388	\$391	\$305	\$598
<b>EBITDA (%)</b>	<b>37.3%</b>	<b>41.7%</b>	<b>41.9%</b>	<b>32.0%</b>	<b>49.6%</b>
Net profit (US\$ mn)	\$145	\$186	\$155	\$7	\$94
<b>EPS (HK\$)</b>	<b>\$1.08</b>	<b>\$1.31</b>	<b>\$0.97</b>	<b>\$0.49</b>	<b>\$0.74</b>
EPS growth (%)	768%	22%	-26%	-49%	51%
<hr/>					
<b>Valuation metrics</b>	<b>2017</b>	<b>2018</b>	<b>2019</b>	<b>2020</b>	<b>2021</b>
<b>P/E (x)</b>	<b>30.8</b>	<b>25.3</b>	<b>34.2</b>	<b>67.7</b>	<b>44.8</b>
<b>P/B (x)</b>	<b>4.5</b>	<b>3.5</b>	<b>3.4</b>	<b>3.2</b>	<b>3.1</b>
<b>ROE (%)</b>	<b>9%</b>	<b>8%</b>	<b>7%</b>	<b>3%</b>	<b>5%</b>
EV/Sales	9.6	8.3	8.3	8.1	6.4
EV/EBITDA	25.6	19.9	19.8	25.4	12.9
<b>FCF yield (%)</b>	<b>1.6%</b>	<b>0.5%</b>	<b>-10.0%</b>	<b>-15.6%</b>	<b>-2.7%</b>
<b>Dividend yield (%)</b>	<b>0.0%</b>	<b>0.1%</b>	<b>0.0%</b>	<b>0.5%</b>	<b>0.8%</b>

Source: Company data, Credit Suisse

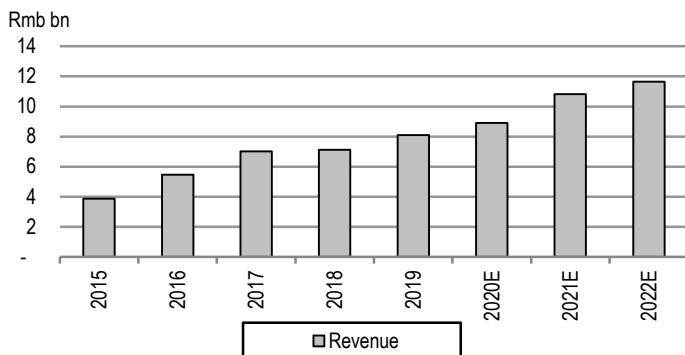
# Huatian (002185.SZ, Outperform)

## Overview/product mix

Founded in 2003 and listed on the Shenzhen Stock Exchange in 2007, Huatian is China's third-largest and the world's seventh-largest pure-play OSAT (Outsourced Semiconductor Assembly and Test) company. The company now has four production bases (Tianshui, Xi'an, Kunshan, Nanjing) in China, and Unisem in Malaysia.

Huatian is the #3 China OSAT and #7 globally.

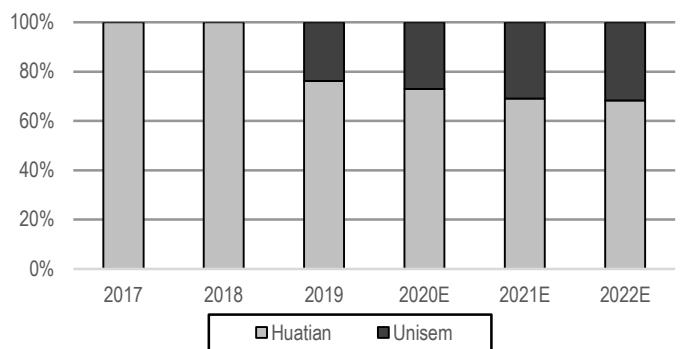
**Figure 260: Huatian sales growth expected to continue**



Source: Company data, Credit Suisse estimates

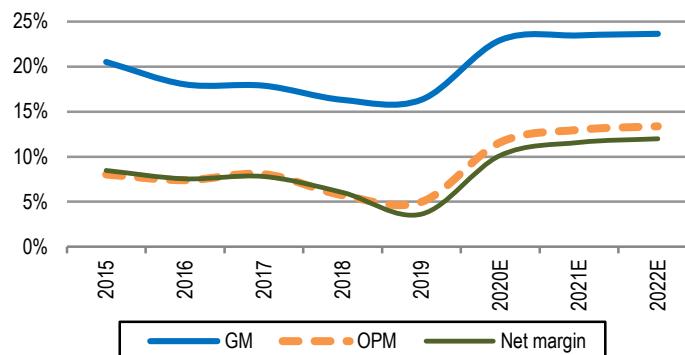
Huatian achieved revenue of Rmb8.1 bn in 2019, with 20% CAGR in 2016-19. We expect its revenue CAGR to reach 18% in 2021-22, with improving gross margin after 2019. Unisem accounted for roughly 24% of Huatian's total revenue in 2019, while Xi'an and Kunshan subsidiaries accounted for 27% and 7%.

**Figure 261: Unisem is nearly a third of Huatian's total revenue**



Source: Company data, Credit Suisse estimates

**Figure 262: We expect GM recovery after 2019**



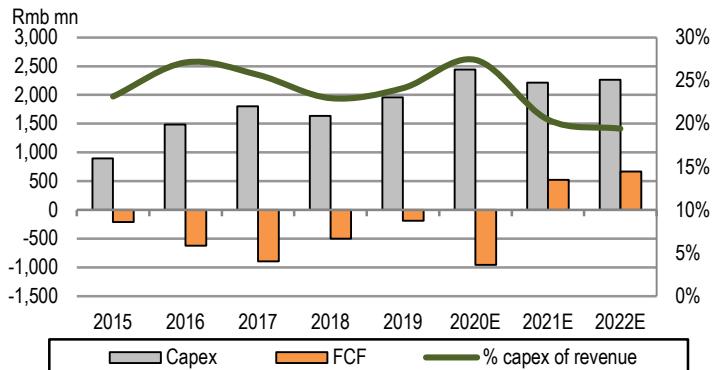
Source: Company data, Credit Suisse estimates

## Business drivers

**Industry-wide supply tightness.** The supply tightness is industry-wide across foundry, OSAT, substrate, passive components and across regions. The largest pure-play OSAT ASE has announced to raise prices in 1Q21. Our conversations with multiple fabless between September and mid-December also indicated the same industry-wide tightness across chips/applications. We thus believe the tightness is very likely to continue into 2Q21 and thus benefit Huatian, a follower in the OSAT space.

**Capacity expansion.** In 2020, Huatian's major capacity expansion was in Kunshan (mainly for CIS) and in Nanjing (memory and MEMS, phase I), and Huatian has been ramping up new capacity since 3Q20. Although the NAND progress is a bit slow, the Nanjing factory now has full loadings for NOR flash, MEMS, RF, wafer-level packaging and so on. So the industry-wide

**Figure 263: Huatian's capex and free cash flow**



Source: Company data, Credit Suisse estimates

tightness should help it quickly grow revenue/profitability for the new capacity in Kunshan and Nanjing. The company has started the Nanjing factory phase II project, and suggests the construction might be accelerated if strong demand lasts.

**Improved packaging capabilities to increase customer base.** By 1H20, Huatian finished the development of packaging technology for side-mounted fingerprint, ambient light/temperature/pressure sensor, and PA (power amplifier) of multi-GaAs chips and capacitance chips for 5G base station. Its packaging technology has passed qualification and been ready for mass production for 16-layer 3D NAND, Hybrid UFS (universal flash storage), and multiple chip package of NAND and DRAM. Meanwhile, Huatian has achieved mass production of packaging for SiP (System-in-Package) for 5G smartphone RF (radio frequency) and FCBGA (flip chip ball grid array) AI chip on 12nm node. In 2019, Huatian introduced 146 new customers including BOSCH, Realtek, and Longsys. The improved packaging technology might support the company's further customer introduction.

**YMTC progress might affect sentiment.** As one of YMTC's major OSAT partners, the market has expected YMTC to be a catalyst for Huatian. However, we remind that YMTC only accounts for very little of Huatian's revenue so far and uncertainties remain on actual order volume from YMTC, though YMTC's ramp-up progress might continue to affect market sentiment on Huatian.

## Near-term trends

Huatian reported 3Q revenue grew 9% QoQ to Rmb2.2 bn, with GM down 0.9 pp to 23%. Huatian has nearly full loadings across its Tianshui, Xian, Kunshan, Nanjing and Unisem factories. Its customers across chips/applications have been aggressively asking for back-end capacity, including NOR flash, CIS, Bluetooth, RF, and power. The company has recently raised packaging/assembly prices as a result of the strong demand and also partly due to higher raw materials cost. A few back-end materials also raised prices in 4Q, but as of now we have not noticed material shortage for Huatian. The high loadings should continue into 1H21. Huatian's better pricing should help continue its revenue/GM expansion into 2021, especially after new capacity (~20% capacity addition) ramping up since 3Q20.

**Figure 264: 3Q19-3Q20 and 2016-19 financial summary**

Rmb mn	Quarters					Years			
	3Q19	4Q19	1Q20	2Q20	3Q20	2016	2017	2018	2019
Sales	2,267	1,997	1,692	2,022	2,203	5,475	7,010	7,122	8,103
QoQ/YoY	7%	-12%	-15%	20%	9%	41%	28%	2%	14%
Gross profit	374	443	314	491	514	988	1,255	1,162	1,323
<b>GM %</b>	<b>16%</b>	<b>22%</b>	<b>19%</b>	<b>24%</b>	<b>23%</b>	<b>18%</b>	<b>18%</b>	<b>16%</b>	<b>16%</b>
R&D	104	125	96	103	121	0	0	384	402
SG&A	146	145	127	144	155	583	689	371	518
Op income	123	174	91	244	238	405	566	408	403
<b>OPM %</b>	<b>5%</b>	<b>9%</b>	<b>5%</b>	<b>12%</b>	<b>11%</b>	<b>7%</b>	<b>8%</b>	<b>6%</b>	<b>5%</b>
Financing cost (net)	29	24	24	19	16	-12	6	14	119
Net income	82	119	63	204	180	391	495	390	287
<b>Net margin %</b>	<b>4%</b>	<b>6%</b>	<b>4%</b>	<b>10%</b>	<b>8%</b>	<b>7%</b>	<b>7%</b>	<b>5%</b>	<b>4%</b>
Shares	2,740	2,740	2,740	2,740	2,740	1,066	2,131	2,131	2,740
<b>EPS (Rmb)</b>	<b>0.03</b>	<b>0.05</b>	<b>0.02</b>	<b>0.07</b>	<b>0.07</b>	<b>0.37</b>	<b>0.23</b>	<b>0.18</b>	<b>0.11</b>

Source: Company data, WIND, Credit Suisse

## Valuation

At the current price of Rmb14.9, Huatian has a market cap of Rmb40.8 bn and trades at 58.8x/35.7x 2020/21 CSe EPS and 4.9x/4.3x 2020/21 CSe BPS. We rate Huatian OUTPERFORM with a target price of Rmb18.0 based on 43x and 2021E EPS, supported by 37% earnings CAGR in 2021-22. Huatian has net debt accounting for 16% of total equity, with

net debt per share of Rmb0.65 vs a six-year average of -Rmb0.22. Huatian recorded free cash flow of -Rmb906 mn, -Rmb483 mn and -Rmb395 mn in 2017-19 due to heavy capex.

**Figure 265: Balance sheet summary**

Balance Sheet (Rmb mn)	3Q20 (A)	2Q20	Diff %	6 year avg	+/- Avg
Cash and Investments	1,622	2,013	-19%	1,654	-31
Debt	3,398	3,603	-6%	1,664	1,734
Net debt	1,776	1,590	12%	10	1,765
<b>Net debt/share</b>	<b>0.65</b>	<b>0.58</b>	<b>0.07</b>	<b>-0.22</b>	<b>0.87</b>
Accts. receivable	1,381	1,336	3%	948	433
<b>DSO</b>	<b>56</b>	<b>59</b>	<b>-3</b>	<b>60</b>	<b>-4</b>
Inventory	1,294	1,218	6%	892	402
<b>Inventory days</b>	<b>69</b>	<b>72</b>	<b>-3</b>	<b>65</b>	<b>4</b>
Accts. payable days	109	124	-15	91	18
<b>Cash conversion days</b>	<b>16</b>	<b>7</b>	<b>9</b>	<b>34</b>	<b>-18</b>
SH Equity	8,113	7,944	2%	5,129	2,984
<b>Book value/share</b>	<b>3.0</b>	<b>2.9</b>	<b>0.1</b>	<b>3.6</b>	<b>-0.7</b>

**Figure 266: Financial metrics summary**

Ticker	002185.SZ	Current price (Rmb)	14.9		
Stock connect %	0.0%	52-wk range (Rmb)	6.4-19.7		
Share outstanding (mn)	2,740	Mkt cap (Rmb mn)	40,771		
Daily trad vol-6m avg (mn)	191.9	Perf. 1M 3M 12M			
Daily trad vol-6m avg (Rmb mn)	2,498	Absolute	-4% 6% 114%		
Free floatn (%)	100.0%	Relative	-6% 2% 101%		
Rmb mn	2016	2017	2018	2019	9M20
<b>Revenue</b>	<b>5,475</b>	<b>7,010</b>	<b>7,122</b>	<b>8,103</b>	<b>5,917</b>
YoY	41.3%	28.0%	1.6%	13.8%	-3.1%
Gross profit	988	1,255	1,162	1,323	1,319
<b>GM (%)</b>	<b>18%</b>	<b>18%</b>	<b>16%</b>	<b>16%</b>	<b>22%</b>
Operating profit	405	566	408	403	573
<b>OPM (%)</b>	<b>7%</b>	<b>8%</b>	<b>6%</b>	<b>5%</b>	<b>10%</b>
Net profit	391	495	390	287	447
<b>EPS (Rmb)</b>	<b>0.37</b>	<b>0.23</b>	<b>0.18</b>	<b>0.11</b>	<b>0.16</b>
EPS growth (%)	-18.5%	-36.7%	-21.3%	-38.0%	139.4%
P/E (x)	41	64	81	131	59
Dividend yield (%)	0.3%	0.1%	0.1%	0.1%	n/a
P/B (x)	3.2	5.9	5.6	5.2	4.9
ROE (%)	8%	9%	7%	4%	8%

Note: P/E and P/B in 9M20 column are based on 2020E consensus EPS and BPS.

Source: Company data, WIND, Credit Suisse

Source: Company data, WIND, Credit Suisse

**Figure 267: Cash flow statement summary**

Rmb mn	2013	2014	2015	2016	2017	2018	2019	7 year avg
Revenue	2,447	3,305	3,874	5,475	7,010	7,122	8,103	5,334
Capex	528	600	897	1,485	1,800	1,636	1,956	1,272
<b>Capex/revenue (%)</b>	<b>22%</b>	<b>18%</b>	<b>23%</b>	<b>27%</b>	<b>26%</b>	<b>23%</b>	<b>24%</b>	<b>23%</b>
Depr and amort	216	277	365	437	583	739	1,216	548
<b>Depr/revenue (%)</b>	<b>9%</b>	<b>8%</b>	<b>9%</b>	<b>8%</b>	<b>8%</b>	<b>10%</b>	<b>15%</b>	<b>10%</b>
Operating cash flow	388	553	684	863	904	1,133	1,765	898
<b>Free cash flow</b>	<b>-299</b>	<b>-109</b>	<b>-301</b>	<b>-814</b>	<b>-906</b>	<b>-483</b>	<b>-395</b>	<b>-473</b>
FCF and dividend yield	2013	2014	2015	2016	2017	2018	2019	7 year avg
FCF/share (Rmb)	-0.46	-0.16	-0.37	-0.76	-0.43	-0.23	-0.14	-0.36
FCF yield (%)	-3.1%	-1.1%	-2.5%	-5.1%	-2.9%	-1.5%	-1.0%	-2.4%
<b>FCF/EV (%)</b>	<b>-0.7%</b>	<b>-0.3%</b>	<b>-0.7%</b>	<b>-1.9%</b>	<b>-2.1%</b>	<b>-1.1%</b>	<b>-0.9%</b>	<b>-1.1%</b>
Dividend per share (Rmb)	0.05	0.06	0.06	0.05	0.02	0.02	0.02	0.04
Dividend payout (%)	16%	13%	13%	14%	9%	11%	13%	13%
<b>Dividend yield (%)</b>	<b>0.3%</b>	<b>0.4%</b>	<b>0.4%</b>	<b>0.3%</b>	<b>0.1%</b>	<b>0.1%</b>	<b>0.1%</b>	<b>0.3%</b>

Source: Company data, WIND, Credit Suisse

# JCET (600584.SS, Underperform)

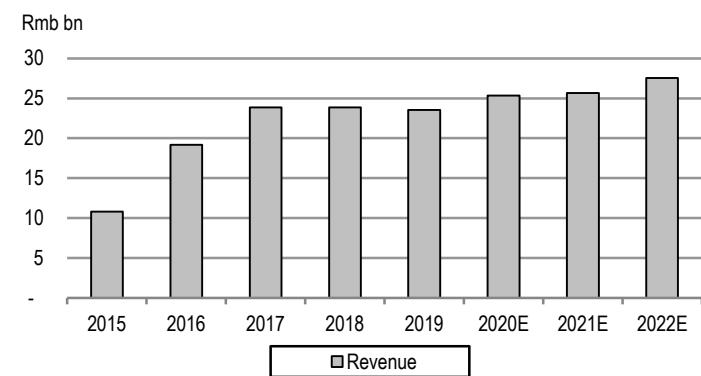
## Overview/product mix

Headquartered in Jiangyin, China, JCET (Jiangsu Changjiang Electronics Technology Co.) was founded in 2000 and listed on the Shanghai Stock Exchange in 2003. JCET is the world's third-largest and China's largest pure-play OSAT (Outsourced Semiconductor Assembly and Test) company, with global market share of 10% in 2020, vs ASE's 25% and Amkor's 13%. JCET is able to offer comprehensive OSAT services, including flip-chip, wafer level packaging and SiP (system-in-package), and so on.

JCET achieved revenue of Rmb23.5 bn in 2019, with a 7% CAGR from 2017-19. We expect modest top-line growth going forward, with 5% revenue CAGR in 2020-22. JCET has two R&D centres in China and South Korea, and six production bases in China, South Korea and Singapore. In 1H20, revenue of STATS CHIPPAC increased 45% YoY, accounting for nearly 40% of total revenue, driven by 5G product, higher utilisation and better execution. The revenue of JCET's Korean factory (JSCK, mainly SiP production) grew 148%, accounting for about 24% of JCET's total revenue, driven by strong high-end SiP demand. Besides, JCAP (Jiangyin Changdian Advanced packaging), JCET Chuzhou and JCET Suqian respectively accounted for 7%, 5% and 4% of total revenue in 1H20.

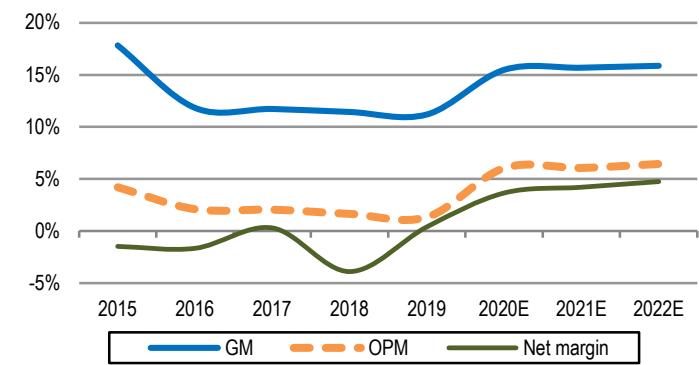
**JCET is China's largest OSAT following its merger with Singapore based Stats-Chippac in 2016.**

**Figure 268: We model JCET to have modest top-line growth**



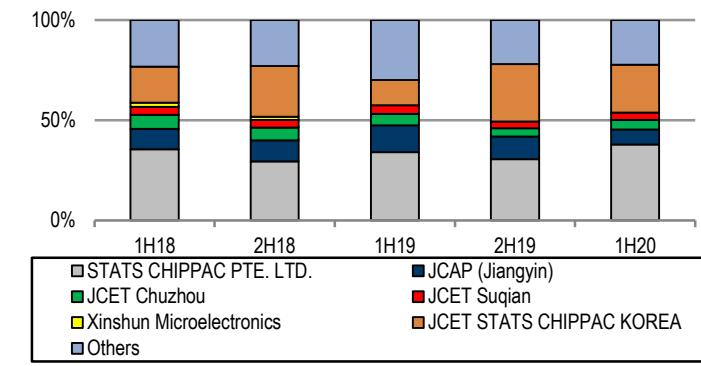
Source: Company data, Credit Suisse estimates

**Figure 269: Margins are recovering since 2018-19**



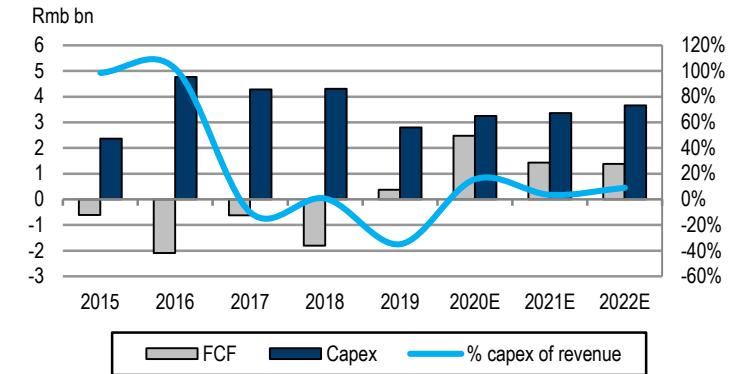
Source: Company data, Credit Suisse estimates

**Figure 270: JCET's revenue mix by subsidiaries**



Source: Company data, Credit Suisse estimates

**Figure 271: We expect positive free cash flow in 2020-22**



Source: Company data, Credit Suisse estimates

## Business drivers

**Better demand across iOS, Android and China to offset the Huawei impact.** CS house view expects global smartphone shipments to recover 8.8% YoY to 1.38 bn in 2021 (vs -7.3% YoY in 2020), with iOS from 194 mn in 2020 to 217 mn in 2021 and Android from 1.08 bn to 1.17 bn. We expect solid demand from Apple SiP (System-in-Package), Qualcomm, and many China fabless might largely offset the revenue drop from Huawei (previously accounted for 10-20% of JCET's revenue).

**Industry-wide OSAT supply tightness.** Similar to the smartphone market, where every other OEM wants to take Huawei's share, in the semiconductor market every China fabless (similar to global fabless) wants to take HiSilicon's share. Our recent meeting with [Amlogic](#) also suggested the same. This partly explains the tight foundry/back-end/substrate supply across regions. In China, many fabless use JCET, and JCET should benefit from the industry-wide back-end supply tightness in 2021.

**Development across mobile, base station, and automotive.** JCET's AiP (antenna-in-package) production line has been qualified and begun volume production. Its high-pixel CIS capacity too is ready. For base station and data-centre, its fcBGA (Flip Chip Ball Grid Array) has been used for high-performance digit ICs of different sizes. In automotive, its SiP technology for DMS (driver monitoring system) is under qualification. It also introduced eWLB (embedded Wafer Level Ball Grid Array) for the 77Ghz LiDAR (Light Detection and Ranging) system for intelligent vehicles. For memory, JCET's packaging for 16-layer NAND has achieved mass production.

**Rmb5 bn private placement to increase capacity.** JCET announced a private placement plan in August 2020 to issue no more than 180 mn shares (11.23% of its outstanding shares) to raise up to Rmb5 bn. Rmb2,660 mn is for high-density IC, and the system-in-package (SiP) module. Rmb840 mn is for high density module for communication applications. The respective construction periods are three and five years. The rest of the capital will be used to repay its loans. JCET had a net debt of Rmb9.8 bn as of 3Q20, or 74% of its net-debt-to-equity. So far, the placement is pending approval from the regulator and exchange.

## Near-term trends

JCET reported 3Q20 revenue grew 8% QoQ to Rmb6.8 bn, with gross margin up 1.1 pp QoQ to 17%. The solid 3Q revenue is likely due to the aggressive procurement from Huawei. In 4Q20, strong demand from Apple SiP, Qualcomm and many China fabless might largely offset the drop in revenue from Huawei. There might be seasonal adjustment and/or potential correction from overbooking in 1H20, largely depending on iPhone/Airpod Pro sales and Android recovery.

**Figure 272: 3Q19-3Q20 and 2016-19 financial summary**

Rmb mn	Quarters					Years			
	3Q19	4Q19	1Q20	2Q20	3Q20	2016	2017	2018	2019
Sales	7,047	7,330	5,708	6,268	6,787	19,155	23,856	23,856	23,526
QoQ/YoY	52%	4%	-22%	10%	8%	77%	25%	0%	-1%
Gross profit	838	942	748	997	1,157	2,264	2,794	2,726	2,631
<b>GM %</b>	<b>12%</b>	<b>13%</b>	<b>13%</b>	<b>16%</b>	<b>17%</b>	<b>12%</b>	<b>12%</b>	<b>11%</b>	<b>11%</b>
R&D	227	393	214	277	277	0	0	888	969
SG&A	345	307	274	294	322	1,860	2,303	1,442	1,345
Op income	267	242	259	426	558	404	492	396	317
<b>OPM %</b>	<b>4%</b>	<b>3%</b>	<b>5%</b>	<b>7%</b>	<b>8%</b>	<b>2%</b>	<b>2%</b>	<b>2%</b>	<b>1%</b>
Financing cost (net)	223	213	147	156	179	964	983	1,131	870
Net income	77	271	134	232	398	106	343	-939	89
<b>Net margin %</b>	<b>1%</b>	<b>4%</b>	<b>2%</b>	<b>4%</b>	<b>6%</b>	<b>1%</b>	<b>1%</b>	<b>-4%</b>	<b>0%</b>
Shares	1,603	1,603	1,603	1,603	1,603	1,036	1,360	1,603	1,603
<b>EPS (Rmb)</b>	<b>0.05</b>	<b>0.17</b>	<b>0.08</b>	<b>0.15</b>	<b>0.00</b>	<b>0.10</b>	<b>0.28</b>	<b>-0.65</b>	<b>0.06</b>

Source: Company data, WIND, Credit Suisse

## Valuation

At the current price of Rmb41.8, JCET has a market cap of Rmb67 bn and trades at 69.3x/59.3x 2020/21 CSe EPS and 4.8x/4.4x 2020/21 CSe BPS. We rate JCET

UNDERPERFORM on rich valuation, with a target price of Rmb36.6 based on 3.9x (+0.5 SD to historical P/B) and 2021E BPS. JCET has net debt of Rmb9.8 bn, accounting for 74% of its total equity. It recorded free cash flow (FCF) of Rmb733 mn, -Rmb1.0 bn and Rmb494 mn in 2017-19. We model JCET to have positive FCF in 2021-22, and expect JCET to lower its debt ratio with better FCF and money raised from the private placement, if successful.

**Figure 273: Cash flow statement summary**

Rmb mn	2013	2014	2015	2016	2017	2018	2019	7 year avg
Revenue	5,102	6,428	10,807	19,155	23,856	23,856	23,526	16,104
Capex	1,119	1,190	2,364	4,768	4,284	4,311	2,804	2,977
<b>Capex/revenue (%)</b>	<b>22%</b>	<b>19%</b>	<b>22%</b>	<b>25%</b>	<b>18%</b>	<b>18%</b>	<b>12%</b>	<b>13%</b>
Depr and amort	671	718	1,533	2,704	3,172	3,097	3,097	2,142
<b>Depr/revenue (%)</b>	<b>13%</b>	<b>11%</b>	<b>14%</b>	<b>14%</b>	<b>13%</b>	<b>13%</b>	<b>13%</b>	<b>13%</b>
Operating cash flow	810	1,049	1,746	2,669	3,657	2,509	3,176	2,231
<b>Free cash flow</b>	<b>-409</b>	<b>-85</b>	<b>-336</b>	<b>-1,497</b>	<b>733</b>	<b>-1,024</b>	<b>494</b>	<b>-304</b>
FCF and dividend yield	2013	2014	2015	2016	2017	2018	2019	7 year avg
FCF/share (Rmb)	-0.48	-0.09	-0.32	-1.45	0.54	-0.64	0.31	-0.30
FCF yield (%)	-1.1%	-0.2%	-0.8%	-3.5%	1.3%	-1.5%	0.7%	-0.7%
<b>FCF/EV (%)</b>	<b>-0.5%</b>	<b>-0.1%</b>	<b>-0.4%</b>	<b>-1.9%</b>	<b>1.0%</b>	<b>-1.3%</b>	<b>0.6%</b>	<b>-0.4%</b>
Dividend per share (Rmb)	0.02	0.01	0.01	0.02	0.03	0.00	0.00	0.01
Dividend payout (%)	150%	6%	20%	15%	9%	0%	0%	28%
<b>Dividend yield (%)</b>	<b>0.0%</b>	<b>0.0%</b>	<b>0.0%</b>	<b>0.0%</b>	<b>0.1%</b>	<b>0.0%</b>	<b>0.0%</b>	<b>0.0%</b>

Source: Company data, WIND, Credit Suisse

**Figure 274: Balance sheet summary**

Balance Sheet (Rmb mn)	3Q20 (A)	2Q20	Diff %	6 year avg	+/- Avg
Cash and Investments	2,248	2,813	-20%	2,863	-615
Debt	12,009	12,914	-7%	11,765	244
Net debt	9,761	10,101	-3%	8,902	859
<b>Net debt/share</b>	<b>6.09</b>	<b>6.30</b>	<b>-0.21</b>	<b>7.01</b>	<b>-0.92</b>
Accts. receivable	3,851	2,958	30%	2,520	1,332
<b>DSO</b>	<b>51</b>	<b>42</b>	<b>9</b>	<b>53</b>	<b>-2</b>
Inventory	3,138	2,663	18%	1,876	1,262
<b>Inventory days</b>	<b>50</b>	<b>45</b>	<b>5</b>	<b>46</b>	<b>5</b>
Accts. payable days	91	75	16	96	-5
<b>Cash conversion days</b>	<b>10</b>	<b>13</b>	<b>-3</b>	<b>2</b>	<b>8</b>
SH Equity	13,194	13,151	0%	7,839	5,355
<b>Book value/share</b>	<b>8.2</b>	<b>8.2</b>	<b>0.0</b>	<b>5.8</b>	<b>2.4</b>

Source: Company data, WIND, Credit Suisse

**Figure 275: Financial metrics summary**

Ticker	600584.SS	Current price (Rmb)	41.8		
Stock connect %	0.0%	52-wk range (Rmb)	19.7-51.2		
Share outstanding (mn)	1,603	Mkt cap (Rmb mn)	67,016		
Daily trad vol-6m avg (mn)	73.6	Perf.	1M 3M 12M		
Daily trad vol-6m avg (Rmb)	2,453	Absolute	-3% 16% 72%		
Free floatn (%)	75.4%	Relative	-5% 12% 59%		
Rmb mn	2016	2017	2018	2019	9M20
<b>Revenue</b>	<b>19,155</b>	<b>23,856</b>	<b>23,856</b>	<b>23,526</b>	<b>18,763</b>
YoY	77.2%	24.5%	0.0%	-1.4%	15.9%
Gross profit	2,264	2,794	2,726	2,631	2,901
<b>GM (%)</b>	<b>12%</b>	<b>12%</b>	<b>11%</b>	<b>11%</b>	<b>15%</b>
Operating profit	404	492	396	317	1,242
<b>OPM (%)</b>	<b>2%</b>	<b>2%</b>	<b>2%</b>	<b>1%</b>	<b>7%</b>
Net profit	106	343	-939	89	764
<b>EPS (Rmb)</b>	<b>0.10</b>	<b>0.28</b>	<b>-0.65</b>	<b>0.06</b>	<b>0.48</b>
EPS growth (%)	100.0%	180.0%	-332.1%	-109.2%	-536.4%
P/E (x)	418	149	-64	697	71
Dividend yield (%)	0.0%	0.1%	0.0%	0.0%	n/a
P/B (x)	9.4	6.0	5.5	5.3	4.9
ROE (%)	2%	4%	-8%	1%	7%

Note: P/E and P/B in 9M20 column are based on 2020E consensus EPS and BPS.

Source: Company data, WIND, Credit Suisse

# Maxscend (300782.SZ, Outperform)

## Overview/product mix

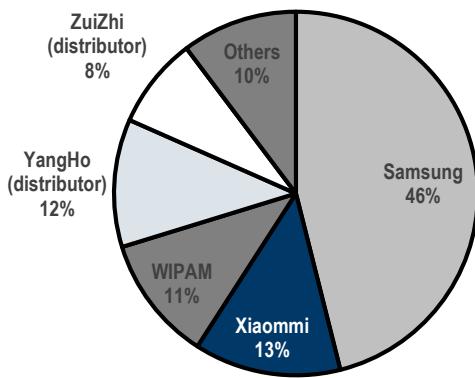
Established in 2006 and headquartered in Wuxi, China, Maxscend is the only radio frequency front-end (RF FE) IC design (fabless) company in A-share (IPO in 2019). It develops various RF FE chips and modules, including switch, LNA, antenna tuner, filter, and PA (Power Amplifier). Maxscend supplies RF chips to global top five Android OEMs and its customers include both international and Chinese customers. International customers include Samsung, Qualcomm and WiPAM. Chinese customers include Xiaomi, Huawei, vivo, OPPO, Lenovo, ZTE, and TCL among others.

**Maxscend is an emerging Chinese supplier of RF front-end and discrete components.**

Maxscend's technology portfolio includes RF CMOS (complementary metal oxide semiconductor), RF SOI (silicon on insulator), SiGe (silicon germanium), and GaAs (gallium arsenide) and it can customise solutions based on customer requirements. Maxscend continues developing new products to expand its technology portfolio beyond switch, LNA and tuner. It launched multiple SAW (Surface Acoustic Wave) filters in 2019, including GPS filter, Wi-Fi filter, and LTE filter, and has begun shipments in 1H20. It has also introduced Wi-Fi PA and began shipping Wi-Fi FEM (PA + switch + LNA) in 1H20. Besides Wi-Fi FEM, it also developed other RF modules and began volume production in 2020, including DiFEM (Diversity Receive Front-End Module), LFEM (LNA Integrated FEM), and LNA (Low Noise Amplifier) bank. All the cellular and Wi-Fi modules use Maxscend's own switch, LNA, filter and PA chips.

Maxscend recorded a 58% top line CAGR in 2017-19. Switch and tuner, LNA and module/filters/Wi-Fi accounted for 80%, 17% and 3% of total revenues in 2019. Future growth momentum lies in: (1) the global RF FE market's 10% CAGR as a result of 5G phone penetration, IoT and connected vehicles, (2) the six-time addressable market with Maxscend's expanding product portfolio, from switch/LNA/antenna tuner to also supply filter/PA/module, and (3) Maxscend's penetrating non-mobile application markets, including base station, IoT and automotive.

**Figure 276: Maxscend customer mix in 2018**

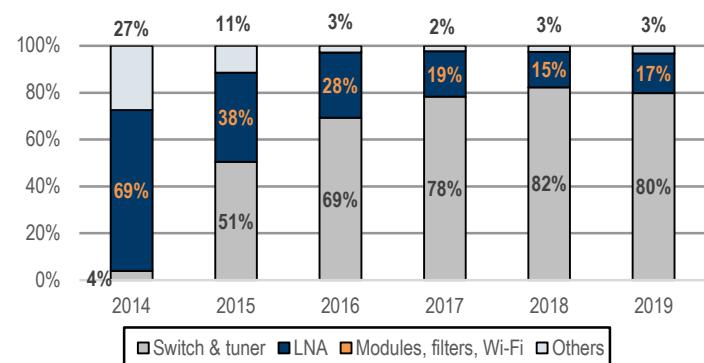


Source: Company data, Credit Suisse

## Business drivers

**New product ramp-up.** Maxscend's new RF chips have achieved decent shipment, including antenna tuning switch, LNA (Low Noise Amplifier) Bank, LFEM (LNA Front-End Module), etc. The new Wi-Fi FEM with self-produced PA (Power Amplifier) has been adopted by routers and also module customers for IoT applications. Management addressed the company's technological capabilities to penetrate the high-end market. For instance, its LNA portfolio covers both low-cost CMOS (Complementary Metal Oxide Semiconductor) and high-performance SiGe (Silicon Germanium). Further, Maxscend's RF chips have been used by global major Android OEMs for their flagship, as well as mainstream, models.

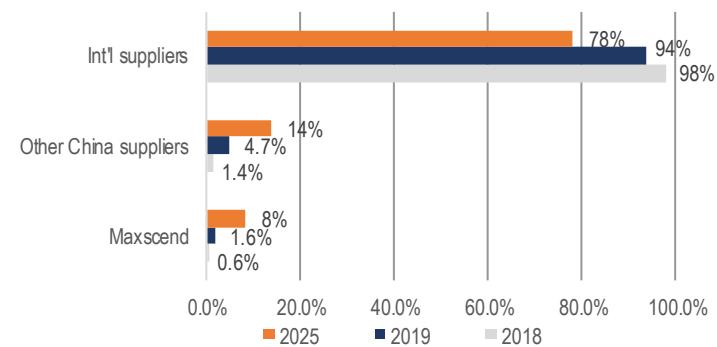
**Figure 277: Maxscend revenue mix**



Source: Company data, Credit Suisse

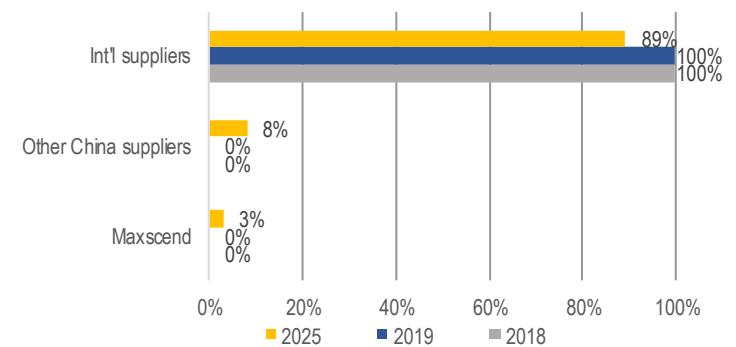
**Gaining market share.** Within China RF suppliers, we believe Maxscend is one of the most capable suppliers as of now, and should lead China RF suppliers in this wave of import substitution trend and the growing 5G market, together with other manufacturers like Vanchip and UNISOC.

**Figure 278: Global mobile RF market—China RF suppliers to increase market share from 6% in 2019 to 22% in 2025E**



Source: Company data, Credit Suisse estimates

**Figure 279: Global non-mobile RF market—China suppliers to expand market share from 0% in 2019 to 11% in 2025E**



Source: Company data, Credit Suisse estimates

## Near-term trends

4Q is traditionally a low season and 4Q20 is no exception, especially this year having seen some customer adjustments. But recently other Android OEMs have raised orders and forecasts. As a result of demand recovery, rising 5G penetration and other Android OEMs' higher demands, a healthy growth in 1Q-2Q21 is expected, according to management.

RF (Radio frequency) semiconductor usually records declining ASP and GM during its lifetime due to competition, and thus Maxscend relies on continuous launch of new products to maintain ASP and margin. As the pandemic delayed new product launches in 1H20, unfavourable product resulted in a sequential decline in GM in 3Q. But, management suggests rising revenue contribution from new products to help GM recover going forward.

**Figure 280: 3Q19-3Q20 and 2016-19 financial summary**

Rmb mn	Quarters					Years			
	3Q19	4Q19	1Q20	2Q20	3Q20	2016	2017	2018	2019
Sales	470	528	451	547	975	385	592	560	1,512
QoQ/YoY	41%	12%	-15%	21%	78%	247%	54%	-5%	170%
Gross profit	247	273	237	288	489	239	331	290	793
GM %	53%	52%	53%	53%	50%	62%	56%	52%	52%
R&D	35	51	51	39	48	59	48	68	138
SG&A	19	23	14	12	15	84	63	59	85
Op income	193	199	173	237	426	97	220	163	571
OPM %	41%	38%	38%	43%	44%	25%	37%	29%	38%
Financing cost (net)	-13	5	-4	0	5	-3	8	-15	-12
Net income	170	175	152	201	364	84	170	162	497
Net margin %	36%	33%	34%	37%	37%	22%	29%	29%	33%
Shares	100	100	100	180	180	12	75	75	100
EPS (Rmb)	1.83	1.81	1.52	0.44	2.03	1.17	2.27	2.16	5.68

Source: Company data, WIND, Credit Suisse

## Valuation

At the current price of Rmb550.2 Maxscend has a market cap of Rmb99 bn and trades at 96x/74.4x 2020-21 CSe EPS and 37.3x/26x 2020-21 CSe BPS. We rate Maxscend OUTPERFORM with a DCF-based target price of Rmb561. Maxscend has a healthy balance

sheet, with net cash accounting for 51% of total equity and net cash per share of Rmb6.59 vs six-year average of Rmb4.21. Maxscend recorded free cash flow (FCF) of Rmb128 mn and Rmb98 mn in 2017-18, while 2019 FCF declined to -Rmb41 mn on increased working capital and capex.

**Figure 281: Balance sheet summary**

Balance Sheet (Rmb mn)	3Q20 (A)	2Q20	Diff %	6 year avg	+/- Avg
Cash and Investments	1,185	908	31%	259	927
Debt	0	0	n/a)	4	-4
Net debt	-1,185	-908	31%	-255	-931
<b>Net debt/share</b>	<b>-6.59</b>	<b>-5.04</b>	<b>-1.54</b>	<b>-4.21</b>	<b>-2.38</b>
Accts. receivable	714	442	62%	87	626
<b>DSO</b>	<b>66</b>	<b>73</b>	<b>-7</b>	<b>42</b>	<b>24</b>
Inventory	409	540	-24%	114	295
<b>Inventory days</b>	<b>76</b>	<b>188</b>	<b>-112</b>	<b>171</b>	<b>-95</b>
Accts. payable days	22	33	-12	55	-33
<b>Cash conversion days</b>	<b>120</b>	<b>227</b>	<b>-107</b>	<b>159</b>	<b>-39</b>
SH Equity	2,312	1,960	18%	443	1,869
<b>Book value/share</b>	<b>12.8</b>	<b>10.9</b>	<b>2.0</b>	<b>6.9</b>	<b>5.9</b>

Source: Company data, WIND, Credit Suisse

**Figure 282: Financial metrics summary**

Ticker	300782.SZ	Current price (Rmb)	550.2		
Stock connect %	0.0%	52-wk range (Rmb)	209.7-571.1		
Share outstanding (mn)	180	Mkt cap (Rmb mn)	99,032		
Daily trad vol-6m avg (mn)	2.3	Perf.	<b>1M</b> <b>3M</b> <b>12M</b>		
Daily trad vol-6m avg (Rmb mn)	1,115	Absolute	41% 47% 143%		
Free floatn (%)	58.8%	Relative	38% 48% 127%		
Year	2016	2017	2018	2019	9M20
Revenue (Rmb mn)	385	592	560	1,512	1,972
YoY	247.2%	53.6%	-5.3%	170.0%	100.3%
Gross profit (Rmb mn)	239	331	290	793	1,014
GM (%)	62%	56%	52%	52%	51%
Operating profit (Rmb mn)	97	220	163	571	836
OPM (%)	25%	37%	29%	38%	42%
Net profit (Rmb mn)	84	170	162	497	718
EPS (Rmb)	1.17	2.27	2.16	5.68	3.99
EPS growth (%)	606.8%	94.2%	-4.4%	162.5%	2.9%
P/E (x)	472	243	254	97	107
Dividend yield (%)	0.0%	0.0%	0.0%	0.4%	n/a
P/B (x)	46.7	132.9	86.8	32.3	38.1
ROE (%)	58%	55%	34%	29%	40%

Note: P/E and P/B in 9M20 column are based on 2020E consensus EPS and BPS.

Source: Company data, WIND, Credit Suisse

**Figure 283: Cash flow statement summary**

Rmb mn	2015	2016	2017	2018	2019	5 year avg
Revenue	111	385	592	560	1,512	632
Capex	1	5	16	29	96	29
<b>Capex/revenue (%)</b>	<b>1%</b>	<b>1%</b>	<b>3%</b>	<b>5%</b>	<b>6%</b>	<b>3%</b>
Depr and amort	0	1	3	8	20	7
<b>Depr/revenue (%)</b>	<b>0%</b>	<b>0%</b>	<b>1%</b>	<b>1%</b>	<b>1%</b>	<b>1%</b>
Operating cash flow	9	95	129	134	56	84
<b>Free cash flow</b>	<b>-6</b>	<b>39</b>	<b>128</b>	<b>98</b>	<b>-41</b>	<b>44</b>
FCF and dividend yield	2015	2016	2017	2018	2019	5 year avg
FCF/share (Rmb)	-0.58	3.23	1.70	1.31	-0.41	1.05
FCF yield (%)	-0.1%	0.6%	0.3%	0.2%	-0.1%	0.2%
<b>FCF/EV (%)</b>	<b>0.0%</b>	<b>0.0%</b>	<b>0.1%</b>	<b>0.1%</b>	<b>0.0%</b>	<b>0.0%</b>
Dividend per share (Rmb)	0.00	0.00	0.00	0.00	2.00	0.40
Dividend payout (%)	0%	0%	0%	0%	35%	7%
<b>Dividend yield (%)</b>	<b>0.0%</b>	<b>0.0%</b>	<b>0.0%</b>	<b>0.0%</b>	<b>0.4%</b>	<b>0.1%</b>

Source: Company data, WIND, Credit Suisse

# Montage (688008.SS, Neutral)

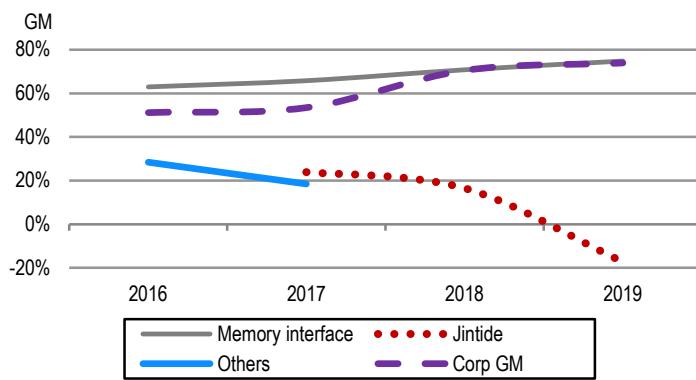
## Overview/product mix

Founded in 2004 and headquartered in Shanghai, Montage is an IC Design (fabless) company supplying memory interface chips for the server market since 2008. Montage was co-founded by Mr Chonghe Yang, Chairman and CEO, and Mr Stephen Kuang-lo Tai, President. Mr Tai also co-founded Marvell Technology in 1995 and served as Director of R&D in 1995-2003. In 2017, Montage had 17% revenue from the consumer applications (TV, over-the-top set-up box chips) and it disposed of this consumer business in 2017 to focus on the server chip business. With now virtually all revenues from memory interface chips, Montage has been developing new chip products to fuel future growth for servers and cloud computing. Further, Montage has indicated it continues to seek supply chain investment and M&A opportunities. Montage had 392 employees as of 2020, including 260 R&D employees (66% of total). Montage was listed on the A-share Sci-Tech Board in July 2019.

Montage recorded 9% CAGR in 2017-19. After disposing of the consumer electronics chip, Montage earns nearly all its revenues from memory interface chip. Montage's Jintide® server platform started small volume shipments in 2017, while the volume production of its PCIe (Peripheral Component Interface Express) 4.0 retimer started in September 2020. The company's memory interface chip has a decent GM of nearly 70%.

**Montage supplies memory interfaces for the server market and a local tailored server platform**

**Figure 284: Montage's gross margin performance**



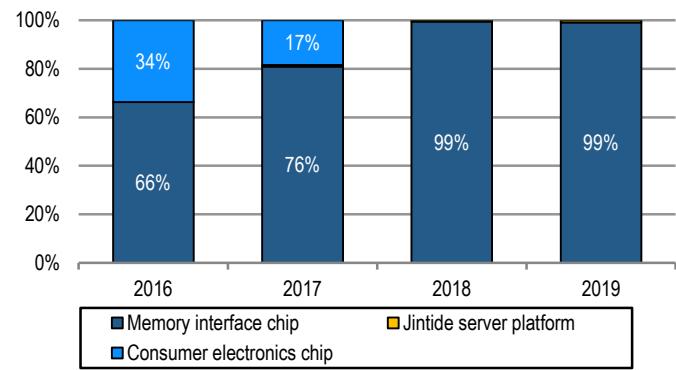
Source: Company data, WIND, Credit Suisse

## Business drivers

**Memory interface chip.** Montage supplies memory interface chips for DDR modules used by servers and data centres and has 40-50% market share globally, with the remaining 50-60% held by IDT and Rambus. Montage is expected to maintain the same market share, as it is difficult to gain share from the 40-50% level unless the competitor(s) has any new product issued. As such, we expect its memory interface business to grow in line with the global memory interface market's 25% CAGR in 2021-25. The growth should be driven by the global server market's 4% unit CAGR, spec migration from DDR4 to DDR5/6, rising data buffer consumption, and new chipset from DDR5. Also, while the market has been expecting next-generation DDR5 products, we remind that mass revenue may not come until 2022, as the industry has to wait for Intel/AMD's next-generation server CPU supporting DDR 5 (expected to launch in 2021-22).

**Jintide® server platform.** Montage has been working with Tsinghua University and Intel to develop Jintide® server platform since 2016, consisting of Jintide® server CPU and Montage's memory solution. Jintide® server CPU is based on Intel's latest generation Xeon server CPU die (x86 architecture), with Montage's security chips integrated to achieve functions of PrC (Pre-Check) and DSC (Dynamic Security Check, developed by Tsinghua University). In the China server market, we expect Montage's Jintide server platform to be one of the major beneficiaries

**Figure 285: Montage's revenue mix**

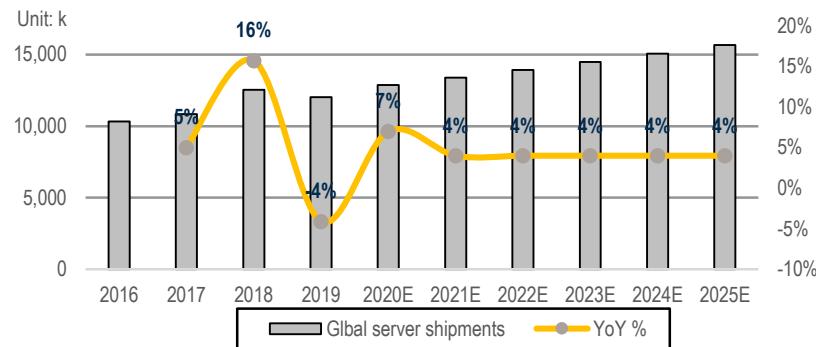


Source: Company data, WIND, Credit Suisse

of China's localisation plan. Montage's Jintide® server platform provides a 'localisation' option for China server market with Intel processors (thus no pain for server OEM/customers to switch to Montage, compared to other ARM-based China CPUs) and also domestically developed real-time security monitoring and memory protection technology. We also believe that Intel, who invested in Montage in 2005-06 and remains the #2 top shareholder today, is supportive of Montage's Jintide® server platform in China. Though Montage has not signed any long-term procurement contract with Intel so far, we believe Intel is supportive of Montage's Jintide® server platform in China. The higher the market share Jintide® secures, the more market share Intel secures against AMD/Phytium/Huawei.

**PCIe 4.0 retimer.** Montage has announced mass production of its new PCIe 4.0 retimers for servers and data centres in September 2020, and the volume shipments should kick off from 1H21. PCIe retimers are adopted by servers to enhance data transmission reliability and enable longer PCIe interconnect cables and/or PCB traces, enabling system scalability. Currently Parade is the only supplier globally for PCIe 4.0 retimers. So we believe there is penetration opportunity for Montage as server OEMs are unlikely to be happy with one supplier to dominate the market. We expect 6%/10%/14% market share for Montage in 2021-23 in global PCIe retimer market. Montage has started developing next-generation PCIe 5.0 retimers and targets to launch in line with Intel/AMD's new CPU schedule (2021-22).

**Figure 286: Our model assumes global server shipments at 4% CAGR**



Source: IDC, Gartner, Credit Suisse estimates

## Near-term trends

Due to the pandemic and high cloud demand, many customers had aggressive inventory builds in 2Q, resulting in the industry-wide destocking in 3Q. Management indicated customers' destocking had come to an end by October and the supply chain's inventory level now approaches a normal level. However, uncertainties remain in 4Q as the second outbreak of the pandemic and deteriorating global enterprise cash flow might delay IT capex and server demand.

Its Jintide server platform won orders in the financial and transportation sectors in China. As the Jintide CPU is still under the marketing phase and has very low GM, the corporate 3Q GM was dragged down by 4.1 pp QoQ. Its memory interface chips' GM also decreased ~2 pp QoQ. Gen2+ DDR4 interface chip accounted for over 70% of total interface chip sales in 3Q, with the rest to be Gen2, and this might reach nearly 100% in 2021.

**Figure 287: 3Q19-3Q20 and 2016-19 financial summary**

Rmb mn	Quarters					Years			
	3Q19	4Q19	1Q20	2Q20	3Q20	2016	2017	2018	2019
Sales	505	353	496	594	379	845	1,228	1,758	1,738
QoQ/YoY	6%	-30%	40%	20%	-36%	n/a	45%	43%	-1%
Gross profit	381	258	360	443	267	433	657	1,240	1,285
<b>GM %</b>	<b>75%</b>	<b>73%</b>	<b>73%</b>	<b>75%</b>	<b>71%</b>	<b>51%</b>	<b>53%</b>	<b>71%</b>	<b>74%</b>
R&D	47	70	97	67	55	198	188	277	267
SG&A	34	34	66	67	67	105	124	241	170
Op income	300	154	197	309	146	130	344	722	849
<b>OPM %</b>	<b>59%</b>	<b>44%</b>	<b>40%</b>	<b>52%</b>	<b>39%</b>	<b>15%</b>	<b>28%</b>	<b>41%</b>	<b>49%</b>
Financing cost (net)	-66	0	-40	-8	-3	-15	3	-35	-101
Net income	293	189	263	339	276	93	347	737	933
<b>Net margin %</b>	<b>58%</b>	<b>54%</b>	<b>53%</b>	<b>57%</b>	<b>73%</b>	<b>11%</b>	<b>28%</b>	<b>42%</b>	<b>54%</b>
Shares	1,130	1,130	1,130	1,130	1,130	757	757	1,017	1,130
<b>EPS (Rmb)</b>	<b>0.27</b>	<b>0.17</b>	<b>0.23</b>	<b>0.30</b>	<b>0.00</b>	<b>0.12</b>	<b>0.46</b>	<b>0.87</b>	<b>0.88</b>

Source: Company data, WIND, Credit Suisse

## Valuation

At the current price of Rmb78, Montage has a market cap of Rmb88.2 bn and trades at 83.2x/79.6x 2020-21 CSe EPS and 11.7x/10.5x 2020-21 CSe BPS. We rate Montage NEUTRAL with a DCF-based TP of Rmb82. Montage has a healthy balance sheet, with net cash accounting for 87% of total equity and net cash per share of Rmb6.08 vs four-year average of Rmb2.91. Montage recorded strong FCF of Rmb350 mn, Rmb538 mn, and Rmb909 mn in 2017-19.

**Figure 288: Cash flow statement summary**

Rmb mn	2017	2018	2019	3 year avg
Revenue	1,228	1,758	1,738	1,574
Capex	58	18	22	32
<b>Capex/revenue (%)</b>	<b>5%</b>	<b>1%</b>	<b>1%</b>	<b>2%</b>
Depr and amort	19	22	32	24
<b>Depr/revenue (%)</b>	<b>2%</b>	<b>1%</b>	<b>2%</b>	<b>2%</b>
Operating cash flow	227	969	869	688
<b>Free cash flow</b>	<b>350</b>	<b>538</b>	<b>909</b>	<b>599</b>
FCF and dividend yield	2017	2018	2019	3 year avg
FCF/share (Rmb)	0.46	0.53	0.80	0.60
FCF yield (%)	0.6%	0.7%	1.0%	0.8%
<b>FCF/EV (%)</b>	<b>0.4%</b>	<b>0.7%</b>	<b>1.1%</b>	<b>0.7%</b>
Dividend per share (Rmb)	0.00	0.00	0.30	0.10
Dividend payout (%)	0%	0%	34%	11%
<b>Dividend yield (%)</b>	<b>0.0%</b>	<b>0.0%</b>	<b>0.4%</b>	<b>0.1%</b>

Source: Company data, WIND, Credit Suisse

**Figure 289: Balance sheet summary**

Balance Sheet (Rmb mn)	3Q20 (A)	2Q20	Diff %	4 year avg	+/- Avg
Cash and Investments	6,872	7,709	-11%	3,045	3,827
Debt	0	0	n/a)	0	0
Net debt	-6,872	-7,709	-11%	-3,045	-3,827
<b>Net debt/share</b>	<b>-6.08</b>	<b>-6.82</b>	<b>0.74</b>	<b>-2.91</b>	<b>-3.17</b>
Accts. receivable	120	122	-1%	138	-17
<b>DSO</b>	<b>29</b>	<b>18</b>	<b>10</b>	<b>34</b>	<b>-6</b>
Inventory	199	177	12%	167	32
<b>Inventory days</b>	<b>161</b>	<b>106</b>	<b>55</b>	<b>129</b>	<b>32</b>
Accts. payable days	64	72	-8	72	-9
<b>Cash conversion days</b>	<b>126</b>	<b>53</b>	<b>73</b>	<b>91</b>	<b>35</b>
SH Equity	7,943	7,736	3%	3,254	4,689
<b>Book value/share</b>	<b>7.0</b>	<b>6.8</b>	<b>0.2</b>	<b>3.2</b>	<b>3.8</b>

Source: Company data, WIND, Credit Suisse

**Figure 290: Financial metrics summary**

Ticker	688008.SS	Current price (Rmb)	78.0
Stock connect %	0.0%	52-wk range (Rmb)	63.5-117.6
Share outstanding (mn)	1,130	Mkt cap (Rmb mn)	88,171
Daily trad vol-6m avg (mn)	5.8	Perf.	1M 3M 12M
Daily trad vol-6m avg (Rmb mn)	512	Absolute	6% -10% 23%
Free floatn (%)	37.2%	Relative	4% -9% 7%
Year	2016	2017	2018
Revenue (Rmb mn)	845	1,228	1,758
YoY	n/a	45.3%	43.2%
Gross profit (Rmb mn)	433	657	1,240
GM (%)	51%	53%	71%
Operating profit (Rmb mn)	130	344	722
OPM (%)	15%	28%	41%
Net profit (Rmb mn)	93	347	737
EPS (Rmb)	0.12	0.46	0.87
EPS growth (%)	n/a	283.3%	89.1%
P/E (x)	650	170	90
Dividend yield (%)	0.0%	0.0%	0.0%
P/B (x)	66.9	49.8	21.9
ROE (%)	11%	29%	20%
			13% 15%

Note: P/E and P/B in 9M20 column are based on 2020E consensus EPS and BPS.

Source: Company data, WIND, Credit Suisse

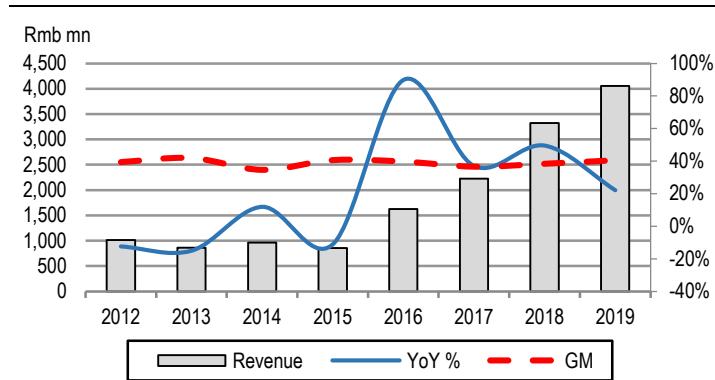
# Naura (002371.SZ, Not Covered)

## Overview/product mix

Headquartered in Beijing, Naura was established in 2016, through the strategic merger between Sevenstar Electronics and Beijing North Microelectronics. Its controlling shareholder is Beijing Electronics Holdings. Naura mainly engages in semiconductor equipment, vacuum equipment, new energy lithium battery equipment and precision components businesses. Naura achieved revenue of Rmb4.1 bn in 2019, with 17% CAGR in 2012-19. About 80% of total revenue comes from electronic equipment with about 21% from electronic component. The company recorded stable GM of roughly 40% in the past years.

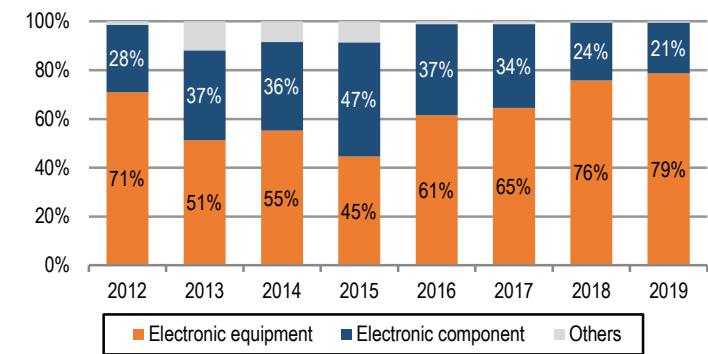
**Naura is an emerging Chinese front-end equipment supplier with diversified product line.**

**Figure 291: NAURA recorded 17% revenue CAGR in 2012-19**



Source: Company data, Credit Suisse

**Figure 292: Electronic equipment is the major revenue contributor**



Source: Company data, Credit Suisse

Naura is one of the leading semiconductor equipment suppliers in China. The product portfolio includes PVD (Physical Vapor Deposition) equipment, CVD (Chemical Vapor Deposition) equipment, high-temperature diffusion equipment, cleaning equipment, gas quality control equipment, etching equipment, furnace tube, etc. Naura has entered the supply chain of major foundries/IDMs in China, like YMTC, SMIC, Hua Hong, Huali, Innotron Memory, XMC, etc.

## Business drivers

The company's growth opportunities lie in: (1) higher penetration rate at China foundries/IDMs thanks to the import substitution trend, (2) continuously R&D on equipment for more advanced nodes and equipment genre expansion, (3) Mini/Micro LED driving equipment replacement and ramp-up of OLED capacities in China, and (4) higher adoption of 5G driving the demand for compound semi equipment.

**Etching equipment.** Naura's self-developed 8"/12" silicon etching machine and 8" Aluminum etching machine for 28nm and above nodes have achieved mass production. Meanwhile, its 12" silicon etching machine for 14nm is under qualification by mainstream foundries.

**PVD equipment.** Naura's TiN Hardmask PVD system, Al Pad PVD system have been applied on 28nm and 14nm nodes. Besides, its TiN Hardmask PVD system has become baseline equipment for SMIC's 28nm line, and Al Pad PVD system has broken into the supply chain of international foundries/IDMs for logic, memory and display applications.

**CVD equipment.** Naura's has completed the development of a comprehensive CVD product portfolio, including PECVD (Plasma Enhanced CVD), APCVD (Atmospheric Pressure CVD), LPCVD (Low Pressure CVD), ALD (Atomic Layer Deposition), etc. Its ALD equipment could cover 28-14nm logic process.

## Near-term trends

Naura reported 3Q20 revenue increased 34% QoQ to Rmb1.7 bn, with GM at 34%, down 2 pp QoQ. But the increased opex offset the revenue growth, and operating income decreased 43% QoQ to Rmb96 mn, with OPM down 8 pp QoQ to 6%.

## Valuation

At the current price of Rmb178.9, Naura has a market cap of Rmb88.6 bn and trades at 187x/128x consensus 2020-21E EPS and 13.8x/12.5x consensus 2020-21E BPS. The company has maintained a healthy balance sheet, with net cash accounting for 13% of total equity and net cash per share of Rmb1.66 vs six-year average of Rmb0.27. Free cash flow (FCF) was -Rmb760 mn, -Rmb435 mn, and -Rmb205 mn in 2017-19.

**Figure 293: Balance sheet summary**

Balance Sheet (Rmb mn)	3Q20 (A)	2Q20	Diff %	6 year avg	+/- Avg
Cash and Inv estments	2,363	2,335	1%	1,056	1,307
Debt	1,539	1,479	4%	919	620
Net debt	-825	-856	-4%	-138	-687
<b>Net debt/share</b>	<b>-1.66</b>	<b>-1.73</b>	<b>0.07</b>	<b>-0.27</b>	<b>-1.39</b>
Accts. receivable	2,259	1,861	21%	1,054	1,205
<b>DSO</b>	<b>123</b>	<b>135</b>	<b>-13</b>	<b>198</b>	<b>-76</b>
Inventory	4,686	4,441	6%	1,837	2,849
<b>Inventory days</b>	<b>383</b>	<b>506</b>	<b>-123</b>	<b>462</b>	<b>-78</b>
Accts. payable days	215	243	-28	246	-31
<b>Cash conversion days</b>	<b>291</b>	<b>399</b>	<b>-107</b>	<b>414</b>	<b>-123</b>
SH Equity	6,297	6,009	5%	3,267	3,030
<b>Book value/share</b>	<b>12.7</b>	<b>12.1</b>	<b>0.6</b>	<b>7.4</b>	<b>5.3</b>

**Figure 294: Financial metrics summary**

Ticker	002371.SZ	Current price (Rmb)	178.9		
Stock connect %	0.0%	52-wk range (Rmb)	70.6-229.3		
Share outstanding (mn)	495	Mkt cap (Rmb mn)	88,571		
Daily trad vol-6m avg (mn)	10.4	Perf. 1M 3M 12M			
Daily trad vol-6m avg (Rmb mn)	1,527	Absolute	13% -10% 153%		
Free floatn (%)	92.5%	Relative	11% -10% 138%		
Year	2016	2017	2018	2019	9M20
<b>Revenue (Rmb mn)</b>	<b>1,622</b>	<b>2,223</b>	<b>3,324</b>	<b>4,058</b>	<b>3,836</b>
YoY	89.9%	37.0%	49.5%	22.1%	40.2%
Gross profit (Rmb mn)	645	813	1,276	1,645	1,349
<b>GM (%)</b>	<b>40%</b>	<b>37%</b>	<b>38%</b>	<b>41%</b>	<b>35%</b>
Operating profit (Rmb mn)	-378	-125	232	295	310
<b>OPM (%)</b>	<b>-23%</b>	<b>-6%</b>	<b>7%</b>	<b>7%</b>	<b>8%</b>
Net profit (Rmb mn)	93	126	234	309	327
<b>EPS (Rmb)</b>	<b>0.22</b>	<b>0.27</b>	<b>0.51</b>	<b>0.67</b>	<b>0.67</b>
EPS growth (%)	100.2%	24.6%	86.0%	31.5%	38.9%
P/E (x)	812	652	351	267	187
Dividend yield (%)	0.0%	0.0%	0.0%	0.0%	n/a
BPS (Rmb)	7.0	7.2	7.7	11.9	12.7
P/B (x)	25.7	24.8	23.1	15.0	13.8
ROE (%)	3%	4%	7%	5%	8%

Note: P/E and P/B in 9M20 column are based on 2020E consensus EPS and BPS.

Source: Company data, WIND, Credit Suisse

Source: Company data, WIND, Credit Suisse

**Figure 295: Cash flow statement summary**

Rmb mn	2011	2012	2013	2014	2015	2016	2017	2018	2019	9 year avg
Revenue	1,156	1,012	860	962	854	1,622	2,223	3,324	4,058	1,786
Capex	229	374	166	196	67	178	232	244	171	206
<b>Capex/revenue (%)</b>	<b>20%</b>	<b>37%</b>	<b>19%</b>	<b>20%</b>	<b>8%</b>	<b>11%</b>	<b>10%</b>	<b>7%</b>	<b>4%</b>	<b>15%</b>
Depr and amort	40	48	44	68	83	193	200	265	307	139
<b>Depr/revenue (%)</b>	<b>3%</b>	<b>5%</b>	<b>5%</b>	<b>7%</b>	<b>10%</b>	<b>12%</b>	<b>9%</b>	<b>8%</b>	<b>8%</b>	<b>7%</b>
Operating cash flow	-28	-22	-26	93	-44	-201	32	-20	-941	-129
<b>Free cash flow</b>	<b>-233</b>	<b>-266</b>	<b>-164</b>	<b>1</b>	<b>29</b>	<b>-880</b>	<b>-760</b>	<b>-435</b>	<b>-205</b>	<b>-324</b>
<b>FCF and dividend yield</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>	<b>2014</b>	<b>2015</b>	<b>2016</b>	<b>2017</b>	<b>2018</b>	<b>2019</b>	<b>9 year avg</b>
FCF/share (Rmb)	-2.75	-1.51	-0.47	0.00	0.08	-1.92	-1.66	-0.95	-0.42	-1.07
FCF yield (%)	-1.5%	-0.8%	-0.3%	0.0%	0.0%	-1.1%	-0.9%	-0.5%	-0.2%	-0.6%
<b>FCF/EV (%)</b>	<b>-0.3%</b>	<b>-0.3%</b>	<b>-0.2%</b>	<b>0.0%</b>	<b>0.0%</b>	<b>-1.0%</b>	<b>-0.9%</b>	<b>-0.5%</b>	<b>-0.2%</b>	<b>-0.4%</b>
Dividend per share (Rmb)	0.10	0.10	0.10	0.00	0.03	0.02	0.03	0.05	0.06	0.06
Dividend payout (%)	6%	11%	34%	0%	27%	10%	10%	9%	13%	
<b>Dividend yield (%)</b>	<b>0.1%</b>	<b>0.1%</b>	<b>0.1%</b>	<b>0.0%</b>	<b>0.0%</b>	<b>0.0%</b>	<b>0.0%</b>	<b>0.0%</b>	<b>0.0%</b>	<b>0.0%</b>

Source: Company data, WIND, Credit Suisse

# NSIG (688126.SS, Not Covered)

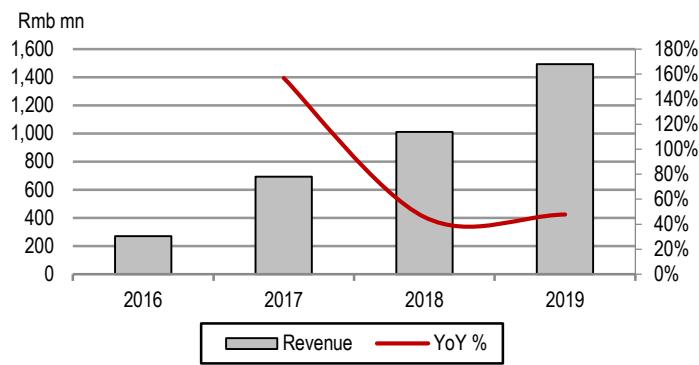
## Overview/product mix

NSIG (National Silicon Industry Group) was formed through the consolidation of three entities, including Zing Semiconductor, Shanghai Simgui and Okmetic. The company also tried to acquire Siltronic in 2016 for technology and capacity, but it did not come through due to concerns on IP leakage and the industry was at the inflection point for pricing upturn from more balanced supply-demand following years of loss.

**NSIG consolidated three wafer suppliers to target share gains in silicon wafers.**

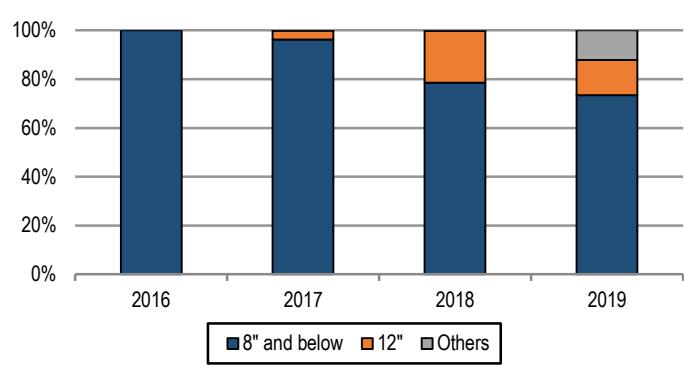
Zing Semiconductor is leading its China peers on the mass production of 300mm silicon wafer, some of which has been qualified by GlobalFoundries, SMIC, Hua Hong, Huali, YMTC (Yangtze Memory Technologies Co.) and CR Micro. Shanghai Simgui produces <8" EPI and SOI wafers and it licenses SOI technology from SOITEC. Based in Finland, Okmetic is the seventh-largest silicon wafer supplier for wafers used in manufacturing MEMS, sensor, discrete and analog circuits. Storage device is the largest end market for NSIG's wafer, followed by logic and power IC. NSIG's consolidated revenue was Rmb694 mn, Rmb1,010 mn and Rmb1,493 mn in 2017-19, mainly from the sales of 8" wafers.

**Figure 296: NISG revenue has been growing fast**



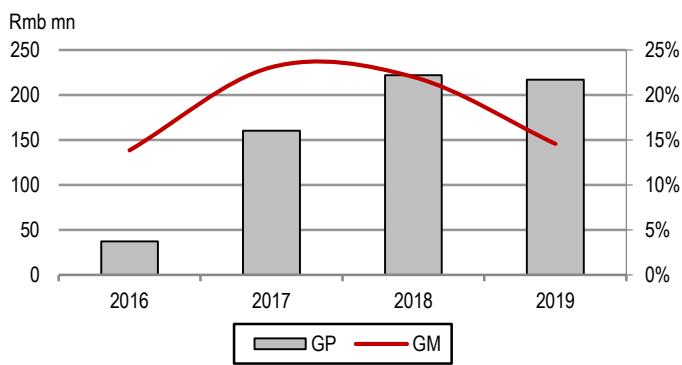
Source: Company data, Credit Suisse

**Figure 297: More revenue contribution from 12"**



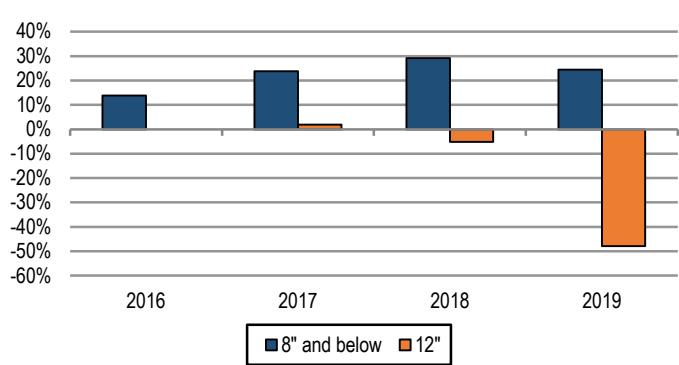
Source: Company data, Credit Suisse

**Figure 298: Gross margin was affected by 12" ramp up**



Source: Company data, Credit Suisse

**Figure 299: 12" still has negative GM**



Source: Company data, Credit Suisse

## Business drivers

**Capacity expansion on track.** The company maintained its capacity plan of 200k wafers per month for 300mm product by end-2020, vs 150k in end-2019. New manufacturing tools have arrived in Shanghai and are under installation as of September. Management suggests 300mm capacity should have a major increase in 2021. Storage device is the largest end-market for NSIG's wafer, followed by logic and power ICs.

**Qualification in progress.** NSIG has passed qualification for 28 nm and matured nodes and 64-layer 3D NAND, with the qualification for 14nm logic IC, 19nm DRAM and 128-layer 3D NAND in progress. The company is also trying to qualify with foundries outside China.

**Competition.** Management thinks NSIG still has some gap with global competitors regarding technical specifications and yield. But the company is confident in its technology development and shipment growth given the big domestic demand in China and support from government. So far, NSIG is the largest silicon wafer supplier with strongest technical competence in mainland China.

**Wafer price in up cycle.** Management suggests wafer price is likely to stay flat or steadily decline in the long term. But work-from-home, cloud service, and IoT trend should fuel wafer demand and result in wafer price upside in the next one to two years.

## Near-term trends

NSIG reported its 3Q20 revenue grew 4% QoQ to Rmb453 mn, with GM down 4 pp QoQ to 14%. The low yield rate of 300mm silicon wafer during capacity ramp-up might be a major reason for the low GM performance. The company recorded fair value gain from investment of Rmb108 mn in 3Q partly, offsetting the lower GM performance, and NI of Rmb81 mn.

## Valuation

At the current price of Rmb33.4 NSIG has a market cap of Rmb82.7 bn and trades at 11.2x consensus 2020E BPS and 41.9x/31.4x consensus 2020-21E EV/sales. Net debt accounted for only 5% of total equity by 3Q20. Since the company is still investing heavily in capacity build and technology improvement, it recorded free cash flow of -Rmb666 mn, -Rmb906 mn and -Rmb1099mn in 2017-19.

**Figure 300: Balance sheet summary**

Balance Sheet (Rmb mn)	3Q20 (A)	2Q20	Diff %	4 year avg	+/- Avg
Cash and Investments	1,997	1,472	36%	701	1,296
Debt	2,382	1,705	40%	1,196	1,186
Net debt	385	234	65%	495	-110
<b>Net debt/share</b>	<b>0.16</b>	<b>0.09</b>	<b>0.06</b>	<b>0.26</b>	<b>-0.11</b>
Accts. receivable	374	350	7%	175	199
<b>DSO</b>	<b>74</b>	<b>72</b>	<b>2</b>	<b>77</b>	<b>-2</b>
Inventory	545	509	7%	205	340
<b>Inventory days</b>	<b>126</b>	<b>128</b>	<b>-2</b>	<b>108</b>	<b>18</b>
Accts. payable days	46	51	-5	68	-22
<b>Cash conversion days</b>	<b>154</b>	<b>149</b>	<b>5</b>	<b>116</b>	<b>38</b>
SH Equity	8,294	7,498	11%	3,583	4,711
<b>Book value/share</b>	<b>3.3</b>	<b>3.0</b>	<b>0.3</b>	<b>1.9</b>	<b>1.5</b>

Source: Company data, WIND, Credit Suisse

**Figure 301: Financial metrics summary**

Ticker	688126.SS	Current price (Rmb)	33.4		
Stock connect %	0.0%	52-wk range (Rmb)	0-63.9		
Share outstanding (mn)	2,480	Mkt cap (Rmb mn)	82,791		
Daily trad vol-6m avg (mn)	76.5	<b>Perf.</b>	<b>1M</b> <b>3M</b> <b>12M</b>		
Daily trad vol-6m avg (Rmb mn)	2,444	Absolute	3% -24% n/a		
Free floatn (%)	19.3%	Relative	1% -23% n/a		
Year	2016	2017	2018	2019	9M20
<b>Revenue (Rmb mn)</b>	<b>270</b>	<b>694</b>	<b>1,010</b>	<b>1,493</b>	<b>1,307</b>
YoY	n/a	156.9%	45.6%	47.7%	22.1%
Gross profit (Rmb mn)	37	160	222	217	200
<b>GM (%)</b>	<b>14%</b>	<b>23%</b>	<b>22%</b>	<b>15%</b>	<b>15%</b>
Operating profit (Rmb mn)	-96	-93	-73	-115	-86
<b>OPM (%)</b>	<b>-35%</b>	<b>-13%</b>	<b>-7%</b>	<b>-8%</b>	<b>-7%</b>
Net profit (Rmb mn)	-87	224	11	-90	-2
<b>EPS (Rmb)</b>	<b>-0.05</b>	<b>0.12</b>	<b>0.01</b>	<b>-0.05</b>	<b>0.00</b>
EPS growth (%)	n/a	n/a	-95.2%	-962.7%	n/a
P/E (x)	-695	284	5,958	-691	-982
Dividend yield (%)	0.0%	0.0%	0.0%	0.0%	n/a
BPS (Rmb)	1.3	1.8	1.7	2.7	3.3
P/B (x)	25.7	18.1	19.7	12.2	11.2
ROE (%)	-4%	6%	0%	-2%	-1%

Note: P/E and P/B in 9M20 column are based on 2020E consensus EPS and BPS.

Source: Company data, WIND, Credit Suisse

# Sanan (600703.SS, Neutral)

## Overview/product mix

Founded in 2000 and headquartered in Xiamen, Sanan Optoelectronics develops and produces light emitting diode (LED) products and chips. In recent years, it focus more in compound semiconductor besides mini LED. Sanan is now China's hope for compound semi manufacturing, although its compound semi capability is largely behind international peers. In 1H20, Sanan has 65% revenue from LED product, 24% from sales of materials/scrap & others, and 11% from IC business.

**Sanan is a leading LED supplier and targets growth in compound semiconductor manufacturing.**

## Business drivers

**IC business.** The IC business grew 41% from Rmb171 mn in 2018 to Rmb241 mn in 2019. In 1H20, it also grew revenue to Rmb375 mn, +680% YoY/+95% HoH, and with net loss narrowed to Rmb11 mn in 1H20. Its 0.1/0.15/0.25um pHEMT process has reached mass production. For RF filter, it has planned a comprehensive supply chain in Quanzhou Nan'an manufacturing site with vertical integration of R&D design, substrate materials, chip manufacturing, packaging and testing. It expects capacity to reach 120 mn units/month by 2Q21. For laser, its 25G DFB has passed international qualification and started small production; it expects to complete the capacity expansion plan by end-2020 to reach 1 mn units/month. Sanan has acquired a 100% stake of Beidian New Material from its related party at a price of Rmb381.5 mn to break the bottleneck of materials supply and expand scale.

**LED cycle bottoming out.** We anticipate 15-20% YoY decline in the China LED market in 2020 after a muted growth in 2019. LED chips market will likely decline at least c.25% in 2020 post a 16% decline in 2019. We expect a 15% market recovery in 2021, driven by: (1) ASP improvement, (2) demand recovery, and (3) rational capacity expansion. ASP stabilised from September given the demand recovery and from late November, Shenzhen MTC started rising ASP. On the supply side, we see a slight increase of effective capacity in 2021 after Sanan and MTC drove the major expansion in 2020, partially offset by the shutdown and winding up from several lower-tier suppliers. Additionally, for LED chips, we see a slight increase in effective capacity in 2021 after Sanan and MTC drove the major expansion in 2020, partially offset by shutdown and winding up from several lower tier suppliers.

**Mini LED.** We expect Mini LED to remain a niche product in 2021 even though the market expects Apple to adopt Mini LED for iPad and Macbook in 2021. Cost should still be a major concern for Mini LED to achieve higher penetration rate. Existing mainstream LED display with small-pitch of 1212 is priced at Rmb50k-60k per sq m. Mini LED could cost much more. Epistar starts to ramp Mini LED for Apple from 4Q20. CS Taiwan team have noted that Epistar will not be the sole supplier for Apple's Mini LED products and have assumed 25-30% of the allocation will go to other parties in 2021, among which Sanan is one of the alternatives, subject to its qualification status. We expect Sanan to be one of the key beneficiaries of the coming boost of Mini LED.

## Near-term trends

**Earnings recovery in 2021.** We forecast 19%/22% YoY revenue growth in 2021/22 driven by ASP recovery in LED chips and continuous growth in compound semis business. We also expect GM to recover from 30% in 2020 to 33%/35% in 2021/22. We forecast the IC business to grow by 44%/55% YoY in 2021/22 from Rmb643 mn in 2020, benefiting from domestic substitution. We expect Mini LED should remain as a niche product in 2021 but capex investment should come in 2H21. Sanan has mass shipped Mini/Micro LED chips to Samsung and became its first supplier, and built a joint lab with TCL to develop the market. We see the company has potential to enter Apple's Mini LED product but subject to its qualification status. We think Sanan is one of the key beneficiaries of the coming boost in the Mini LED cycle.

**Figure 302: 3Q19-3Q20 and 2016-19 financial summary**

Rmb mn	Quarters					Years			
	3Q19	4Q19	1Q20	2Q20	3Q20	2016	2017	2018	2019
Sales	1,945	2,128	1,682	1,886	2,333	6,273	8,394	8,364	7,460
QoQ/YoY	17%	9%	-21%	12%	24%	29%	34%	0%	-11%
Gross profit	535	465	475	617	637	2,612	4,095	3,740	2,191
<b>GM %</b>	<b>28%</b>	<b>22%</b>	<b>28%</b>	<b>33%</b>	<b>27%</b>	<b>42%</b>	<b>49%</b>	<b>45%</b>	<b>29%</b>
R&D	41	76	46	97	103	0	0	144	197
SG&A	196	179	182	184	201	585	738	719	720
Op income	298	210	247	336	332	2,027	3,357	2,876	1,274
<b>OPM %</b>	<b>15%</b>	<b>10%</b>	<b>15%</b>	<b>18%</b>	<b>14%</b>	<b>32%</b>	<b>40%</b>	<b>34%</b>	<b>17%</b>
Financing cost (net)	18	30	5	28	8	-107	72	56	114
Net income	269	146	392	243	304	2,167	3,164	2,830	1,298
<b>Net margin %</b>	<b>14%</b>	<b>7%</b>	<b>23%</b>	<b>13%</b>	<b>13%</b>	<b>35%</b>	<b>38%</b>	<b>34%</b>	<b>17%</b>
Shares	4,078	4,078	4,078	4,479	4,479	4,078	4,078	4,078	4,078
<b>EPS (Rmb)</b>	<b>0.06</b>	<b>0.04</b>	<b>0.10</b>	<b>0.06</b>	<b>0.00</b>	<b>0.53</b>	<b>0.78</b>	<b>0.69</b>	<b>0.32</b>

Source: Company data, WIND, Credit Suisse

## Valuation

At a price of Rmb27.4, Sanan has a market cap of Rmb122 bn and trades at 76x/52x consensus 2020-21E EPS and 4.6x/4.2x consensus 2020-21E BPS. It has volatile FCF over past few years largely given heavy capex.

**Figure 303: Balance sheet summary**

Balance Sheet (Rmb mn)	3Q20 (A)	2Q20	Diff %	6 year avg	+/- Avg
Cash and Inv estments	7,988	8,897	-10%	4,377	3,610
Debt	2,231	2,723	-18%	2,103	128
Net debt	-5,756	-6,174	-7%	-2,274	-3,482
<b>Net debt/share</b>	<b>-1.29</b>	<b>-1.38</b>	<b>0.09</b>	<b>-0.64</b>	<b>-0.64</b>
Accts. receivable	2,926	2,189	34%	3,254	-327
<b>DSO</b>	<b>113</b>	<b>104</b>	<b>8</b>	<b>177</b>	<b>-64</b>
Inv entory	4,223	3,949	7%	1,844	2,379
<b>Inventory days</b>	<b>224</b>	<b>280</b>	<b>-56</b>	<b>168</b>	<b>56</b>
Accts. payable days	129	169	-40	105	23
<b>Cash conversion days</b>	<b>208</b>	<b>216</b>	<b>-7</b>	<b>240</b>	<b>-31</b>
SH Equity	29,232	28,943	1%	17,906	11,326
<b>Book value/share</b>	<b>6.5</b>	<b>6.5</b>	<b>0.1</b>	<b>5.1</b>	<b>1.4</b>

Source: Company data, WIND, Credit Suisse

**Figure 304: Financial metrics summary**

Ticker	600703.SS	Current price (Rmb)	27.4
Stock connect %	0.0%	52-wk range (Rmb)	18.3-31.4
Share outstanding (mn)	4,479	Mkt cap (Rmb mn)	122,510
Daily trad vol-6m avg (mn)	101.0	Perf.	1M 3M 12M
Daily trad vol-6m avg (Rmb)	2,464	Absolute	6% 5% 40%
Free floatn (%)	91.0%	Relative	4% 2% 27%
Year	2016	2017	2018 2019 9M20
Revenue (Rmb mn)	6,273	8,394	8,364 7,460 5,900
YoY	29.1%	33.8%	-0.3% -10.8% 10.7%
Gross profit (Rmb mn)	2,612	4,095	3,740 2,191 1,729
<b>GM (%)</b>	<b>42%</b>	<b>49%</b>	<b>45%</b> <b>29%</b> <b>29%</b>
Operating profit (Rmb mn)	2,027	3,357	2,876 1,274 916
<b>OPM (%)</b>	<b>32%</b>	<b>40%</b>	<b>34%</b> <b>17%</b> <b>16%</b>
Net profit (Rmb mn)	2,167	3,164	2,830 1,298 938
<b>EPS (Rmb)</b>	<b>0.53</b>	<b>0.78</b>	<b>0.69</b> <b>0.32</b> <b>0.22</b>
EPS growth (%)	-25.4%	47.2%	-11.5% -53.6% -21.4%
P/E (x)	52	35	40 85 79
Dividend yield (%)	0.7%	0.9%	0.7% 0.4% n/a
P/B (x)	6.4	5.6	5.2 5.1 4.9
ROE (%)	12%	16%	13% 6% 5%

Note: P/E and P/B in 9M20 column are based on 2020E consensus EPS and BPS.

Source: Company data, WIND, Credit Suisse

**Figure 305: Cash flow statement summary**

Rmb mn	2013	2014	2015	2016	2017	2018	2019	7 year avg
Revenue	3,732	4,580	4,858	6,273	8,394	8,364	7,460	6,237
Capex	951	2,048	2,804	1,412	3,363	5,296	2,997	2,696
<b>Capex/revenue (%)</b>	<b>25%</b>	<b>45%</b>	<b>58%</b>	<b>23%</b>	<b>40%</b>	<b>63%</b>	<b>40%</b>	<b>42%</b>
Depr and amort	633	784	810	1,050	1,255	1,480	1,675	1,098
<b>Depr/revenue (%)</b>	<b>17%</b>	<b>17%</b>	<b>17%</b>	<b>17%</b>	<b>15%</b>	<b>18%</b>	<b>22%</b>	<b>18%</b>
Operating cash flow	765	665	2,391	2,056	2,561	3,339	2,789	2,081
<b>Free cash flow</b>	<b>332</b>	<b>-980</b>	<b>-629</b>	<b>889</b>	<b>-592</b>	<b>-2,563</b>	<b>2,768</b>	<b>-111</b>
FCF and dividend yield	2013	2014	2015	2016	2017	2018	2019	7 year avg
Total share	1,444	2,393	2,549	4,078	4,078	4,078	4,078	3,243
FCF/share (Rmb)	0.23	-0.41	-0.25	0.22	-0.15	-0.63	0.68	-0.04
FCF yield (%)	0.8%	-1.5%	-0.9%	0.8%	-0.5%	-2.3%	2.5%	-0.2%
<b>FCF/EV (%)</b>	<b>0.3%</b>	<b>-0.8%</b>	<b>-0.5%</b>	<b>0.8%</b>	<b>-0.5%</b>	<b>-2.2%</b>	<b>2.4%</b>	<b>-0.1%</b>
Dividend per share (Rmb)	0.20	0.20	0.25	0.20	0.25	0.20	0.10	0.20
Dividend payout (%)	28%	33%	35%	38%	32%	29%	31%	32%
<b>Dividend yield (%)</b>	<b>0.7%</b>	<b>0.7%</b>	<b>0.9%</b>	<b>0.7%</b>	<b>0.9%</b>	<b>0.7%</b>	<b>0.4%</b>	<b>0.7%</b>

Source: Company data, WIND, Credit Suisse

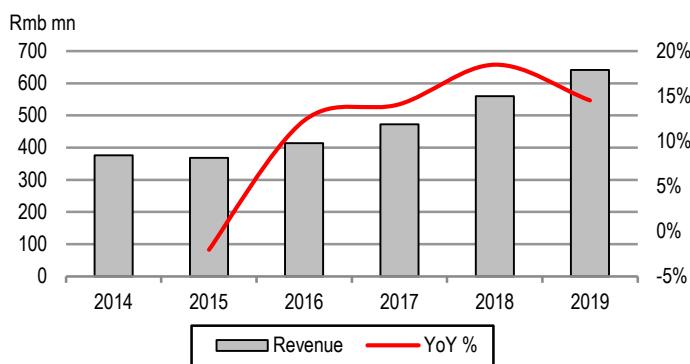
# Shanghai Sinyang (300236.SZ, Not Covered)

## Overview/product mix

Headquartered in Shanghai, Sinyang was founded in 1999 and listed on the Shenzhen Stock Exchange in 2011. The company has developed more than 140 types of electronics plating and cleaning chemicals, widely adopted by IC fabrication, 3D advanced packaging, IC testing, etc. Its existing product portfolio includes plating solution/additive for Damascene copper interconnects or through-silicon via (TSV), cleaning fluid after copper/aluminium etching, silicon nitride etchant, cleaning fluid after CMP (Chemical Mechanical Polishing), tin plating solution, etc. Beside semi chemicals, Sinyang also manufactures fluorocarbon coating materials.

**Shanghai Singyang provides a wide variety of semiconductor plating and clean chemicals for the semiconductor front-end and back-end process.**

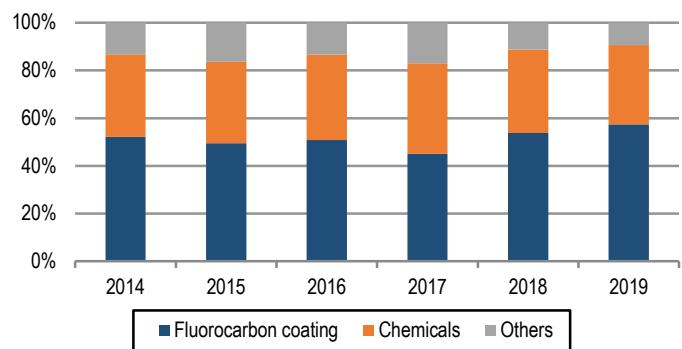
**Figure 306: Sinyang recorded 11% revenue CAGR in 2015-19**



Source: Company data, Credit Suisse

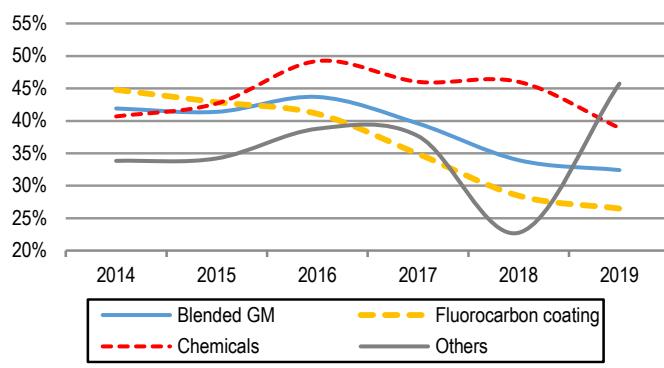
Sinyang is the only Chinese company that is able to supply ultrapure plating solution/additive for copper process on 90-28nm nodes. Key clients include SMIC, Hynix, CR Micro, JCET (Jiangsu Changjiang Electronics Technology CO.), Huatian Technology, WLCSP (China Wafer Level CSP), etc. The company's revenue reached Rmb641 mn in 2019, with a CAGR of 11% in 2015-19. Chemicals contributed about one-third of revenues and 40% of gross profit in 2019, while fluorocarbon coating accounting for 57% of revenue and 47% of gross profit.

**Figure 307: Fluorocarbon coating and chemicals drive sales**



Source: Company data, Credit Suisse

**Figure 308: Sinyang's chemical business records decent GM**



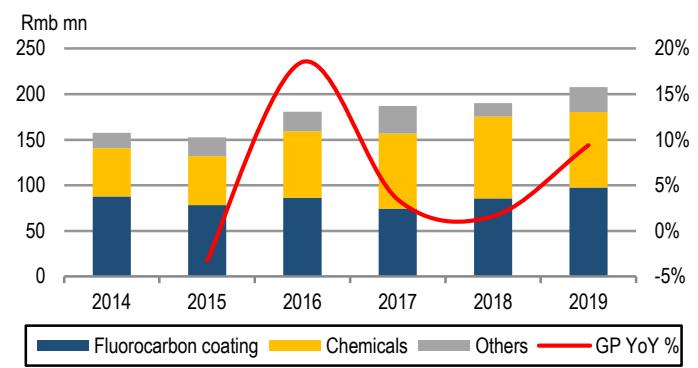
Source: Company data, Credit Suisse

## Business drivers

The increasing foundry capacity in China and significant import substitution trend have been key drivers for Sinyang's business growth. The company is developing higher-end products and working on product genre expansion to take more advantage of the import substitution trend.

Sinyang's ultrapure plating solution/additive for copper process on 20-14nm nodes is under R&D. Meanwhile, Sinyang has been developing high-end photoresist products. According to its

**Figure 309: Sinyang's GP recorded 6% CAGR from 2015-19**



Source: Company data, Credit Suisse

private placement plan in November 2020 (Rmb815 mn raised for the photoresist project), Sinyang's KrF (Krypton Fluoride, wave length of 248nm) photoresist, primarily for 3D NAND, is expected to reach mass production in 2022, and 193nm ArF should start production in 2023.

**Figure 310: Sinyang's private placement announced in Nov-2020**

Project	Total investment (Rmb mn)	\$ from placement (Rmb mn)
High-end photoresist for integrated circuit	1,046	815
Key materials for integrated circuit	350	335
Working capital	300	300
<b>Total</b>	<b>1,696</b>	<b>1,450</b>

Source: Company data, Credit Suisse

## Near-term trends

Sinyang's revenue grew 8% QoQ to Rmb187 mn in 3Q20, with GM up 1pp QoQ to 34%. Its OPM stayed constant at 11% QoQ, but fair value gain reached Rmb156 mn in 3Q, significantly driving NI to increase 843% YoY to Rmb151 mn.

## Valuation

Sinyang, at a current price of Rmb56.8, has a market cap of Rmb16.5 bn and trades at 146x/146x consensus 2020-21E EPS and 5.1x/4.9x consensus 2020-21E BPS. The company has maintained a healthy balance sheet, with a net debt ratio of only 0.6% by 3Q20. Free cash flow in 2017-2019 was Rmb52 mn, Rmb34 mn, and -Rmb15 mn.

**Figure 311: Balance sheet summary**

Balance Sheet (Rmb mn)	3Q20 (A)	2Q20	Diff %	6 year avg	+/- Avg
Cash and Investments	246	190	30%	227	19
Debt	278	176	58%	55	223
Net debt	32	-14	-330%	-172	204
<b>Net debt/share</b>	<b>0.11</b>	<b>-0.05</b>	<b>0.16</b>	<b>-0.88</b>	<b>0.99</b>
Accts. receivable	471	435	8%	388	83
<b>DSO</b>	<b>227</b>	<b>226</b>	<b>1</b>	<b>301</b>	<b>-73</b>
Inventory	130	118	10%	95	35
<b>Inventory days</b>	<b>95</b>	<b>92</b>	<b>3</b>	<b>122</b>	<b>-27</b>
Accts. payable days	179	145	33	167	12
<b>Cash conversion days</b>	<b>144</b>	<b>173</b>	<b>-29</b>	<b>256</b>	<b>-112</b>
SH Equity	5,278	5,155	2%	1,181	4,098
<b>Book value/share</b>	<b>18.2</b>	<b>17.7</b>	<b>0.4</b>	<b>6.2</b>	<b>12.0</b>

Source: Company data, WIND, Credit Suisse

**Figure 312: Financial metrics summary**

Ticker	300236.SZ	Current price (Rmb)	56.8
Stock connect %	0.4%	52-wk range (Rmb)	21.7-83.9
Share outstanding (mn)	291	Mkt cap (Rmb mn)	16,509
Daily trad vol-6m avg (mn)	18.4	Perf. 1M 3M 12M	
Daily trad vol-6m avg (Rmb m)	972	Absolute 12% -5% 150%	
Free floatn (%)	98.4%	Relative 11% -4% 134%	
Year	2016	2017	2018 2019 9M20
Revenue (Rmb mn)	414	472	560 641 487
YoY	12.3%	14.1%	18.5% 14.5% 6.8%
Gross profit (Rmb mn)	181	187	190 208 167
GM (%)	44%	40%	34% 32% 34%
Operating profit (Rmb mn)	65	73	44 30 52
OPM (%)	16%	15%	8% 5% 11%
Net profit (Rmb mn)	54	72	7 210 177
EPS (Rmb)	0.28	0.37	0.03 0.73 0.61
EPS growth (%)	0.0%	33.5%	-90.8% 2011.9% -59.6%
P/E (x)	203	152	1,651 78 146
Dividend yield (%)	0.2%	0.2%	0.0% 0.3% n/a
P/B (x)	8.9	8.4	8.6 11.0 5.1
ROE (%)	4%	6%	1% 14% 2%

Note: P/E and P/B in 9M20 column are based on 2020E consensus EPS and BPS.

Source: Company data, WIND, Credit Suisse

# Shanghai Wanye (600641.SS, Not Covered)

## Overview/product mix

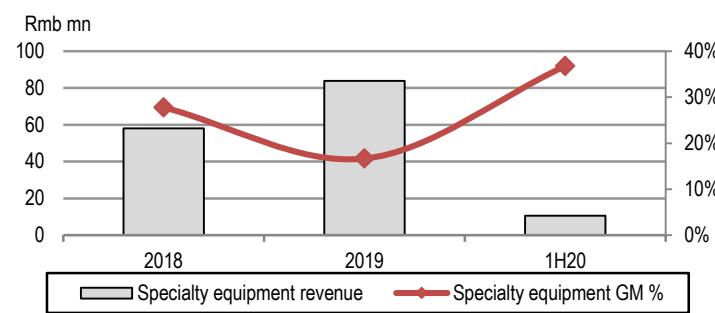
Shanghai Wanye Group is originally a property company and is transforming into a semiconductor investment platform. The Shanghai Pudong Science and Technology Investment Co., is its largest shareholder with 28% equity, and the China IC Fund is its No. 3 shareholder, with a 7% equity stake. In 3Q20, ~95% of its revenue came from property, but the company expects that by 2023 its revenue sources will mainly come from the semiconductor business. Wanye has its direct investment in semiconductor companies and also works with its partners for investment. It is also a major stakeholder of the Shanghai Semiconductor Equipment and Material Investment Fund which has invested in over ten semiconductor companies.

**Shanghai Wanye is an investment company that invested in ten semiconductor companies including Kingstone, an ion implant supplier.**

Kingstone is one of the major semiconductor equipment companies Wanye has invested in. Founded in 2009 by a group of experienced industry veterans, Kingstone first developed ion implant platform for photovoltaic, and has been developing ion implant platform for semiconductor over the past few years. Kingstone is having good progress for its ion implant tool in both the domestic and overseas markets. In the domestic market, they expect solid demand from both logic and memory customers in the near term and good shipments in 2021. In the overseas market, they see a good opportunity that their ion implantation module may be used for a global customer's leading fabrication process in the foreseeable future.

Notably, Kingstone's ion implantation platform has all components from Europe and Asia. This can help reduce the risk from geopolitical tension. The company is optimistic about its growth potential with the localisation effort in the industry.

**Figure 313: Wanye's equipment (Kingstone) revenue and GM**

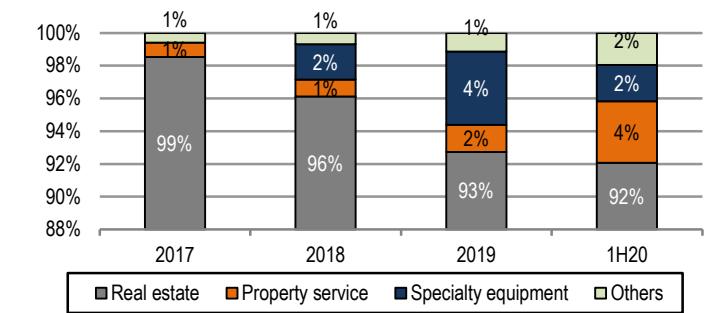


Source: Company data, Credit Suisse

## Near-term trends

Currently Shanghai Wanye's revenues still come largely from its original property business. The company will continue to generate revenue from its existing property inventory, but does not plan to increase more new property inventory, according to management.

**Figure 314: Equipment was for 4% of Wanye's sales in 2019**



Source: Company data, Credit Suisse

## Valuation

**Figure 315: Balance sheet summary**

Balance Sheet (Rmb mn)	3Q20 (A)	2Q20	Diff %	6 year avg	+/- Avg
Cash and Investments	4,556	4,265	7%	2,814	1,742
Debt	32	32	0%	336	-304
Net debt	-4,524	-4,234	7%	-2,478	-2,046
<b>Net debt/share</b>	<b>-4.72</b>	<b>-5.25</b>	<b>0.53</b>	<b>-3.07</b>	<b>-1.65</b>
Accts. receivable	92	98	-6%	29	63
<b>DSO</b>	<b>93</b>	<b>56</b>	<b>37</b>	<b>5</b>	<b>88</b>
Inventory	769	748	3%	3,247	-2,478
<b>Inventory days</b>	<b>1,203</b>	<b>745</b>	<b>458</b>	<b>874</b>	<b>329</b>
Accts. payable days	253	176	77	131	122
<b>Cash conversion days</b>	<b>1,043</b>	<b>625</b>	<b>418</b>	<b>748</b>	<b>295</b>
SH Equity	6,496	6,453	1%	5,002	1,494
<b>Book value/share</b>	<b>6.8</b>	<b>8.0</b>	<b>-1.2</b>	<b>6.2</b>	<b>0.6</b>

Source: Company data, WIND, Credit Suisse

**Figure 316: Financial metrics summary**

Ticker	600641.SS	Current price (Rmb)	17.1		
Stock connect %	0.0%	52-wk range (Rmb)	13.2-26.4		
Share outstanding (mn)	958	Mkt cap (Rmb mn)	16,390		
Daily trad vol-6m avg (mn)	19.3	<b>Perf.</b>	<b>1M</b> <b>3M</b> <b>12M</b>		
Daily trad vol-6m avg (Rmb)	421	Absolute	-8% -11% 24%		
Free floatn (%)	100.0%	Relative	-10% -14% 11%		
Year	2016	2017	2018	2019	9M20
<b>Revenue (Rmb mn)</b>	<b>3,188</b>	<b>2,096</b>	<b>2,679</b>	<b>1,869</b>	<b>564</b>
YoY	30.8%	-34.3%	27.8%	-30.2%	-67.9%
Gross profit (Rmb mn)	1,009	1,322	1,475	951	223
<b>GM (%)</b>	<b>32%</b>	<b>63%</b>	<b>55%</b>	<b>51%</b>	<b>40%</b>
Operating profit (Rmb mn)	718	1,027	1,152	640	210
<b>OPM (%)</b>	<b>23%</b>	<b>49%</b>	<b>43%</b>	<b>34%</b>	<b>37%</b>
Net profit (Rmb mn)	718	1,699	972	573	223
<b>EPS (Rmb)</b>	<b>0.89</b>	<b>2.11</b>	<b>1.21</b>	<b>0.75</b>	<b>0.24</b>
EPS growth (%)	239.8%	136.5%	-42.6%	-38.2%	-66.9%
P/E (x)	19	8	14	23	38
Dividend yield (%)	1.6%	3.7%	1.1%	0.0%	n/a
P/B (x)	3.2	2.3	2.2	2.2	2.4
ROE (%)	16%	29%	16%	9%	7%

Note: P/E and P/B in 9M20 column are based on 2020E consensus EPS and BPS.

Source: Company data, WIND, Credit Suisse

**Figure 317: Cash flow statement summary**

Rmb mn	2013	2014	2015	2016	2017	2018	2019	7 year avg
Revenue	1,828	1,826	2,438	3,188	2,096	2,679	1,869	2,275
Capex	38	16	2	1	51	66	24	28
<b>Capex/revenue (%)</b>	<b>2%</b>	<b>1%</b>	<b>0%</b>	<b>0%</b>	<b>2%</b>	<b>2%</b>	<b>1%</b>	<b>1%</b>
Depr and amort	4	4	2	3	7	14	24	8
<b>Depr/revenue (%)</b>	<b>0%</b>	<b>0%</b>	<b>0%</b>	<b>0%</b>	<b>0%</b>	<b>1%</b>	<b>1%</b>	<b>0%</b>
Operating cash flow	456	640	1,504	2,651	730	563	120	952
<b>Free cash flow</b>	<b>-327</b>	<b>914</b>	<b>1,053</b>	<b>2,288</b>	<b>1,915</b>	<b>1,421</b>	<b>810</b>	<b>1,154</b>
FCF and dividend yield	2013	2014	2015	2016	2017	2018	2019	7 year avg
FCF/share (Rmb)	-0.41	1.13	1.31	2.84	2.38	1.76	1.01	1.43
FCF yield (%)	-2.4%	6.6%	7.6%	16.6%	13.9%	10.3%	5.9%	8.4%
<b>FCF/EV (%)</b>	<b>-2.4%</b>	<b>6.8%</b>	<b>7.9%</b>	<b>17.1%</b>	<b>14.3%</b>	<b>10.6%</b>	<b>6.0%</b>	<b>8.6%</b>
Dividend per share (Rmb)	0.10	0.15	0.08	0.27	0.63	0.20	0.00	0.20
Dividend payout (%)	36%	30%	30%	30%	30%	16%	0%	25%
<b>Dividend yield (%)</b>	<b>0.6%</b>	<b>0.9%</b>	<b>0.5%</b>	<b>1.6%</b>	<b>3.7%</b>	<b>1.1%</b>	<b>0.0%</b>	<b>1.2%</b>

Source: Company data, WIND, Credit Suisse

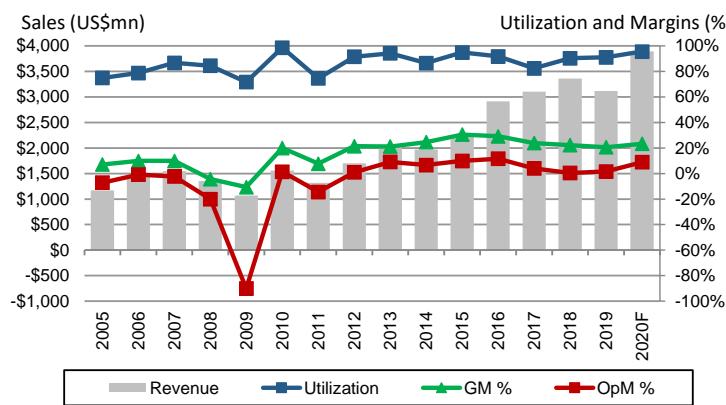
# SMIC (0981.HK/688981.SH, Neutral)

## Overview/product mix

SMIC was established in 2000 and is now China's largest and most advanced foundry, with technologies spanning from 350nm through 14nm FinFET and capabilities across logic, mixed-signal, high voltage, SoC, embedded flash, CIS, power management and MEMs. The foundry has been championed with driving China's semiconductor ecosystem, having received investments by the China National IC fund, CIC, Datang, Tsinghua Unigroup and also JV fabs with the Beijing and Shanghai municipal authorities and specialty technology development in Ningbo China. The company has also received significant R&D subsidies with US\$865 mn on the balance sheet and US\$445 mn new funding received in 2019.

**SMIC is China's leading foundry with 5% industry share and in production down to 14nm FinFET.**

**Figure 318: SMIC has maintained high growth/full utilisation**



Source: Company data, Credit Suisse

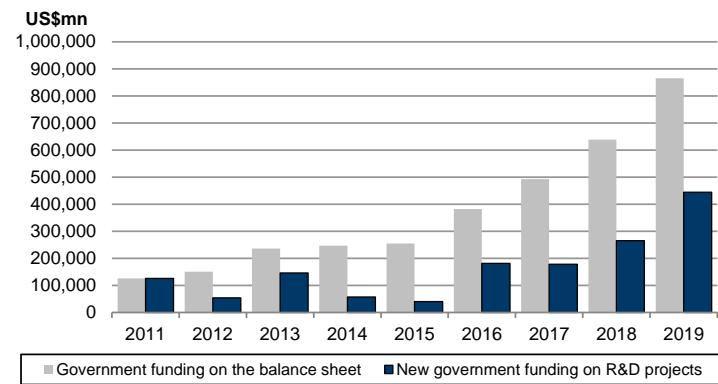
SMIC's leading position in China is on track for US\$3.9 bn sales in 2020 (5% foundry share) and development of 14nm and risk production on n+1 (8nm) is also attracting US attention. The US placed China on a China military user restricted list and more recently its US Commerce Department entity list. The entity list provision for SMIC presumes denial on receiving US tools and technology unique to producing 10nm and below although it allows case-by-case approval on other tools which often means those will be approved. That restriction should allow SMIC to maintain existing fab operations and address the large mainstream foundry market of consumer, communications and IoT/smart home although that may keep it from accessing tools to produce on 7nm and below for 5G, high performance computing and high-end networking.

**Strong growth in 2020 at full capacity.** SMIC's sales have been strong in 2020, tracking up 25% YoY to US\$3.9 bn, with GMs at 23% and OpM at 9%. The company has been operating at full capacity throughout the year to support strong demand from 5G power management, fingerprint sensors, CIS, NOR flash, and smart home devices. Product mix in 3Q20 with the new categories was 46% smartphones, 21% smart home, and 16% from others.

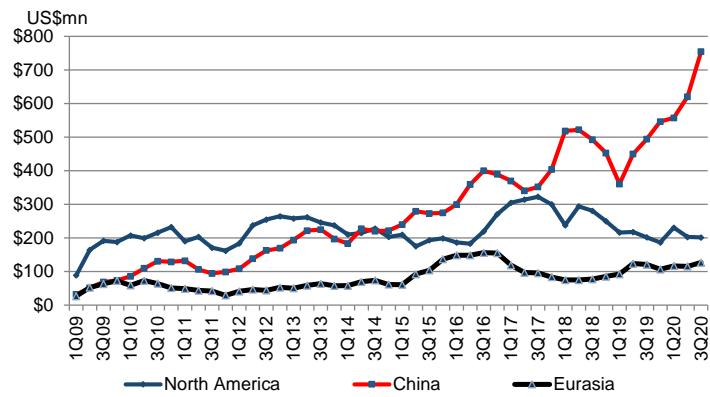
**China customers driving the business.** SMIC's China customers reached a record 70% of sales, up from 61% the prior year as US customers fell from 25% to 19% of sales and Eurasia from 16% to 12%. Over the past decade, growth has been driven entirely by the rise of China fabless, with the North America business unchanged since 2009 and the Eurasia business down from the 2017 peak, led by the early to market ramp of FPC in fingerprint sensors.

**US restriction could have a manageable impact.** SMIC maintains stable operations following the US military use and entity list restriction though trying to work with suppliers to apply licences to ensure no bottlenecks on service and consumables. We upgraded the stock from Underperform to NEUTRAL, as the entity list restriction looks to allow mature tools and service to continue and only restrict unique advanced 10nm and below tools.

**Figure 319: SMIC attracting more R&D grants and funding**



Source: Company data, Credit Suisse

**Figure 320: China customers driving SMIC's business**

Source: Company data, Credit Suisse

## Near-term trends

3Q20 sales grew 15% QoQ to US\$1.08 bn, in line with its raised guidance for +14-16% QoQ and CS/street prior expectations of +2%/+3% on pull-in of Huawei pre-built inventory plus advanced packaging/expedite revenue and strength from WFH, 5G builds (CIS, PMIC and fingerprint). GM was down 230 bp QoQ to 24.2% in 3Q20, with higher utilisation offset by +15% QoQ in depreciation, though the better OpM at 16.9% helped by government funding covered most of the R&D spend.

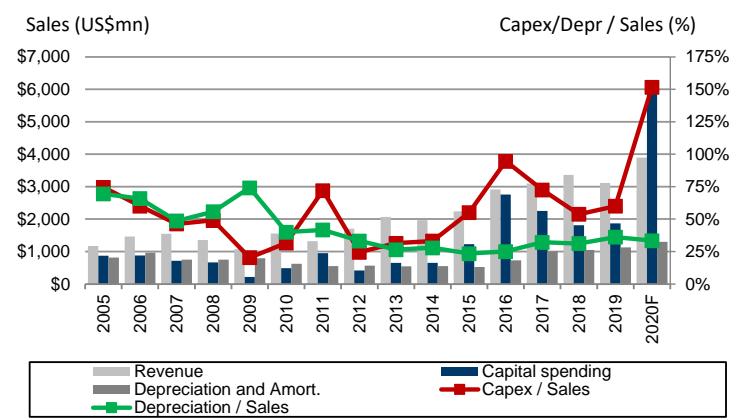
4Q20 sales were guided down 10-12% QoQ to US\$953-974 mn off a high 3Q20 base, supporting full-year sales up 24-26% YoY in 2020. The utilisation for 8" and mature 12" nodes should stay high for connectivity, PMIC, driver IC, specialty memory, and MCU, though demand on 28nm, 14nm and back-end/other should drop following the Huawei restriction, offsetting rising ASPs. With lower revenue scale, rising depreciation, and lower expedited, GM was guided down 620-820 bp to 16-18%, below CSe/street of 19.0%/18.1%. Higher government subsidies from achieving R&D milestones in the year-end should keep OpM at 5% in 4Q20.

2020 capex was lowered from US\$6.7 bn to US\$5.9 bn, implying 4Q delaying about 35% of tools and spend from US\$2.3 bn to US\$1.5 bn. We model US\$2.5 bn in 2021/22E, but it is subject to receiving some tool licences.

**Figure 322: 3Q19-4Q20E and 2017-20E financial summary**

Summary Income Statement	3Q19	4Q19	1Q20	2Q20	3Q20	4Q20	2018	2019	2020F	2021F	2022F
<b>Net Sales</b>	<b>816</b>	<b>839</b>	<b>905</b>	<b>938</b>	<b>1,083</b>	<b>967</b>	<b>3,360</b>	<b>3,116</b>	<b>3,893</b>	<b>4,174</b>	<b>4,709</b>
QoQ	3.2%	2.8%	7.8%	3.7%	15.3%	-10.7%	8.3%	-7.3%	24.9%	7.2%	12.8%
YoY	-4.0%	6.6%	35.3%	18.7%	32.6%	15.2%	2,613	2,473	2,984	3,465	3,856
Cost of Goods Sold	647	640	671	690	821	802	747	642	909	709	852
<b>Gross Profits</b>	<b>170</b>	<b>199</b>	<b>234</b>	<b>249</b>	<b>262</b>	<b>165</b>	<b>22.2%</b>	<b>20.6%</b>	<b>23.4%</b>	<b>17.0%</b>	<b>18.1%</b>
GM (%)	20.8%	23.8%	25.8%	26.5%	24.2%	17.0%	30	27	24	28	30
Operating Exp. Promotion	6	5	6	5	6	7	201	255	248	236	246
Operating Exp. Adminstrative	70	77	74	59	57	58	577	715	612	620	641
Operating Expense R&D	185	170	166	158	159	129	15	49	346	165	275
<b>EBIT</b>	<b>47</b>	<b>20</b>	<b>47</b>	<b>65</b>	<b>183</b>	<b>51</b>	<b>0.4%</b>	<b>1.6%</b>	<b>8.9%</b>	<b>4.0%</b>	<b>5.8%</b>
OpM (%)	5.8%	2.4%	5.2%	6.9%	16.9%	5.3%	77	133	241	176	176
Net Non-Operating Income	42	67	18	77	102	44	87	180	584	341	451
<b>Pretax Income</b>	<b>89</b>	<b>88</b>	<b>66</b>	<b>142</b>	<b>284</b>	<b>95</b>	<b>2.6%</b>	<b>5.8%</b>	<b>15.0%</b>	<b>8.2%</b>	<b>9.6%</b>
% of Sales	10.9%	10.4%	7.3%	15.1%	26.3%	9.9%	73	157	528	324	428
<b>Net Income pre-Extraordinaries</b>	<b>85</b>	<b>76</b>	<b>51</b>	<b>126</b>	<b>264</b>	<b>91</b>	(56.8)	(75.8)	(33.0)	(60)	(60)
Minority Interest	(31)	(13.1)	(13)	(12)	7	(15)	130	233	561	384	488
<b>Net Income post-Extraordinaries</b>	<b>115</b>	<b>89</b>	<b>64</b>	<b>138</b>	<b>256</b>	<b>106</b>	3.9%	7.5%	14.4%	9.2%	10.4%
% of Sales	14.1%	10.6%	7.1%	14.7%	23.7%	10.9%	0.03	0.04	0.07	0.05	0.06
<b>Net EPS</b>	<b>0.02</b>	<b>0.02</b>	<b>0.01</b>	<b>0.02</b>	<b>0.03</b>	<b>0.01</b>	<b>0.20</b>	<b>0.33</b>	<b>0.55</b>	<b>0.37</b>	<b>0.48</b>
Hong Kong \$ EPS	0.15	0.12	0.08	0.18	0.25	0.10	5,100	5,424	7,944	7,944	7,944
Adjusted Share Count	5,784	5,788	5,968	6,006	7,901	7,944					

Source: Company data, WIND, Credit Suisse

**Figure 321: SMIC had a steep ramp of capex in 2020**

Source: Company data, Credit Suisse

## Valuation

At the current price of HK\$27.70 SMIC has a market capitalisation of US\$38.2 bn and trades at 17.5x EV/EBITDA and 2.5x P/B with ROE at 3%. Its A-share listing at Rmb53.43 trades at a premium of 4.3x P/B and 33.8x EV/EBITDA. We rate SMIC Neutral with a TP of HK\$19.6 based on 1.3x P/B (1.5x pre listing P/B), the midpoint of its 1x-2x range reflecting swing factors on whether the US maintains its level of restriction or imposes further restrictions on tool approvals to also include some legacy technologies.

**Figure 323: Balance sheet summary**

Balance Sheet (US\$ mn)	3Q20(A)	2Q20	Diff	10 year Ave.	+/- Average
Cash and Investments	\$12,340	\$7,013	\$5,327	\$1,768	\$10,572
Total Debt	\$4,752	\$4,705	\$47	\$2,262	\$2,489
Net Cash	\$7,588	\$2,308	\$5,280	-\$495	\$8,083
<b>Net Cash/Share</b>	<b>\$1.06</b>	<b>\$0.53</b>	<b>\$0.53</b>	<b>-\$0.07</b>	<b>\$1.13</b>
A/R	1,116	1,448	-\$332	517	\$599
<b>DSO</b>	<b>94</b>	<b>141</b>	<b>-47</b>	<b>76</b>	<b>18</b>
Inventory	648	669	-\$22	397	\$251
<b>Inventory Days</b>	<b>72</b>	<b>89</b>	<b>-16</b>	<b>78</b>	<b>-6</b>
Accounts Payable Days	261	236	25	140	121
<b>Cash Conversion Cycle</b>	<b>-95</b>	<b>-6</b>	<b>-88</b>	<b>14</b>	<b>-108</b>
SH Equity	14,869	7,010	\$7,859	3,536	\$11,333
<b>Book Value / Share</b>	<b>\$1.88</b>	<b>\$1.17</b>	<b>\$0.71</b>	<b>\$0.87</b>	<b>\$1.02</b>

Source: Company data, WIND, Credit Suisse

**Figure 324: Financial metrics summary**

Ticker	0981.HK	Current Price (HK\$)	27.70
Qfii holding (%)	59.7%	52-wk range (HK\$)	11.4-42.0
Shares outstanding (mn)	7,944.2	Mkt cap (US\$mn)	38,118
Net cash (US\$mn)	\$6,162	<b>Perf. (%)</b>	<b>1M</b> <b>3M</b> <b>12M</b>
Daily trad val-6m avg (US\$mn)	9,530	Absolute	-14.4 6.6 61.1
Free Float (%)	78.2%	Relative	-28.6 -23.9 -1.3

Financial metrics	2017	2018	2019	2020	2021
<b>Revenues (US\$ mn)</b>	<b>\$3,101</b>	<b>\$3,360</b>	<b>\$3,116</b>	<b>\$3,893</b>	<b>\$4,174</b>
YoY Growth (%)	6.4%	8.3%	-7.3%	24.9%	7.2%
Gross profit (US\$mn)	\$741	\$747	\$642	\$909	\$709
<b>GM (%)</b>	<b>23.9%</b>	<b>22.2%</b>	<b>20.6%</b>	<b>23.4%</b>	<b>17.0%</b>
Operating profit (US\$mn)	\$125	\$15	\$49	\$346	\$165
<b>OPM (%)</b>	<b>4.0%</b>	<b>0.4%</b>	<b>1.6%</b>	<b>8.9%</b>	<b>4.0%</b>
EBITDA (US\$mn)	\$1,114	\$1,087	\$1,197	\$1,715	\$1,824
<b>EBITDA (%)</b>	<b>35.9%</b>	<b>32.4%</b>	<b>38.4%</b>	<b>44.0%</b>	<b>43.7%</b>
Net profit (US\$ mn)	\$170	\$130	\$233	\$561	\$384
<b>EPS (HK\$)</b>	<b>\$0.27</b>	<b>\$0.20</b>	<b>\$0.33</b>	<b>\$0.55</b>	<b>\$0.37</b>
EPS growth (%)	254%	-27%	69%	65%	-32%
Valuation metrics	2017	2018	2019	2020	2021
P/E (x)	224.0	293.6	163.7	67.9	99.3
P/B (x)	7.3	7.0	6.1	2.5	2.5
ROE (%)	3%	2%	4%	4%	3%
EV/Sales	10.3	9.5	10.3	8.2	7.7
EV/EBITDA	28.7	29.4	26.7	18.6	17.5
<b>FCF yield (%)</b>	<b>-3.3%</b>	<b>-2.6%</b>	<b>-2.2%</b>	<b>-12.1%</b>	<b>-3.2%</b>
Dividend yield (%)	0.0%	0.0%	0.0%	0.0%	0.0%

Source: Company data, WIND, Credit Suisse

**Figure 325: Cash flow statement summary**

Annual (US\$mn)	CY13	CY14	CY15	CY16	CY17	CY18	CY19	CY20E	06-17 Avg
Revenue	2,069	1,970	2,236	2,914	3,101	3,360	3,116	3,893	1,859
Capital spending	650	653	1,231	2,757	2,250	1,808	1,870	5,900	990
<b>Capex/revenue (%)</b>	<b>31%</b>	<b>33%</b>	<b>55%</b>	<b>95%</b>	<b>73%</b>	<b>54%</b>	<b>60%</b>	<b>152%</b>	<b>49%</b>
Dep and amort	547	549	524	730	998	1,048	1,128	1,300	700
<b>Depr/revenue (%)</b>	<b>26%</b>	<b>28%</b>	<b>23%</b>	<b>25%</b>	<b>32%</b>	<b>31%</b>	<b>36%</b>	<b>33%</b>	<b>42%</b>
Operating cash flow	738	617	669	977	1,001	799	1,019	1,270	653
<b>Free cash flow</b>	<b>88</b>	<b>-36</b>	<b>-562</b>	<b>-1,780</b>	<b>-1,249</b>	<b>-1,009</b>	<b>-851</b>	<b>-4,630</b>	<b>-337</b>
FCF / share (HK\$)	0.21	-0.08	-1.01	-2.85	-1.98	-1.53	-1.22	-4.52	-0.62
<b>FCF Yield (%)</b>	<b>2.5%</b>	<b>-0.9%</b>	<b>-12.3%</b>	<b>-34.8%</b>	<b>-24.1%</b>	<b>-18.7%</b>	<b>-14.8%</b>	<b>-55.1%</b>	<b>-8%</b>

Source: Company data, WIND, Credit Suisse

# Tongfu (002156.SZ, Outperform)

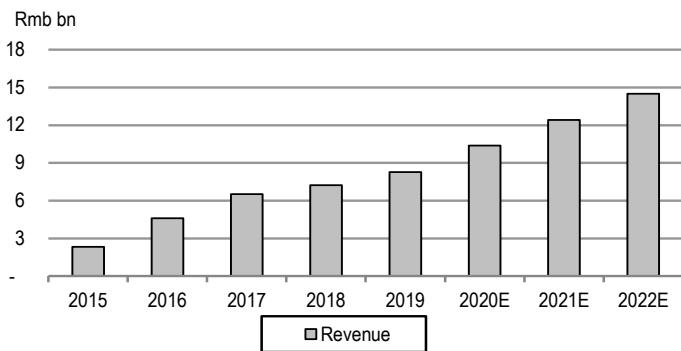
## Overview/product mix

Headquartered in Nantong, Tongfu was founded in 1997 and listed on the Shenzhen Stock Exchange in 2007. Tongfu is the China's second largest and world's sixth largest pure-play OSAT (Outsourced Semiconductor Assembly and Test) company. Tongfu has five production bases in operation: Tongfu Chongchuan, Tongfu Sutong, Tongfu Hefei, Tongfu-AMD Suzhou JV (Tongfu holds 85% stake) and Tongfu-AMD Penang JV (Tongfu holds 85% stake). Besides, Tongfu Xiamen (Tongfu holds 10% stake, but is responsible for the operation), the sixth production base, is under construction. Tongfu's key customers include AMD, Mediatek, STMicro, Texas Instruments, NXP, Infineon, Broadcom, Toshiba, Realtek, UNISOC, Goodix, Maxscend, AWINIC, and Will Semi, among others.

**Tongfu is the #2 OSAT in China and #6 globally, with large footprint at AMD following its acquisition of their facilities.**

Tongfu's production bases have different business focusses. Tongfu Chongchuan offers a comprehensive product portfolio, covering both high- and low-end products. Tongfu Sutong focusses on high-end products, especially for smartphone applications. Tongfu Hefei mainly covers high-density lead frame packaging, and also serves memory and LCD driver IC. The two Tongfu-AMD JVs focus on FCBGA (flip chip ball grid array) packaging for CPU, GPU, game machine ICs, and AI chips. The Xiamen factory will mainly target bumping and WLCSP (wafer level chip scale packaging).

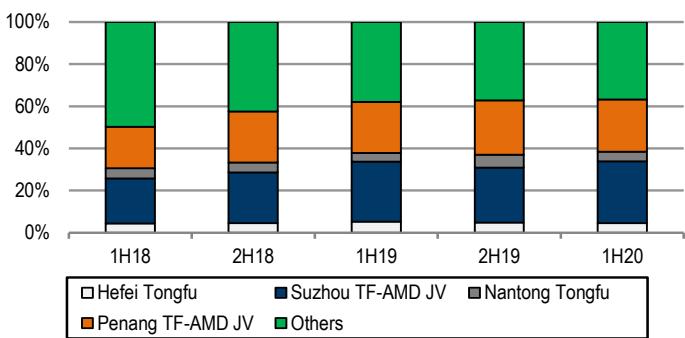
**Figure 326: We expect solid top line growth for Tongfu**



Source: Company data, Credit Suisse estimates

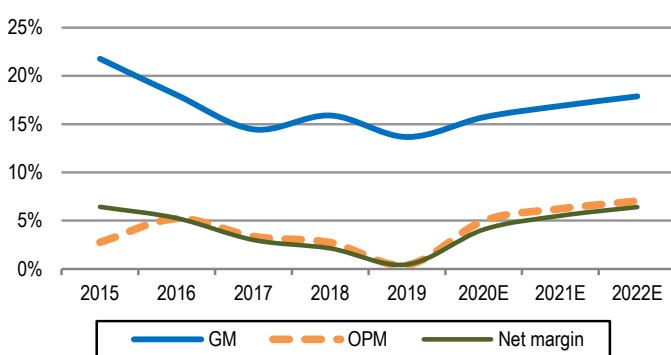
Tongfu achieved revenue of Rmb8.3 bn in 2019, with 37% CAGR in 2016-19, and we expect 23% revenue CAGR in 2020-22, with improving gross margin performance. The Suzhou Tongfu-AMD JV and Penang Tongfu-AMD JV accounted for 29% and 25% of Tongfu's total revenue in 1H20, totally adding up to 54%. Tongfu's Suzhou and Nantong factories contributed respectively 5% and 5% of total revenue.

**Figure 327: Tongfu's revenue mix by subsidiaries**



Source: Company data, Credit Suisse estimates

**Figure 328: We expect Tongfu's margin to recover after 2019**

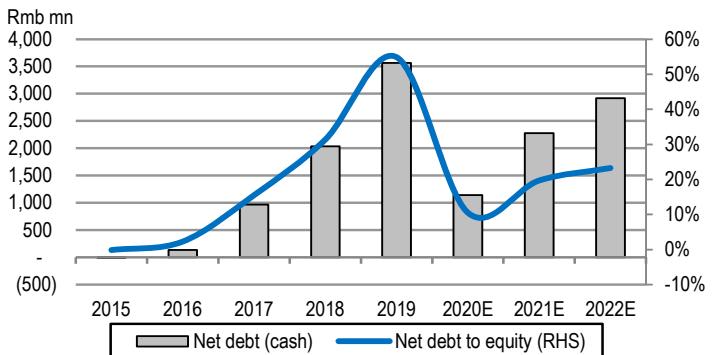


Source: Company data, Credit Suisse estimates

Global Semiconductors Sector

This document is being provided for the exclusive use of SHIBIN XIE at ALLIANZ GLOBAL INVESTORS US LLC.

**Figure 329: Tongfu has a manageable scale of net debt**



Source: Company data, Credit Suisse estimates

## Business drivers

### **2021 growth from AMD, China CPU, MTK, and memory on top of China's localisation.**

The two AMD JV factories, 54% of total revenue in 1H20, has been operating at a high utilisation rate this year. We expect AMD demand to remain solid in 2021, with AMD's continued share gains across PC and server markets. 7nm high-end products accounted for 60% production of Tongfu's two AMD JVs in 1H20, and Tongfu is developing 5nm packaging technology with AMD. Meanwhile, Tongfu works with multiple China CPU fabless, including Phytiium, Zhaoxin and Loongson; Tongfu should also grow CPU back-end revenue with these China CPU companies as a result of China's localisation ambition. Mediatek is the next growth driver, with better demand for mobile and various smart home devices/IoT applications. Further, Tongfu's Hefei factory also observes better demand with increasing memory orders.

**OSAT supply tightness and price hike should continue into 2021.** Similar to the smartphone market where every other OEM wants to take Huawei's share, in the semiconductor market every China fabless (similar to global fabless) wants to take HiSilicon's share. This partly explains the tight foundry/back-end/substrate supply across regions. Tongfu is progressing well with multiple fabless including Mediatek, UniSOC, ZTE, Goodix, Maxscend, Gigadevice, Beken, and Will Semi, for 5G processors, auto, sensor, memory, DDI (display driver IC) and so on. It is also penetrating new customers such as Samsung, Rohm, Panasonic, AMS, Dialog and Nordic. We thus expect the high utilisation rate to continue into 2021.

**Ongoing R&D.** (1) In 1H20, Tongfu was progressing well with 2D/2.5D packaging technology, with large-size FCBGA (flip chip ball grid array) having started small-volume qualification. (2) It has achieved breakthrough on low-power DDR and DDP (dual die package) packaging technology, and expects small-volume qualification by end-2020. (3) The company is developing multiple technologies of Fan-out for CIS (CMOS image sensor), pressure sensor and heart rate sensor. Some module samples are expected before end-2020. (4) Tongfu has built SiP (system-in-package) simulation platform and R&D team, targeting products for 5G, autopilot, fingerprint, sensor, optical components, IoT (Internet of Things), and so on.

**Private placement completed to increase capacity and improve balance sheet.** Tongfu finished its private placement of Rmb3.2 bn on 23 November (excluding issuance fee), vs the previous target of no more than Rmb4 bn. The company planned to use 36%, 26% and 13% of the money raised as capex for smartphone/consumer IC packaging, automotive IC packaging and CPU/GPU packaging projects. Construction should take 2-3 years. The balance 26% (Rmb828 mn based on actual money raised) will be used for working capital or debt repayment. By 3Q20, Tongfu had net debt of Rmb5.4 bn accounting for 80% of total equity. Besides, the placement led to 13% EPS dilution.

## Near-term trends

Tongfu's revenue increased 10% QoQ or 11% YoY to Rmb2.8 bn in 3Q20, with gross margin down 1 pp to 15.9% as a result of higher depreciation from new equipment. Our check suggested the two AMDs continued their high utilisation rates into 4Q, and other domestic factories' utilisation rates are improving in 4Q. Thus, we expect 4Q20 to stay strong due to the recent OSAT supply tightness.

**Figure 330: 3Q19-3Q20 and 2016-19 financial summary**

Rmb mn	Quarters					Years			
	3Q19	4Q19	1Q20	2Q20	3Q20	2016	2017	2018	2019
Sales	2,467	2,212	2,166	2,503	2,750	4,592	6,519	7,223	8,267
QoQ/YoY	28%	-10%	-2%	16%	10%	98%	42%	11%	14%
Gross profit	399	348	283	422	438	826	943	1,149	1,130
<b>GM %</b>	<b>16%</b>	<b>16%</b>	<b>13%</b>	<b>17%</b>	<b>16%</b>	<b>18%</b>	<b>14%</b>	<b>16%</b>	<b>14%</b>
R&D	208	172	167	171	153	0	0	562	688
SG&A	105	120	96	112	96	591	723	390	408
Op income	86	57	19	139	190	236	220	197	34
<b>OPM %</b>	<b>3%</b>	<b>3%</b>	<b>1%</b>	<b>6%</b>	<b>7%</b>	<b>5%</b>	<b>3%</b>	<b>3%</b>	<b>0%</b>
Financing cost (net)	61	71	67	69	47	47	198	114	225
Net income	50	46	-12	123	150	181	122	127	19
<b>Net margin %</b>	<b>2%</b>	<b>2%</b>	<b>-1%</b>	<b>5%</b>	<b>5%</b>	<b>4%</b>	<b>2%</b>	<b>2%</b>	<b>0%</b>
Shares	1,154	1,154	1,154	1,154	1,154	973	1,154	1,154	1,154
<b>EPS (Rmb)</b>	<b>0.05</b>	<b>0.04</b>	<b>-0.01</b>	<b>0.11</b>	<b>0.13</b>	<b>0.19</b>	<b>0.13</b>	<b>0.11</b>	<b>0.02</b>

Source: Company data, WIND, Credit Suisse

## Valuation

At the current price of Rmb27.4, Tongfu has a market cap of Rmb36.4 bn and trades at 81x/52x 2020-21 CSe EPS and 3.8x/3.5x 2020-21 CSe BPS. We rate Tongfu OUTPERFORM with a target price of Rmb33.3 based on 4.2x and 2021E BPS. The 4.2x multiple is at +1.5 SD of its historical P/B on forward consensus BPS and is still below A-share OSAT sector's average of 5.6x on 2021 consensus BPS. We expect Tongfu to continue re-rating towards A-share peers with its revenue growth and improving profitability. Tongfu has net debt of Rmb5.4 bn, accounting for 80% of total equity, and net debt per share of Rmb4.71 vs the six-year average of Rmb1.04. Tongfu recorded free cash flow (FCF) of -Rmb1.1 bn, -Rmb1.3 bn and -Rmb1.2 bn in 2017-19 due to heavy capex.

**Figure 331: Cash flow statement summary**

Rmb mn	2013	2014	2015	2016	2017	2018	2019	7 year avg
Revenue	1,767	2,091	2,322	4,592	6,519	7,223	8,267	4,683
Capex	119	664	1,251	1,561	1,657	2,231	2,109	1,370
<b>Capex/revenue (%)</b>	<b>7%</b>	<b>32%</b>	<b>54%</b>	<b>34%</b>	<b>25%</b>	<b>31%</b>	<b>26%</b>	<b>30%</b>
Depr and amort	251	292	355	655	893	1,021	1,223	670
<b>Depr/revenue (%)</b>	<b>14%</b>	<b>14%</b>	<b>15%</b>	<b>14%</b>	<b>14%</b>	<b>14%</b>	<b>15%</b>	<b>14%</b>
Operating cash flow	309	415	231	785	1,010	753	1,415	703
<b>Free cash flow</b>	<b>356</b>	<b>-339</b>	<b>-995</b>	<b>-779</b>	<b>-1,070</b>	<b>-1,284</b>	<b>-1,188</b>	<b>-757</b>
<b>FCF and dividend yield</b>	<b>2013</b>	<b>2014</b>	<b>2015</b>	<b>2016</b>	<b>2017</b>	<b>2018</b>	<b>2019</b>	<b>7 year avg</b>
FCF/share (Rmb)	0.55	-0.52	-1.33	-0.80	-0.93	-1.11	-1.03	-0.74
FCF yield (%)	2.0%	-1.9%	-4.9%	-2.9%	-3.4%	-4.1%	-3.8%	-2.7%
<b>FCF/EV (%)</b>	<b>0.9%</b>	<b>-0.8%</b>	<b>-2.4%</b>	<b>-1.9%</b>	<b>-2.6%</b>	<b>-3.1%</b>	<b>-2.8%</b>	<b>-1.8%</b>
Dividend per share (Rmb)	0.02	0.00	0.06	0.00	0.00	0.04	0.00	0.02
Dividend payout (%)	22%	0%	29%	0%	0%	35%	0%	12%
<b>Dividend yield (%)</b>	<b>0.1%</b>	<b>0.0%</b>	<b>0.2%</b>	<b>0.0%</b>	<b>0.0%</b>	<b>0.1%</b>	<b>0.0%</b>	<b>0.1%</b>

Source: Company data, WIND, Credit Suisse

**Figure 332: Balance sheet summary**

Balance Sheet (Rmb mn)	3Q20 (A)	2Q20	Diff %	6 year avg	+/- Avg
Cash and Investments	2,124	2,088	2%	1,484	640
Debt	7,553	6,977	8%	2,650	4,903
Net debt	5,430	4,889	11%	1,166	4,263
<b>Net debt/share</b>	<b>4.71</b>	<b>4.24</b>	<b>0.47</b>	<b>1.04</b>	<b>3.67</b>
Accts. receivable	2,527	2,668	-5%	1,194	1,334
<b>DSO</b>	<b>83</b>	<b>96</b>	<b>-13</b>	<b>83</b>	<b>0</b>
Inventory	1,509	1,513	0%	929	580
<b>Inventory days</b>	<b>59</b>	<b>65</b>	<b>-7</b>	<b>72</b>	<b>-13</b>
Accts. payable days	73	97	-24	115	-42
<b>Cash conversion days</b>	<b>68</b>	<b>64</b>	<b>4</b>	<b>40</b>	<b>28</b>
SH Equity	6,328	6,245	1%	4,698	1,630
<b>Book value/share</b>	<b>5.5</b>	<b>5.4</b>	<b>0.1</b>	<b>4.7</b>	<b>0.7</b>

Source: Company data, WIND, Credit Suisse

**Figure 333: Financial metrics summary**

Ticker	002156.SZ	Current price (Rmb)	27.4		
Stock connect %	0.0%	52-wk range (Rmb)	15.6-33.3		
Share outstanding (mn)	1,329	Mkt cap (Rmb mn)	36,376		
Daily trad vol-6m avg (mn)	53.0	Perf.	1M 3M 12M		
Daily trad vol-6m avg (Rmb mn)	1,298	Absolute	7% 25% 57%		
Free floatn (%)	86.8%	Relative	6% 22% 44%		
Year	2016	2017	2018	2019	9M20
Revenue (Rmb mn)	4,592	6,519	7,223	8,267	7,420
YoY	97.8%	42.0%	10.8%	14.5%	22.5%
Gross profit (Rmb mn)	826	943	1,149	1,130	1,144
GM (%)	18%	14%	16%	14%	15%
Operating profit (Rmb mn)	236	220	197	34	348
OPM (%)	5%	3%	3%	0%	5%
Net profit (Rmb mn)	181	122	127	19	262
EPS (Rmb)	0.19	0.13	0.11	0.02	0.23
EPS growth (%)	-9.5%	-31.6%	-15.4%	-81.8%	#####
P/E (x)	144	211	249	1,369	88
Dividend yield (%)	0.0%	0.0%	0.1%	0.0%	n/a
P/B (x)	6.8	5.3	5.1	5.2	5.4
ROE (%)	5%	2%	2%	0%	7%

Note: P/E and P/B in 9M20 column are based on 2020E consensus EPS and BPS.

Source: Company data, WIND, Credit Suisse

# Will Semi (603501.SS, Outperform)

## Overview/product mix

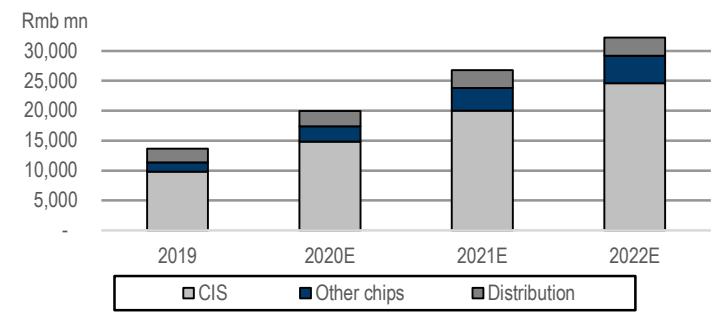
Headquartered in Shanghai, Will Semiconductor was a distributor and acquired multiple IC design companies over the past few years. The biggest acquisition was OmniVision in 2019. The company is now global No. 3 CIS supplier, with No. 3 position in the smartphone segment and No. 2 position in the automotive segment. It is one of the Top 5 largest-market-cap semiconductor companies in the A-share market.

By product, the company has 70-75% revenue from CIS, 5-7% from TDDI, 7-10% from other chip products, and 10-15% from distribution. CIS should remain the key growth driver in 2021, but the company also aggressively developed other chip products in order to diversify its business.

Will Semi outsources CIS production to multiple foundry partners, including TSMC, Huali Microelectronics, Dongbu, SMIC, and Powerchip. It should continue the multi-foundry strategy going forward.

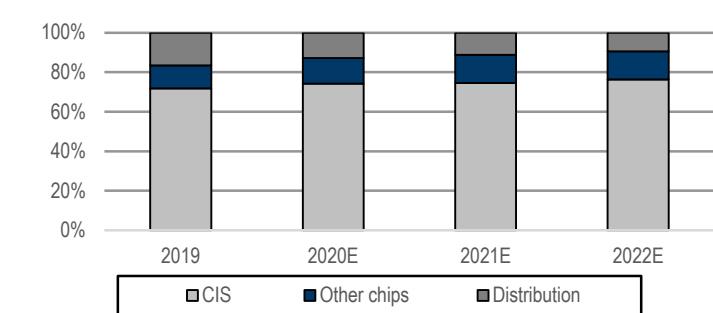
**Will Semiconductor acquired several design companies including Omnipixel to grow share in the CMOS image sensor market.**

**Figure 334: Revenue by product**



Source: Company data, Credit Suisse estimates

**Figure 335: Revenue mix % by product**



Source: Company data, Credit Suisse estimates

## Business drivers

We estimate Will Semi to grow its CIS revenue by approximately 50% in 2020 and to continue to grow CIS revenue by 30-40% in 2021. The growth in 2020 is mainly driven by Will Semi's share gain, especially for high-pixel CIS, and also driven by the smartphone market's multi-cam trend and main camera pixel upgrade. Into 2021, we expect its CIS growth from: (1) mobile/vehicle shipment recovery from a bad 2020, (2) Android's accelerating main camera upgrades, and (3) Will Semi's share gains in mobile and automotive.

While the multi-cam penetration will be slower in 2021 given already high penetration, we expect the smartphone market's main camera upgrade to continue in 2021, as all Android OEMs want to gain share from the original Huawei share. Our recent check suggested that multiple Chinese Android OEMs' new model plans already have Rmb1,500-3,500 new phones to adopt 64mp main cam spec. Compared with 2020 models, high-end phones will see main camera upgrade from 48mp to 64mp and mid-end phones will see main camera upgrade from 24/32mp to 64mp. Further, even for low-end phones, main cameras will also see upgrade from 16/24mp to 48mp. As a result, CIS suppliers can earn more dollar content per phone, US\$1.0-2.5 dollars per box. Additionally, for 48mp and above CIS, currently there are only three suppliers, namely Sony, Samsung and OmniVision. So the smartphone main camera upgrades will benefit all the three suppliers.

**Figure 336: We expect global CIS shipments to grow 16% in 2021, driven by shipment recovery and rising multi-cam adoption.**

CS base case:	Implied CIS demand:						
	2019	2020	2021	Rear cam	2019	2020	2021
Unit: mn							
Smartphone shipments	1,372	1,271	1,383	Single	453	229	138
YoY %	-2.2%	-7.3%	8.8%	Dual	1,098	585	609
<b>Rear cam adoption</b>				Triple	864	1,068	1,162
Dual	40%	23%	22%	Quad	329	1,576	2,213
Triple	21%	28%	28%	Total	2,744	3,458	4,122
Quad	6%	31%	40%	<b>Front cam</b>			
<b>Total</b>	<b>67%</b>	<b>82%</b>	<b>90%</b>	Single	1,372	1,271	1,383
				Total cam	4,116	4,729	5,505
				YoY %		15%	16%

Source: Company data, Credit Suisse estimates

Within the ex-Samsung Android main camera market (addressable market for Will Semi), we estimate Will Semi to have 12-14% unit share in 2020, from 2-3% in 2019. We expect Will Semi to expand share within this market to 18-20% in 2021 and 23-25% in 2022. In the automotive market, On Semi remains the global No. 1 supplier, with 40-50% market share, and Will Semi has 20-25% share. We expect Will Semi to slightly expand its automotive market positioning over the next two to three years, mainly driven by better shares in China.

Automotive and medical are the major drivers for the next five years. We estimate the global automotive CIS market to grow at 30% in 2021 as a result of vehicle shipment recovery and more cameras per car. Will Semi has about 20-25% market share in automotive and thus will benefit from the global auto rebound. Further, Will Semi's medical products, CameraCubeChip (CCC) and cable line of medical endoscope, catheter, and dental cables should have better penetration in the US, Europe, and Japan, as regulators are looking for single-use endoscope to minimise cross infection. This emerging medical demand is creating another RMB multi-billion market with better GM. Automotive and Medical will fuel growth in 2021-25.

## Near-term trends

**Figure 337: 3Q19-3Q20 and 2016-19 financial summary**

Rmb mn	Quarters					Years			
	3Q19	4Q19	1Q20	2Q20	3Q20	2016	2017	2018	2019
Sales	3,703	4,226	3,817	4,226	5,926	2,161	2,406	3,964	13,632
QoQ/YoY	348%	14%	-10%	11%	40%	9%	11%	65%	244%
Gross profit	938	1,232	1,230	1,371	1,653	435	494	928	3,734
GM %	25%	29%	32%	32%	28%	20%	21%	23%	27%
R&D	335	349	356	452	420	0	0	127	1,282
SG&A	295	396	254	266	304	252	298	544	1,149
Op income	309	488	620	652	928	182	196	257	1,303
OPM %	8%	12%	16%	15%	16%	8%	8%	6%	10%
Financing cost (net)	61	109	86	45	71	34	48	53	274
Net income	59	331	445	545	736	142	137	139	466
Net margin %	2%	8%	12%	13%	12%	7%	6%	4%	3%
Shares	864	864	864	864	864	374	456	456	864
EPS (Rmb)	0.11	0.59	0.53	0.67	0.64	0.38	0.34	0.32	0.76

Source: Company data, WIND, Credit Suisse

3Q revenue grew 40% on strong shipments besides Huawei pull-in. 3Q NI rose 35% QoQ, with inventory down 13% QoQ and inventory days declining from 206 in 2Q to 119 in 3Q. Management expects 4Q revenue to be at least flat QoQ in RMB (with USD depreciation), and 4Q gross margin to return to the level of above 30% driven by high-end CIS (CMOS Image

Sensor) and TDDI (Touch and Display Driver Integration). The recent Honor spin-off from Huawei should not have a major impact on demand in the near term, as Huawei has procured high level inventory in 3Q though it has uncertainty in the medium-term. OmniVision does have multiple high-pixel CISs to launch in 1H21 and a few to launch in 2H21, according to management.

## Valuation

At the current price of Rmb218.8, Will Semi has a market cap of Rmb189 bn and trades at 73x/41x 2020-21 CSe EPS and 16.8x/11.5x 2020-21 CSe BPS. We rate Will Semi OUTPERFORM with a target price of Rmb266 based on 50x and 2021 EPS. Will Semi has net debt accounting for 34% of total equity and net debt per share of Rmb3.91 vs the six-year average of Rmb1.57. The company recorded FCF of -Rmb2.5 bn in 2019 to build working capital after acquiring OVTI.

**Figure 338: Balance sheet summary**

Balance Sheet (Rmb mn)	3Q20 (A)	2Q20	Diff %	6 year avg	+/- Avg
Cash and Investments	3,032	2,801	8%	814	2,218
Debt	6,411	6,283	2%	1,449	4,963
Net debt	3,380	3,481	-3%	635	2,745
<b>Net debt/share</b>	<b>3.91</b>	<b>4.03</b>	<b>-0.12</b>	<b>1.57</b>	<b>2.34</b>
Accts. receivable	3,753	3,195	17%	1,028	2,724
<b>DSO</b>	<b>57</b>	<b>68</b>	<b>-11</b>	<b>105</b>	<b>-48</b>
Inventory	5,594	6,445	-13%	1,113	4,481
<b>Inventory days</b>	<b>118</b>	<b>203</b>	<b>-85</b>	<b>96</b>	<b>22</b>
Accts. payable days	40	80	-39	53	-13
<b>Cash conversion days</b>	<b>135</b>	<b>192</b>	<b>-57</b>	<b>148</b>	<b>-13</b>
SH Equity	10,085	9,581	5%	2,119	7,966
<b>Book value/share</b>	<b>11.7</b>	<b>11.1</b>	<b>0.6</b>	<b>4.3</b>	<b>7.4</b>

Source: Company data, WIND, Credit Suisse

**Figure 339: Financial metrics summary**

Ticker	603501.SS	Current price (Rmb)	218.8		
Stock connect %	0.0%	52-wk range (Rmb)	136-249.6		
Share outstanding (mn)	864	Mkt cap (Rmb mn)	188,925		
Daily trad vol-6m avg (mn)	7.3	Perf. 1M 3M 12M			
Daily trad vol-6m avg (Rmb n	1,372	Absolute 2% 18% 51%			
Free floatn (%)	90.6%	Relative -2% 16% 33%			
Year	2016	2017	2018	2019	9M20
<b>Revenue (Rmb mn)</b>	<b>2,161</b>	<b>2,406</b>	<b>3,964</b>	<b>13,632</b>	<b>13,969</b>
YoY	8.9%	11.3%	64.7%	243.9%	48.5%
Gross profit (Rmb mn)	435	494	928	3,734	4,254
<b>GM (%)</b>	<b>20%</b>	<b>21%</b>	<b>23%</b>	<b>27%</b>	<b>30%</b>
Operating profit (Rmb mn)	182	196	257	1,303	2,201
<b>OPM (%)</b>	<b>8%</b>	<b>8%</b>	<b>6%</b>	<b>10%</b>	<b>16%</b>
Net profit (Rmb mn)	142	137	139	466	1,727
<b>EPS (Rmb)</b>	<b>0.38</b>	<b>0.34</b>	<b>0.32</b>	<b>0.76</b>	<b>1.84</b>
EPS growth (%)	22.6%	-10.5%	-5.9%	137.5%	982.4%
P/E (x)	576	643	684	288	80
Dividend yield (%)	0.0%	0.0%	0.1%	0.0%	n/a
P/B (x)	101.3	84.5	61.0	23.8	17.6
ROE (%)	18%	12%	8%	6%	24%

Note: P/E and P/B in 9M20 column are based on 2020E consensus EPS and BPS.

Source: Company data, WIND, Credit Suisse

**Figure 340: Cash flow statement summary**

Rmb mn	2013	2014	2015	2016	2017	2018	2019	7 year avg
Revenue	1,141	1,408	1,983	2,161	2,406	3,964	13,632	3,813
Capex	65	26	27	88	61	88	743	157
<b>Capex/revenue (%)</b>	<b>6%</b>	<b>2%</b>	<b>1%</b>	<b>4%</b>	<b>3%</b>	<b>2%</b>	<b>5%</b>	<b>3%</b>
Depr and amort	4	5	13	19	25	40	578	98
<b>Depr/revenue (%)</b>	<b>0%</b>	<b>0%</b>	<b>1%</b>	<b>1%</b>	<b>1%</b>	<b>1%</b>	<b>4%</b>	<b>1%</b>
Operating cash flow	45	20	-47	70	-272	5	805	90
<b>Free cash flow</b>	<b>40</b>	<b>-11</b>	<b>-51</b>	<b>-30</b>	<b>-223</b>	<b>-169</b>	<b>-2,513</b>	<b>-423</b>
FCF and dividend yield	2013	2014	2015	2016	2017	2018	2019	7 year avg
FCF/share (Rmb)	0.44	-0.08	-0.36	-0.08	-0.49	-0.37	-2.91	-0.55
FCF yield (%)	0.2%	0.0%	-0.2%	0.0%	-0.2%	-0.2%	-1.3%	-0.3%
<b>FCF/EV (%)</b>	<b>0.0%</b>	<b>0.0%</b>	<b>0.0%</b>	<b>0.0%</b>	<b>-0.1%</b>	<b>-0.1%</b>	<b>-1.3%</b>	<b>-0.2%</b>
Dividend per share (Rmb)	0.00	0.00	0.00	0.00	0.05	0.18	0.07	0.04
Dividend payout (%)	0%	0%	0%	0%	13%	56%	9%	11%
<b>Dividend yield (%)</b>	<b>0.0%</b>	<b>0.0%</b>	<b>0.0%</b>	<b>0.0%</b>	<b>0.0%</b>	<b>0.1%</b>	<b>0.0%</b>	<b>0.0%</b>

Source: Company data, WIND, Credit Suisse

## Valuation, Methodology and Risks

### Target Price and Rating

#### Valuation Methodology and Risks: (12 months) for ASE Industrial Holdings (3711.TW)

**Method:** Our target price of NT\$105 for ASE is based on 14x 2021 P/E (price-to-earnings) consolidated earnings contribution from SPIL. We believe the consolidation gives the new ASE 30% global outsourced packaging and test market share, and half of advanced packaging, supporting the synergy in 2021. The company's growth outlook should be supported by growing 5G and HPC demand more than offsetting its business loss in Huawei (18% of its sales) in 2021. We thus rate the stock OUTPERFORM.

**Risk:** Risks to our target price of NT\$105 and OUTPERFORM rating for ASE would be an escalating trade war that places tariffs on imports to China or the US limiting tech demand, a recession and semiconductor downturn, or a rise in competitive pricing from Chinese suppliers.

### Target Price and Rating

#### Valuation Methodology and Risks: (12 months) for ASM International (ASMI.AS)

**Method:** For our TP of €204, we take average of EV/Sales multiple of 4.5x and P/E multiple of 21x (~10% and ~15% premium to sector average given faster growth seen at ASMI in recent years) on our adjusted 2023 sales and EPS (excl. investment income from ASMPT). To this we add adjusted current net cash and ASMI's stake in ASMPT at its current market value. We rate the shares Outperform given our view that ASMI will continue to benefit from increasing TAM at its major chip customers, while improving prospects for margin expansion.

**Risk:** Risks to our TP of €204 and Outperform rating include: i) a slowdown in the semiconductor industry (smartphones, PCs, tablets, consumer electronics, automotive & industrial products) which could have a negative impact on demand for deposition equipment; ii) re-use of tools at customers, and ii) no further success in newer product areas like Epitaxy and CVD (chemical vapour deposition).

### Target Price and Rating

#### Valuation Methodology and Risks: (12 months) for ASM Pacific Technology Ltd (0522.HK)

**Method:** Our target price of HK\$119 for ASM Pacific Tech reflects 21x upcycle P/E (price-to-earnings) and 2021E EPS (earnings per share). We have an OUTPERFORM rating on the stock. We like its structural trend and we believe CIS (CMOS image sensing), backend and SMT (surface mount technology) equipment would benefit from macro recovery in 2021. Besides, heterogeneous integration will continue to drive advanced packaging demand while 5G infrastructure roll-out will drive SMT demand and mini-LED (Light Emitted Diode) picking up from 2H21 also support ASMPT structural growth outlook, in addition to increase of production capacity in SEA (south-east Asia) and India, and localisation of China supply chain.

**Risk:** Risks to our HK\$119 target price and OUTPERFORM rating for ASM Pacific include execution of transformation, slowing/improving orders, lower/higher multi-chip adoption, inventory correction cycle, weaker/improving macro demand, continuous pandemic impact and forex risks.

### Target Price and Rating

#### Valuation Methodology and Risks: (12 months) for ASML Holding N.V. (ASML.AS)

**Method:** Our TP of €450 and Outperform rating for ASML are based on a P/E multiple of 33x applied to our 2023E EPS. This 33x P/E multiple is slightly over ARM Holdings (semis company), which traded at a historical average (from 2010) of around 30x for FY3 P/E before it was acquired in 2016. Given ASML's dominant position in lithography market with a near monopoly status (60-65% share in Dry tools, 90-95% share in Immersion tools and now 100% share in EUV tools), we believe the ASML shares can potentially re-rate to a higher multiple, similar to companies (like ARM Holdings, Dassault Systemes and Temenos) that also hold market leadership positions with rising barriers to entry. Hence, we rate the stock Outperform.

**Risk:** Risks to our €450 target price and Outperform rating for ASML include: (1) Adoption of EUV could be slower than expected, which could prove disappointing; (2) Growth in the semiconductor market may slow down, which could affect the demand for ASML's products; (3) General macroeconomic slowdown; (4) Emergence of newer competing technology that could be used as a replacement for EUV; and (5) Critical dependence on a small number of suppliers.

### Target Price and Rating

#### Valuation Methodology and Risks: (12 months) for Alchip Tech (3661.TW)

**Method:** Our OUTPERFORM rating and target price of NT\$980 for Alchip Tech is based on 35x 2020-21 P/E (price-to-earnings), factoring in our expectation for 30% sales CAGR from 2019-22. We believe the upper half of the long-term valuation should be supported by the company's earnings upside from stronger-than-expected China PC CPU replacement demand and faster-than-expected Phytium's server CPU penetration into the China government and SOE projects.

**Risk:** Risk to our OUTPERFORM rating and target price of NT\$980 for Alchip Tech include: (1) Macro uncertainty leads to slower semiconductor investment, (2) Timing uncertainty in AI chipset development, (3) Customers shift to foundry direct business model, (4) Slower local CPU penetration in China, (5) U.S. further expands its ban on China companies' access to IP/EDA tools.

### Target Price and Rating

#### Valuation Methodology and Risks: (12 months) for Amkor Technology Inc. (AMKR.OQ)

**Method:** Our target price of US\$16.5 for Amkor Technology is based on 12x 2021E P/E and 1.5x forward P/B (price-to-book) based on Amkor's mid-cycle range. Valuation is at the lower-end, at 0.8x EV/sales vs its 0.5x-1.2x range and 3.2x EV/EBITDA vs its 2.5x-5x range. We thus rate Amkor OUTPERFORM.

**Risk:** Downside risks to our US\$16.5 target price and OUTPERFORM rating for Amkor Technology include: the share price could perform worse due to slower-than-expected premium smartphones, and worse-than-expected opex control leading to low profitability.

### Target Price and Rating

#### Valuation Methodology and Risks: (12 months) for Analog Devices Inc. (ADI.OQ)

**Method:** Our \$165 target price and Outperform rating for ADI are based on 28.0 times CY21 P/E. We rate ADI Outperform as we expect it to appreciate more than its peers.

**Risk:** Risks to our \$165 target price and Outperform rating for ADI are: (1) competitive pricing pressure in the analog universe by new entrants and Chinese semiconductor companies and (2) market share loss in amplifiers, data converters, power management, due to new entrants and new technologies being introduced.

### Target Price and Rating

#### Valuation Methodology and Risks: (12 months) for Applied Materials Inc. (AMAT.OQ)

**Method:** Our \$100 target price and Outperform rating for AMAT are based on 19.5x our CY20 EPS estimate. We rate AMAT as Outperform, as we would note that (i) AMAT is relatively cheap on CY20E PE. (ii) The company has bought back 28% of shares outstanding, with \$3.0B left in the authorization, which will drive further accretion. (iii) OLED is driving a stronger Display investment cycle which, while lumpy, will uniquely benefit AMAT among the large equipment suppliers. We rate AMAT Outperform as we expect it to appreciate more than its peers.

**Risk:** Risks to AMAT's \$100 target price and Outperform rating are material weakness in the semicap cycle due to disappointments in electronics end-demand, or execution issues causing lower peak earnings than we expected.

### Target Price and Rating

#### Valuation Methodology and Risks: (12 months) for Aspeed (5274.TWO)

**Method:** We have an NEUTRAL rating on Aspeed as we see limited upside due to stretched valuation already reflecting the growth potential in 2021-22. Our target price of NT\$2,150 is based on 50x 2022E earnings, from the upper half of its historical range.

**Risk:** Risks to our target price of NT\$2,150 and NEUTRAL rating for Aspeed include: (1) data centre growth hits a prolonged slowdown, (2) share gains in BMC do not materialise in servers or networking, (3) competition emerges on new product generation or customers insource, (4) new products fail to gain market acceptance, and (5) valuations for semiconductor growth companies de-rate.

### Target Price and Rating

#### Valuation Methodology and Risks: (12 months) for Broadcom Ltd (AVGO.OQ)

**Method:** Our Outperform rating and \$480 target price for AVGO are based on weighted avg ~19x times CY21 EV/FCF between Semi Solution (70% of Rev) and Infrastructure SW (30% of Rev), conservatively below peers despite superior returns and profitability. We rate AVGO Outperform as we expect it to appreciate more than its peers.

**Risk:** Risks to our \$480 target price and Outperform rating for AVGO are (1) competitive pressures in the Wireless business, (2) high customer concentration, (3) failure to execute on cost synergies, and (4) the highly cyclical nature of the semiconductor industry.

### Target Price and Rating

#### Valuation Methodology and Risks: (12 months) for CR Micro (688396.SS)

**Method:** We expect CR Micro's revenue and EPS to grow at 21% and 36% CAGR in 2021-23, with GM improving from 29% to 35%, driven by China's share gain in global power semi market, the company's product genre expansion, and global 8-inch foundry capacity tightness. We use discounted cash flow (DCF) as the primary valuation methodology, as the A-share semi sector's valuation nature is often based on investors' expectation for next five to ten years' growth potential. Our OUTPERFORM rating is based on our DCF-based target price of Rmb85, for which we apply a beta of 1.2, terminal growth rate 2.7% and WACC (weighted average cost of capital) of 8.0%.

**Risk:** Downside risks to our target price Rmb85 and OUTPERFORM rating for CR Micro include: (1) Weaker end-demand with lingering pandemic, (2) Slower global market share gain of China power semiconductor manufacturers or CR Micro, (3) CR Micro's R&D progress behind schedule, (4) Slower-than-expected new capacity construction, (5) China semi devaluation, (6) geopolitical tension, and (7) forex.

#### Target Price and Rating

##### Valuation Methodology and Risks: (12 months) for ChipMOS Technologies Inc. (8150.TW)

**Method:** Our 12-month forward target price of NT\$43 for ChipMOS is based on 1.4x 12M P/B (price-to-book), the mid-point of its historical 1.0-2.0x. We like ChipMOS as we expect its operating profit to recover on better driver IC demand and turnaround of the Shanghai affiliate; we therefore rate the stock OUTPERFORM.

**Risk:** Key risks to our target price of NT\$43 and OUTPERFORM rating for ChipMOS include: (1) delay in the turnaround of ChipMOS Shanghai; (2) more competition on pricing; (3) end demand slowdown; and (4) share loss to peers.

#### Target Price and Rating

##### Valuation Methodology and Risks: (12 months) for Chipbond (6147.TWO)

**Method:** Our 12-month forward target price of NT\$83 for Chipbond is based on 12x average 2021-22E P/E (0.5 standard deviation below historical average). We have OUTPERFORM rating on Chipbond as we believe it is the most leveraged play on resolution upgrade, TDDI/OLED DDI proliferation, ASP improvement, and the new opportunities at non-driver IC should drive its growth.

**Risk:** Key risks to our target price of NT\$83 and OUTPERFORM rating for Chipbond include: (1) weaker-than-expected demand for smartphones, tablet PCs, NBs, monitors and TVs; (2) market share loss; and (3) NTD appreciation.

#### Target Price and Rating

##### Valuation Methodology and Risks: (12 months) for Chunghwa Precision (6510.TWO)

**Method:** We rate Chungwa Precision OUTPERFORM with a target price of NT\$1000, based on 30x 2022 P/E, in line with its growth peers, as we believe the company's sales will reaccelerate in 2022 following the moderation in 2021E supported by potential share gain back in high-end mobile and diversifying 5G drivers.

**Risk:** Downside risks to our OUTPERFORM rating and TP of NT\$1000 for Chungwa Precision include slower-than-expected full-solution ramp-up at high margin from key customers and worse than expected share loss in its mobile business.

#### Target Price and Rating

##### Valuation Methodology and Risks: (12 months) for Egis Technology Inc. (6462.TWO)

**Method:** We set our target price for Egis at NT\$170 using 10x 12M P/E (price-to-earnings), mid-point of historical 5-16x range. We rate Egis NEUTRAL, as we see limited upside in the near-term on weaker smartphone demand, although fingerprint proliferation should continue.

**Risk:** Risks to our NEUTRAL rating and NT\$170 target price for Egis include: (1) slower/faster adoption rate of fingerprint sensors for non-Apple smartphones; (2) new entrants intensifying the competition; (3) weaker/better smartphone demand; and (4) faster/slower growth leading to re-rating/de-rating of the stock.

#### Target Price and Rating

##### Valuation Methodology and Risks: (12 months) for Elan Microelectronics Corp (2458.TW)

**Method:** We have a OUTPERFORM-rating with a target price of NT\$200 for Elan Microelectronics based on 14x 2021E P/E (price-to-earnings), 1 standard deviation above its past year average (and a range of 10-17x) vs fabless companies' average of 15x-25x, given its leading position in computing and key beneficiary from further share-gain and market consolidation. Its high dividend pay-out at 90-100% also provides good downside support with 6-7% cash yield along with profitability expansion.

**Risk:** Risks to our NT\$200 target price and OUTPERFORM rating for Elan Microelectronics include: (1) weaker ASP, (2) slower ramp-up of fingerprint sensors, (3) market share loss for NB touchpad and point stick, and (4) weaker-than-expected global NB market demand.

#### Target Price and Rating

##### Valuation Methodology and Risks: (12 months) for GUC (3443.TW)

**Method:** Our NEUTRAL rating and target price of NT\$325 for GUC is based on 30x P/E (price-to-earnings). We believe the company's share is fairly valued at the upper half of its historical range, factoring in its opportunity in 5G and AI, though the timing of the project ramp for meaningful revenue contribution and profitability remain uncertainty.

**Risk:** Risk to our NEUTRAL rating and target price of NT\$325 for GUC include: (1) Macro uncertainty leads to slower semiconductor investment, (2) Timing uncertainty in AI chipset development, (3) Customers shift to foundry direct business model. Better semiconductor demand and higher visibility on AI and 5G projects are the upside risks for GUC.

**Target Price and Rating****Valuation Methodology and Risks: (12 months) for Gigadevice (603986.SS)**

**Method:** Our target price of Rmb226 for Gigadevice is based on 72x and 2021 EPS (earnings per share). The 72x multiple is at A-share fabless sector average P/E multiple on 2021 EPS. We like its upside from NOR flash and MCU, but that growth is fair at the current price. As a result, we rate the stock NEUTRAL.

**Risk:** Upside/downside risks to our Rmb226 target price and NEUTRAL rating for Gigadevice include: Upside risks: high-density NOR passes qualification with Huawei 5G base station, successful DRAM production without any patent issue, and secure high share within 2020 Airpods. Downside risks: insufficient foundry supply, DRAM IP risk, US restriction on its foundry partner(s), or lower-than-expected shipments of new fingerprint optical sensor for 5G or LCD phones.

**Target Price and Rating****Valuation Methodology and Risks: (12 months) for Goodix (603160.SS)**

**Method:** Our target price of Rmb140 for Goodix is based on 39x and 2021 EPS (earnings per share) plus Rmb8.1 net cash per share. The 39x multiple is at its historical average P/E on forward consensus EPS and is at 40-50% discount to the A-share IC design companies' trading average of 75x. The shares are expensively valued, and we see more downside than upside for Goodix. Therefore, we have an UNDERPERFORM rating.

**Risk:** Risks to our target price of Rmb140 and UNDERPERFORM rating for Shenzhen Goodix include: (1) More policy support from the Chinese government for the domestic semi supply chain may drive another round of domestic investor sentiment, (2) failures of other fingerprint IC design companies, (3) accelerating adoption of under-display fingerprint as a result of further delay of Android 3D sensing solutions, (4) better wafer pricing on foundry capacity easing and (5) earlier-than-expected commercial adoption of its new biometric sensing technologies.

**Target Price and Rating****Valuation Methodology and Risks: (12 months) for Himax Technologies, Inc. (HIMX.OQ)**

**Method:** Our target price of US\$7.0 for Himax Technologies based on 18x cash adjuted 2021E P/E, average of the historical up-cycle valuation. We rate Himax OUTPERFORM on improving small-/mid-size display driver IC momentum, as it catches up on TDDI for smartphones and tablets. In addition, we also see a better sales outlook with large display driver business given the Samsung TFT-LCD fab shutdown, as its Chinese panel makers are likely to gain share, which should help Himax from 2H20, as well its timing controller sales.

**Risk:** Risks that could impede achievement of our US\$7.0 target price and OUTPERFORM rating for Himax Technologies include: (1) weaker demand for smartphone and tablet PCs; (2) weaker 4K2K penetration; and (3) slower ramp up of the non-driver business, especially 3D sensing.

**Target Price and Rating****Valuation Methodology and Risks: (12 months) for Hua Hong Semiconductor Limited (1347.HK)**

**Method:** Our target price of HK\$42 for Hua Hong Semiconductor Limited is based on 3x P/B (price-to-book), which is its mid cycle valuation and reflecting only low single digits ROE (return on equity) in the next 1-2 years. Hua Hong will still benefit from the China localization but in the next 2 years will face margin pressure from ramping new capacity for its 12" fab and higher depreciation, dragging its profitability, offsetting the premium the company benefits from China semiconductor localization. We therefore rate the stock NEUTRAL.

**Risk:** Hua Hong faces several risks that could impact its business outlook and our HK\$42 target price, and could cause us to change our NEUTRAL rating including better China semiconductor demand and more disciplined capacity expansion from its major foundry competition on 8" and mature 12" nodes.

**Target Price and Rating****Valuation Methodology and Risks: (12 months) for Huatian (002185.SZ)**

**Method:** Our target price of Rmb18.0 for Tianshui Huatian is based on 43x on 2021 EPS. The multiple is at its +1.5STDEV of historical average P/E on forward consensus EPS and supported by its 37% earnings CAGR in 2021-22. Our OUTPERFORM rating is supported by Huatian's more stable margin and earnings and strong growth upsides with Huawei and China's huge domestic replacement momentum.

**Risk:** Key investment risks for our OUTPERFORM rating and target price of Rmb18.0 for Huatian include post-deal execution risk, losing Unisem customers, slower-than-expected demand from key clients, deteriorating end-market demand and forex risks.

**Target Price and Rating****Valuation Methodology and Risks: (12 months) for Inari Amertron (INAR.KL)**

**Method:** We value Inari using the P/E methodology. We peg Inari's FY22E EPS to its +1SD above mean P/E, which is 33x, deriving a target price of RM3.30 per share. We rate the stock OUTPERFORM as we believe the stock should re-rate in the near term due to the smartphone replacement cycle driven by 5G post COVID-19.

**Risk:** Key downside risks that may impact earnings and in turn, our RM3.30 target price and OUTPERFORM rating for Inari are: (1) single customer risk (revenue from Inari's key client forms ~75% of its total revenue today); (2) contraction in demand for smartphones/smart devices; and (3) forex risk (90% revenue in USD, but only 55% of COGS are in USD). Key upside risks are: (1) better-than-expected prospects for RF; (2) faster-than-expected market share gains for BRCM opportunity; and (3) proliferation of iris scan in mainstream smartphones.

### Target Price and Rating

#### Valuation Methodology and Risks: (12 months) for Intel Corp. (INTC.OQ)

**Method:** Our \$80 target price and Outperform rating for Intel are based on 13x 2020E P/E. Our Outperform rating is based upon the following: INTC remains well levered to Data Growth not only in DCG but also in its IoT and NSG businesses. We believe the company's business model/IP has significant barriers to entry (evidenced by one of the highest "R&D + CapEx to Revenue" ratio), and we continue to argue that Moore's Law has been the cornerstone of Tech economics for 40 years and that INTC will be the Last-man-standing on Moore's Law, leading to market share gains in Compute (including Mobile), as well as Foundry.

**Risk:** Risks to our \$80 target price and Outperform rating for Intel are aggressive pricing, higher manufacturing spending, loss of market share in key enterprise markets, reversal of recent strength in servers where Intel has renewed momentum, ability to maintain share in desktop and mobile, with the new Core i3/i5/i7 offering, lower gross margin due to higher manufacturing costs, and seeing slower-than-expected unit growth of PC units.

### Target Price and Rating

#### Valuation Methodology and Risks: (12 months) for JCET (600584.SS)

**Method:** Our target price of Rmb36.60 for JCET is based on 3.6x 2021E P/B (price-to-book), which is at its +0.5 s.d. of historical P/B, consistent with valuation for other A-share Apple suppliers. We like its margin expansion and growth with both iOS/Android 5G phones, but think the valuation is expensive and as a result, rate it UNDERPERFORM.

**Risk:** Upside risks to our Rmb36.60 target price and UNDERPERFORM rating for JCET include: Better iPhone/Airpod demand, faster Android 5G demand pick-up, even better GM expansion, and US lifting Huawei restrictions, A-share semi valuation momentum in July with potential SMIC listing. Downside risks: Weaker mobile/wearable shipments due to even longer pandemic and lower GM; currency fluctuation.

### Target Price and Rating

#### Valuation Methodology and Risks: (12 months) for KLA Corporation (KLAC.OQ)

**Method:** Our TP of \$240 represents 19x CY21 EPS. With the stock trading at just 17x our CY20 EPS and our long-term thesis intact (EUV SAM expansion, growing process control intensity), we rate the stock Outperform.

**Risk:** Risks to our target price of \$240 and our Outperform rating for KLAC include: (i) KLAC could see increased competition from AMAT and others in the process control segment. (ii) Process control could begin to saturate as a percentage of overall equipment spending, resulting in lower growth rates for KLAC. (iii) We could be under-estimating the risk of oversupply in memory. (iv) A global macro slowdown would negatively impact KLAC and most other stocks in our universe.

### Target Price and Rating

#### Valuation Methodology and Risks: (12 months) for Lam Research Corp. (LRCX.OQ)

**Method:** We are using a Price to Earnings Valuation Methodology to come up with our Target Price (TP) for LRCX. Our price target of \$450 represents ~19.7x CY21 EPS. We rate the LRCX shares as Outperform given that the company could potentially continue to outgrow peers driven by (i) SAM growth from 3D NAND transition; (ii) increasing adoption of Multi patterning in DRAM, Foundry and Logic; (iii) TSV; and (iv) Market share gains at Intel.

**Risk:** Risks to our \$450 target price and our Outperform rating for LRCX are: (i) Excess supply in the memory industry; (ii) Excess inventories leading to a pause in spending for logic industry; (iii) End-demand weakness due to macro economic factors; (iv) Market share loss for LRCX in its etch, deposition or clean businesses; (v) Margin issues from lower margin clean products which are ramping in volume; and (vi) Unfavorable rulings on tax treatment.

### Target Price and Rating

#### Valuation Methodology and Risks: (12 months) for Marvell Technology Group Ltd. (MRVL.OQ)

**Method:** Our \$60 target price and Outperform rating for MRVL are based on an in-line ~30x multiple of 2025 EPS estimate discounted back to 2020 at ~8% WACC. We rate MRVL Outperform as we believe new management at MRVL can reduce operating expenses and still have the resources to invest in new growth initiatives. We expect MRVL to appreciate more than the typical stock in our coverage.

**Risk:** Risks to our \$60 target price and Outperform rating for MRVL are: A repositioning of the Company could prove difficult by a structurally declining HDD TAM, an SSD portfolio which does not benefit LT from a structural inflection in SSD demand due to increased competition, and a networking business which has under grown peers over multiple years implying that OpEx spending will likely need to remain high to capitalize on growth opportunities delaying the Company's stated goal of achieving profit levels in-line with peers.

### Target Price and Rating

#### Valuation Methodology and Risks: (12 months) for Maxscend (300782.SZ)

**Method:** We expect Maxscend to grow revenue at 48% CAGR and net profit at 51% CAGR in 2020-23, driven by the global RF market's 10% CAGR, Maxscend's better technology capabilities and share wins in the smartphone, base station, IoT and automotive markets. Given the multi-year growth cycle and solid ROE, we rate Maxscend as OUTPERFORM with a DCF-based target price of Rmb702 (at 7.5% WACC and 3% terminal growth rate).

**Risk:** Key risks to our target price of Rmb702 and OUTPERFORM rating for Maxscend include: (1) an even longer pandemic resulting in weaker demand, (2) slower-than-expected research and development progress, (3) wafer supply tightness, (4) an A-share tech valuation crash, and (5) currency fluctuation.

### Target Price and Rating

#### Valuation Methodology and Risks: (12 months) for MediaTek Inc. (2454.TW)

**Method:** Our OUTPERFORM rating and target price of NT\$960 for Mediatek is based on 20x 2022E ex-cash EPS (earnings per share), in line with global peers. We still view the company better off than pre-Huawei restriction as Huawei had sourced 85% in-house and may be unable to build smartphones.

**Risk:** Risks that could impede achievement of our NT\$960 target price and cause us to change our OUTPERFORM rating for Mediatek include the impact of competitive products and pricing, timely design acceptance by its customers, timely introduction of new technologies, ability to ramp new products into volume, industry-wide shifts in supply and demand for semiconductor products, industry overcapacity, availability of manufacturing capacity, and financial stability in end markets.

### Target Price and Rating

#### Valuation Methodology and Risks: (12 months) for Microchip Technology Inc. (MCHP.OQ)

**Method:** Our \$145 target price and Outperform rating for MCHP are based on ~21x our estimated CY21 P/E. We believe MCHP should trade near the high end of the group given our structural favorable view of the company. We rate MCHP Outperform rating as we continue to see it as one of the most diversified and well run companies in the Semi Industry - with consistent execution, as well as its strong track record of successful M&A to augment organic growth. We expect MCHP to return more than its peers.

**Risk:** Risks to our \$145 target price and Outperform rating for MCHP are a slowdown in the overall economy, as its revenue is spread over a large number of customers (none over ~2% of revenue) and tends to be tied to the macroeconomic environment, failure to meet the long-term gross margin target, share loss in the MCU market, failure to show good revenue growth in the 16-bit MCU market and a slowdown in auto sales (auto is about 15% of revenue).

### Target Price and Rating

#### Valuation Methodology and Risks: (12 months) for Montage (688008.SS)

**Method:** We expect Montage to grow revenue at 50% CAGR and net profit at 29% CAGR in 2021-23, driven by global server market's 4% CAGR, the industry's DDR/PCIe spec migration, and Montage's share gain in the PCIe retimer market and China server market. Given A-share semiconductor sector's valuation nature is often based on investor's expectation for next five to ten years' growth potential, we adopt DCF (discounted cash flow) method. Our NEUTRAL rating is based on our DCF-based target price of Rmb90, which is based on beta of 1.2, tax rate of 8%, terminal growth of 3%, and WACC (weighted average cost of capital) of 8.6%.

**Risk:** Upside/downsides risks to our Rmb90 target price and NEUTRAL rating for Montage include better/lower market share for memory interface/Jintide/retimer, higher/weaker server market growth, faster/slower industry spec upgrades, faster/slower Intel/AMD new processor roll-out, greater/lower new product GMs, M&A with its high net cash, China semi rally/devaluation, domestic policy support and geopolitical tension, and Montage's own R&D and new chip roll-out.

### Target Price and Rating

#### Valuation Methodology and Risks: (12 months) for NVIDIA Corporation (NVDA.OQ)

**Method:** Our \$620 target price and Outperforming rating for NVDA are based on 52x FY23 P/E - still in-line with average premium to the SOX. We rate NVDA the stock Outperform as we expect it to appreciate more than its peers.

**Risk:** Risks to our \$620 target price and Outperform rating are (1) a shift in consumer preferences in the gaming industry; (2) volatile demand in NVDA's key growth segments; and (3) competition in the Gaming, AV, and AI markets.

**Target Price and Rating****Valuation Methodology and Risks: (12 months) for Novatek Microelectronics Corp Ltd (3034.TW)**

**Method:** Our TP of NT\$460 for Novatek is derived from our DCF (discounted cash flow) model, implying 16.5x cash adjusted 2021E P/E. We assume a neutral beta with a risk-free rate of 1%, equity risk premium of 6.0%, and terminal growth rate of 3.0%. We rate Novatek OUTPERFORM as we believe all three business segments are returning to growth and its margin should also improve.

**Risk:** Risks to our target price of NT\$460 and OUTPERFORM rating for Novatek include: (1) lower pricing pressure; (2) weaker smartphone demand; (3) slower transition and ramp up of TDDI/OLED DDI for smartphone; and (4) share loss to its peers on SOC products.

**Target Price and Rating****Valuation Methodology and Risks: (12 months) for ON Semiconductor Corp. (ON.OQ)**

**Method:** Our TP of \$17 represents ~13.1x P/E on CY21. We maintain our Underperform rating as we see shares as fully valued, ON has historically underperformed post y/y Rev peaks, and we see longer-term structural competitive issues without an M&A bid. We see higher quality assets at similar multiples with better risk/reward.

**Risk:** Major Risks to our \$17 target price and our Underperform rating for ON include successful execution towards its LT EPS target and better than expected content gains in Autos and Mobile.

**Target Price and Rating****Valuation Methodology and Risks: (12 months) for Parade Technologies (4966.TWO)**

**Method:** Our target price of NT\$1,400 for Parade Technologies is based on 21x cash adjusted 2021 P/E (price-to-earnings) or 23x straight P/E, vs historical 11-22x P/E range, given its strengthened industry position on eDP and SIPI IC business, as well as it has developed new products for data centre applications. We rate Parade OUTPERFORM as it is well positioned to benefit from the display resolution migration and opportunities in the high-speed transmission interfaces.

**Risk:** Risks that could impede the achievement of our NT\$1,400 target price and OUTPERFORM rating for Parade Technologies include: (1) slower-than-expected migration to eDP T-Con v1.3 among Apple products leading to lower revenue growth; (2) lower-than-expected penetration of the eDP T-Con among non-Apple NB models; and (3) failure to diversify into non-eDP products, including SIPI source IC, high-speed interface, TDDI, etc.

**Target Price and Rating****Valuation Methodology and Risks: (12 months) for Powertech Technology (6239.TW)**

**Method:** We stay positive on the growth outlook of Powertech Technology, and have an OUTPERFORM rating on the stock. Our target price of NT\$114, based on 12x 2021E EPS and 1.8x P/B, is at the lower end of its 11-15x range on continued sales growth across memory and logic though we believe the stock is fairly valued factoring in slower mobile demand in the near term.

**Risk:** The downside risks that may impede achievement of our NT\$114 target price and our OUTPERFORM rating for Powertech are: (1) milder price competition from its peers; (2) cost control is not as good as expected; and (3) there is a more severe drop in DRAM pricing than expected, leading to higher pricing pressure and a decline in ASPs. The stock has upside to our estimates if the DRAM and NAND demand recover and there is slower-than-expected assembly insourcing from Mircon.

**Target Price and Rating****Valuation Methodology and Risks: (12 months) for Realtek Semiconductor (2379.TW)**

**Method:** Our target price of NT\$475 and OUTPERFORM rating for Realtek are based on 20x cash-adjusted 2021E EPS, in line with its peers. Realtek's upside could continue from sales into new products, and if more benign competition also drives operating leverage.

**Risk:** The major risk to Realtek achieving our NT\$475 target price and OUTPERFORM rating is the company's business concentration on the PC industry. Due to the large size and standard nature of the architecture, many of Realtek's products face competition and commoditisation, placing risks on pricing and margins. The segment is also at risk of slowdown as consumer purchasing shifts to tablets or other media consumption devices where Realtek may have less silicon designed in. Other risks include: (1) its capability to gain market share in key products; (2) its margin trends, (3) foundry manufacturing risks, and (4) inventory cycle risks to sales when channel inventories are at high levels.

**Target Price and Rating****Valuation Methodology and Risks: (12 months) for SCREEN (7735.T)**

**Method:** Our ¥4,430 target price for SCREEN Holdings is based on P/B of 1.04x to our end-FY3/22 BPS forecast of ¥4,263. Unlike for other Japanese SPE companies, for SCREEN we apply a discount of one standard deviation to the average P/B for the 12 months of memory price decline from September 2018. This reflects our concerns about business issues such as the urgent need for profitability improvement, including via structural reform. We expect the risk of weakening memory prices to result in valuation adjustments. Our UNDERPERFORM rating is based on a comparison of the company's 12-month potential total return versus our coverage universe.

**Risk:** Risks to our ¥4,430 target price and UNDERPERFORM rating for SCREEN Holdings include the execution of structural reforms under the medium-term plan, a rebound in smartphone output at Huawei (under license from Qualcomm), an upturn in memory prices, and the resumption of large-scale investment in cutting-edge process at TSMC.

### Target Price and Rating

#### Valuation Methodology and Risks: (12 months) for SUMCO (3436.T)

**Method:** Our ¥2,090 target price for SUMCO is based on a P/B of 1.87x applied to our FY12/21E BPS of ¥1,120. Our fair P/B of 1.87x is the average relative P/B since 2012, when the market was not pricing in expectations for higher wafer prices (excluding the period from 2017 to 2018, when expectations were that wafer prices could move higher), multiplied by the average TOPIX P/B 1.37x (as of January 2021). We expect the risk of supply chain adjustments to emerge from the 2021 Chinese New Year. In addition, semiconductor makers' wafer inventories apparently rose throughout 2020, so we expect wafer inventory adjustments to occur during the adjustment. Given current share price levels, we see correction risk, as we think the prospect of post-Chinese New Year adjustments has not been priced in. We thus assign our NEUTRAL rating, based on a comparison of the 12-month projected total returns for SUMCO shares and our coverage universe.

**Risk:** Risks to our ¥2,090 target price and NEUTRAL rating for SUMCO include: Upside - higher selling prices or the level of wafer inventories required by customers rising, meaning inventory adjustments do not occur; Downside - ongoing deterioration in cutting-edge product yields and a protracted correction in the semiconductor market.

### Target Price and Rating

#### Valuation Methodology and Risks: (12 months) for Sanan Optoelectronics Co. Ltd (600703.SS)

**Method:** Our target price of Rmb27.3 for Sanan Optoelectronics is based on upcycle P/B of 4.0x and 2021 BPS. We rated Sanan a NEUTRAL rating as we think the LED industry has reached bottom of the cycle but valuation has well reflected.

**Risk:** Key investment risks to our NEUTRAL rating and Rmb27.3 target price for Sanan Optoelectronics include: (1) stronger/weaker LED demand, (2) aggressive capacity expansion in other Chinese players, (3) pricing pressure, (4) changes in government policy and support, (5) IP risks, (6) any potential disruptive technology in the lighting area, and (7) execution risk.

### Target Price and Rating

#### Valuation Methodology and Risks: (12 months) for Semiconductor Manufacturing International Corp. (0981.HK)

**Method:** Our HK\$19.6 target price for Semiconductor Manufacturing International Corp. is based on 1.5x P/B (price-to-book) + HK\$6 net cash, at the low end of its past three-year range. We have an NEUTRAL rating on SMIC due to profitabilty upside being limited by its investment.

**Risk:** Risks to our HK\$19.6 target price and NEUTRAL rating for SMIC include: (1) the global semiconductor cycle picks up stronger than expected especially for China smartphones in 2020 from 5G ramps (being an upstream company, SMIC tends to be more cyclical than other tech plays). (2) Price competition from peers. (3) Its advanced technology development is less than expected.

### Target Price and Rating

#### Valuation Methodology and Risks: (12 months) for Shin-Etsu Chemical (4063.T)

**Method:** We base our target price of ¥15,080 for Shin-Etsu Chemical is based on our FY3/22 EBITDA estimate for each segment multiplied by peer-average EV/EBITDA (Formosa Plastic, Dow, Wacker Chemie, SUMCO, etc.); we then add in net cash. The company took a COVID-19 hit in FY3/21 despite its solid business structure, but we expect OP to decline just 5% YoY. Specifically, we anticipate (1) higher profits in the semiconductor silicon business amid a strong semiconductor market, (2) growth in PVC sales amid strong demand and a recovery in prices in the US housing market from 3Q, and (3) sales growth across other businesses as economic activity resumes, including silicones (functional products for automotive), specialty chemicals (pharmaceutical cellulose), and electronics & functional materials (rare earth magnets as production activity resumes in automotive and other client industries). While the shares' recent rise could limit further upside, we see the stock as comparatively safe. We assign a rating of NEUTRAL based on a comparison of its 12-month forward estimated total returns and that for the coverage universe.

**Risk:** Risks to our ¥15,080 target price and NEUTRAL rating for Shin-Etsu Chemical include upside risks include continued strength in the semiconductor market after Lunar New Year and a further improvement in PVC prices. Downside risks include only modest earnings recovery in PVC and silicones and a semiconductor market correction.

### Target Price and Rating

#### Valuation Methodology and Risks: (12 months) for Taiwan Semiconductor Manufacturing (2330.TW)

**Method:** Our NT\$650 target price for TSMC is based on 25x 2022E EPS (earnings per share), in line with the SOX index. We see its business outlook improving, and technology leadership should keep its market share and profitability intact; dividends will likely rise again as capex moderates. We therefore have an OUTPERFORM rating on the stock.

**Risk:** Risks that could impede achievement of our NT\$650 target price and OUTPERFORM rating for TSMC would include: fierce competition, demand failing to pick up, or Apple orders not being as strong as expected.

### Target Price and Rating

#### Valuation Methodology and Risks: (12 months) for Texas Instruments Inc. (TXN.OO)

**Method:** Our \$170 PT represents ~30.0x P/E on CY21. Our Outperform rating is based upon: (1) Street Estimates that are under modeling both Rev Growth and OpM Leverage, (2) Continued dominant franchise position which skews risk to duration not fundamentals, and (3) Solid downside support at ~\$100.

**Risk:** The primary risk factors to our Outperform rating and our \$170 price target are weak end-market demand, share loss in the embedded or analog businesses, less than normal seasonality, and overall company execution. TXN has a broad based business which is affected by many macro economic conditions, any one of which could impact the stock price.

### Target Price and Rating

#### Valuation Methodology and Risks: (12 months) for Tokyo Electron (8035.T)

**Method:** Our ¥16,440 target price for Tokyo Electron is based on end-FY3/22E BPS (¥6,322) and a P/B of 2.60x (TOPIX-relative P/B of 2.30x for the period above x current TOPIX P/B of 1.13x). We use the average P/B for the 12-month period of memory price deterioration from Sep CY18. We think equity market expectations for a sustained rise in valuations are unlikely to materialize, and we believe now is a good time to take profits. Our UNDERPERFORM rating is based on a comparison of the company's 12-month potential total return versus our coverage universe.

**Risk:** Risks to our ¥16,440 target price and UNDERPERFORM ratings for Tokyo Electron include: a recovery in high-end smartphone output due to Qualcomm license approval, an upturn in memory prices, an improved capex stance at memory makers, and buyback announcements.

### Target Price and Rating

#### Valuation Methodology and Risks: (12 months) for TongFu (002156.SZ)

**Method:** Our target price of Rmb33.3 is based on 4.2x (+1.5 STDEV) and 2021 BPS. The multiple is below A-share OSAT sector average multiple of 5.6x on 2021 consensus BPS. Our TP and Outperform rating reflects the company's improving margins and profitability driven by solid AMD demand, growing China CPU and better orders from multiple domestic and international customers.

**Risk:** Downside risks to our Rmb33.3 target price and Outperform rating are (1) weaker domestic investor sentiment for China's semi supply chain, (2) lower end-market demand recovery, (3) AMD's slower CPU/GPU share gains, (4) weaker shipments of high-end products to other major fabless, (5) slower technology development and (6) currency fluctuation risks.

### Target Price and Rating

#### Valuation Methodology and Risks: (12 months) for Tower Semiconductor (TSEM.OQ)

**Method:** Our TP of \$37.5 (ILa 11,925 using FX rate of 318) is based on an average of i) 15x P/E on our 2023 EPS estimate and adding back net cash per share ending Q420E and ii) EV/sales of 2.25x on our 2023 sales estimate adjusted for net cash per share ending Q420E. With acceleration in top-line growth, higher fab utilization and tightness in foundry capacity globally, we seen room for material margin expansion. Hence, we rate the stock Outperform.

**Risk:** In terms of risks to our Outperform rating and TP of \$37.5 (ILa 11,925 using FX rate of 318), we see the following: 1) deceleration in the semiconductor industry, which could lead to downside risk to our estimates; 2) Nuvoton (formerly owned by Panasonic) accounted for roughly one-third of Tower Semiconductor sales, which presents a concentration risk; and 3) Appreciation in NIS vs. USD fx rate is a potential headwind to margins.

### Target Price and Rating

#### Valuation Methodology and Risks: (12 months) for Tower Semiconductor (TSEM.TA)

**Method:** Our TP of \$37.5 (ILa 11,925 using FX rate of 318) is based on an average of i) 15x P/E on our 2023 EPS estimate and adding back net cash per share ending Q420E and ii) EV/sales of 2.25x on our 2023 sales estimate adjusted for net cash per share ending Q420E. With acceleration in top-line growth, higher fab utilization and tightness in foundry capacity globally, we seen room for material margin expansion. Hence, we rate the stock Outperform.

**Risk:** In terms of risks to our Outperform rating and TP of \$37.5 (ILa 11,925 using FX rate of 318), we see the following: 1) deceleration in the semiconductor industry, which could lead to downside risk to our estimates; 2) Nuvoton (formerly owned by Panasonic) accounted for roughly one-third of Tower Semiconductor sales, which presents a concentration risk; and 3) Appreciation in NIS vs. USD fx rate is a potential headwind to margins.

### Target Price and Rating

#### Valuation Methodology and Risks: (12 months) for United Microelectronics (2303.TW)

**Method:** Our NT\$57.00 target price for United Microelectronics is based on 3.0x P/B and 16x ex-cash 2022 P/E, the mid-cycle valuation, as we could see a bounce from over-sold levels once cyclical trends show signs of improvement. We believe the stock has protection from the current level with its modestly improving business outlook and dividend, though profitability may stay at a lower level. We expect upside to be contained by muted profitability, sluggish and still-competitive end-markets with TSMC also aiming to protect share and grow its 28nm. We thus have a OUTPERFORM rating on UMC.

**Risk:** Downside risks to our NT\$57.00 target price and OUTPERFORM rating for the stock could be continued inventory correction across the semiconductor supply chain and worse-than-expected tech end-market demand. The intensified competition in the mature 12" nodes could also dampen the company's profitability.

#### Target Price and Rating

#### Valuation Methodology and Risks: (12 months) for Vanguard International Semiconductor (5347.TWO)

**Method:** Our target price of NT\$125 and NEUTRAL rating for Vanguard International Semiconductor are based on 20x cash adjusted '22 EPS, which is the mid-cycle valuation for the company, to reflect a more muted business outlook. While ROE (return on equity) looks modest at 15%, RONA (return on net assets), excluding the cash, is a healthy 32%. Thus, we have a NEUTRAL rating on Vanguard.

**Risk:** Upside risk to our NT\$125 target price and NEUTRAL rating for Vanguard International Semiconductor is a growing fingerprint business and continued healthy growth for its power management IC business from both fabless and IDM customers. Downside risk is weaker-than-expected driver IC demand and more competition from its China peers for power management IC business.

#### Target Price and Rating

#### Valuation Methodology and Risks: (12 months) for Visual Photonics Epitaxy Co., Ltd (2455.TW)

**Method:** Our target price of NT\$115 for VPEC is based on 27x 12M EPS (earnings per share), average forward P/E multiple in the past three years. We rate VPEC OUTPERFORM as we believe its optical/VCSEL business should start to rebound and the 5G take-off could consume more wafer area.

**Risk:** Risks that could impede achievement of our target price of NT\$115 and OUTPERFORM rating for VPEC include: (1) weaker growth in the RF component space, (2) slower traction in the optical communication expansion, and (3) lower margin profile due to more favourable product mix and less pricing pressure.

#### Target Price and Rating

#### Valuation Methodology and Risks: (12 months) for Will Semi (603501.SS)

**Method:** We expect Will Semi's revenue and EPS to grow at 31% and 61% CAGR in 2021-22, driven by its share gain in the smartphone main camera, TDDI and automotive camera segments, the smartphone/automotive market's camera upgrade, its product genre expansion, GM expansion and operating leverage. We use discounted cash flow (DCF) as the primary valuation methodology, as the A-share semi sector's valuation nature is often based on investors' expectation for next five to ten years' growth potential. Our OUTPERFORM rating is based on our DCF-based target price of Rmb387, which is based on beta 1.2, terminal growth rate 2.7% and WACC 8.0%.

**Risk:** Key risks to our TP Rmb387 and OUTPERFORM rating for Will Semi include loss of major customer(s) due to failures in technology or product deliveries, obsolete inventories as a result of customers cancelling or deferring orders, weaker smartphone or automotive demand, worse pricing competition in the CIS market, and major foundry suppliers unable to deliver in a timely fashion.

#### Target Price and Rating

#### Valuation Methodology and Risks: (12 months) for Win Semiconductors Corp (3105.TWO)

**Method:** Our target price of NT\$315 for Win Semiconductors Corp is based on based on 22x 2021E P/E (price-to-earnings), its historical peak multiple. We rate Win Semi NEUTRAL as we believe Win Semi should benefit from the improving margin profile, ToF and 5G take-off, but remain cautious on its outlook given Huawei ban from the United States.

**Risk:** Risks that could impede achievement of our NT\$315 target price and NEUTRAL rating for Win Semi include: (1) faster/slower shipment growth in 4G/5G devices, (2) higher/lower capex among telecom operators for 5G infrastructure due to macro uncertainties, (3) stronger/weaker WiFi demand on delayed spec upgrade to 802.11ax and softer IoT device proliferation, and (4) stronger/weaker growth for the VCSEL foundry business.

#### Target Price and Rating

#### Valuation Methodology and Risks: (12 months) for X-FAB (XFAB.PA)

**Method:** Our TP of €2.70, which helps drive our Underperform rating, is based on an EV/sales of 0.6x on our 2022 sales estimate adjusted for net cash per share ending 2020E, and then converting it from USD to EUR. Given significant underperformance in X-FAB sales trends when compared to demand trends in Automotive and Industrial semiconductor markets in recent years, we rate the shares as Underperform.

**Risk:** In terms of risks to our Underperform rating and TP of €2.70, we see the following: 1) acceleration in the semiconductor industry could lead to risk to our view of faster than estimated growth for the specialty analog foundry market; 2) Melexis accounted for roughly one-third of X-FAB's sales, which could present a concentration risk; however, should X-FAB manage to better diversify its customer base, it would rely less on Melexis; and 3) Apreciation in the USD vs. EUR and MYR is a potential tailwind given 40% of the cost base is in EUR and 10% in MYR, with ~30-35% of sales in EUR.

**Companies Mentioned** (*Price as of 19-Jan-2021*)

**ACM Rsrch** (ACMR.OQ, \$94.6)  
**AMEC** (688012.SS, Rmb174.0)  
**ASE Industrial Holdings** (3711.TW, NT\$105.5)  
**ASM International** (ASMI.AS, €213.2)  
**ASM Pacific Technology Ltd** (0522.HK, HK\$117.0)  
**ASML Holding N.V.** (ASML.AS, €437.6)  
**Alchip Tech** (3661.TW, NT\$847.0)  
**Amkor Technology Inc.** (AMKR.OQ, \$18.04)  
**Amlogic** (688099.SS, Rmb78.67)  
**Analog Devices Inc.** (ADI.OQ, \$157.75)  
**Anji Technology** (688019.SS, Rmb355.0)  
**Applied Materials Inc.** (AMAT.OQ, \$103.14)  
**Aspeed** (5274.TWO, NT\$2000.0)  
**Bestechnic SH** (688608.SS, Rmb382.98)  
**Broadcom Ltd** (AVGO.OQ, \$445.85)  
**CR Micro** (688396.SS, Rmb68.3)  
**ChipMOS Technologies Inc.** (8150.TW, NT\$37.05)  
**Chipbond** (6147.TWO, NT\$74.5)  
**Chungwha Precision** (6510.TWO, NT\$974.0)  
**Egis Technology Inc.** (6462.TWO, NT\$164.5)  
**Elan Microelectronics Corp** (2458.TW, NT\$171.0)  
**Faraday Technology Corporation** (3035.TW, NT\$53.0)  
**GUC** (3443.TW, NT\$413.0)  
**Gigadevice** (603986.SS, Rmb225.0)  
**Goodix** (603160.SS, Rmb155.7)  
**Himax Technologies, Inc.** (HIMX.OQ, \$8.07)  
**Hua Hong Semiconductor Limited** (1347.HK, HK\$48.5)  
**Huatian** (002185.SZ, Rmb16.05)  
**Inari Amertron** (INAR.KL, RM2.99)  
**Intel Corp.** (INTC.OQ, \$57.58)  
**JCET** (600584.SS, Rmb47.17)  
**KLA Corporation** (KLAC.OQ, \$304.13)  
**Lam Research Corp.** (LRCX.OQ, \$547.53)  
**Marvell Technology Group Ltd.** (MRVL.OQ, \$50.77)  
**Maxscend** (300782.SZ, Rmb660.0)  
**MediaTek Inc.** (2454.TW, NT\$879.0)  
**Microchip Technology Inc.** (MCHP.OQ, \$148.56)  
**Montage** (688008.SS, Rmb88.07)  
**NAURA** (002371.SZ, Rmb231.01)  
**NSIG** (688126.SS, Rmb36.91)  
**NVIDIA Corporation** (NVDA.OQ, \$514.38)  
**NavInfo** (002405.SZ, Rmb15.78)  
**Novatek Microelectronics Corp Ltd** (3034.TW, NT\$410.0)  
**ON Semiconductor Corp.** (ON.OQ, \$36.71)  
**Parade Technologies** (4966.TWO, NT\$1315.0)  
**Powertech Technology** (6239.TW, NT\$101.5)  
**QUALCOMM Inc.** (QCOM.OQ, \$157.09)  
**Realtek Semiconductor** (2379.TW, NT\$469.0)  
**SCREEN** (7735.T, ¥8,860)  
**SG Micro** (300661.SZ, Rmb313.98)  
**SMIC** (688981.SS, Rmb60.48)  
**SUMCO** (3436.T, ¥2,413)  
**Sanan Optoelectronics Co. Ltd** (600703.SS, Rmb32.87)  
**Semiconductor Manufacturing International Corp.** (0981.HK, HK\$29.6)  
**Sh Wanye** (600641.SS, Rmb16.9)  
**Shanghai Sinyang** (300236.SZ, Rmb52.31)  
**Shin-Etsu Chemical** (4063.T, ¥19,290)  
**Silergy** (6415.TW, NT\$2745.0)  
**Silicon Mtn Tec** (SIMO.OQ, \$49.42)  
**Taiwan Semiconductor Manufacturing** (2330.TW, NT\$627.0)  
**Texas Instruments Inc.** (TXN.OQ, \$169.19)  
**Tokyo Electron** (8035.T, ¥44,130)  
**TongFu** (002156.SZ, Rmb29.38)  
**Tower Semiconductor** (TSEM.OQ, \$28.45)  
**Tower Semiconductor** (TSEM.TA, agora9226.0)  
**United Microelectronics** (2303.TW, NT\$53.0)  
**Vanguard International Semiconductor** (5347.TWO, NT\$118.5)  
**VeriSilisMicroSH** (688521.SS, Rmb83.83)  
**Visual Photonics Epitaxy Co., Ltd** (2455.TW, NT\$114.0)  
**WINGTECH** (600745.SS, Rmb127.15)  
**Will Semi** (603501.SS, Rmb314.89)  
**Win Semiconductors Corp** (3105.TWO, NT\$445.0)  
**X-FAB** (XFAB.PA, €7.0)

---

## Disclosure Appendix

### **Analyst Certification**

Randy Abrams, CFA, Chaolien Tseng and John W. Pitzer each certify, with respect to the companies or securities that the individual analyzes, that (1) the views expressed in this report accurately reflect his or her personal views about all of the subject companies and securities and (2) no part of his or her compensation was, is or will be directly or indirectly related to the specific recommendations or views expressed in this report.

### **As of December 10, 2012 Analysts' stock rating are defined as follows:**

**Outperform (O)** : The stock's total return is expected to outperform the relevant benchmark\* over the next 12 months.

**Neutral (N) :** The stock's total return is expected to be in line with the relevant benchmark\* over the next 12 months.

**Underperform (U) :** The stock's total return is expected to underperform the relevant benchmark\* over the next 12 months.

\*Relevant benchmark by region: As of 10th December 2012, Japanese ratings are based on a stock's total return relative to the analyst's coverage universe which consists of all companies covered by the analyst within the relevant sector, with Outperforms representing the most attractive, Neutrals the less attractive, and Underperforms the least attractive investment opportunities. As of 2nd October 2012, U.S. and Canadian as well as European (excluding Turkey) ratings are based on a stock's total return relative to the analyst's coverage universe which consists of all companies covered by the analyst within the relevant sector, with Outperforms representing the most attractive, Neutrals the less attractive, and Underperforms the least attractive investment opportunities. For Latin America, Turkey and Asia (excluding Japan and Australia), stock ratings are based on a stock's total return relative to the average total return of the relevant country or regional benchmark (India - S&P BSE Sensex Index); prior to 2nd October 2012 U.S. and Canadian ratings were based on (1) a stock's absolute total return potential to its current share price and (2) the relative attractiveness of a stock's total return potential within an analyst's coverage universe. For Australian and New Zealand stocks, the expected total return (ETR) calculation includes 12-month rolling dividend yield. An Outperform rating is assigned where an ETR is greater than or equal to 7.5%; Underperform where an ETR less than or equal to 5%. A Neutral may be assigned where the ETR is between -5% and 15%. The overlapping rating range allows analysts to assign a rating that puts ETR in the context of associated risks. Prior to 18 May 2015, ETR ranges for Outperform and Underperform ratings did not overlap with Neutral thresholds between 15% and 7.5%, which was in operation from 7 July 2011.

**Restricted (R) :** In certain circumstances, Credit Suisse policy and/or applicable law and regulations preclude certain types of communications, including an investment recommendation, during the course of Credit Suisse's engagement in an investment banking transaction and in certain other circumstances.

**Not Rated (NR) :** Credit Suisse Equity Research does not have an investment rating or view on the stock or any other securities related to the company at this time.

**Not Covered (NC) :** Credit Suisse Equity Research does not provide ongoing coverage of the company or offer an investment rating or investment view on the equity security of the company or related products.

**Volatility Indicator [V] :** A stock is defined as volatile if the stock price has moved up or down by 20% or more in a month in at least 8 of the past 24 months or the analyst expects significant volatility going forward.

Analysts' sector weightings are distinct from analysts' stock ratings and are based on the analyst's expectations for the fundamentals and/or valuation of the sector\* relative to the group's historic fundamentals and/or valuation:

**Overweight :** The analyst's expectation for the sector's fundamentals and/or valuation is favorable over the next 12 months.

**Market Weight :** The analyst's expectation for the sector's fundamentals and/or valuation is neutral over the next 12 months.

**Underweight :** The analyst's expectation for the sector's fundamentals and/or valuation is cautious over the next 12 months.

\*An analyst's coverage sector consists of all companies covered by the analyst within the relevant sector. An analyst may cover multiple sectors.

Credit Suisse's distribution of stock ratings (and banking clients) is:

#### Global Ratings Distribution

Rating	Versus universe (%)	Of which banking clients (%)
Outperform/Buy*	52%	(33% banking clients)
Neutral/Hold*	35%	(27% banking clients)
Underperform/Sell*	12%	(21% banking clients)
Restricted	1%	

Please click [here](#) to view the MAR quarterly recommendations and investment services report for fundamental research recommendations.

\*For purposes of the NYSE and FINRA ratings distribution disclosure requirements, our stock ratings of Outperform, Neutral, and Underperform most closely correspond to Buy, Hold, and Sell, respectively; however, the meanings are not the same, as our stock ratings are determined on a relative basis. (Please refer to definitions above.) An investor's decision to buy or sell a security should be based on investment objectives, current holdings, and other individual factors.

#### Important Global Disclosures

Credit Suisse's research reports are made available to clients through our proprietary research portal on CS PLUS. Credit Suisse research products may also be made available through third-party vendors or alternate electronic means as a convenience. Certain research products are only made available through CS PLUS. The services provided by Credit Suisse's analysts to clients may depend on a specific client's preferences regarding the frequency and manner of receiving communications, the client's risk profile and investment, the size and scope of the overall client relationship with the Firm, as well as legal and regulatory constraints. To access all of Credit Suisse's research that you are entitled to receive in the most timely manner, please contact your sales representative or go to <https://plus.credit-suisse.com>.

Credit Suisse's policy is to update research reports as it deems appropriate, based on developments with the subject company, the sector or the market that may have a material impact on the research views or opinions stated herein.

Credit Suisse's policy is only to publish investment research that is impartial, independent, clear, fair and not misleading. For more detail please refer to Credit Suisse's Policies for Managing Conflicts of Interest in connection with Investment Research: <https://www.credit-suisse.com/sites/disclaimers-ib/en/managing-conflicts.html>.

Any information relating to the tax status of financial instruments discussed herein is not intended to provide tax advice or to be used by anyone to provide tax advice. Investors are urged to seek tax advice based on their particular circumstances from an independent tax professional.

Credit Suisse has decided not to enter into business relationships with companies that Credit Suisse has determined to be involved in the development, manufacture, or acquisition of anti-personnel mines and cluster munitions. For Credit Suisse's position on the issue, please see <https://www.credit-suisse.com/media/assets/corporate/docs/about-us/responsibility/banking/policy-summaries-en.pdf>.

The analyst(s) responsible for preparing this research report received compensation that is based upon various factors including Credit Suisse's total revenues, a portion of which are generated by Credit Suisse's investment banking activities

Please refer to the firm's disclosure website at <https://rave.credit-suisse.com/disclosures/view/selectArchive> for the definitions of abbreviations typically used in the target price method and risk sections.

*See the Companies Mentioned section for full company names*

Credit Suisse currently has, or had within the past 12 months, the following as investment banking client(s): 002185.SZ, 3661.TW, ADI.OQ, ON.OQ, NVDA.OQ, INTC.OQ, AVGO.OQ

Credit Suisse provided investment banking services to the subject company (002185.SZ, 3661.TW, ADI.OQ, ON.OQ, NVDA.OQ, INTC.OQ, AVGO.OQ) within the past 12 months.

Within the last 12 months, Credit Suisse has received compensation for non-investment banking services or products from the following issuer(s): ADI.OQ, INTC.OQ, AVGO.OQ

Credit Suisse has managed or co-managed a public offering of securities for the subject company (002185.SZ, 3661.TW, ADI.OQ, AVGO.OQ) within the past 12 months.

Within the past 12 months, Credit Suisse has received compensation for investment banking services from the following issuer(s): ADI.OQ, ON.OQ, NVDA.OQ, INTC.OQ, AVGO.OQ

Credit Suisse expects to receive or intends to seek investment banking related compensation from the subject company (600584.SS, 002185.SZ, ADI.OQ, ON.OQ, MRVL.OQ, LRCX.OQ, KLAC.OQ, NVDA.OQ, AMAT.OQ, INTC.OQ, AVGO.OQ) within the next 3 months.

Credit Suisse currently has, or had within the past 12 months, the following issuer(s) as client(s), and the services provided were non-investment-banking, securities-related: ADI.OQ, INTC.OQ, AVGO.OQ

Credit Suisse currently has, or had within the past 12 months, the following issuer(s) as client(s), and the services provided were non-investment-banking, non securities-related: ADI.OQ, INTC.OQ, AVGO.OQ

Credit Suisse acts as a market maker in the shares, depositary receipts, interests or units issued by, and/or any warrants or options on these shares, depositary receipts, interests or units of the following subject issuer(s): 0981.HK, 1347.HK, 0522.HK.

Credit Suisse or a member of the Credit Suisse Group is a market maker or liquidity provider in the securities of the following subject issuer(s): 3711.TW, ASMI.AS, 0522.HK, ASML.AS, 3661.TW, AMKR.OQ, ADI.OQ, AMAT.OQ, 5274.TWO, AVGO.OQ, 688396.SS, 8150.TW, 6147.TWO, 6510.TWO, 6462.TWO, 2458.TW, 3443.TW, 603986.SS, 603160.SS, HIMX.OQ, 1347.HK, 002185.SZ, INAR.KL, INTC.OQ, 600584.SS, KLAC.OQ, LRCX.OQ, MRVL.OQ, 300782.SZ, 2454.TW, MCHP.OQ, 688008.SS, NVDA.OQ, 3034.TW, ON.OO, 4966.TWO, 6239.TW, 2379.TW, 7735.T, 3436.T, 600703.SS, 0981.HK, 4063.T, 2330.TW, TXN.OQ, 8035.T, 002156.SZ, TSEM.OQ, TSEM.TA, 2303.TW, 5347.TWO, 2455.TW, 603501.SS, 3105.TWO, XFAB.PA

A member of the Credit Suisse Group is party to an agreement with, or may have provided services set out in sections A and B of Annex I of Directive 2014/65/EU of the European Parliament and Council ("MiFID Services") to, the subject issuer (002185.SZ, 3661.TW, ADI.OQ, ON.OQ, NVDA.OQ, INTC.OQ, AVGO.OQ) within the past 12 months.

Credit Suisse may have interest in (INAR.KL)

As of the date of this report, Credit Suisse beneficially own 1% or more of a class of common equity securities of (2379.TW, 3661.TW, 6239.TW, 3436.T, 2458.TW, 2303.TW, 3443.TW, 2455.TW, 6147.TWO, 6510.TWO, 3034.TW, 4966.TWO, 3105.TWO, ASML.AS).

Credit Suisse Securities (Europe) Limited and Credit Suisse Seoul Branch are the financial advisor to SK Hynix Inc on the announced M&A transaction involving Intel Corporation's HAND memory business and the Dalian NAND memory manufacturing facility in China.

For date and time of production, dissemination and history of recommendation for the subject company(ies) featured in this report, disseminated within the past 12 months, please refer to the link: <https://rave.credit-suisse.com/disclosures/view/report?i=572577&v=19yc711jw0wqm1kyvij9cjw03>.

### Important Regional Disclosures

Singapore recipients should contact Credit Suisse AG, Singapore Branch for any matters arising from, or in connection with, this research report. The analyst(s) involved in the preparation of this report may participate in events hosted by the subject company, including site visits. Credit Suisse does not accept or permit analysts to accept payment or reimbursement for travel expenses associated with these events.

For Credit Suisse Securities (Canada), Inc.'s policies and procedures regarding the dissemination of equity research, please visit <https://www.credit-suisse.com/sites/disclaimers-ib/en/canada-research-policy.html>.

Investors should note that income from such securities and other financial instruments, if any, may fluctuate and that price or value of such securities and instruments may rise or fall and, in some cases, investors may lose their entire principal investment.

To the extent any Credit Suisse equity research analyst employed by Credit Suisse International (a "UK Analyst") has interactions with a Spanish domiciled client of Credit Suisse AG or its affiliates, such UK Analyst will be acting for and on behalf of CSSSV, with respect only to the provision of equity research services to Spanish domiciled clients of Credit Suisse AG or its affiliates.

Pursuant to CVM Instruction No. 598/2018, of May 3, 2018, the author(s) of the report hereby certify(ies) that the views expressed in this report solely and exclusively reflect the personal opinions of the author(s) and have been prepared independently, including with respect to Credit Suisse. Part of the author(s)'s compensation is based on various factors, including the total revenues of Credit Suisse, but no part of the compensation has been, is, or will be related to the specific recommendations or views expressed in this report. In addition, Credit Suisse declares that: Credit Suisse has provided, and/or may in the future provide investment banking, brokerage, asset management, commercial banking and other financial services to the subject company/companies or its affiliates, for which they have received or may receive customary fees and commissions, and which constituted or may constitute relevant financial or commercial interests in relation to the subject company/companies or the subject securities.

**Taiwanese Disclosures: This research report is for reference only. Investors should carefully consider their own investment risk and note they may be subject to the applicable rules and regulations in Taiwan. Investment results are the responsibility of the investor. Reports written by Taiwan based analysts on non-Taiwan listed companies are not considered as recommendations to**

**buy or sell securities. Reports may not be reproduced without the permission of Credit Suisse. Pursuant to the 'Taiwan Stock Exchange Regulations Governing Securities Firms Recommending Trades in Securities to Customers' and the 'Taipei Exchange Rules Governing Securities Firms Recommending Trades in Securities to Customers', in order for a non-client of Credit Suisse AG, Taipei Securities Branch to receive this research report, no provision by such non-client of the content of the report to a third party, nor any conflict of interest, is permitted. By receiving this research report, any such non-client is deemed to acknowledge and accept our terms and disclaimers included herein.**

As at the date of this report, Credit Suisse has financial interests that aggregate to an amount equal to or more than 1% of the market capitalization of (1347.HK, 0522.HK).

This research report is authored by:

**Credit Suisse (Hong Kong) Limited** ..... Chaolien Tseng

**Credit Suisse Securities (Japan) Limited** ..... Hideyuki Maekawa ; Yoshiyasu Takemura ; Daisuke Tanimoto

**Credit Suisse Securities (Europe) Limited, Seoul Branch** ..... Keon Han ; Sang Uk Kim

**Credit Suisse International** ..... Achal Sultania

**Credit Suisse AG, Taipei Securities Branch** ..... Randy Abrams, CFA ; Jerry Su ; Haas Liu

**Credit Suisse Securities (USA) LLC** ..... John W. Pitzer ; Dalya Hahn

To the extent this is a report authored in whole or in part by a non-U.S. analyst and is made available in the U.S., the following are important disclosures regarding any non-U.S. analyst contributors: The non-U.S. research analysts listed below (if any) are not registered/qualified as research analysts with FINRA. The non-U.S. research analysts listed below may not be associated persons of CSSU and therefore may not be subject to the FINRA 2241 restrictions on communications with a subject company, public appearances and trading securities held by a research analyst account.

**Credit Suisse (Hong Kong) Limited** ..... Chaolien Tseng

**Credit Suisse Securities (Japan) Limited** ..... Hideyuki Maekawa ; Yoshiyasu Takemura ; Daisuke Tanimoto

**Credit Suisse Securities (Europe) Limited, Seoul Branch** ..... Keon Han ; Sang Uk Kim

**Credit Suisse International** ..... Achal Sultania

**Credit Suisse AG, Taipei Securities Branch** ..... Randy Abrams, CFA ; Jerry Su ; Haas Liu

---

Important disclosures regarding companies that are the subject of this report are available by calling +1 (877) 291-2683. The same important disclosures, with the exception of valuation methodology and risk discussions, are also available on Credit Suisse's disclosure website at <https://rave.credit-suisse.com/disclosures>. For valuation methodology and risks associated with any recommendation, price target, or rating referenced in this report, please refer to the disclosures section of the most recent report regarding the subject company.

This report is produced by subsidiaries and affiliates of Credit Suisse operating under its Global Markets Division. For more information on our structure, please use the following link: <https://www.credit-suisse.com/who-we-are>. This report may contain material that is not directed to, or intended for distribution to or use by, any person or entity who is a citizen or resident of or located in any locality, state, country or other jurisdiction where such distribution, publication, availability or use would be contrary to law or regulation or which would subject Credit Suisse or its affiliates ("CS") to any registration or licensing requirement within such jurisdiction. All material presented in this report, unless specifically indicated otherwise, is under copyright to CS. None of the material, nor its content, nor any copy of it, may be altered in any way, transmitted to, copied or distributed by any other party, without the prior express written permission of CS. All trademarks, service marks and logos used in this report are trademarks or service marks or registered trademarks or service marks of CS or its affiliates. The information, tools and material presented in this report are provided to you for information purposes only and are not to be used or considered as an offer or the solicitation of an offer to sell or to buy or subscribe for securities or other financial instruments. CS may not have taken any steps to ensure that the securities referred to in this report are suitable for any particular investor. CS will not treat recipients of this report as its customers by virtue of their receiving this report. The investments and services contained or referred to in this report may not be suitable for you and it is recommended that you consult an independent investment advisor if you are in doubt about such investments or investment services. Nothing in this report constitutes investment, legal, accounting or tax advice, or a representation that any investment or strategy is suitable or appropriate to your individual circumstances, or otherwise constitutes a personal recommendation to you. Please note in particular that the bases and levels of taxation may change. Information and opinions presented in this report have been obtained or derived from sources believed by CS to be reliable, but CS makes no representation as to their accuracy or completeness. CS accepts no liability for loss arising from the use of the material presented in this report, except that this exclusion of liability does not apply to the extent that such liability arises under specific statutes or regulations applicable to CS. This report is not to be relied upon in substitution for the exercise of independent judgment. CS may have issued, and may in the future issue, other communications that are inconsistent with, and reach different conclusions from, the information presented in this report. Those communications reflect the different assumptions, views and analytical methods of the analysts who prepared them and CS is under no obligation to ensure that such other communications are brought to the attention of any recipient of this report. Some investments referred to in this report will be offered solely by a single entity and in the case of some investments solely by CS, or an associate of CS or CS may be the only market maker in such investments. Past performance should not be taken as an indication or guarantee of future performance, and no representation or warranty, express or implied, is made regarding future performance. Information, opinions and estimates contained in this report reflect a judgment at its original date of publication by CS and are subject to change without notice. The price, value of and income from any of the securities or financial instruments mentioned in this report can fall as well as rise. The value of securities and financial instruments is subject to exchange rate fluctuation that may have a positive or adverse effect on the price or income of such securities or financial instruments. Investors in securities such as ADR's, the values of which are influenced by currency volatility, effectively assume this risk. Structured securities are complex instruments, typically involve a high degree of risk and are intended for sale only to sophisticated investors who are capable of understanding and assuming the risks involved. The market value of any structured security may be affected by changes in economic, financial and political factors (including, but not limited to, spot and forward interest and exchange rates), time to maturity, market conditions and volatility, and the credit quality of any issuer or reference issuer. Any investor interested in purchasing a structured product should conduct their own investigation and analysis of the product and consult with their own professional advisers as to the risks involved in making such a purchase. Some investments discussed in this report may have a high level of volatility. High volatility investments may experience sudden and large falls in their value causing losses when that investment is realised. Those losses may equal your original investment. Indeed, in the case of some investments the potential losses may exceed the amount of initial investment and, in such circumstances, you may be required to pay more money to support those losses. Income yields from investments may fluctuate and, in consequence, initial capital paid to make the investment may be used as part of that income yield. Some investments may not be readily realisable and it may be difficult to sell or realise those investments, similarly it may prove difficult for you to obtain reliable information about the value, or risks, to which such an investment is exposed. This report may provide the addresses of, or contain hyperlinks to, websites. Except to the extent to which the report refers to website material of CS, CS has not reviewed any such site and takes no responsibility for the content contained therein. Such address or hyperlink (including addresses or hyperlinks to CS's own website material) is provided solely for your convenience and information and the content of any such website does not in any way form part of this document. Accessing such website or following such link through this report or CS's website shall be at your own risk.

This report is issued and distributed in **European Union (except Germany and Spain)**: by Credit Suisse Securities (Europe) Limited, One Cabot Square, London E14 4QJ, England, which is authorised by the Prudential Regulation Authority and regulated by the Financial Conduct Authority and the Prudential Regulation Authority; **Spain**: Credit Suisse Securities, Sociedad de Valores, S.A. ("CSSSV") regulated by the Comisión Nacional del Mercado de Valores; **Germany**: Credit Suisse (Deutschland) Aktiengesellschaft regulated by the Bundesanstalt für Finanzdienstleistungsaufsicht ("BaFin"). **United States**: Credit Suisse Securities (USA) LLC; **Canada**: Credit Suisse Securities (Canada), Inc.; **Switzerland**: Credit Suisse AG; **Brazil**: Banco de Investimentos Credit Suisse (Brasil) S.A or its affiliates; **Mexico**: Banco Credit Suisse (México), S.A., Institución de Banca Múltiple, Grupo Financiero Credit Suisse (México) and Casa de Bolsa Credit Suisse (México), S.A. de C.V., Grupo Financiero Credit Suisse (México) ("Credit Suisse Mexico"). This document has been prepared for information purposes only and is exclusively distributed in Mexico to Institutional Investors. Credit Suisse Mexico is not responsible for any onward distribution of this report to non-institutional investors by any third party. The authors of this report have not received payment or compensation from any entity or company other than from the relevant Credit Suisse Group company employing them; **Japan**: by Credit Suisse Securities (Japan) Limited, Financial Instruments Firm, Director-General of Kanto Local Finance Bureau ('Kinfo') No. 66, a member of Japanese Securities Dealers Association, The Financial Futures Association of Japan, Japan Investment Advisers Association, Type II Financial Instruments Firms Association; **Hong Kong**: Credit Suisse (Hong Kong) Limited; **Australia**: Credit Suisse Equities (Australia) Limited; **Thailand**: Credit Suisse Securities (Thailand) Limited, regulated by the Office of the Securities and Exchange Commission, Thailand, having registered address at 990 Abdulrahim Place, 27th Floor, Unit 2701, Rama IV Road, Silom, Bangkok, Bangkok10500, Thailand, Tel. +66 2614 6000; **Malaysia**: Credit Suisse Securities (Malaysia) Sdn Bhd; **Singapore**: Credit Suisse AG, Singapore Branch; **India**: Credit Suisse Securities (India) Private Limited (CIN no.U67120MH1996PTC104392) regulated by the Securities and Exchange Board of India as Research Analyst (registration no. INH 000001030) and as Stock Broker (registration no. INZ000248233), having registered address at 9th Floor, Ceejay House, Dr.A.B. Road, Worli, Mumbai - 18, India, T- +91-22 6777 3777; **South Korea**: Credit Suisse Securities (Europe) Limited, Seoul Branch; **Taiwan**: Credit Suisse AG Taipei Securities Branch; **Indonesia**: PT Credit Suisse Sekuritas Indonesia; **Philippines**: Credit Suisse Securities (Philippines) Inc., and elsewhere in the world by the relevant authorised affiliate of the above.

#### Additional Regional Disclaimers

**Australia**: Credit Suisse Securities (Europe) Limited ("CSEL") and Credit Suisse International ("CSI") are authorised by the Prudential Regulation Authority and regulated by the Financial Conduct Authority ("FCA") and the Prudential Regulation Authority under UK laws, which differ from Australian Laws. CSEL and CSI do not hold an Australian Financial Services Licence ("AFSL") and are exempt from the requirement to hold an AFSL under the Corporations Act (Cth) 2001 ("Corporations Act") in respect of the financial services provided to Australian wholesale clients (within the meaning of section 761G of the Corporations Act) (hereinafter referred to as "Financial Services"). This material is not for distribution to retail clients and is directed exclusively at Credit Suisse's professional clients and eligible counterparties as defined by the FCA, and wholesale clients as defined under section 761G of the Corporations Act. Credit Suisse (Hong Kong) Limited ("CSHK") is licensed and regulated by the Securities and Futures Commission of Hong Kong under the laws of Hong Kong, which differ from Australian laws. CSHKL does not hold an AFSL and is exempt from the requirement to hold an AFSL under the Corporations Act in respect of providing Financial Services. Investment banking services in the United States are provided by Credit Suisse Securities (USA) LLC, an affiliate of Credit Suisse Group. CSSU is regulated by the United States Securities and Exchange Commission under United States laws, which differ from Australian laws. CSSU does not hold an AFSL and is exempt from the requirement to hold an AFSL under the Corporations Act in respect of providing Financial Services. Credit Suisse Asset Management LLC (CSAM) is authorised by the Securities and Exchange Commission under US laws, which differ from Australian laws. CSAM does not hold an AFSL and is exempt from the requirement to hold an AFSL under the Corporations Act in respect of providing Financial Services. This material is provided solely to Institutional Accounts (as defined in the FINRA rules) who are Eligible Contract Participants (as defined in the US Commodity Exchange Act). Credit Suisse Equities (Australia) Limited (ABN 35 068 232 708) ("CSEAL") is an AFSL holder in Australia (AFSL 237237).

**Malaysia**: Research provided to residents of Malaysia is authorised by the Head of Research for Credit Suisse Securities (Malaysia) Sdn Bhd, to whom they should direct any queries on +603 2723 2020.

**Singapore**: This report has been prepared and issued in Singapore to institutional investors, accredited investors and expert investors (each as defined under the Financial Advisers Regulations) only, and is also distributed by Credit Suisse AG, Singapore Branch to overseas investors (as defined under the Financial Advisers Regulations). Credit Suisse AG, Singapore Branch may distribute reports produced by its foreign entities or affiliates pursuant to an arrangement under Regulation 32C of the Financial Advisers Regulations. Singapore recipients should contact Credit Suisse AG, Singapore Branch at +65-6212-2000 for matters arising from, or in connection with, this report. By virtue of your status as an institutional investor, accredited investor, expert investor or overseas investor, Credit Suisse AG, Singapore Branch is exempted from complying with certain compliance requirements under the Financial Advisers Act, Chapter 110 of Singapore (the "FAA"), the Financial Advisers Regulations and the relevant Notices and Guidelines issued thereunder, in respect of any financial advisory service which Credit Suisse AG, Singapore Branch may provide to you.

**EU**: This report has been produced by subsidiaries and affiliates of Credit Suisse operating under its Global Markets Division

In jurisdictions where CS is not already registered or licensed to trade in securities, transactions will only be effected in accordance with applicable securities legislation, which will vary from jurisdiction to jurisdiction and may require that the trade be made in accordance with applicable exemptions from registration or licensing requirements.

This material is issued and distributed in the U.S. by CSSU, a member of NYSE, FINRA, SIPC and the NFA, and CSSU accepts responsibility for its contents. Clients should contact analysts and execute transactions through a Credit Suisse subsidiary or affiliate in their home jurisdiction unless governing law permits otherwise.

CS may provide various services to US municipal entities or obligated persons ("municipalities"), including suggesting individual transactions or trades and entering into such transactions. Any services CS provides to municipalities are not viewed as "advice" within the meaning of Section 975 of the Dodd-Frank Wall Street Reform and Consumer Protection Act. CS is providing any such services and related information solely on an arm's length basis and not as an advisor or fiduciary to the municipality. In connection with the provision of the any such services, there is no agreement, direct or indirect, between any municipality (including the officials, management, employees or agents thereof) and CS for CS to provide advice to the municipality. Municipalities should consult with their financial, accounting and legal advisors regarding any such services provided by CS. In addition, CS is not acting for direct or indirect compensation to solicit the municipality on behalf of an unaffiliated broker, dealer, municipal securities dealer, municipal advisor, or investment adviser for the purpose of obtaining or retaining an engagement by the municipality for or in connection with Municipal Financial Products, the issuance of municipal securities, or of an investment adviser to provide investment advisory services to or on behalf of the municipality. If this report is being distributed by a financial institution other than Credit Suisse AG, or its affiliates, that financial institution is solely responsible for distribution. Clients of that institution should contact that institution to effect a transaction in the securities mentioned in this report or require further information. This report does not constitute investment advice by Credit Suisse to the clients of the distributing financial institution, and neither Credit Suisse AG, its affiliates, and their respective officers, directors and employees accept any liability whatsoever for any direct or consequential loss arising from their use of this report or its content. No information or communication provided herein or otherwise is intended to be, or should be construed as, a recommendation within the meaning of the US Department of Labor's final regulation defining "investment advice" for purposes of the Employee Retirement Income Security Act of 1974, as amended and Section 4975 of the Internal Revenue Code of 1986, as amended, and the information provided herein is intended to be general information, and should not be construed as, providing investment advice (impartial or otherwise).

Copyright © 2021 CREDIT SUISSE AG and/or its affiliates. All rights reserved.

When you purchase non-listed Japanese fixed income securities (Japanese government bonds, Japanese municipal bonds, Japanese government guaranteed bonds, Japanese corporate bonds) from CS as a seller, you will be requested to pay the purchase price only.