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Rise of the "Big 4"
The semiconductor industry in Asia Pacific

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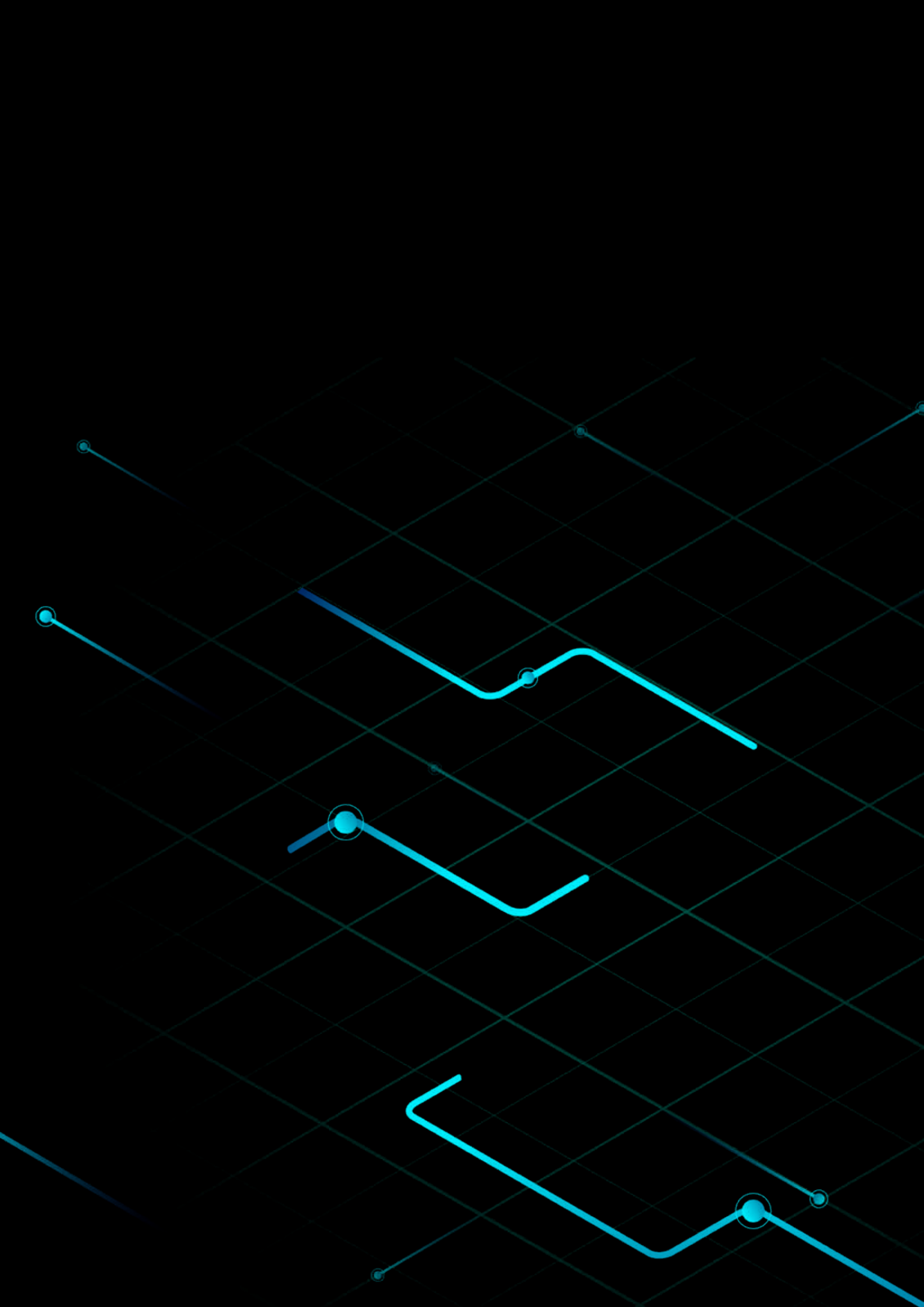

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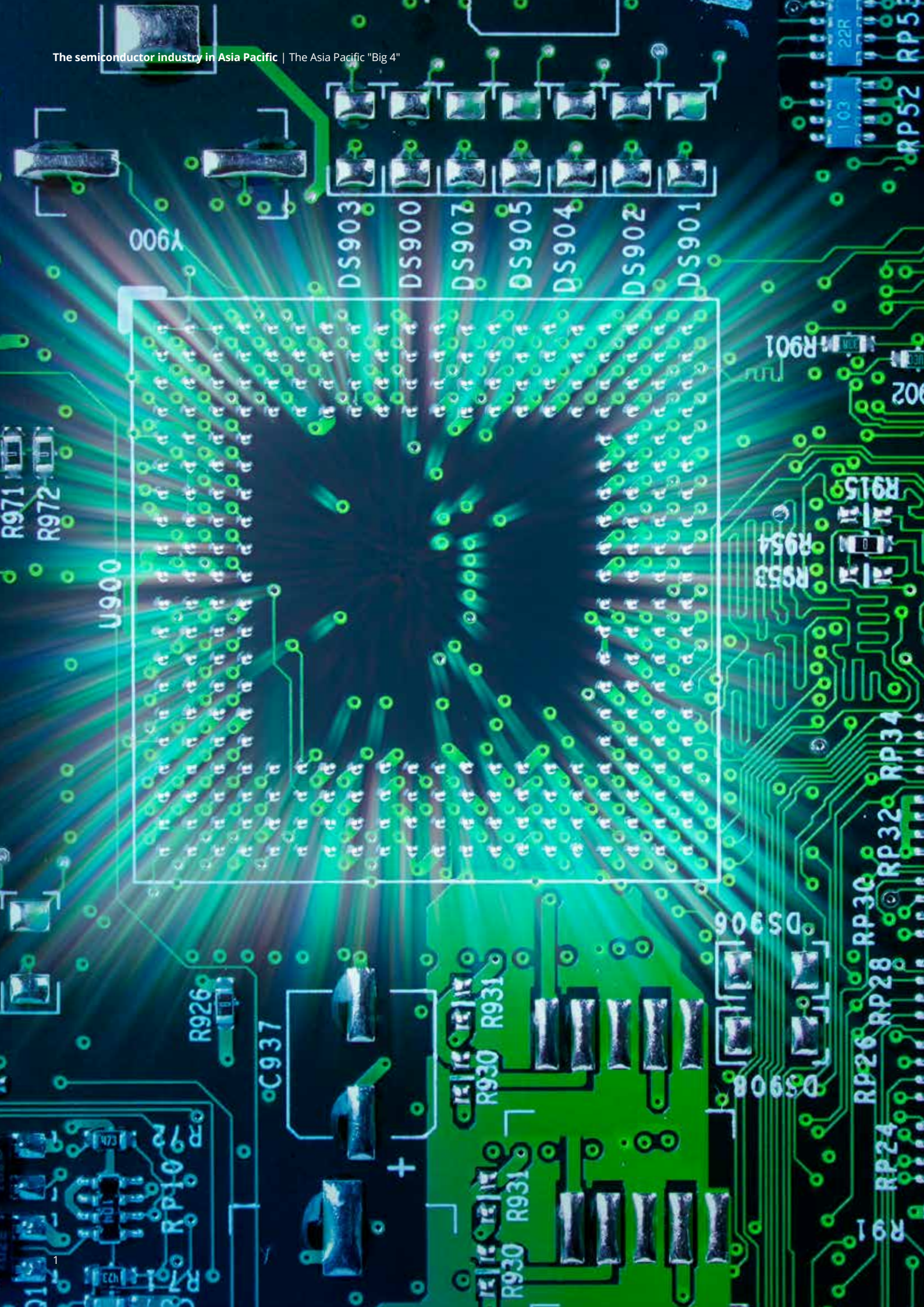
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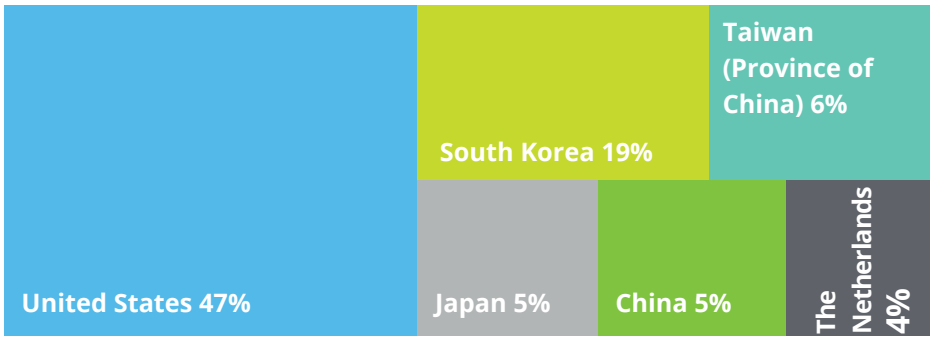
The Asia Pacific "Big 4"

Rise of "Big 4" in semiconductor

Driven by government support, vast market and increasing R&D spending, China, Japan, South Korea and Taiwan together have become the "Big 4" semiconductor players in Asia Pacific, holding four of the top six spots by overall semiconductor revenue and each have several global semiconductor giants. Asia Pacific is also the world's biggest market for semiconductors, accounting for 60% of global semiconductor sales, within which China alone accounts for over 30%.

Figure 1: Semiconductor revenue by country (Top 6) :



Source: SIA

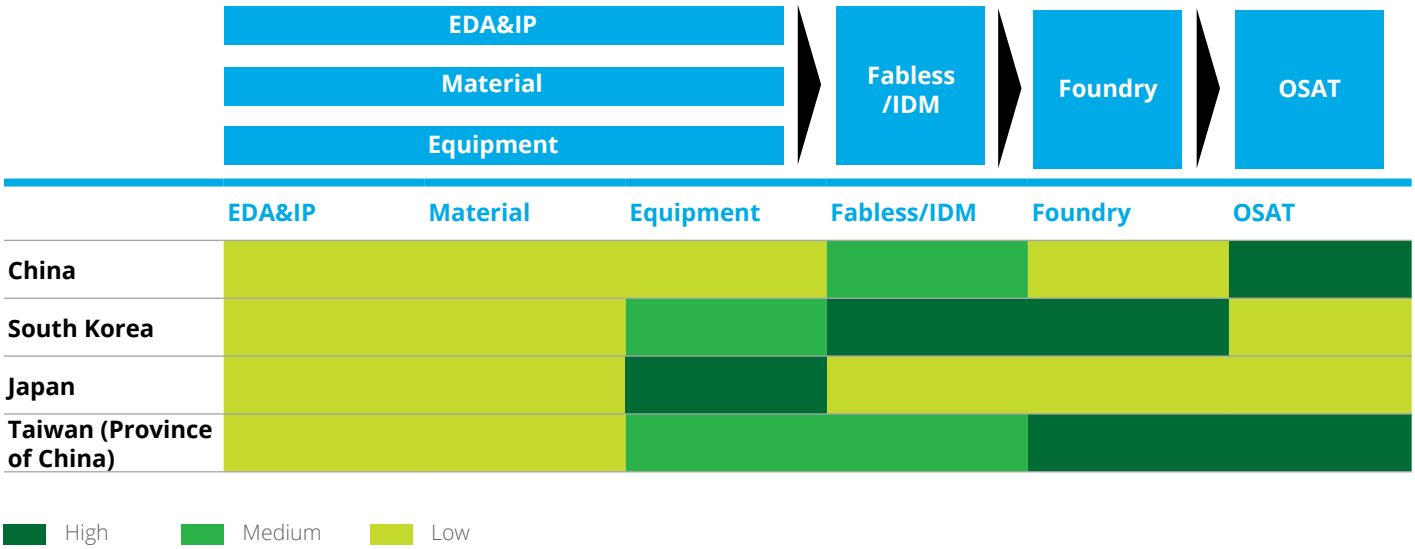
Figure 2: Top 10 Asian semiconductor vendors by revenue in 2019 (USD million)

Company	2019 Revenue (USD million)	Country/Region
Samsung Electronics	52,214	South Korea
TSMC	34,632	Taiwan (Province of China)
SK hynix	22,478	South Korea
Hisilicon	11,550	China
Kioxia	8,797	Japan
Sony	8,654	Japan
MediaTek	8,066	Taiwan (Province of China)
Renesas	6,755	Japan
SMIC	3,014	China
ROHM	2,803	Japan

Source: Company reports

The semiconductor value chain is long and involves many specialized fields: equipment, Electronic Design Automation software (EDA), Intellectual Property core (IP), Integrated Device Manufacturer (IDM and fabless), foundry and Outsourced Semiconductor Assembly & Test (OSAT). Each of the "Big 4" has different strengths and plays a critical role in the global semiconductor value chain.

Figure 3: Relative strength of the "Big 4" across the semiconductor value chain



Source: Deloitte analysis

South Korea – Leading the pack

South Korea's semiconductor industry is large and include numerous enterprises. The biggest semiconductor enterprises are Samsung and SK Hynix. Samsung is the most important semiconductor company in South Korea, which conducts in IC design、smart phones and wafer manufacturing. SK Hynix has led the world in DRAM and NAND Flash market share for many years.

South Korea has more than 20000 semiconductor related companies, including 369 IC manufacturing enterprises, 2650 semiconductor equipment enterprises and 4078 semiconductor material enterprises. A typical semiconductor factory is surrounded by a variety of supporting enterprises. Through layers of outsourcing and subcontracting, a huge semiconductor industry chain has been created in South Korea, forming city clusters of semiconductor industries such as Yongin and Icheon, supporting the whole semiconductor industry of South Korea. South Korea also surpassed Japan and Taiwan to become the second largest semiconductor country after the United States.

Japan – Specialty expert

Japan's strengths in semiconductors are in raw materials, equipment and small active-passive components. Along the semiconductor value chain, Japan has substantial advantages in upstream semiconductor materials.

Semiconductor materials have high requirements for purity, which only Japan is capable of creating. Although Japan's performance in other fields of the semiconductor industry remains under the radar, its deep industrial expertise should not be underestimated. For example, in 2019, Sony semiconductor became a top 10 global semiconductor supplier just by producing camera image sensors.

Taiwan (Province of China) – Manufacturing powerhouse

Taiwan has well-developed semiconductor clusters. It is one of the few regions in the world with a depth and breadth of semiconductor clusters packed into a small geographical area. Taiwan's cluster effect has great advantages for semiconductor development, which focuses on vertical integration and cooperation between different industries. Taiwan is very strong and competitive in chip manufacturing and IC design and has the world's biggest foundry and most advanced semiconductor manufacturing process technology. Taiwan also has an advantage in brand image. For example, many of Taiwan's ODM/OEM production bases and supporting supply chains have been transferred to China, and the subsidies they receive are essentially no different from those received by Chinese companies. But, the brand image accumulated over the years still wields power. Taiwan is also benefiting from the impact of the US-China trade war, in which a large amount of talent and many enterprises are rapidly flowing back to Taiwan. This means Taiwan's semiconductor industry should continue to grow.

China – Rapidly advancing

China's strength in semiconductors is its ability to rapidly scale a technology once it reaches maturity, an area in which no country can really compete with it. China is also quite strong in OSAT, and has a large share of the global market. In integrated circuit (IC) design, China's capability has surged over the past 5 years, and started to catch up with Taiwan's and South Korea's, joining them as the main players in Asia Pacific IC design. Although labor costs in China have increased, overall cost is still quite low because manufacturing continues to be subsidized by the government.

The development of China's semiconductor industry has been comparatively rapid, making Chinese enterprises accustomed to investing in areas that can earn short-term returns. Semiconductor products that require longer investment periods have less of a footprint in China. For example, it takes time for automotive electronics to be certified, and there's little participation in this segment by Chinese manufacturers. That said, China will play an increasingly important role in the semiconductor industry.

Figure 4: Major semiconductor clusters of "Big 4"

	Key Cluster	Characteristics	Major Companies	Key Areas
Japan	Silicon Island Kyushu	• Accounts for about 5% of all world semiconductor production • Surrounded by 41 universities	• Sony Semiconductor • Sony LSI Design • Hitachi ULSI Systems • Toshiba Corporation • Rohm Fukuoka • Mitsui High-tec	• Integrated device manufacturers (IDMs)
South Korea	lGyeonggi-do and Chungcheong-do regions	• It plans to spend about 120 trillion won over 10 years and forming semiconductor cluster in 2030. • Establish four large semiconductor manufacturers and about 50 upstream and downstream suppliers	• Samsung • SK Hynix	• SME (semiconductor manufacturing equipment)
Taiwan (Province of China)	Hsinchu Science park	• More than 70% of global IT industry products are initiated from companies at the Hsinchu Science Park. • Generates an annual revenue of more than 33 billion USD over the past five years and enjoys its global reputation as a brilliant science park. • More than 520 tenant companies employ more than 150,000 people. • Close to the Industrial Technology Research Institute(ITRI), National Tsing Hua University and National Chiao Tung University • Covers six locations—the Hsinchu, Jhunan, Tongluo, Longtan and Yilan parks as well as the Hsinchu Biomedical Science Park—that span a total area of nearly 1,400 hectares.	• TSMC • UMC • Media Tek. Inc • Realtek • CHIMEI INNOLUX • Macronix	• Wafer foundry • IC Design • PC • Telecom • Oproelectronics • Precision Machinery & Materials
China	ZhangJiang Hi-Tech Park	• China's largest semiconductor cluster. • LinGang free trade zone is currently the hotspot for fab development. • Surrounded by Wuxi, Nanjing, Suzhou, Ningbo and Hefei forming the Yangtze River Delta (YRD) with major fab investments in the past decade.	• SMIC • HuaHong • ASML • ASE • NXP • infineon	• Yangtze River Delta (YRD) account for 53% of total domestic fab revenue. • 33% of chip design revenue. • Up to 60% of ATP (assembly, test and package) revenue in 2018 according to the Shanghai Integrated Circuit Association.

Source: Deloitte analysis

On the road to recovery

Global semiconductor revenue was declining even before the COVID-19 pandemic (down 12% in 2019 to USD418 billion, according to IDC), largely due to lower demand and the US-China trade dispute dampening industry sentiment. In addition, inventory pressures in smartphones and cloud infrastructure caused prices to decline, which impacted semiconductor revenues. The emergence of COVID-19 drove another contraction in the semiconductor market.

The semiconductor industry can be divided into several sub-segments. The market for memory is volatile due to oversupply and falling prices, which are expected to continue. Analog IC has suffered due to weak end-equipment markets, particularly in industrial and legacy automotive segments. Optoelectronics, on the other hand, has fared well due to the increasing number of cameras in smartphones. In the next 5 years, logic IC and analogy IC will likely continue to grow, with inventory clearance eventually driving up silicon chip's average selling price.

In addition, the maturity of many disruptive technologies, including AI, big data and 5G, will drive the growth of the semiconductor market. Considerable growth will be maintained once the economy recovers, especially in connectivity-related products and applications. After all, connectivity is the mother of advanced technology and the premise of all technology applications. Therefore, despite the volatility caused by COVID-19 delaying the recovery, the long-term outlook for the semiconductor industry remains positive.

Shock to small-sized firms

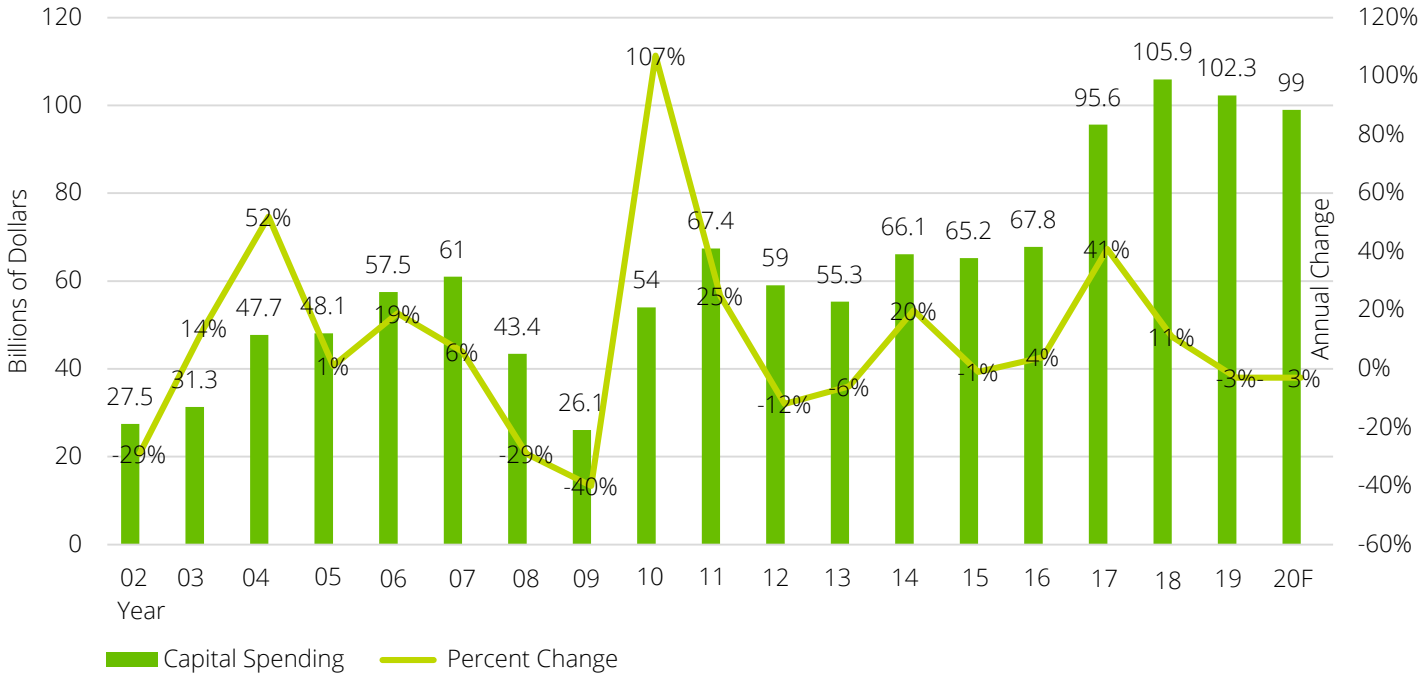
Although the pandemic and trade war are impacting large companies with healthy financials, in the long run they are merely a dent. However, the impact will be extensive for small companies and those in relatively poor financial health, and some could shut down due to poor capital turnover.

The companies that suffer blows from the pandemic will probably be small assemblies and factories, because their gross profit margins are low to begin with. With decline falling due to COVID-19, they have very little leeway to use volume to support their operations.

Semiconductor capex rolls on

Due to the nature of the semiconductor industry, capital expenditure will continue (albeit at a slower pace), because it is used for manufacturing process improvements and additional wafer capacity to increase competitiveness. Now that the pandemic has eased across most of the world, capex is expected to experience a slight dip at worst, with memory suppliers suffering the most. Foundry, on the other hand, will likely experience the largest growth in expenditure. For example, TSMC essentially accounted for all of 2019's increase in foundry capital expenditure, and in 2020 it is expected to spend a further USD560 million. Meanwhile China-based SMIC is planning to increase its outlay this year by about USD1 billion.

Figure 5: Global semiconductor capex (2002-2020F)



Source: IC Insights

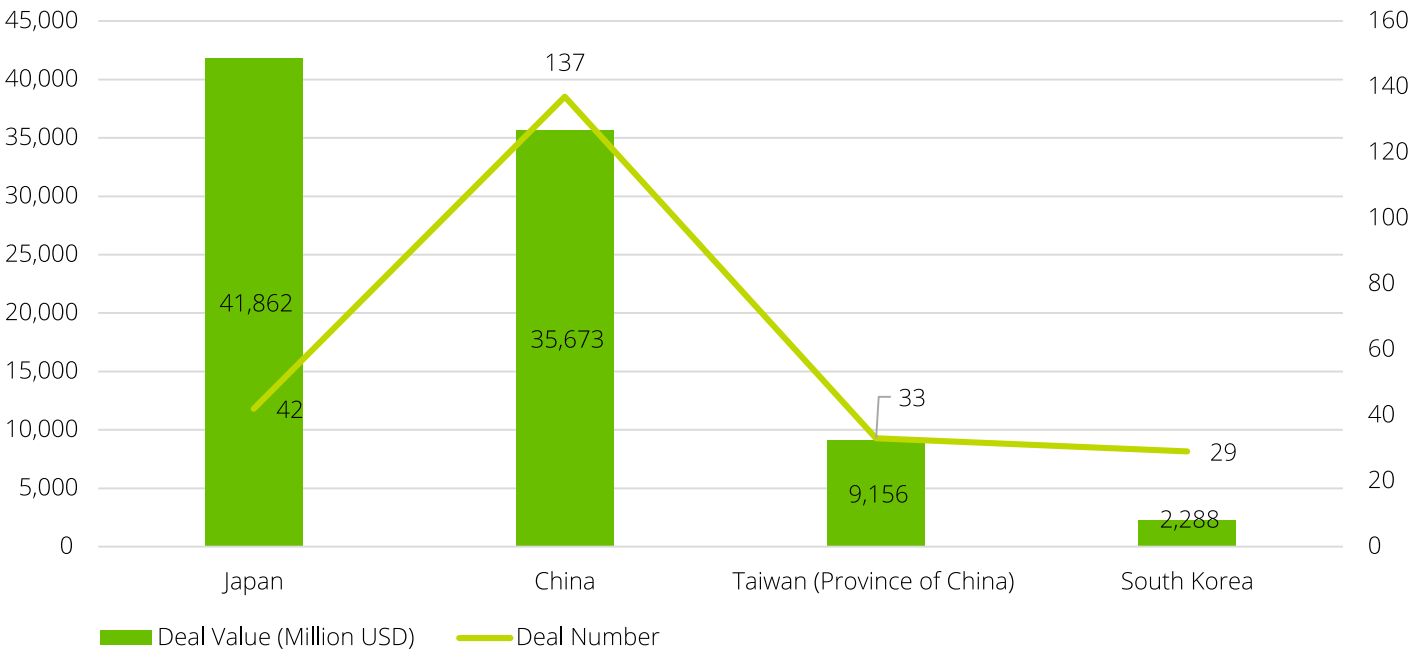
R&D will continue to rise

The semiconductor industry has for decades led all other major industrial sectors in R&D, with annual spending averaging about 15% of total sales. Over the past three years, however, the industry's R&D-to-sales percentage averaged 13%-14%, mostly due to stronger revenue growth and industry consolidation. As R&D investment plays a major role in semiconductors, resources will be invested continuously, driven by growing product complexity and process advancements.

M&A activities stable

In the past five years, Japan has the highest M&A deal value because in 2016 Softbank acquired UK based semiconductor design company ARM for 30,164 million USD, which is the biggest deal in the past five years. However, China is the most active in semiconductor industry M&A activities with 137 deals in the past five year.

Figure 6: M&A Deals of "Big 4" (2015-2019)



In addition, China is also most active in outbound semiconductor deals in the past five years while South Korea is mainly focused on domestic M&A.

Figure 7: 2015-2019 semiconductor cross border deals number

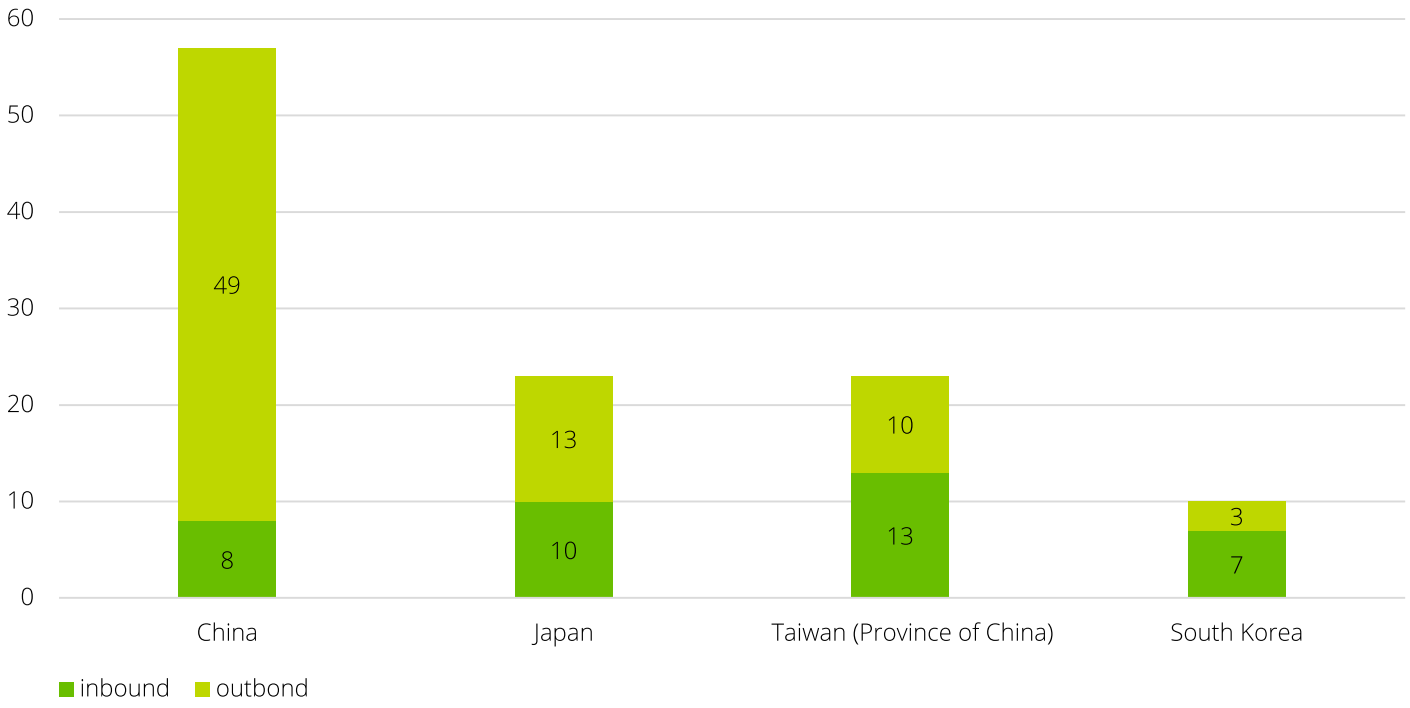
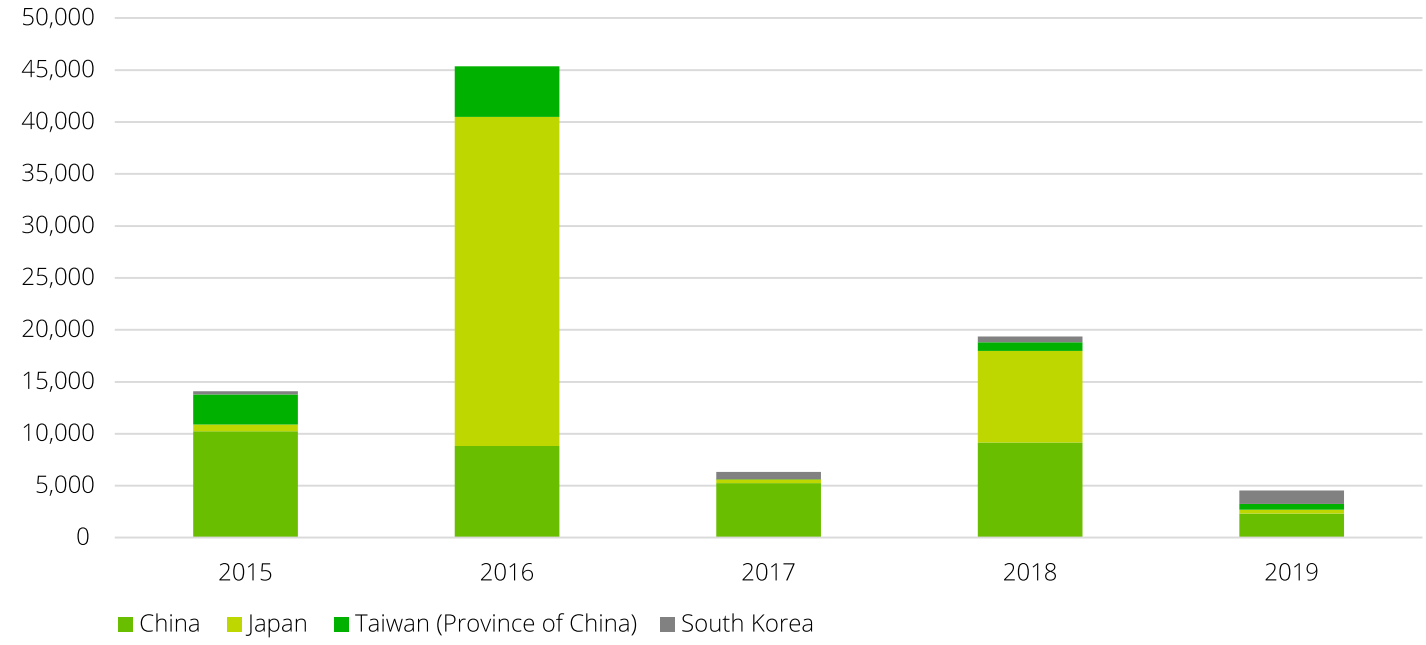


Figure 8: 2015-2019 big four as buyer semiconductor deal value(mUSD)



There is ups and downs in big four M&A activities. After 2018's boom, the "Big 4" M&A deal value shrank in 2019 but China is still most active in deal making.

Figure 10: Top 10 deals of "Big 4" in 2019

Announced Date	Bidder Company	Bidder Country/ Region	Target Company	Target Country	Deal Value (Million USD)	Motivation
9/12/2019	Ingenic Semiconductor Co., Ltd.	China	Integrated Silicon Solution Inc; Integrated Silicon Solution (Cayman); Si En Integration Holdings Limited	USA	863.97	Expand industry supply chain
30/4/2019	Samsung Electronics Co., Ltd.	South Korea	Samsung Electro-Mechanics Co., Ltd. (PLP business)	South Korea	677.47	Strengthen market position and expand market share
29/4/2019	Huada Semiconductor Co., Ltd.; Shanghai Integrated Circuit Industrial Investment Fund Co., Ltd.	China	GTA Semiconductor Co Ltd (84.88% Stake)	China	504.15	New Product line funding
17/12/2019	MinebeaMitsumi Inc.	Japan	ABLIC Inc.	Japan	312.97	Expand industry supply chain
27/11/2019	China Academy of Telecom Technology Co., Ltd.	China	Datang Semiconductor Design Co., Ltd. (49.22% Stake)	China	258.55	Major assets restructuring
28/11/2019	Nuvoton Technology Corporation	Taiwan (Province of China)	Panasonic Semiconductor Solutions Co., Ltd.;	Japan	250	Strengthen market position and expand market share
31/1/2019	Vanguard International Semiconductor Corporation	Taiwan (Province of China)	GLOBALFOUNDRIES U.S. Inc. (Fab 3E)	Singapore	236	Strengthen market position and expand market share
31/3/2019	Wuxi Xichan Weixin Semiconductor Co., Ltd.	China	SMIC Hong Kong International Limited	Hong Kong	175.96	Expand industry supply chain
23/12/2019	SG Micro Corp.	China	ETA Solutions (Nantong) Co., Ltd. (71.3% Stake)	China	152.51	Strengthen market position and expand market share
18/10/2019	NARI Technology Co., Ltd.	China	Narui Lianyan Power Semiconductor Co., Ltd. (69.83% Stake)	China	78.76	Set up a Joint Venture

Source: MergerMarket

Light at the end of tunnel

The pandemic initially started as a supply-side problem issue confined to China. But, as COVID-19 spread across the globe, it began to hit the global economic crisis as its demand-side problems impacted the consumers. Given rising unemployment worldwide, consumer spending is expected to reduce in the next 1-2 years.

The supply chain in China had largely recovered by the end of Q2, but consumers globally are spending more cautiously during a period of economic uncertainty, with sales of consumer electronics such as smartphones suffering as a result. The closure of retail shops also contributed to a drop in demand. Worldwide smartphone shipments fell 11.7% year-on-year in the first quarter of 2020 (1Q20, according to IDC). The largest regional decline was in China, which saw shipments drop 20.3%. Given China accounts for about a quarter of global shipments, this sent shockwaves through the market.

Smartphones will continue to be the largest driver of semiconductor demand. OEMs in China are focused on launching 5G handsets despite uncertain demand. As ODMs and OEMs roll out a broad range of 5G devices, they will drive semiconductor content. The beginning of 1Q20 saw slight rebounds in smartphones, computing, connectivity and memory. Smartphone sales in many parts of Asia Pacific bounced back from all-time lows, but changes in consumer behavior will still hinder consumer and business spending in the second half of the year, and demand for semiconductors will be uneven across different markets. In the short term, upstream semiconductor companies are still getting orders from OEM and ODM factories, and the impact on operations has been relatively slight. In the long term, if consumer demand cannot rebound consistently, development of new devices could be delayed, and OEM and ODMs might not recover lost sales.

The emergence of "multi-markets"

Companies worldwide rely on Asia Pacific manufacturing now more than ever. China accounts for 30% of global manufacturing and more than 50,000 companies worldwide have Tier 1 suppliers in China.
The semiconductor industry is no exception. Wuhan in China, one of the world's largest manufacturing bases for optoelectronics, at the beginning of 2020 under COVID-19, was frustrated by the logistics issues, while its manufactures running around the clock to ensure output against the severely reduced workforce though. The fabs in other parts of China have been resuming to the normal track thanks to their highly automated facilities, while the downstream assembly, packaging and testing factories were badly hit due to the labor shortage.

Disruption has not been limited to China. It has spilled over into other Asian economies. In South Korea, some semiconductor production plants had to temporarily stop operations. Japan has also been hit, with its sourcing of semiconductor raw materials challenged. Due to a sudden drop in overseas demand, economies in Asia Pacific are struggling to win orders from abroad. In China, factories have reportedly seen 10%-20% of their orders cancelled (in some cases for goods that were already manufactured).

But the semiconductor "Big 4" are returning to normal, so there is hope that a disastrous supply-side hit to the global technology supply chain can be avoided. However, slackening demand for end products could further delay the recovery. It will be important to observe the long-term impact of the pandemic and how the US-China tech war reshapes the market and supply chain.

A tale of multi-markets

The US-China tech war is likely to prompt global semiconductor manufacturers to divide between multiple groups for production, design and sales. This might not be wholly deliberate. Market separation sometimes comes down to differences in demand, and different adjustments in specification. This is not far removed from a product design issue, so is less complex than it might appear. In the semiconductor industry, it's a given that production capacity cannot reside in only one country. This not only bears much risk, but it also discomforts customers. Most downstream OEM and ODM customers—even some Chinese enterprises—are beginning to shift supply chain for other countries. TSMC has plants in Taiwan and China, and plans to build a foundry in the US.

The US-China trade war has been going for nearly two years, and large factories have started to respond. It's not easy to move a factory, but in the past two years, manufacturers have prepared contingency plans. Any intensification in the trade war or the pandemic will show manufacturers whether their policies are correct, and if so they will speed up relocations. Each manufacturer will move at a different pace, so this should not have much impact. That said, manufacturers could rethink their relocation choices after the pandemic.

OEM and ODM diversification underway

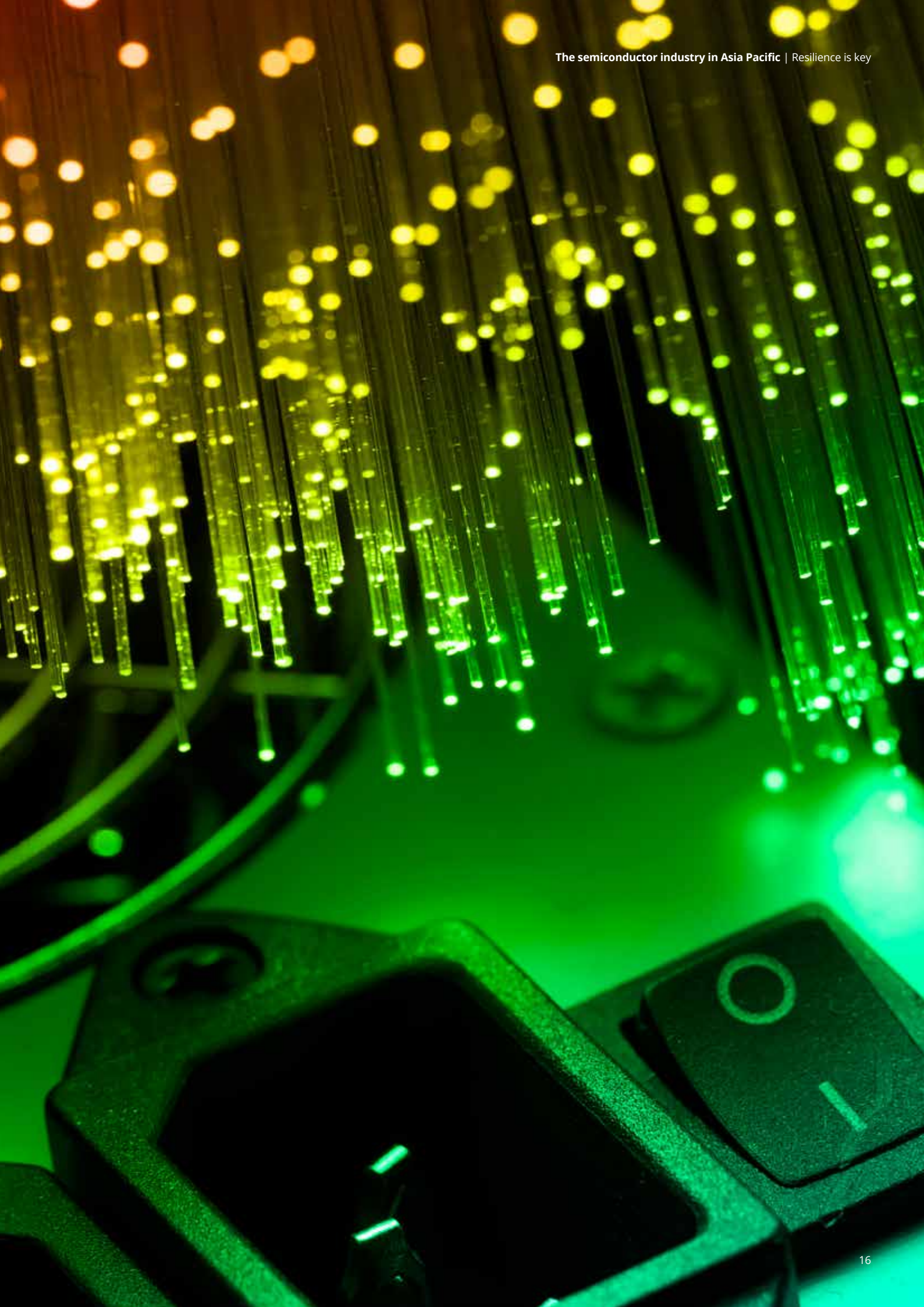
Multinationals have long enjoyed a reliable supply chain in Asia Pacific, but its interconnectedness and layered interdependency also increased risks. In a recent Deloitte survey of managers at Japanese, South Korean, and Taiwanese MNCs, one-third of respondents had already relocated some or all of their manufacturing or assembly outside China in response to trade tensions. Some 55% of Japanese MNCs plan to move some or all of their operations out of China, with the figure reaching 78% and 75% among South Korean and Taiwanese MNCs. The COVID-19 pandemic will likely accelerate the longer-term shift of low-value-added manufacturing from China to Southeast Asia as the Chinese government looks to move into high value tech production, including semiconductors.

The integrity and completeness of a supply chain is the priority when OEM and ODM manufacturers choose to relocate. Due to its proximity to China, South East Asia is set to benefit from some of the relocations.

For example, some of the world's biggest pure-play foundries have manufacturing facilities in Singapore, as well as leasing outsourced semiconductor assembly and test companies. They are also supported by an ecosystem of leading materials & equipment and electronics manufacturing services players.

Vietnam, because of its proximity to China, is an ideal choice for manufacturers. Last year, Google shifted its Pixel smartphone production to Vietnam from China as it built a supply chain in Southeast Asia. South Korean semiconductor companies have no plans to relocate production outside China, but they might consider some supply chain adjustments. If South Korean semiconductor companies relocate their plants, Vietnam would benefit, as Samsung Electronics is already building a production base there.

Malaysia is also another possible choice. According to SEMI, Penang contributes approximately 8% of the global back-end semiconductor output, making it among the world' s leading location for microelectronics assembly, packaging and testing. Thailand is yet another possible candidate because of the completeness of its electronics value chain due to the long-time investment made by Japanese corporations.



Resilience is key

Supply chain disruption from the COVID-19 pandemic was caused by a combination of lean production and global, multistage supply networks. Only a small fraction of companies have carefully assessed their supply-chain risks. Businesses should promptly consider actions that will improve supply chain network resilience. The most pressing needs are to find alternative supply sources, account for supply chain visibility and build safety reserves. In the long term, sourcing is a complex issue that will take time to perfect. To succeed, it is likely to need a combination of:

- **Mapping and digitize supply chains**: Supply chain mapping results in better visibility, indicating which suppliers, sites, parts and products are at risk of disruption. This allows businesses to develop mitigation strategies to ease constrained inventory and identify alternative capacity, and most companies find the benefits outweigh the cost. Businesses with limited resources can start with a focus on key parts that drive the most revenue, and work down through as many tiers as possible to gain visibility. Companies should also look for ways to digitize supply chains. For example, an apparel manufacturer can create 3D samples of clothing online, instead of having to travel back and forth between their buyer and manufacturer to see samples in person.
- **Build strategic backup capacity and flexibility**: Business should also invest in back up capacity by "hiding" one or more supporting supply networks within their core supply chains. A backup network will be able to take over immediately if a core network is shut down. For example, Toyota redistributed its standard components manufacturing after the 2011 T ō hoku earthquake, giving multiple nodes of its supply network the same production capability. Flexible manufacturing, meanwhile, improves supply chain resilience. General Motors has factories in Argentina, Poland, Thailand and Brazil that follow the same design, template and manufacturing processes, so if one region experiences issues, factories elsewhere can provide immediate support.
- **Keep a global perspective while diversifying**: Businesses should also consider that over-reliance on one region could jeopardize their ability to continue business-as-usual. Add to this the risk of ever-more-frequent unforeseen disasters, and it becomes apparent that companies need to reconfigure their global value chains to mitigate and manage risks in advance. Businesses should first assess their supply chain risks, and look to diversify their supply chains by building up parallel networks—more fragmented but tightly managed value chains to diversify risks. This requires longer term, scenario-based analysis of risks and opportunities, rather than simply shifting to a lower-wage country.
- **"Re-shoring" an option for some**: Businesses can also consider strategies such as bringing supply chains closer to demand with on-shoring or near-shoring. For example, South Korean and Taiwanese manufacturers have plans to re-shore some of their high value manufacturing. The trend of companies moving back to their home bases is most prevalent among Taiwanese MNCs, driven by the “Invest Taiwan” initiative, which aims to attract companies back home with low-interest loans to cover the cost of relocation. The Japan and US governments have similar incentives to lure multinationals back to their home soils.

Determined to be self-sufficient

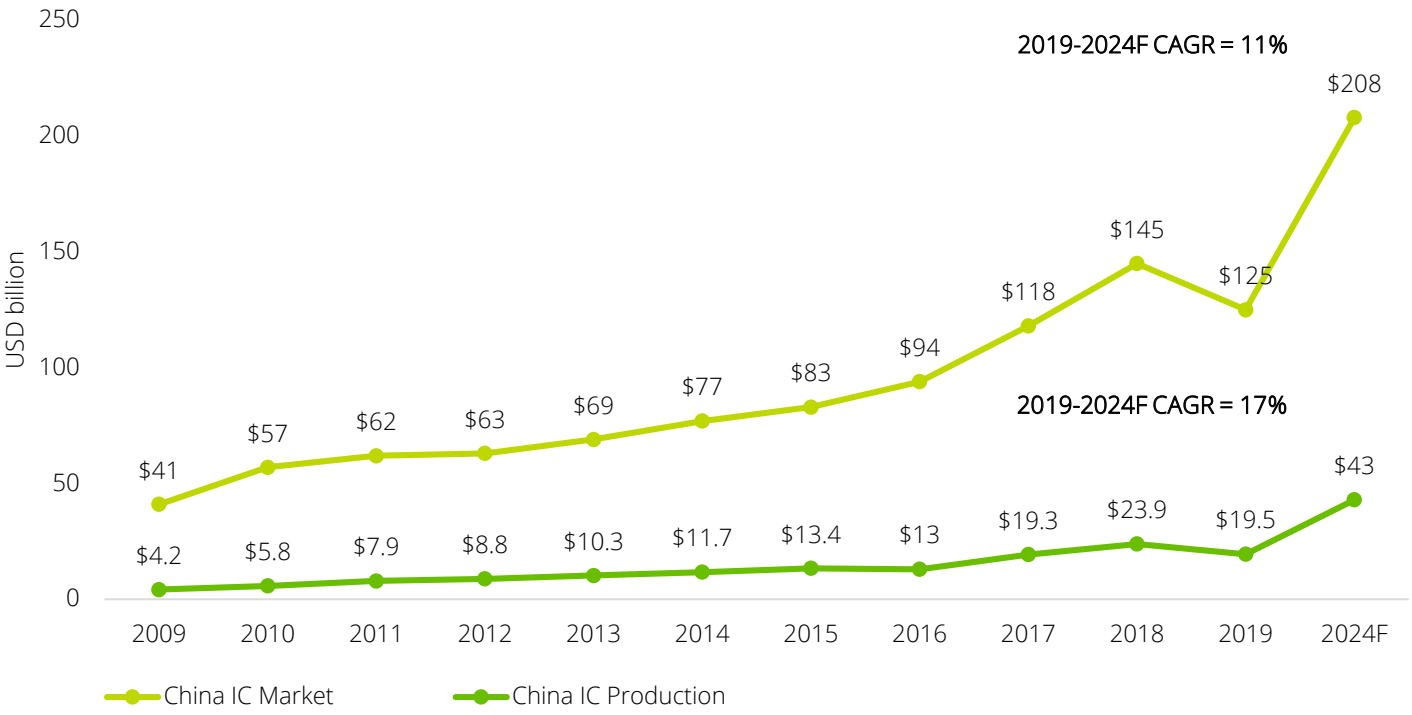
Quest for import substitution

The US-China trade war has in fact had a relatively small impact on the upstream semiconductor companies, but it has been more severe for downstream ODMs and OEMs. This is due to the cost structure of final products, wherein IC represents a relatively low proportion. Therefore, even if a semiconductor is manufactured in China, so long as assembly of the final product is elsewhere, it will not be subject to tariffs when sold to the US.

That said, in 2019 the US added several Chinese companies to its entity list restricting the sale of US components. The immediate impact was to push Chinese vendors into looking outside the US for alternative suppliers in Japan, Taiwan, South Korea, and China itself. However, further tightening of restrictions could put Taiwan and South Korea out of reach for Chinese vendors. The latest such restrictions will likely make things difficult for both sides.

Currently, China is the largest IC consumer globally, but its domestic IC production has lagged. According to IC Insights, of the USD19.5 billion in ICs manufactured in China in 2019, China-headquartered companies produced only 6.1% of the country's IC market. TSMC, SK Hynix, Samsung, Intel, and other foreign companies with IC wafer fabs in China produced the rest, showing MNCs are a big part of China-based IC production.

Figure 11: IC market vs IC production in China



Source: IC Insights

Moreover, many of the top US semiconductor companies receive more than 50% of their revenue from China, so trade actions risk cutting off these MNC's biggest market and could hinder their ability to invest in R&D. This is a particular issue given semiconductor R&D is very costly, so a slowdown in spending could hurt the competitiveness of American firms.

The trade war and entity list restrictions could give China the impetus it needs to develop its semiconductor industry. An avalanche of events has exacerbated China's sense of crisis, and it began to worry that the US could prohibit most semiconductor exports to China, or even the export of semiconductors to China from other countries. China is therefore expected to accelerate the structural adjustment of its semiconductor industry, which has already been underway for many years. After all, China is aware of its low self-sufficiency in semiconductors.

Hence, China is expected to accelerate semiconductor import substitution, so its demand for non-imported semiconductors will grow, and it will eventually lead to an increase in domestic investment. That said, the road to self-sufficiency will not be easy, and it will require a huge amount of capital, talent and time to catch up.

More R&D spending needed

In the semiconductor industry, size matters. This is because firms need to continuously invest to stay competitive. R&D is of paramount importance and companies with higher revenue can invest more in new technology and innovation. In terms of available capital, China has the "Big Fund", of USD 50 billion for the development of its domestic semiconductor industry, which will be leveraged in two phases. But it mostly focuses on manufacturing capacity and acquiring existing technology instead of original R&D and lack investment in tools and equipment (for chip manufacturing), and software (for design) in the value chain.
In contrast, many top global semiconductor companies spend more than USD1 billion on R&D every year, so the "Big Fund" might not be big enough to provide the needed capital in the long run. For example, the top 10 US semiconductor companies spend more on R&D each year than all industry and government spending put together. It will be difficult to catch up with industry leaders when they spend much more on R&D to maintain their tech advantages.

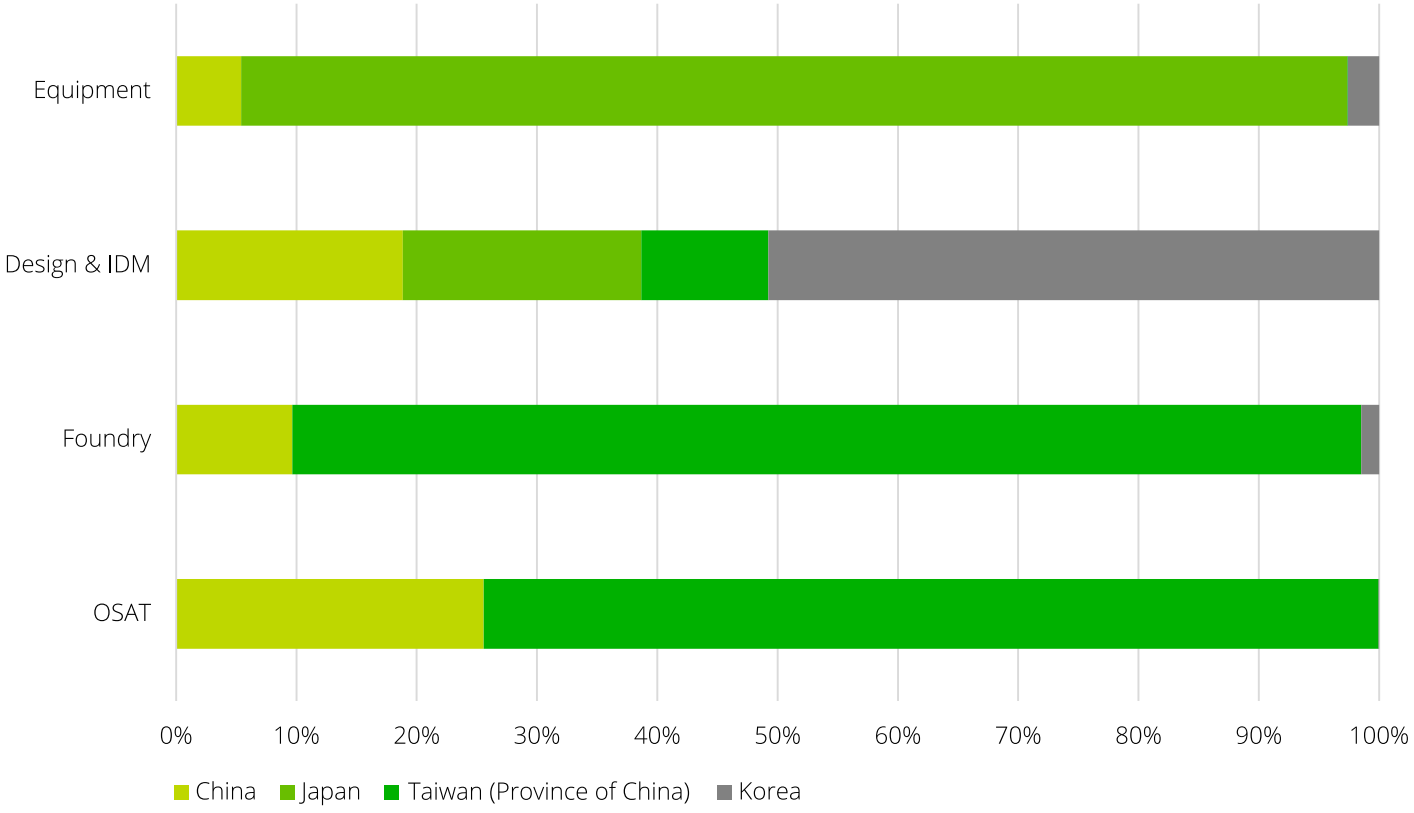
Talent shortage an issue

According to China's Ministry of Industry and Information Technology (MIIT), China needs at least 400,000 more people working in IC industry to reach its goal of growing the industry fivefold before 2030. China will also need to nurture its talent pool by strengthening education and encouraging more students to major in electronics, although not many universities can train quality electronics engineers. Currently, salaries for chip-related hardware research is low compared to Internet companies.

Closing the gap on all front

The semiconductor industry's global value chain spans materials, equipment, design, manufacturing, assembly and testing. The technology level of Chinese companies mostly generally lags that of the global leaders. China is still a relatively small player in the global semiconductor value chain. Particularly lacking in the mid-to high end segments, such as those for semiconductor equipment and EDA & IP.

Figure 12: Semiconductor revenue distribution along the value chain for "Big 4"



Source: Company reports

Equipment: Many different types of equipment are needed to manufacture semiconductor chips, including lithography, ion implantation, deposition, etching, cleaning, and testing equipment. Most of them are manufactured in the US, Japan and the Netherlands. In lithography equipment, the most advanced maker, ASML, is based in the Netherlands. Its only competitors in Asia Pacific are Japan's Nikon and Canon. In deposition equipment, Japan is the regional leader. In China's domestic market, NAURA and AMEC are the largest semiconductor equipment companies.

EDA & IP: The Electronic Design Automation (EDA) software market in China is dominated by global giants like Cadence and Synopsys. There are some domestic EDA companies but their offerings and capabilities lag behind those of peers overseas. China also lacks core IP, which is the crucial building block for chip design. Most IC design companies use their own and third party IP to design IC chips. For example, most smartphones today use ARM architecture. The company has been selling IP licenses to China, although it has now developed some local Chinese IP. China could use open source architecture such as RISC-V, which is not yet export controlled. Chinese companies are increasingly active in this segment, with some claiming their RISC-V IP has the world's most powerful design.

Fabless & IDM: Fabless design & IDM is the largest segment of the semiconductor value for the "Big 4". Including Samsung, SK Hynix, and fabless design companies HiSilicon (owned by Huawei; designs smartphone chips, GPU and server chips) and Unis (part of the Tsinghua Unigroup ecosystem; owns fabless, foundries and OSAT companies). Chinese consumer electronics company Xiaomi has also been active in chip design, focusing on the development of AI and IoT chips as well as investing in IP provider VeriSilicon.

Figure 13: Share of Chinese domestic chips

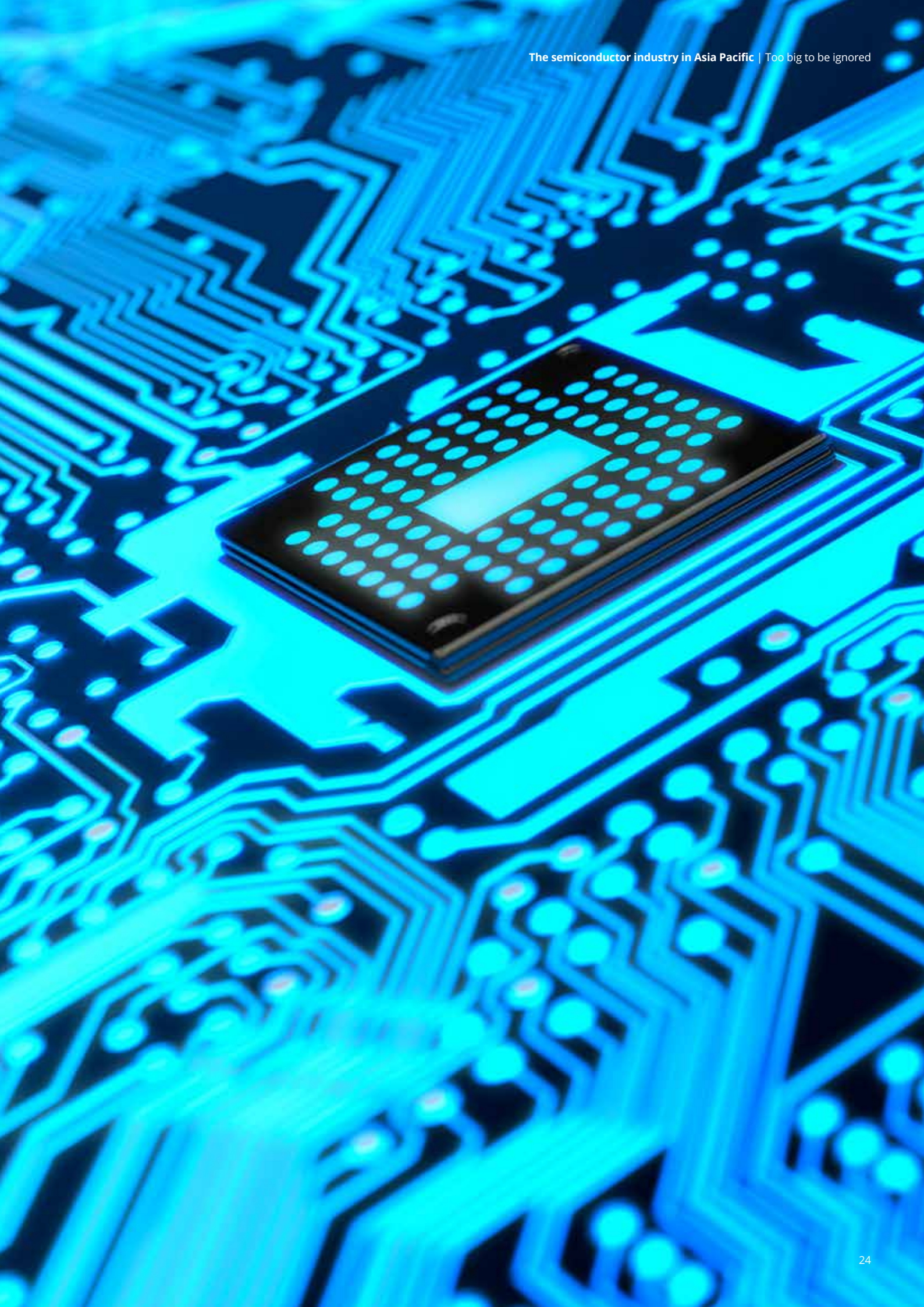
System	Equipment	Core Integrated Circuit	Share of Domestic Chips
Computer System	Server	MPU	0%
	Personal computer	MPU	0%
	Industrial application	MCU	2%
General Electronic System	Editable logic devices	FPGA/EPLD	0%
	Digital signal processing equipment	DSP	0%
Communication Equipment	Mobile communication terminal	Application Processor	18%
		Communication Processor	22%
		Embedded MPU	0%
		Embedded MPU	0%
	Core network equipment	NPU	15%
Storage Device	Semiconductor memory	DRAM	0%
		NAND Flash	0%
		NOR Flash	5%
Display and Video System	HDTV/Smart TV	Image Processor	5%
		Display Driver	0%

Source: China semiconductor association

The outlook for homegrown China design is positive. China has recently developed a domestic x86 CPU to reduce reliance on foreign chips. It may not be competitive in the consumer market, but it is good enough for government use. Others have created domestically RISC-V based CPUs, AI inference chips and flash memory chips. Meanwhile, HiSilicon has become one of the biggest semiconductor companies by revenue.

Foundry: The semiconductor foundry market is dominated by Taiwan' s TSMC. The Chinese Mainland's largest foundry is SMIC. China has made rapid progress over the years and is capable of mass producing 14nm chips, although this still lags the capability of industry leaders such as TSMC and Samsung, which are rolling out 5nm processes. Although China does not yet have state-of-the-art processes, it is making important steps towards self-sufficiency.

OSAT: Taiwan is also strong in OSAT, accounting for half of the top 10 globally. China has recently caught up in this segment, and has a good chance of a breakthrough. It now has more than 20% of the global OSAT market, and three of the top six OSAT companies. This demonstrates the rapid progress of Chinese OSAT firms, but China's semiconductor industry is not yet mature. For example, Chinese manufacturers' yields and quality in packaging and testing lags behind those of other "Big 4" manufacturers.

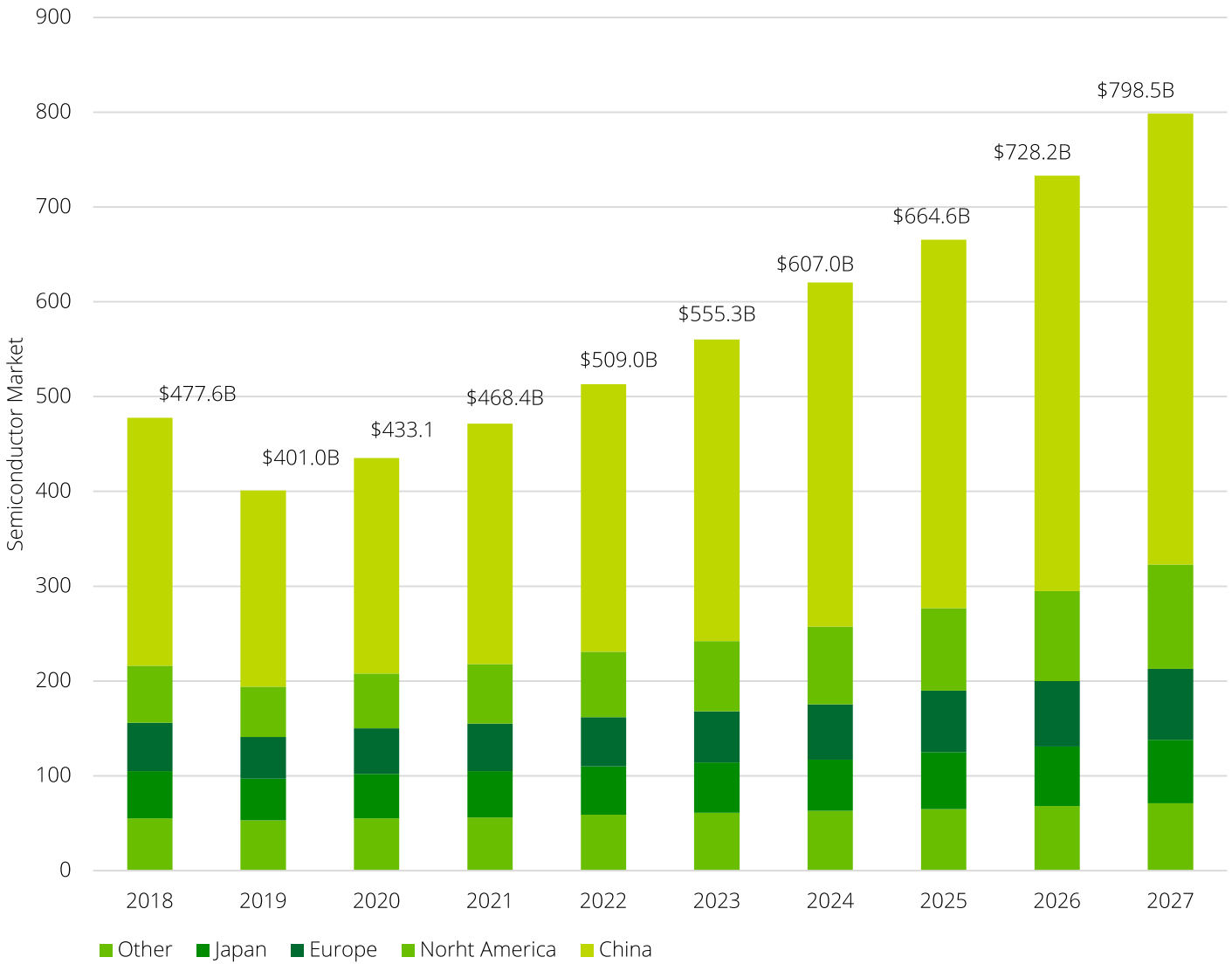


Too big to be ignored

China's consumption is difficult to replace

China's population is too large for the country not to be an important market in Asia Pacific and the world. Of the 15 largest semiconductor companies globally, most sell more to China than they sell to the United States. Consumption of semiconductors by region indicates China absorbed more than 50% of supply in 2019.

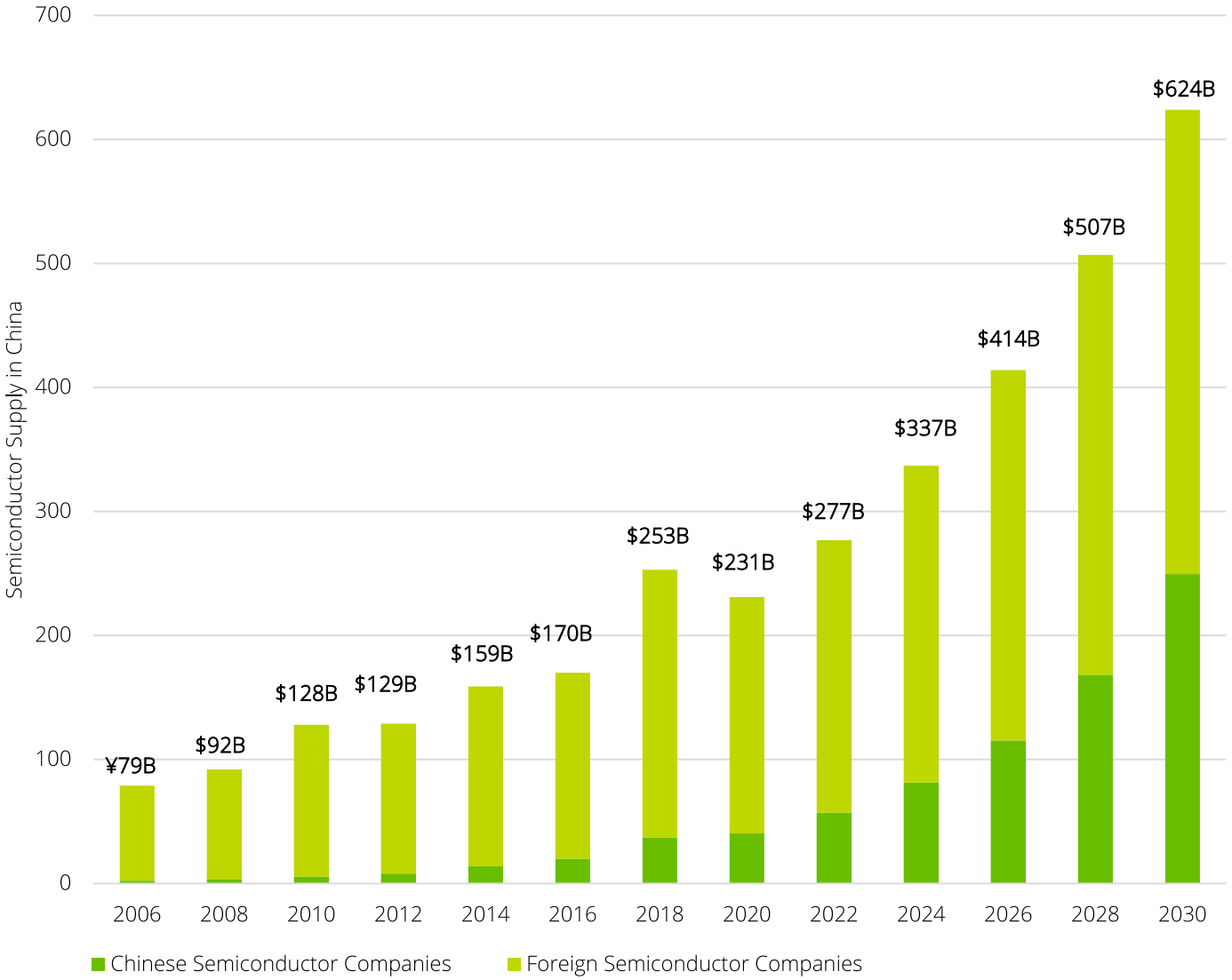
Figure 14: Semiconductors consumption by geographic region



Source: IBS

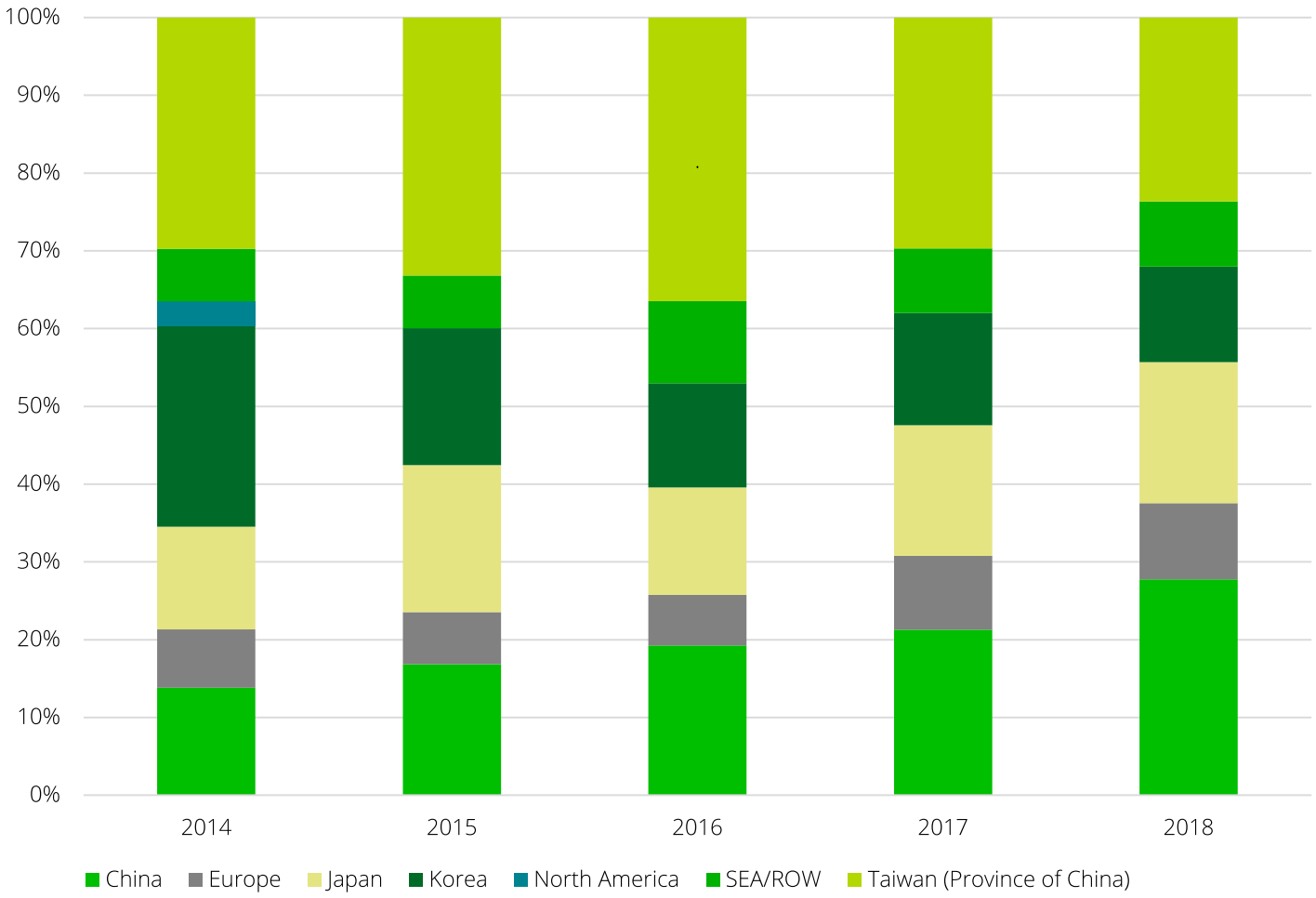
China's semiconductor consumption pattern is also shifting. Ten years ago almost 90% of semiconductors were for exports. But today, 50% of semiconductors are consumed by domestic firms, including smartphone makers and data centers. By 2035, 75% of China's semiconductors are expected to be consumed internally. In addition, China is expected to spend the most in semiconductor equipment in the next 5 years.

Figure 15: Share of semiconductor consumption (domestic vs foreign) (USD billion)



Source: IBS

Figure 16: New semiconductor equipment spending in 2018 (USD billion)



Source: SIA

Furthermore, not all manufacturing can be outsourced to Southeast Asia. China's sheer scale is difficult to be replicated, because it has more migrant workers, clusters of key suppliers and a relatively higher level of skill. For example, China' s established supply chain network and capabilities allow MNCs to source any kind of type of technology from Guangdong and its vicinity.

Thus, regardless of whether and how external factors hinder the Chinese market, it will remain large. The importance of the terminal market in particular cannot be ignored. A key initiative to drive higher levels of semiconductor consumption is 5G. By 2020, China will have about 1 million 5G base stations installed. In addition to the construction of 5G infrastructure, China will produce about 70% of the world's 5G enabled smartphones. In the past, Chinese smartphone companies lagged behind global leaders, but now many of the biggest vendors are Chinese, and they will drive semiconductor consumption.

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