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Q-Series

Is the technology industry heading towards de-globalization?

Equities

Global

Nicolas Gaudois
Analyst
nicolas.gaudois@ubs.com
+65-6495 5148

Jimmy Yoon
Associate Analyst
jimmy.yoon@ubs.com
+65-6495 4617

William Deng
Economist
william-w.deng@ubs.com
+852-2971 6765

Jimmy Yu
Analyst
S1460517080002
jimmy.yu@ubs.com
+86-21-3866 8880

Timothy Arcuri
Analyst
timothy.arcuri@ubs.com
+1-415-352 5676

Sunny Lin
Analyst
sunny.lin@ubs.com
+886-2-8722 7346

Taewoo Lee
Analyst
taewoo.lee@ubs.com
+65-6495 4592

David Vogt
Analyst
david.vogt@ubs.com
+1-212-713 4296

Grace Chen
Analyst
grace-h.chen@ubs.com
+886-2-8722 7340

Francois-Xavier Bouvignies
Analyst
francois.bouvignies@ubs.com
+44-20-7568 7105

Kenji Yasui
Analyst
kenji.yasui@ubs.com
+81-3-5208 6211

Jerry Liu
Analyst
jerry.liu@ubs.com
+852-2971 7493

Will government policies fundamentally change the nature of the Tech supply chain?

The technology industry has been the poster-child of a truly globalised supply chain, accounting for at least 9% of global trade. In that process, it became ever more specialised and clusterised, bringing innovation at diminishing costs. All of this should contribute to Tech net profits growing from US$700bn globally to US$1.5tn by 2030. Yet over the past few years, the technology industry, in particular semis, have been at the center of more assertive government policies such as "Made in China 2025", US exports controls, or the CHIPS Act. Could those threaten the globalisation of Tech? Leveraging the expertise of 50 UBS Global Equity Research and Macro team analysts, over 20 industry/expert calls, and UBS Evidence Lab, we conclude that a full de-coupling scenario is unlikely. Even so, US export controls may develop further, pushing China to reconsider its policy options. Re-shoring will occur to some extent. Amidst those megatrends, we analyse which sectors and stocks could benefit or be negatively impacted.

Tech re-shoring to find limitations, further exports controls likely

"Made in China 2025" has already lead to c. US$120bn of spending into the semis industry. The various subsidy plans for semis manufacturing and re-shoring such as the US CHIPS Act amount for over US$190bn into 2030, and semis fab announcements totalling c. US$270bn of capex. In spite of all this, the current order of things will not dramatically change. We estimate that the US will still only account for 10% of global semis capacity by 2026, while South Korea and Taiwan will still represent 21% / 24% respectively. The de-coupling of supply chains will have natural limits as the US will still lack scale for manufacturing and access to specialised components. The US exports controls will make it very challenging for China to develop and bring up to scale its leading edge semis manufacturing ecosystem. Our industry and expert discussions indicate that more restrictions are possible, notably regarding AI and possibly software.

Scenarios from Tech De-Coupling to Global Village

Assuming that more export restrictions occur, and re-shoring continues, we assess the net impact to the Tech industry would be negative. In that scenario, global tech industry net profits may move down to US$1.3tn and semis revs US$850bn by 2030 (base case US$950bn). If export restrictions are largely rolled back, and government let private capital more efficiently allocate where semis manufacturing capacity is built, we see upside to tech net profits to US$1.8tn and semis revs to US$1.05tn.

Most & least favoured stocks around the theme

The outcome from those scenarios is, to us relatively binary for Tech stocks: globalisation is Positive, de-coupling is Negative. In any cases, re-shoring and national policies are unlikely to challenge the systemic importance of key semiconductor technology providers, which are: ASML, Samsung and TSMC. Both SK Hynix and MU could benefit from the declining threat from Chinese memory companies. China wafer fab equipment vendors including ACM Research, Naura and AMEC could be negatively impacted. Like Semiscap, Chemicals (ex-China) and Japan Machinery is moderately helped by more re-shoring resulting in spending and capacity additions. OEMs (tech, autos, etc) may face re-shoring costs, although supply chain security is a benefit. China Internet would be negatively impacted should we see incremental restrictions further targeting leading edge chips for GPU, CPU, FPGAs etc. as they would limit AI development.

Contents

Nicolas Gaudois
Analyst
nicolas.gaudois@ubs.com
+65-6495 5148

Jimmy Yoon
Associate Analyst
jimmy.yoon@ubs.com
+65-6495 4617

William Deng
Economist
william-w.deng@ubs.com
+852-2971 6765

Jimmy Yu
Analyst
S1460517080002
jimmy.yu@ubs.com
+86-21-3866 8880

Timothy Arcuri
Analyst
timothy.arcuri@ubs.com
+1-415-352 5676

Sunny Lin
Analyst
sunny.lin@ubs.com
+886-2-8722 7346

Taewoo Lee
Analyst
taewoo.lee@ubs.com
+65-6495 4592

David Vogt
Analyst
david.vogt@ubs.com
+1-212-713 4296

Grace Chen
Analyst
grace-h.chen@ubs.com
+886-2-8722 7340

Francois-Xavier Bouvignies
Analyst
francois.bouvignies@ubs.com
+44-20-7568 7105

Kenji Yasui
Analyst
kenji.yasui@ubs.com
+81-3-5208 6211

Jerry Liu
Analyst
jerry.liu@ubs.com
+852-2971 7493

Ken Tay, CFA
Analyst
ken.tay@ubs.com
+603-2781 1121

Thompson Wu
Analyst
thompson.wu@ubs.com
+886-2-8722 7338

Lloyd Walmsley
Analyst
lloyd.walmsley@ubs.com
+1-212-713 9981

Patrick Hummel, CFA
Analyst
patrick.hummel@ubs.com
+41-44-239 52 54

Andrew Stott
Analyst
andrew.stott@ubs.com
+44-20-7567 9227

Geoff Haire
Analyst
geoff.haire@ubs.com
+44-20-7568 8327

Paul Gong
Analyst
paul.gong@ubs.com
+852-2971 7868

Hikaru Mizuno
Analyst
hikaru.mizuno@ubs.com
+81-3-5208 6207

Shunta Omura
Analyst
shunta.omura@ubs.com
+81-3-5208 6244

Shingo Hirata, CFA
Analyst
shingo.hirata@ubs.com
+81-3-5208 6224

Zoe Xu
Analyst
zoe-za.xu@ubs.com
+852-2971 7724

Grant Chi
Analyst
grant.chi@ubs.com
+886-28-722 7343

Chris Kuntarich
Analyst
chris.kuntarich@ubs.com
+1-212-713-9717

Wei Xiong
Analyst
S1460518100005
wei.xiong@ubs.com
+86-21-3866 8883

Felix Liu
Analyst
S1460518040001
felix-a.liu@ubs.com
+86-21-3866 8850

Rachel Freeman
Analyst
rachel.freeman@ubs.com
+1-212-713 1416

Amily Guo
Analyst
S1460518050002
amily.guo@ubs.com
+86-10-5832 8845

Why read this report?

Over the last few years, more assertive government policies towards the technology industry have emerged and significantly gained importance on the global stage: "Made in China 2025", US exports controls, CHIPS Act etc. Those policies are clearly identifying the Technology industry and within it, core enabling tech such as semiconductors, as assets of strategic importance for countries. This does raise, for us, a key question: Is the Technology industry being forced to "de-globalise"? Could we see the partial, or complete, undoing of how the technology industry became more and more global - which in many ways defined and empowered it. To address those issues, we pulled together the combined expertise of UBS Global Technology equity research as well as Macroeconomics research team. We further leveraged experts calls, multiple industry discussions, UBS Evidence Lab datasets as well as our detailed costs analysis (notably through UBS Tear Downs).

Is the Technology industry being forced to "de-globalise" with the emergence of various government policies over the past years?

Figure 1: Key numbers to remember

Source: UBS estimates, BIS; SIA; Note*: Incl. National Fund, IC Fund and estimated government grants, equity investments etc.

A Global Village… til recently

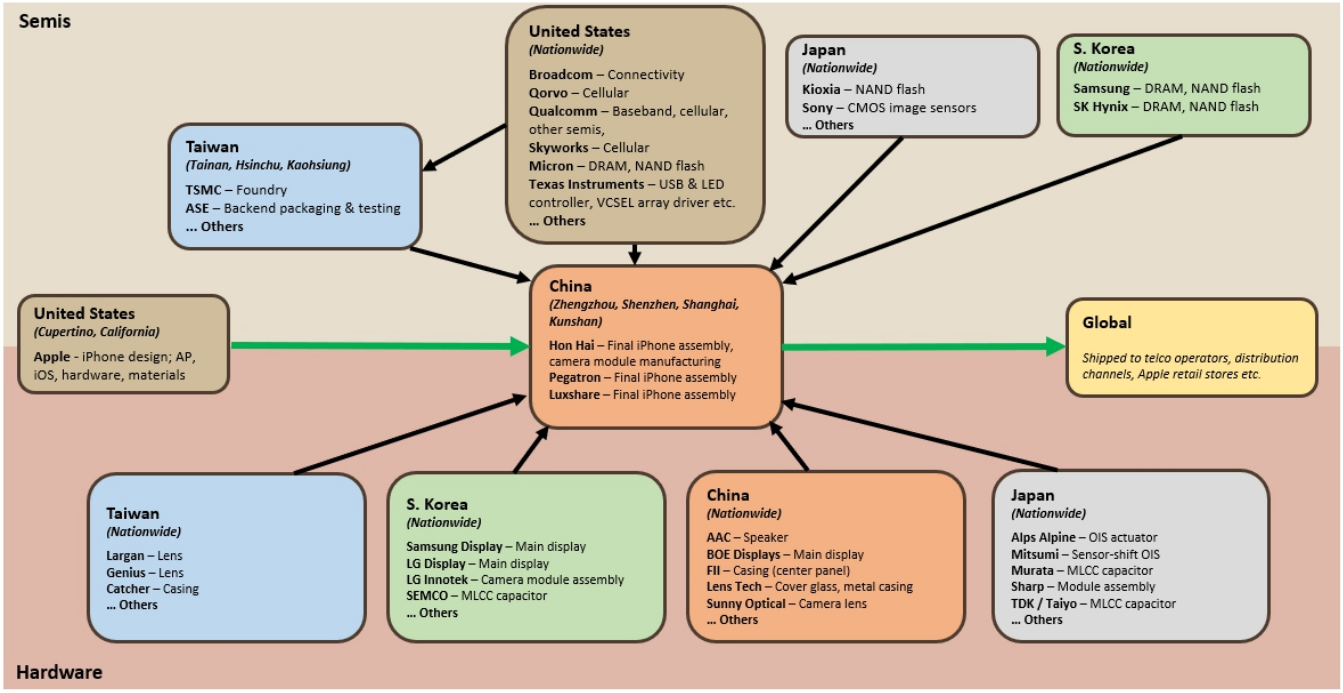
Since humble beginnings in the 1950s in the Silicon Valley, the technology industry exponentially grew by becoming every more globalised and specialised. This lead to the emergence of "technology champions" which leveraged their growing scale to support R&D spending as well as adding significant manufacturing capacity. This also lead to Asia - and notably Taiwan, South Korea and mainland China - becoming key pillars to the global technology supply chain.

Emerging from this evolution path, three key characteristics came to define the global technology industry:

Globalisation, specialisation and clusterization are three key characteristics that define a global technology industry

- **Globalisation:** From design to end-assembly, a technology product / system transits through several countries and use components from various origins. The "poster child" of a globalised supply chain is, in many ways, Apple's iPhone, as we summarised below.
- **Specialisation:** Most component and semiconductor suppliers are highly specialised, as R&D intensity and manufacturing complexity, especially for semis, significantly grew over time. ASML, Samsung or TSMC have become systematically important technology providers.

Figure 2: iPhone production cycle - from design to delivery to customer



Source: UBS

- **Clusterization:** The Silicon Valley, and more recently, Taiwan and South Korea have grown into highly efficient innovation and manufacturing centers. Most of the key talent at TSMC is concentrated in a limited radius in Taiwan.

Tech now at the center of government policies

We have begun seeing policies start to emerge over the past few years as Tech becomes a strategically key asset

That journey towards a highly efficient, globalised technology supply chain culminated by the middle of last decade, but has also planted the seeds towards a more nationalistic approach to policies towards the technology industry. At that time, governments realised that Tech had become a strategically key asset, and defining force towards longer economic development and sovereignty. Hence, after many years of "laissez-faire", **technology policies started to emerge.**

First, China set the stage in 2015 towards improving its self-reliance for semiconductor by 2025. The US then rolled out an expanding list of exports controls towards mostly China, focused for now on semiconductor technologies. One key casualty of this has been Huawei, whose smartphones and semis businesses have not recovered from US sanctions. More recently, the newer US exports controls regarding US manufacturing equipment for leading edge semis could significantly impact China's ambitions in that segment.

Figure 3: Chronology of key US technology restrictions

Date	Key event
Mar 2016	ZTE added to the US DoC's BIS Entity List
Apr 2018	US DoC issues export Denial Order on ZTE for US core technology
Oct 2018	Fujian Jinhua Integrated Circuit (JHICC) export restrictions on US technology transfers
May 2019	Huawei and affiliates added to the US DoC's BIS Entity List
May 2020	US DoC revises Foreign Direct Product Rule to further tighten Huawei restrictions
Aug 2020	US DoC widens the list of Huawei affiliates and the US technology restriction scope
Dec 2020	SMIC and affiliates added to the US DoC's BIS Entity List
Feb 2022	33 Chinese companies including HKC added to the US DoC's Unverified List
Oct 2022	US implements export controls on advanced computing and semis equipment to China

Source: UBS

Meanwhile, **multiple governments, are unveiling subsidy programmes aimed at supporting their semiconductor industries.** The US, Europe and to a lesser extent Japan, are trying to partly rewind the clock to a time when they dominated semiconductor manufacturing. Some of the impetus to this is also heightened by recent geopolitical tensions. In total, those **subsidies towards the semis industry total c. US $350-400bn**. This is a big number, but also misleading, as China, Taiwan, South Korea, Singapore and Malaysia have had policies supporting their semiconductor industry for multiple years. Hence the **incremental subsidies enabling semiconductor re-shoring/shoring are closer to US$121-136bn** (US, Europe, Japan and India); still a meaningful catalyser for the semis industry.

The aggregate sum of subsidies towards the semis industry is estimated to total c. US$350-400bn with incremental subsidies enabling re-shoring close to US$121-136bn

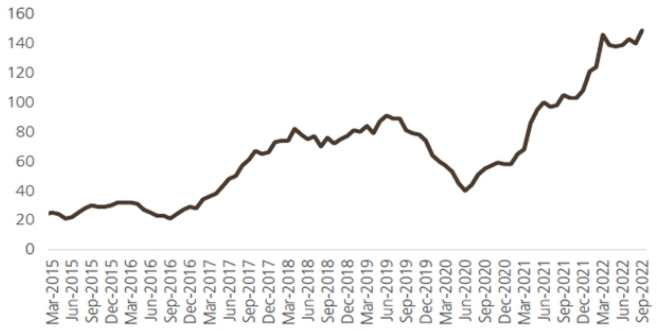
Figure 4: Summary of key government incentives for investments in semiconductor manufacturing

	United States	European Union	India	Mainland China	Taiwan	S. Korea	Japan
Semis Manufacturing Capacity (12", k wpm)	743k wpm *(8%)*	580k wpm *(5%)*	*(> 2%)*	1,620k wpm *(18%)*	2,070k wpm *(22%)*	2,113k wpm *(23%)*	1,337k wpm *(14%)*
Incentives Overview	CHIPS & Science Act of 2022	Digital Compass Plan & EU CHIPS Act	Self-reliant India Plan	14th Five-Year Plan	Statute for Indust. Innovation	K-Semiconductor Belt Strategy	National Semis Project
Period	2022-2026	2022-2030	Not Specified	2021-2025	2023-2029	2022-2031	2022-2025
Est. Value of Incentives (US$bn)	US$74bn *(US$52bn; Incentives) (US$22bn; Tax credit)*	US$30-45bn	Up to US$10bn in incentives *(Up to 50% gov't co-funding)*	Up to US$150bn*	US$15-20bn *(25% tax credit for leading edge R&D; 5% for adv. manuf equipment)*	US$55bn-65bn *(R&D tax credits up to 50%; up to 20% for new facility spend)*	Up to US$7bn *(Mainly for leading edge production; up to 50% setup cost subsidy)*

Source: Company Data, UBS; *Note: Estimated value of total incentives from 2014-2030

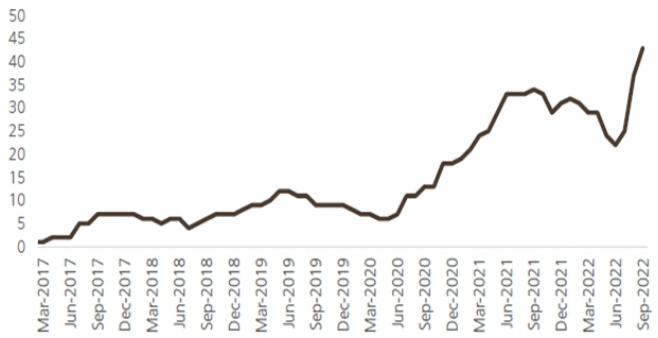
The US in particular has been fairly active in looking at technology re-shoring. As the CHIPS Act got closer to passing through the Congress, reshoring announcements have accelerated, as we can see in the latest UBS Evidence Lab US Reshoring Monitor dataset published by Chris Snyder and team (link). The dataset was accumulated via a process of web scrapping, tracking announcements of US supply chain /business process reshoring, expansion and foreign direct investment.

Figure 5: Tech hardware US reshoring announcements (12mo trailing sum)



Source: UBS Evidence Lab (>Access Dataset)

Figure 6: Semiconductor US reshoring announcements (12mo trailing sum)



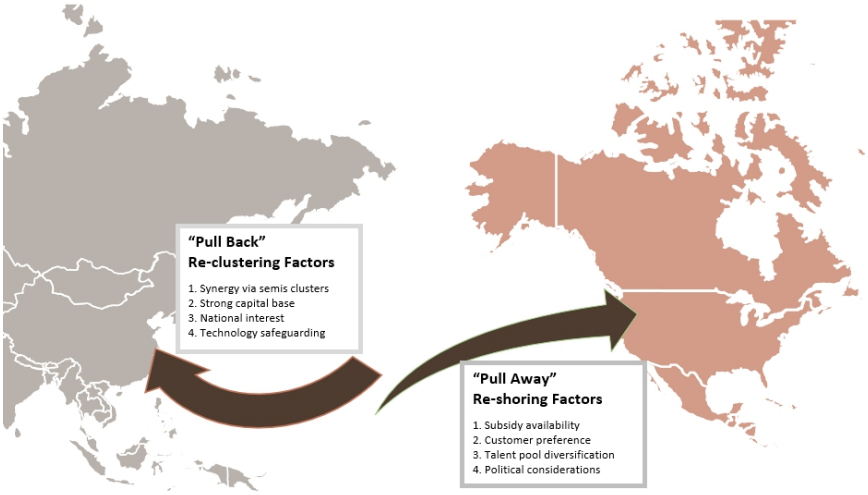
Source: UBS Evidence Lab (>Access Dataset)

The backdrop of the recent "chip shortages" during COVID provided a fitting backdrop as to why nations should care about semiconductor independency, as they did, after the first Oil Crisis in 1973, for energy. A key question is: How realistic those objectives are? And are they even to be wished for, considering how much value a globally integrated technology supply chain has delivered so far?

Is this the beginning of "Tech De-Globalisation"?

So, how far could this really go? Will we move from an era of "global giants" to one of "local champions"? Or are we already too late into a globalised set-up to go in reverse gear?

Figure 7: Tech industry re-shoring vs. re-clustering competing forces



Source: UBS

What can China do to still work towards semiconductor self-sufficiency?

The most recently announced US exports controls will have a profound impact upon China's ability to grow its semiconductor industry. While nobody doubts that this will if anything reinforce the policy drive towards self-sufficiency, a more realistic assessment outlines significant challenges. **We may see a "two lane road" emerging for the global semiconductor industry.**

- **Leading edge semiconductor manufacturing:** The US restrictions are towards US wafer fab equipment (WFE) exports and support for leading edge processes, defined as 16/14nm and below Logic, 18nm and below DRAM, and 128L and above 3D NAND flash. As US WFE is essential for any semiconductor manufacturing lines, considering the market positions held by AMAT, LAM Research and KLA Tencor, **the US restrictions make it unlikely for Chinese semis manufacturers to ramp up leading edge capacity** for the forseeable future. It also makes operating existing memory lines very difficult, and could lead to the DRAM and NAND flash output from Chinese memory companies (CXMT, YMTC) to rapidly diminish.

The recent US export restrictions make it unlikely for Chinese semis manufacturers to ramp up leading edge capacity for the foreseeable future

- **China semiconductor manufacturing equipment:** The above restrictions are effectively removing a sizeable part of the TAM for Chinese semiscap equipment vendors (c. 22% of total), which were naturally over-exposed to YMTC/CXMT vs peers. They also lose the proximity to any leading edge customers. **On some segments: Lithography, Inspection/Metrology but also some of the more advanced Deposition/Etch processes, we believe that the China ecosystem is unlikely to catch up for the foreseeable future.**

- **AI and Supercomputing:** US restrictions regarding specific AI accelerators and supercomputing solutions are already penalising. **AI is also an area where we may see more restrictions emerging over time**. This would negatively impact the nascent China leading edge computing semis industry. It could also over time limit the ability of Chinese hyperscale companies to innovate.

AI is an area where we may potentially see more restrictions emerge over time

- **Some segments are so far less or not impacted: Trailing edge (28nm or above) Foundry is not impacted, and is by far the bulk of revenues in the sector in China.** Note though that 14/16nm will, within 5 years, be trailing edge. Semis assembly and Test contractors (OSATs) have limited direct impact (coming

from memory mostly). Fabless ICs are largely not impacted apart from the fringe at the very leading edge.

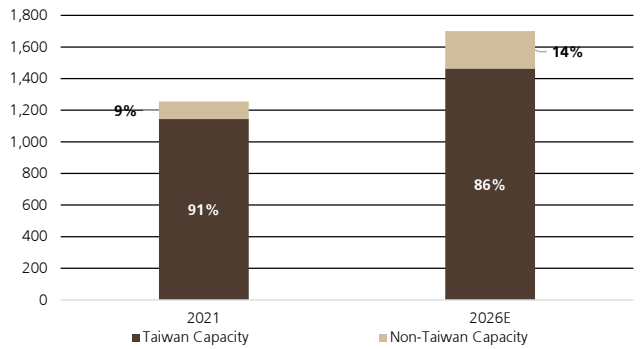
How far will re-shoring and de-clusterisation go?

Reshoring programmes unlikely to significantly impact the balance of the semiconductor ecosystem

In spite of the magnitude of incentives, our analysis concludes that **re-shoring programmes will not significantly change the balances of the semiconductor ecosystems**. Looking five years out, we estimate that:

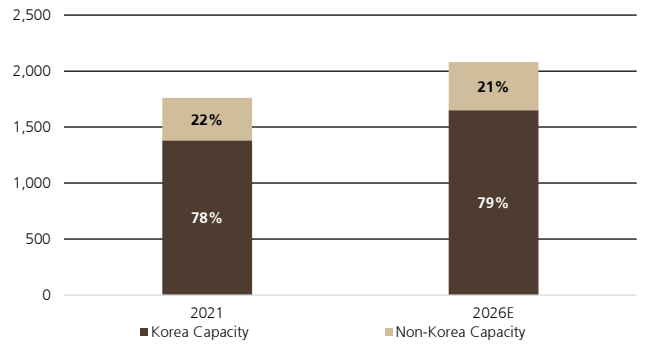
- **Taiwan will continue to dominate leading edge Logic semiconductor manufacturing, and South Korea Memory.**
- Non-Taiwan installed capacity at TSMC may only be 14% of total vs. 9% in 2021. As for Samsung, non-Korea capacity will likely be 21% of total in 2026 (assuming no changes to China capacity either way) vs. 22% currently.
- Intel's wafer capacity would still account for 32% of TSMC's forecast capacity by 2026. Similarly, Micron's capacity adding the two fabs under US CHIPS Act would be 56% of forecast Samsung's capacity (memory only) by 2026.

Figure 8: TSMC Taiwan vs non-Taiwan capacity (12" basis, k wpm)



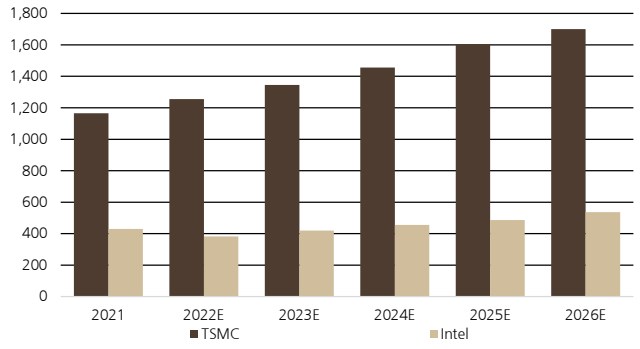
Source: Company data , UBS estimates

Figure 9: Samsung Korea vs non-Korea capacity (12" basis, k wpm)



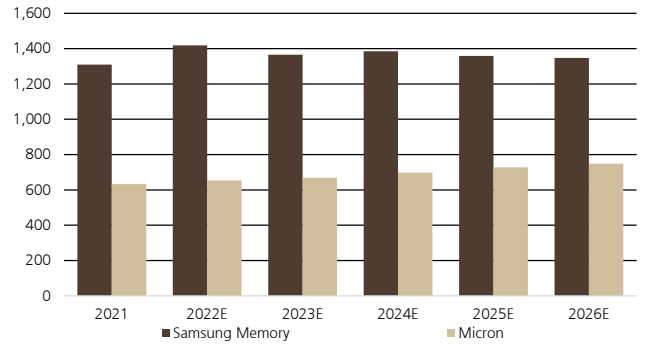
Source: Company data , UBS estimates

Figure 10: Intel vs TSMC capacity 2021-26 (12" basis, k wpm)



Source: Company data , UBS estimates

Figure 11: Micron vs Samsung memory capacity 2021-26 (12" basis, k wpm)



Source: Company data , UBS estimates

… And can tech de-coupling even function?

Industry expert checks suggest we are unlikely to move in full reverse towards a de-globalised industry

Tech companies now have to factor in stronger national policies and their impact when planning their strategy and future. Be as it may, **most executives and experts we have talked to over the past few months are doubtful that we will go in full reverse gear towards a de-globalised industry**. Those are the key reasons why:

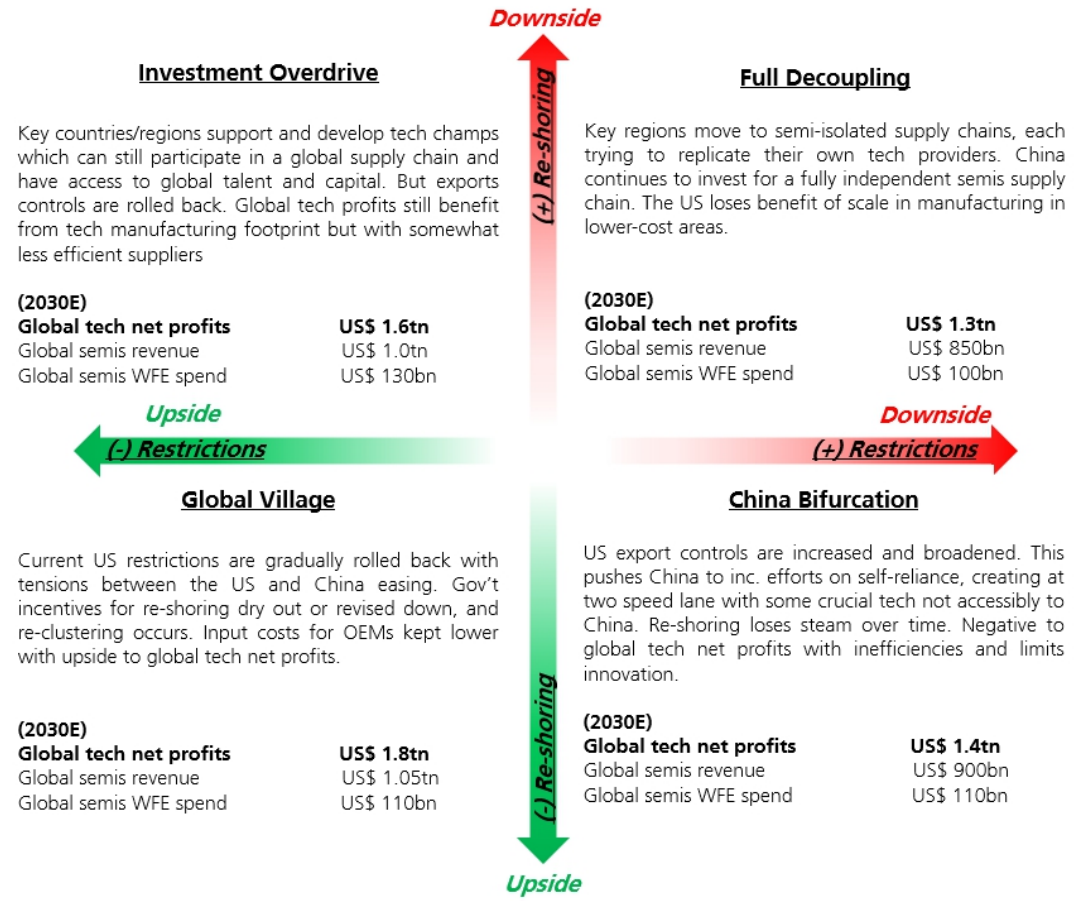
- **National supply chains may never truly materialise:** The US would lack manufacturing capabilities operating at scale, notably for electronic

manufacturing services (EMS) and semiconductor foundry. Other obvious holes include MLCCs and other passive components, as well as precision components, and Displays. China dos not have a full setup for semis manufacturing equipment, software develop tools (EDA) as well as core semis IP (microprocessors, graphics processors etc).

- **The costs are simply too large to absorb:** In a world where inflation is making a comeback, it is somewhat counter-intuitive to believe that governments would force policies which would make tech products more expensive. But de-clustering and fragmenting supply chains would ultimately do that. Our analysis indicates that a "made in the USA" (or as much "made in the USA") as possible higher end smartphone would see a c. 5% increase in bill of materials costs. In the tech hardware world, this is a big add-on considering operating costs. In addition, de-clustering and a less mobile workforce would also penalise innovation.

Scenarios from Globalisation to De-Coupling

Figure 12: How re-shoring and US restrictions may re-shape Tech



Source: UBS

Base Case:

- Our base case projection is for overall global tech net profits (UBS covered net profits) to reach US$1.5tn by 2030. Specifically related to Semis, our base case assumes global semis industry revenues to reach US$950bn in 2030, and wafer fab equipment (WFE) spending of US$120bn. The tech industry remains largely global, but with some distortions promoted by national policies.
- For tech earnings – 2021 are reported earning within UBS global tech coverage (including semis, tech hardware, software and internet), and have explicit company forecasts til 2026. We then assume 10% net earnings CAGR which implies 7% revenue CAGR, and the delta being operating leverage. For semis revenue, 2021 are reported global industry revenues (source: SIA); we have explicit forecasts til 2024 (link). We then apply a CAGR of 7% til 2030.

Upside Case:

- **"Global Village":** Current US restrictions are gradually rolled back and overall tensions between US and China ease. Government incentives for re-shoring dry out or are revised down, and re-clustering occur. In that scenario, input costs for OEMs are kept lower, which in turn favour software and app ecosystems. The total global tech net profit pool is higher and close to US$1.8tn by 2030. Semis revenues are helped by higher specialisation and efficiency and are 10% higher at US$1.05tn. On the other hand, WFE is somewhat lower as re-shoring incentives are not as supportive, and is close to US$110bn.
- **"Investment Overdrive":** Key countries or regions support and develop tech champions which can still participate in a global supply chain, and have access to global talent and capital. But exports controls are rolled back. In that scenario,

global tech profits may still benefit from the investment drive into the tech manufacturing footprint, but may have somewhat less efficient suppliers. Hence the global tech net profits would reach US$1.6tn by 2030. Semis revenues are supported by subsidies and are close to US$1tn in 2030. WFE benefits from full spend on announced subsidy schemes and goes to US$130bn.

Downside Cases:

- **"China Bifurcation":** US export controls are increased and broadened. This pushes China to further accelerate efforts to increase its self-reliance. But this also creates the risk of a "two-speed " lane system where some of the crucial enabling tech ins not accessible to China. Meanwhile re-shoring loses steam, as the US can assert some degree of technological advance without committing more public spending to the sector. Net net, this scenario is somewhat negative to the global tech net profits pool as increasing inefficiencies and limiting innovation and goes to US$1.4tn by 2030. Semis revs are also negatively impacted to US$900bn, and WFE to US$110bn by 2030.
- **" Full Decoupling":** All key regions move to semi-isolated supply chains, each of them trying to replicate their own key technology providers. China throws everything in to create a fully functional and independent semiconductor supply chain, but it takes a long time. The US loses the benefit of scale for manufacturing in lower costs countries. Global tech net profits move down another notch to US $1.3tn, semis revs to US$850bn, WFE revs to US$100bn by 2030.

Figure 13: Signposts - What will we be tracking?

DATA RELEASE / EVENT DATE		WHAT WE EXPECT
2023	**Impact of most recent US exports controls**	**China memory and semiscap most directly impacted** The most recent announced US exports controls vis-à-vis 128L and above NAND flash and 18nm and below DRAM will make it very difficult for Chinese memory companies to gain scale, go through tech migration and possibly operate the current installed base. Without access to US wafer fab equipment as well as parts/services, not only will YMTC and CXMT will not be able to add capacity, but they may also struggle to efficient run installed lines. YMTC is also on the Unverified List, which means it could be added to the Entity List next. Wafer fab equipment vendors have already warned about a revenue impact in 2023. We could also see a decline in both NAND flash bit shipments from YMTC as well as DRAM from CXMT in the course of 2023. The impact on SMIC will be more limited as 14nm is a small portion of revenues.
2023-2025	**Further US exports controls**	**More likely to increase than recede** The general direction of travel is likely to be more, rather than less, US restrictions related to Technology exports / transfers to China. This is in large part because there is broad political consensus on this in the US. The debate is more around what could be the next wave of US export controls? We do not expect much incremental on manufacturing, although a pending question is whether some of the thresholds - notably 16/14nm - get adjusted or not as "trailing edge" moves on to those over time. On the back of previous legislatory activity, we believe further restrictions regarding AI solutions are possible. Software could also be the next area of focus. We note however that controlling software use is a lot harder than hardware and semis.
2023-2025	**China tech/semis policies**	**Where will "Made in China 2025" go from here is uncertain** The consensus view is that China will only go in one direction after facing more US sanctions - that is to push further its investment into its tech and more specifically tech industry further in overdrive. Yet, a pragmatic assessment indicate that there are material differences between "wanting to" and "can". How to make leading edge semis manufacturing self-sufficient in China boils down in no small part in developing a China wafer fab equipment industry, and for it to fill all the gaps. This will be very challenging. Other key gaps in semiconductor technologies are IP for CPUs, GPUs, high power ICs and EDA tools. We may see capital re-directed to sub-segments not affected by US restrictions including trailing edge foundry, OSAT, and most fabless IC segments. How will the foundations for funding including new private equity set ups and regional financing will also be key.
2023-2025	**Re-shoring & subsidies**	**US CHIPS Act is out, more to come** Whilst the US CHIPS Act has gone through the Congress, not all projects have been announced yet. The exact timing, capacity deployed and technologies of those already announced are not all known yet. TSMC in particular may deploy 4nm (as opposed to 5nm) capacity, and has announed plans on a second fab in the US. The European CHIPS Act is still to be fully formalised, and more projects could follow. The India scheme for Semis and Displays is still to yield fully tangible projects.
2023-2025	**Globalisation resilience**	**The tech industry's natural instincts will be to continue to champion globalisation** The technology industry has been accustomed to operate in a globally integrated supply chain, with key technology enablers and suppliers leveraging high specialisation and scale. Going into reverse mode from this is both very complex and potentially costly. Hence we expect some pull-back forces stemming from the tech industry towards some degree as status quo, if not re-clusterisation. This could come through lobbying as well as the sheer strength of private investments (as opposed to public subsidies). One thing the global tech sector has in abundance is cash to drive those investments.

Source: UBS estimates

Stock implications

We summarise below the impact on our tech coverage, of technology de-globalisation trends. In summary:

- **Most favoured from re-shoring:** Semiscap will benefit from subsidies pulling in capex, though the impact will be inflated. In fact, without subsidies, Samsung or TSMC would simply spend equivalent amounts possibly in different locations. Within semiscap, our preferred plays are ASMI, ASML, LRCX. The same logic goes for Chemical (ex-China) and Japan Machinery, both moderately helped by more re-shoring resulting in spending and capacity additions.
- **Least favoured from re-shoring**: EMS and ODM companies are somewhat forced to diversify their geographic footprint, and this negatively impacts their

margin. But at the same time, it is also prudent planning for those companies to plan for it, and not doing so would be penalising for revenues. Within EMS / ODMs, we prefer Hon Hai, Quanta, USI, Wiwynn over Pegatron, Compal, Inventec and Luxshare. OEMs may be negatively impacted by higher costs and more complex supply chain. This is especially the case for smartphone OEMs. Within OEMs, we prefer AAPL, DELL, Samsung, Xiaomi over CSCO, HPE, HPQ, Lenovo and Asus. Auto OEMs may also face a more fragmented, complex supply chain. At the same time though, re-shoring may help securing continuity of supply,

- **Least favoured given impact of US restrictions towards China:** China wafer fab equipment makers , which had c. 22% exposure to China memory makers. ACM, Naura, AMEC and SMIC will not be in a position to increase 14nm presence, while continuing to aggressively add 28nm capacity in possible overcapacity. GigaDevice could be negatively impacted as reliant on CXMT for DRAM procurement and having had plans to develop their own DRAM tech. China Internet companies may be negatively impacted by restrictions regarding AI chipsets.
- **Less impacted by US restrictions and possible China localisation plays:** Trailing edge, most of fabless ICs, and semis assembly and test subcontractors (OSATs) are less or not impacted. Some of those remain viable localisation plays, Within our coverage, we would single out JCET, Silergy, Maxcend and AccoTEST.
- **Most favoured given impact of US restrictions towards China:** Incumbent memory makers could benefit from the competitive threat posed by Chinese memory makers receding. We prefer SK Hynix, MU and Samsung over WDC.

Figure 14: Sector thesis map summary

Sector	Growth	Margins	ROIC	Valuation	Most Favoured	Least Favoured
Semiconductors - non-memory	→	→	→	→	AMD, Nvidia, TSMC	Intel
Semiconductors - memory	↗	↗	↗	↗	Micron, Samsung, SK Hynix	Western Digital
Semiconductor capital equipment	↗	→	↗	↗	ASMI, ASML, Lam Research	KLA
Semiconductor - China	↘	↘	↘	↘	JCET, Silergy	ACM Research, GigaDevice, SMIC
Tech hardware - OEMs	↘	↘	↘	↘	Apple, Samsung, Xiaomi	Asustek, Dahua, Hikvision, Inspur
Tech hardware - EMS/ODMs	→	↘	↘	→	Hon Hai, Quanta, USI, Wiwynn	GoerTek, Lens Tech, Luxshare
Internet - China	↘	↘	↘	↘	JD, NetEase, Pinduoduo	Alibaba, Baidu, Tencent
Internet - US	↘	↘	↘	↘	Alphabet, Meta	
Autos	→	↘	↘	→	BYD, Mercedes-Benz, Tesla	Renault, Volkswagen
Machinery - Japan	↗	↗	↗	→	Keyence, SMC	
Chemicals - raw materials	↑	↗	→	↗	GlobalWafers, Air Liquide, Air Products, Linde, Wacker Chemie, DuPont	SUMCO, Nippon Sanso HD

Source: UBS research

Note: This list contains stocks that may be impacted by a specific scenario. The scenarios described herein may play out over a multi-year period, whereas UBS equity analysts' base-case views are based on the next 12 months. All ratings are current, as shown in the most recent published UBS research report relating to each company. These reports are available on UBS Neo.

UBS Research THESIS MAP

Non-memory semiconductors

IMPACT ON SECTOR

Growth:  Margins:  ROIC:  Valuation: 

SECTOR IMPACT

Q: Will fabless ICs and foundries benefit or be penalised by re-shoring?

The overall impact is Neutral. The global semis industry has strongly benefited since the 1990s from growing specialisation and clusterization, driving significant scale and innovation benefits. This has lead to the emergence of many successful fabless IC companies, which can combine superior growth to strong cash flow generation. This is in no small part anchored upon a dominant foundry – TSMC – itself hugely profitable and cash flow generative. Introducing government incentives may contribute lead to some degree of de-clusterization, with inherent inefficiencies. On the flipside, it may provide fabless IC vendors with more diversified foundry options. Foundries such as TSMC will benefit from government incentives; on the other hand, de-clusterization and higher operating costs outside of Taiwan will partially offset those.

Q: Are US restrictions towards China impacting the total semis TAM?

Only when those impact end-demand. For example, restrictions regarding AI and supercomputing chips do take off some the TAM specific to China high end computing, directly (eg NVDA's sales of A100 chips in China), or indirectly (demand for CPUs, memory, power management for those servers). On the other hand, restrictions vis-à-vis Huawei/Hi Silicon did not per se change end demand for smartphones, and lead to a transfer of demand to other OEMs and their suppliers.

That said, if we go towards a fully de-coupled supply chain, with China localizing procurement as much as possible, it would have an overall deflationary impact on demand for non-China companies. In specific segments in semis, this could reduce the TAM for US, European, Japanese suppliers in particular. Limits to this is what China may not be in a position to localise: memory, leading edge foundry in particular.

STOCK IMPACT

Q: Which stocks are better/less favourably positioned in a "De-globalisation" scenario?

INTC could benefit the most from the US CHIPS Act and possibly Europe CHIPS Act. But longer term, this does not really put in balance TSMC's leadership in the foundry market, notably leading edge. NVDA and AMD can both manage their exposure to the risk of further US restrictions towards AI solutions for end-use in China. A fully de-coupled scenario, where China localises as much as possible of its supply chain, is overall negative for US Semis in particular and not priced in.

WHAT'S PRICED IN

Investors have taken relatively positive announcements from INTC regarding subsidised fab projects, but do consider it comes second to execution regarding its technology roadmap. Investors tend to view the US CHIPS Act as a relative Negative for TSMC as 1/ allowing Intel to roll out a competing foundry offering; 2/ supporting Intel keeping a substantial degree of insourcing (as opposed to outsourcing more to TSMC over time); 3/ leading to some degree of de-clustering at TSMC (through it investment in the US, to a lesser extent Japan). US restrictions are viewed as an overall Negative for the semis industry, although the impact (excluding Chinese companies – which we address in a specific section) has proven over time more limited.

MOST FAVOURED

Stock	UBS rating	Comment
AMD	Buy	Limited AI exposure in China
NVDA	Buy	AI exposure in China is manageable
TSMC	Buy	Re-shoring will not over time materially affect TSMC's leadership in Foundry, notably leading edge

Source: UBS estimates
Note: This list contains stocks that may be impacted by specific scenarios. The scenarios described herein may play out over a multiyear period, whereas UBS equity analysts' base-case views are based on the next 12 months. All ratings are current, as shown in the most recent published UBS Research report relating to each company. These reports are available on UBS Neo.

LEAST FAVOURED

Stock	UBS rating	Comment
INTC	Neutral	Ultimately re-shoring is a secondary factor to overall execution

Source: UBS estimates
Note: This list contains stocks that may be impacted by specific scenarios. The scenarios described herein may play out over a multiyear period, whereas UBS equity analysts' base-case views are based on the next 12 months. All ratings are current, as shown in the most recent published UBS Research report relating to each company. These reports are available on UBS Neo.

Timothy Arcuri	timothy.arcuri@ubs.com	+1-415-352-5676
Nicolas Gaudois	nicolas.gaudois@ubs.com	+65-6495-5148
Sunny Lin	sunny.lin@ubs.com	+886-2-8722-7346
Francois Bouvignies	francois.bouvignies@ubs.com	+44-20-7568-7105
Kenji Yasui	kenji.yasui@ubs.com	+81-3-5208-6211

UBS Research THESIS MAP

Memory Semiconductors

IMPACT ON SECTOR

Growth:  Margins:  ROIC:  Valuation: 

SECTOR IMPACT

Q: Will incumbent memory companies benefit from US restrictions?

Yes. The most recently announced US exports controls vis-à-vis 128L and above NAND flash and 18nm and below DRAM will make it very difficult for Chinese memory companies to gain scale, go through tech migration and possibly operate the current installed base. Without access to US wafer fab equipment as well as parts/services, not only will YMTC and CXMT not be able to add capacity, but they may also struggle to efficiently run installed lines. YMTC is also on the Unverified List, which means it could be added to the Entity List next. Wafer fab equipment vendors have already warned about a revenue impact in 2023. We could also see a decline in both NAND flash bit shipments from YMTC as well as DRAM from CXMT in the course of 2023.

Q: Will Samsung and SK Hynix be negatively impacted by the size of their operations in China?

To some extent. Xi'an account for 40% of current NAND flash capacity at Samsung, Dalian 25% for SK Hynix NAND capacity, and Wuxi 48% of SK Hynix DRAM capacity. Both companies have gotten a 1-year reprieve from recent US restrictions. After this operating conditions may get more uncertain. But our view is that the US government will likely use this as a point of negotiations to ensure that over time, both companies move towards de-emphasizing China for manufacturing. Either way, neither cos plan to expand capacity in China (nor have the cleanroom space to do so). For SK Hynix, another longer term challenge is the inability (so far) to get EUV litho tools into China for DRAM manufacturing (1a nm and below). Management commented this may result, longer term, in selling the fab and / or equipment (and moving back to Korea). Should that occur (we estimate no earlier than 2024), the supply disruption may more than pay for the costs in our view through DRAM price support.

Q: Are memory companies benefiting from re-shoring?

MU more so than others. MU has announced 2 fabs projects in the US on the back of the CHIPS Act. This will provide the co with significant financial support. On the other hand, both Samsung and SK Hynix appear reluctant to make use of the US CHIPS Act for possible memory fab projects. The general view from them appears to be that operating costs in the US and de-clusterization effects are material negatives, for a segment which is inherently very costs-focused (more so than Logic foundry).

STOCK IMPACT

Q: Which stocks are better/less favourably positioned in a "De-globalisation" scenario?

YMTC was in our view a more significant threat to incumbents for NAND flash, than CXMT for DRAM, SK Hynix and Micron both have underscaled NAND flash businesses, which tended to be FCF negative through cycle, They hence benefit more than Samsung relatively from YMTC likely becoming a diminishing threat.

WHAT'S PRICED IN

Investors have largely acknowledged that the most recent US restrictions vis-à-vis China leading edge memory are Positives for memory incumbents. But this has been overshadowed by concerns regarding the near term cycle.

MOST FAVOURED

Stock	UBS rating	Comment
MU	Buy	US CHIPS Act beneficiary as well as from US restrictions vis-à-vis China Memory
Samsung	Buy	Beneficiary from US restrictions vis-à-vis China Memory; manageable operational impact re Xi'an
SK Hynix	Buy	Beneficiary from US restrictions vis-à-vis China Memory; manageable operational impact in China although Wuxi / EUV needs to be addressed LT

Source: UBS estimates
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LEAST FAVOURED

Stock	UBS rating	Comment
WDC	Neutral	Benefits from YMTC facing US restrictions, but does not FCF support from DRAM business peers benefit from

Source: UBS estimates
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Nicolas Gaudois	nicolas.gaudois@ubs.com	+65-6495-5148
Timothy Arcuri	timothy.arcuri@ubs.com	+1-415-352-5676

UBS Research THESIS MAP

Semiconductor capital equipment

IMPACT ON SECTOR

Growth:  Margins:  ROIC:  Valuation: 

SECTOR IMPACT

Q: Are semiscap vendors beneficiaries from re-shoring?

Yes to a certain extent. The combined incentives so far announced to support re-shoring (ex China) are we estimate US$195bn including tax credits. For more incremental programmes ie the US, Europe, Japan and India – US$129bn. So they do support equipment spending by customers. By and large though, it shifts where companies are adding capacity rather than adding some which would not have occurred otherwise. Subsidies are largely pulling forward fab spending. Two reasons for this: 1/ ultimately, semis capex decisions are made considering longer term end demand expectations; 2./ some of the key spenders – Samsung and TSMC in particular – are very cash-rich ie not dependent upon subsidies to spend.

Q: Are semiscap vendors negatively impacted by US restrictions towards China?

Yes. The incremental impact will be felt mostly in 4Q22 and 2023. Assuming denial of licenses for leading edge semis manufacturing in China, we estimate a US$2.4bn incremental negative impact to the global WFE market (which we now estimate to be US$74bn in 2023). This mostly relates to sales which would have otherwise occurred to YMTC and CXMT. Over time though, this does not change memory end-demand, and incumbents will pick up the capex tab for this. This leaves WFE vendors with a slight negative being the difference with selling equipment to relatively inefficient spenders vs more mature ones.

STOCK IMPACT

Q: Which stocks are better/less favourably positioned in a "De-globalisation" scenario?

On a net basis, all US, Japan and European WFE stocks moderately benefit as the net of re-shoring incentives for customers vs. the negative impact of US restrictions on China leading edge process tech is a Positive.

WHAT'S PRICED IN

US CHIPS Act and other re-shoring incentive announcements have provided some support to WFE stocks, amidst the cyclical downturn. Initially the WFE stocks negatively reacted to the US restrictions on China leading edge process tech but have since ten more than recouped this.

MOST FAVOURED

Stock	UBS rating	Comment
ASMI	Buy	Leveraging strong ALD position, limited China exposure
ASML	Buy	Benefits from all re-shoring plans, under-indexed to China memory vs peers, China litho threat very limited longer term
LRCX	Buy	Over-indexed Memory vs peers but reflected in valuation.

Source: UBS estimates
Note: This list contains stocks that may be impacted by specific scenarios. The scenarios described herein may play out over a multiyear period, whereas UBS equity analysts' base-case views are based on the next 12 months. All ratings are current, as shown in the most recent published UBS Research report relating to each company. These reports are available on UBS Neo.

LEAST FAVOURED

Stock	UBS rating	Comment
KLAC	Neutral	Valuation reflecting more than peers re-shoring positives

Source: UBS estimates
Note: This list contains stocks that may be impacted by specific scenarios. The scenarios described herein may play out over a multiyear period, whereas UBS equity analysts' base-case views are based on the next 12 months. All ratings are current, as shown in the most recent published UBS Research report relating to each company. These reports are available on UBS Neo.

Timothy Arcuri	timothy.arcuri@ubs.com	+1-415-352-5676
Nicolas Gaudois	nicolas.gaudois@ubs.com	+65-6495-5148
Francois Bouvignies	francois.bouvignies@ubs.com	+44-20-7568-7105
Kenji Yasui	kenji.yasui@ubs.com	+81-3-5208-6211

UBS Research THESIS MAP

China semiconductors

IMPACT ON SECTOR

Growth:  Margins:  ROIC:  Valuation: 

SECTOR IMPACT

Q: Are China WFE vendors negatively impacted by US restrictions?

Yes. First, Chinese memory makers were expected to be a sizable portion of their revenues – c. 22%. This will be significantly less. Second, the "US Person" rule also appear to leave them in scope. Third, they will lose overtime the proximity to leading edge customers, which is important to drive longer term technology roadmaps. More longer term, China WFE vendors will continue to gain share in some of the non-critical process steps, but will struggle, if at all, to fully cover equipment requirements for a full process flow. This is especially the case for Litho and Inspection/Metrology.

Q: Are all segments within China Semis equally exposed to US restrictions?

No. SMIC is more negatively impacted as restrictions impact its ability to pursue 14nm further. That said, within the next few years 14nm will be trailing edge, so unless the US government moves the yardstick, it may gain broader impact. GigaDevice (Sell) is negatively impacted as reliant on CXMT for procuring DRAM and having had plans to develop their own DRAM tech. OSATs have limited impact notably JCET (less than 2%). Fabless ICs are relatively unaffected, unless they are supplying into higher end AI / Supercomputing. Restrictions around EDA tools for Gate All Around processes could be penalizing longer term (3nm Samsung process and below, 2nm and below TSMC).

STOCK IMPACT

Q: Which stocks are better/less favourably positioned in a "De-globalisation" scenario?

We still see some "China localisation plays" although we strongly recommend investors to be very selective regarding the inherent quality of business models, risks of further US restrictions, and valuation, Within our coverage, we recommend JCET (#2 OSAT player), Silergy (strong Analog position in China) – both Buy-rated. Maxcend (RF), AccoTEST (Testers) – both Neutral – could also benefit. We are particularly cautious on China Semiscap notably ACM Research and Naura, as well as SMIC – all Sell-rated.

WHAT'S PRICED IN

Investors have switched from a mantra in 2020 to "Buy anything China semis" on the Localisation Theme (to which we did not subscribe), to finally realising how taxing US restrictions will be. We are more cautious than our peers on implications. That said, China semis stocks have de-rated a great deal since, and we start to see some select opportunities.

MOST FAVOURED

Stock	UBS rating	Comment
JCET	Buy	Less than 2% exposure to China Memory, sizeable operations out of China (STATS-CHIPPAC)
Silergy	Buy	Analog share gains in China will continue across a wider spectrum of applications

Source: UBS estimates
Note: This list contains stocks that may be impacted by specific scenarios. The scenarios described herein may play out over a multiyear period, whereas UBS equity analysts' base-case views are based on the next 12 months. All ratings are current, as shown in the most recent published UBS Research report relating to each company. These reports are available on UBS Neo.

LEAST FAVOURED

Stock	UBS rating	Comment
ACM Research	Sell	Highest exposure to China memory within peers
GigaDevice	Sell	Directly and indirectly exposed to restrictions for 18nm and below DRAM
SMIC	Sell	No path to invest 14nm and below; unchanged aggressive 28nm ramp up plans

Source: UBS estimates
Note: This list contains stocks that may be impacted by specific scenarios. The scenarios described herein may play out over a multiyear period, whereas UBS equity analysts' base-case views are based on the next 12 months. All ratings are current, as shown in the most recent published UBS Research report relating to each company. These reports are available on UBS Neo.

Jimmy Yu jimmy.yu@ubs.com +86-21-3866-8880

Sunny Lin	sunny.lin@ubs.com	+886-2-8722-7346
Elvin Liu	elvin.liu@ubs.com	+86-213-866-8855
Nicolas Gaudois	nicolas.gaudois@ubs.com	+65-6495-5148

UBS Research THESIS MAP

Tech Hardware - OEMs

IMPACT ON SECTOR

Growth:  Margins:  ROIC:  Valuation: 

SECTOR IMPACT

Q: What will be the impact and cost of re-shoring for OEMs?

We believe the net impact of supply chain re-shoring may be increasing the cost burden for OEMs. In most cases, the cost increase will be passed on to end-users which would in return dent end demand. The incremental costs associated with re-shoring for OEMs would stem from more complex supply chains, higher manufacturing costs (labor, utility), potential delays associated with initial ramp up/ integration at new sites, transportation costs as well as in a broader sense, lesser economies of scale. In addition, there could also be less tangible, hidden costs such as R&D/innovation inefficiency and less concentration of engineers. This is especially the case for smartphone OEMs maintaining a wide global supply chain. Apple in particular has developed over the last two decades a highly efficient, global, and specialized supply chain which is inherent to the success of its business model.

Q: How will the recent US restrictions towards China impact OEMs?

The overall impact of the recent US restrictions on China towards OEMs is Neutral to Slightly Negative. Specifically for server OEMs, the restrictions related to AI and supercomputing chips may take off some TAM for servers, more specific at this point for China high end computing. Chinese OEMs will also have less options for alternative local suppliers for memory semis. Indirectly, their semiconductor suppliers may remain tied up to TSMC for leading edge semiconductor foundry.

STOCK IMPACT

Q: Which stocks are better/less favourably positioned in a "De-globalisation" scenario?

Among OEMs we prefer those that benefit from scale of economy, given they are better able to flexibly adjust their supply chain as well as pricing power. These including Apple, Dell, Samsung and Xiaomi (all Buy-rated) over Cisco, HPE, HPQ, Lenovo (all Neutral-rated) and Asus (Sell-rated).

WHAT'S PRICED IN

We believe investors have yet to price in the potential longer-term impact of de-globalization, especially on margins, for OEMs.

MOST FAVOURED

Stock	UBS rating	Comment
Apple	Buy	Economies of scale, supply chain flexibility and pricing power
Samsung	Buy	Economies of scale, low exposure to China and pricing power
Xiaomi	Buy	Economies of scale

Source: UBS estimates
Note: This list contains stocks that may be impacted by specific scenarios. The scenarios described herein may play out over a multiyear period, whereas UBS equity analysts' base-case views are based on the next 12 months. All ratings are current, as shown in the most recent published UBS Research report relating to each company. These reports are available on UBS Neo.

LEAST FAVOURED

Stock	UBS rating	Comment
Asustek	Sell	Production scale vs peers, higher margin volatility
Hikvision	Neutral	US sanction risk and access to US semiconductor and related IP
Dahua	Neutral	US sanction risk and access to US semiconductor and related IP
Inspur	Neutral	US sanction risk and access to US semiconductor and related IP

Source: UBS estimates
Note: This list contains stocks that may be impacted by specific scenarios. The scenarios described herein may play out over a multiyear period, whereas UBS equity analysts' base-case views are based on the next 12 months. All ratings are current, as shown in the most recent published UBS Research report relating to each company. These reports are available on UBS Neo.

Nicolas Gaudois	nicolas.gaudois@ubs.com	+65-6495-5148
David Vogt	david.vogt@ubs.com	+1-212-713-4296
Grace Chen	grace-h.chen@ubs.com	+886-2-8722-7340
Thompson Wu	thompson.wu@ubs.com	+886-2-8722-7338

UBS Research THESIS MAP

Hardware - EMS/ODMs

IMPACT ON SECTOR

Growth:  Margins:  ROIC:  Valuation: 

SECTOR IMPACT

Q: What is the impact to EMS/ODMs from re-shoring?

We expect the supply chain re-shoring will negatively impact EMS/ODM's margins given the incremental costs stemmed from inefficiencies with initial ramp or integration at new fab locations, higher manufacturing costs associated with labour/utility, incremental transportation and logistics costs given a more complex supply chain, and lesser economies of scale. Despite likely higher costs, we expect to see continued efforts of production site diversification as reducing risks from supply shortage is a higher priority than cost savings. For consumer electronics such as PC/NB and smartphones, the cost increases in most cases should be passed on the end-users, which may impact demand. That being said, for servers, major cloud service providers will help absorb the costs mainly attributed to data security considerations, and closer proximity to their customers will drive stronger connection with better latency.

Q: Are US restrictions towards China impacting EMS/ODMs?

We think US restrictions towards China as well as COVID lockdown measures have accelerated the supply chain relocation to outside of China. We have seen EMS/ODMs expediting their expansion into other regions, notably in Vietnam, India, Indonesia, and Thailand considering lower labor costs as well as local governements' support with financial incentives.

STOCK IMPACT

Q: Which stocks are better/less favourably positioned in a "De-globalisation" scenario?

On a net basis, we prefer EMS/ODMs that will benefit from higher CSP exposure and that are able to enjoy economic of scale and less vulnerable to geopolitical risks given their flexibility to adjust the supply chain. Apple's China based EMS companies continue to have most of its Apple production concentrated (e.g., >80-90%) in mainland China. As a result, we believe they would be most impacted by Apple's plans to diversify manufacturing outside of China. We prefer Hon Hai and Wiwynn and Quanta (all Buy-rated) over Luxshare (Key Call Sell), Lens Tech (Sell rated), GoerTek and Pegatron (both Neutral-rated).

WHAT'S PRICED IN

Investors have largely acknowledge that server productions have been moving out of China towards Taiwan, Mexico, and Thailand based on customers' requirements. While EMS/ODMs have been investing in overseas capacities across multiple product lines, these efforts have been overshadowed by concerns on demand softness and the fact that EMS/ODMs' production for consumer electronics (including PC/NB and smartphone) remains heavily weighted in China.

MOST FAVOURED

Stock	UBS rating	Comment
Hon Hai	Buy	Economies of scale, supply chain flexibility. Expanding server capacities in Mexico and Southeast Asia
Quanta	Buy	High exposure to US cloud server providers. Expanding capacity across Taiwan, US, Thailand, and Germany production sites
Wiwynn	Buy	Sizeable exposure to cloud service providers including Meta, Microsoft, and Amazon

Source: UBS estimates
Note: This list contains stocks that may be impacted by specific scenarios. The scenarios described herein may play out over a multiyear period, whereas UBS equity analysts' base-case views are based on the next 12 months. All ratings are current, as shown in the most recent published UBS Research report relating to each company. These reports are available on UBS Neo.

LEAST FAVOURED

Stock	UBS rating	Comment
Luxshare	Key Call Sell	Customer concentration, mainland China manufacturing capacity concentration
Lens Tech	Sell	Customer concentration, mainland China manufacturing capacity concentration
GoerTek	Neutral	No meaningful growth and share gains in Apple business

Pegatron	Neutral	Expanding production sites in Vietnam, India, Indonesia, and North America; but smartphone and NB production remains heavily weighted in China.

Source: UBS estimates
Note: This list contains stocks that may be impacted by specific scenarios. The scenarios described herein may play out over a multiyear period, whereas UBS equity analysts' base-case views are based on the next 12 months. All ratings are current, as shown in the most recent published UBS Research report relating to each company. These reports are available on UBS Neo.

Grace Chen	grace-h.chen@ubs.com	+886-2-8722-7340
Thompson Wu	thompson.wu@ubs.com	+886-2-8722-7338
Diana Chang	diana.chang@ubs.com	+886-2-8722-7335
Nick Hung	nick.hung@ubs.com	+886-2-8722-7362

UBS Research THESIS MAP

China Internet

IMPACT ON SECTOR

SECTOR IMPACT

Q: How does de-globalisation impact China Internet?

If there are restrictions from the US and other countries (Full Decoupling and China Bifurcation scenarios), then China's internet companies will lose access to key technologies. While Alibaba, Baidu, etc. have invested in their own semiconductor initiatives and companies, they are not able to offset restrictions, especially in the leading edge, such as certain Nvidia GPUs. We expect Chinese internet companies to become less efficient and suffer lower ROIC compared to US internet all else equal without access to the highest performance chips, especially GPUs, CPUs and AI related FPGAs and ASICs, and with potential future restrictions on AI initiatives, such as IP or talent. Long term, China Internet may lag in future chip and software technology breakthroughs and computing cycles.

Q: What can Internet companies do to offset these impacts?

These restrictions may drive the Chinese government and enterprises to encourage domestic software development and usage, which could benefit cloud businesses at Alibaba, Tencent and Baidu. China Internet companies may choose to focus on the domestic market, where they still have technology advantages, and reduce investments in international markets where they will have to compete against US and local Internet companies. We may see certain companies spin out assets so they are not impacted by these restrictions, for example Alibaba's international e-commerce businesses or Bytedance's TikTok.

STOCK IMPACT

Q: Which stocks are better/less favourably positioned in a "De-globalisation" scenario?

None of the companies in our coverage are better off in the deglobalisation scenarios. Some companies are less impacted, such as Pinduoduo, JD, NetEase, etc., as they focus on retail or entertainment. The more technology focused companies or those in more sensitive verticals, such as Alibaba, Tencent and Baidu, will be impacted, but they could see some offsets, if deglobalisation drives more supportive government policies, especially in using domestic software. Alibaba and Tencent has technology advantages over other domestic cloud providers, and have leading office productivity and communication products. Baidu is a leader in smart cities and autonomous driving.

WHAT'S PRICED IN

Investors have de-rated China Internet in the last two years on an absolute basis and relative to US Internet to factor in macro headwinds especially due to Zero COVID policies and geopolitical risks, mainly ADR delisting, and bans and sanctions. While the macro environment is likely improving, we still see China internet valuation at best in line with US internet due to geopolitical risks, which will linger on.

MOST FAVOURED

Stock	UBS rating	Comment
Pinduoduo	Buy	E-commerce platform with a focus on agriculture and value oriented products
JD	Buy	E-commerce platform with a focus on vertical integrated logistics and premium user experiences
NetEase	Buy	Online gaming developer and publisher

Source: UBS estimates
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LEAST FAVOURED

Stock	UBS rating	Comment
Alibaba	Buy	China's largest cloud provider, and has a scientific research division called DAMO Academy and semiconductor investments
Tencent	Buy	A large cloud provider in China, the leading communication and social networking platform, and have investments in AI and semis
Baidu	Buy	Large search engine, leading autonomous driving and smart city technology provider, and have investments in AI and semis

Source: UBS estimates
Note: This list contains stocks that may be impacted by specific scenarios. The scenarios described herein may play out over a multiyear period, whereas UBS equity analysts' base-case views are based on the next 12 months. All ratings are current, as shown in the most recent published UBS Research report relating to each company. These reports are available on UBS Neo.

Jerry Liu	jerry.liu@ubs.com	+1-212-713-1458
Felix Liu	felix-a.liu@ubs.com	+86-21-3866-8850
Wei Xiong	wei.xiong@ubs.com	+86-21-3866-8883

UBS Research THESIS MAP

US Internet

IMPACT ON SECTOR

Growth:  Margins:  ROIC:  Valuation: 

SECTOR IMPACT

Q: What will be the potential cost for de-globalisation the global supply chain for the internet space?"

Meta, Google, and Amazon are increasingly using GPU-based servers within their data centers. If there was a de-globalisation of the supply chain, we could see this creating a more immediate incremental cost risk, but longer term this could weigh on the companies' abilities to roll out new revenue growth products. Other potential products that could face incremental costs from de-globalisation of the supply chain could include: (1) Meta's AR/VR headsets (2) Google Pixel phones and (3) Amazon Kindle and Echo devices.

Q: How else could the US restrictions impact the internet space?

The Senate Homeland Security, Governmental Affairs Committee and the FBI have stated that TikTok raises serious privacy and national security concerns. That said, our base case is that TikTok will not be kicked out of the US, but we believe the regulatory pressure could require TikTok to build out more non-China data infrastructure to support their non-China users. TikTok CEO Shou Chew has recently stated they are taking greater initiatives to keep user data secure and are moving US user data to Oracle's cloud-infrastructure provider (WSJ - 11/30/22).

STOCK IMPACT

Q: Which stocks are better/less favourably positioned in a "De-globalisation" scenario?

We see META, GOOG and AMZN being the most impacted from a de-globalisation scenario in our space. Companies such as PINS and SNAP that use the hyperscalers for their compute/storage needs would be less impacted, but we would expect over time that the hyperscalers would pass along some of the incremental costs.

WHAT'S PRICED IN

We think very little is currently priced in across the internet space as it relates to the de-globalisation of the supply chain.

MOST FAVOURED

Stock	UBS rating	Comment
Alphabet	Buy	We like the ROAS profile of search in a challenging macro environment; Strong FCF yield
META	Buy	Strong cost discipline posture and '23 revenue estimates look fairly well derisked

Source: UBS estimates
Note: This list contains stocks that may be impacted by specific scenarios. The scenarios described herein may play out over a multiyear period, whereas UBS equity analysts' base-case views are based on the next 12 months. All ratings are current, as shown in the most recent published UBS Research report relating to each company. These reports are available on UBS Neo.

Lloyd Walmsley	lloyd.walmsley@ubs.com	+1-212-713-9981
Chris Kuntarich	chris.kuntarich@ubs.com	+1-212-713-3420
Kunal Madhukar	kunal.madhukar@ubs.com	+1-212-713-3317
Rachel Freeman	rachel.freeman@ubs.com	+1-212-713-1416

UBS Research THESIS MAP

Autos

IMPACT ON SECTOR

Growth:  Margins:  ROIC:  Valuation: 

SECTOR IMPACT

Q: How important is reshoring of semis to auto OEMs?

Highly relevant, but cost competitiveness is also key. OEMs are taking significant effort to reduce supply chain risk, and take structural steps to reduce dependencies from geopolitical events and trends. However, semiconductors are amongst the most challenging parts to reshore due structural cost disadvantages and limited political support – the latter is an issue in Europe only. The local-for-local imperative will take years to materialize due to high investments required with long lead times.

Q: What would be the costs penalties of tech de-globalization?

A state-of-the-art electric, connected and increasingly autonomous car has up to >$1k semiconductor content, and reshoring the silicon could increase the cost by several hundred $ per car, or ~100bps in EBIT margin, all else equal. The key question is if car markets remain open or get ringfenced by tariffs and other protectionist legislation. If not, Western (especially European) OEMs would likely lose competitiveness relative to US-based players and even more relative to Chinese OEMs.

STOCK IMPACT

Q: How will the semi reshoring trend affect share prices of global auto stocks?

Chinese OEMs are likely a relative winner as their cost competitiveness vs. western legacy OEMs is likely to increase. Companies with high vertical integration (Tesla) are also likely to benefit on a relative basis. On the positive side, supply chain stability will likely be increased by reshoring, resulting in a more stable (and therefore more cost efficient) auto production and lower working capital due to less chips travelling by plane or ships. Parts suppliers should also benefit from these aspects but the higher parts costs might also pose a challenge as passing on these costs might be difficult in a highly competitive industry.

WHAT'S PRICED IN

Multiples of legacy OEMs and suppliers are at historic lows factoring in significant structural and cyclical earnings headwinds. However, the structural implications of supply chain reshoring and overall de-globalization are not well analyzed yet.

MOST FAVOURED

Stock	UBS rating	Comment
Mercedes-Benz	Buy	Easier to pass on higher semi costs in the luxury segment
Tesla	Buy	Deeply vertically integrated, likely resulting in superior cost position vs. most competitors
BYD	Buy	Adequate in-house components supply as well as access to cost-effective Chinese supply chain enhances its global competitiveness.

Source: UBS estimates
Note: This list contains stocks that may be impacted by specific scenarios. The scenarios described herein may play out over a multiyear period, whereas UBS equity analysts' base-case views are based on the next 12 months. All ratings are current, as shown in the most recent published UBS Research report relating to each company. These reports are available on UBS Neo.

LEAST FAVOURED

Stock	UBS rating	Comment
Renault	Neutral	Competitiveness of European mass-market OEMs will be under pressure
Volkswagen	Neutral	Competitiveness of European mass-market OEMs will be under pressure

Source: UBS estimates
Note: This list contains stocks that may be impacted by specific scenarios. The scenarios described herein may play out over a multiyear period, whereas UBS equity analysts' base-case views are based on the next 12 months. All ratings are current, as shown in the most recent published UBS Research report relating to each company. These reports are available on UBS Neo.

Patrick Hummel patrick.hummel@ubs.com +41-44-239-5254
Paul Gong paul.gong@ubs.com +852-2971-7868

UBS Research THESIS MAP

Machinery - Japan

IMPACT ON SECTOR

Growth:  Margins:  ROIC:  Valuation: 

PIVOTAL QUESTIONS

Q: Will Japanese FA companies benefit or be penalised by re-shoring?

The overall impact is likely to be positive. In many cases, business performance at major Japanese FA companies is being driven by semiconductors and electronic components applications, with these accounting for 20%-40% of sales. Specifically, companies supply linear motion components, pneumatic and fluid control equipment, electrical control equipment, AC servo motors, and others used in semiconductor manufacturing equipment for both front- and rear-end processes. In addition, semiconductor wafer handling equipment contributes to increasing capacity utilisation rates at semiconductor factories. While the semiconductor industry prioritises utilisation rates, Japanese companies have high market shares for their products, supported by high quality and long track records. Many of these companies also have development bases in Japan and Silicon Valley, and they are in a position to contribute to creation of semiconductor supply chains in Japan, Asia, and the United States. Elsewhere, if production of smartphones and notebook computers is transferred to India, Robodrills, which are used to produce metal enclosures, are likely to benefit.

Q: Are US restrictions on China impacting Japanese FA companies?

The impact on Japanese FA companies depends on whether customers such as semiconductors manufacturers, semiconductor manufacturing equipment makers, and EMSs are affected by the US regulations. At present, however, we expect the negative impact to be small. Many of the abovementioned companies also make most of their products in Japan.

On the other hand, risks include: 1) substitution of production by Chinese companies, and 2) increased cost sensitivity of customers in the case of some products. Regarding 1), some TSMC and Samsung Electronics group companies have been making efforts to handle wafer conveyance processes on their own, but it will take a considerable amount of time for Chinese semiconductor companies to implement similar initiatives in our view. Regarding 2), even if production of smartphones and notebook computers by EMSs shifts to India and other countries, idle machines in China being diverted is a plausible scenario. In that case, demand for robodrills is likely to be sluggish, and unit prices of machines may also come under downward pressure.

STOCK IMPACT

Q: Which stocks are better/less favourably positioned in a 'de-globalisation' scenario?

Among FA stocks, we believe core parts for semiconductor manufacturing equipment used in semiconductor production processes are in the best position in terms of both scale and profitability. Looking at major companies, THK for linear motion components, SMC for pneumatic and fluid control equipment, Omron and Keyence for electrical control equipment, and Yaskawa Electric and Mitsubishi Electric for AC servo motors come to mind. Daifuku, a maker of semiconductor wafer transfer equipment, is also in a good position.

WHAT'S PRICED IN

Based on our discussions with investors, the benefits of a shift in production in high-tech industries have not yet been much discussed. Since Japan FA companies are greatly affected by the capital investment environment in China, investors are currently more interested in the outlook for the Chinese macro environment.

MOST FAVOURED

Stock	UBS rating	Comment
Keyence	Buy	The weighting of sales to North America is relatively high among FA companies, while exposure to China is low
SMC	Neutral	The world's largest manufacturer of pneumatic equipment. Particularly competitive in the semi-related market in North America

Source: UBS estimates
Note: This list contains stocks that may be impacted by specific scenarios. The scenarios described herein may play out over a multiyear period, whereas UBS equity analysts' base-case views are based on the next 12 months. All ratings are current, as shown in the most recent published UBS Research report relating to each company. These reports are available on UBS Neo.

Hikaru Mizuno hikaru.mizuno@ubs.com +81-3-5208-6207

UBS Research THESIS MAP

Chemicals - Raw materials

IMPACT ON SECTOR

Growth:  Margins:  ROIC:  Valuation: 

SECTOR IMPACT

Q: Will semi raw materials companies be impacted materially by re-shoring?

APAC chemicals: Overall impact is limited to slightly negative in the short term; 1) China's semi production is 19% of the global production, but re-shoring will not impact the production of currently operating fabs in China. Thus the volume of raw materials such as polysilicon, silicon wafer, photo resist, electronic gases should not contract as a result of re-shoring in the short term. Volumes will be determined by end-demand of semis; 2) However, longer term the growth rate of such materials will likely slow as a result of lower capex growth in China.

European chemicals: Overall impact is positive. The European chemicals sector is exposed to semiconductors through: 1) electronic gases (Air Liquide and Linde) which are essential for semiconductor fabrication (nitrogen, argon, hydrogen, helium and many others); and 2) polysilicon (Wacker Chemie) which is a conductive material that can be formed into semiconductor wafers.

The industrial gas companies (c10% sales from electronic gases) would benefit from growing order books for electronic gas projects outside of Asian markets; the gases are locally supplied on-site/ pipelines or in bulk/cylinders from facilities nearby and are used to create controlled atmospheres specific for each stage of semiconductor manufacturing, cleaning purposes and as reactants.

Polysilicon is used in production of solar cells (~80% of the polysilicon capacity) and in the semiconductor market (~20%). While the solar market is dominated by dominated low cost Chinese producers, there are only a handful of global suppliers to the semiconductor producers, Wacker Chemie is the largest. Wacker main competitors in semi grade polysilicon are Hemlock, Tokuyama and REC. Therefore, we expect Wacker to benefit from re-shoring in the US and European markets, regions in which its production footprint is based, and potentially reduced earnings volatility with prices less influenced by China supply. Polysilicon accounted for c25% of Wacker's group sales in 2021 and c. 45% of volumes sold were semi grade, which the company aims to grow to over 50% by 2025.

US chemicals: Overall impact is positive. Similar to the European chemicals sector, US chemical companies are exposed to semiconductors through: 1) electronic gases (Air Products = ~17% of sales – similar to benefits noted above), 2) electronics chemicals used in the production of semiconductors & printed circuit board materials (DuPont, Element Solutions), 3) high-chemical resistant materials used in semis manufacturing (DuPont, Chemours, Corning), and 4) polysilicon (Corning – who owns Hemlock, noted above - ~5% of sales). More indirectly there are benefits of increased capex spend in semi fabs for companies with exposure to building/construction and flooring materials (i.e. RPM).

Within electronic chemicals, specifically DuPont (~45% of sales) and Element Solutions (~60% of sales), we believe reshoring would be roughly neutral for those segments. Generally, these are global firms, serving primarily the higher end (or leading edge) of the industry. Unless total semi production rates change, we would think overall growth for these companies would be similar. However, there is likely some marginal benefit as US firms supplying into that supply chain, which could add some incremental wins across the spectrum. But this could be offset by some loss of share within China (DuPont has larger China exposure than ESI, and more semis exposure specifically).

In addition to chemicals/materials used in semi production, DuPont, Chemours and Corning have some of the larger direct exposure to materials used in the construction of semiconductor fabs (all ~5% of sales). There would likely be a benefit to sales growth from the build out of the US and European facilities. And like the chemicals/materials, each could gain disproportionate share into those builds because of their existing US presence. DuPont has exposure through Kalrez elastomer parts and water filtration membranes used to provide ultra-pure water needed in semi fabs. Chemours has exposure through advanced fluoropolymer parts (pipes, fittings, valves, etc – high chemical inertness). And Corning produces advanced lithography lenses used in semiconductor etching.

Q: What are the long-term risk of re-shoring?

Incumbent chemical companies may lose market share in currently dominating sub-segments such as silicon wafers, photoresists. Chinese companies are not yet able to supply high quality 12inch wafers

as well photoresists beyond ArF generations. China will likely accelerate its catch up for leading edge products which may distract the market shares for incumbent dominant players.

STOCK IMPACT

Q: Which stocks are better/less favourably positioned in a "De-globalisation" scenario?

GlobalWafers and Wacker would benefit the most from the US CHIPS Act and possibly a 'Europe CHIPS'. GlobalWafers plans to increase its 12inch silicon wafer capacity (1.2mnwpm) in US, while the ultimate subsidy they could get remains to be seen. Wacker produces polysilicon (25% of group sales) in both the US and Europe with a strong focus on semis, whereas Tokuyama only produces in Japan. Industrial gases, Air Liquide and Linde (c10% of sales from electronic gases), and Air Products (c17% of sales), would also benefit from growing order books in the US and Europe.

Positive: Air Liquide (Buy), Linde (Buy), Air Products (Buy), Wacker Chemie (Buy), DuPont (Buy), GlobalWafers (Neutral)
Negative: SUMCO (Neutral), Nippon Sanso HD (Neutral)

WHAT'S PRICED IN

Investors seem to take US CHIPS Act as neutral if not slightly negative in that it may distract the semi-end demand resulting in semi production reduction. Investors seem to take US CHIPS as a neutral if not slightly negative in that it may distract the semi end demand resulting in semi production losses. It does not discount longer term potential positive effect for GlobalWafers. For Wacker, in recent conversations with investors there are limited discussions at present around the benefit from the re-shoring of semiconductor production, the focus is mainly on the opportunities in solar and the risk of oversupply of polysilicon. For the gases (Linde, Air Liquide, & Air Products) investor focus is more around pricing power and opportunities in hydrogen (including potential IRA benefits). And in electronic chems/materials, focus is more on the cycle vs reshoring and if US/Europe fab build-outs lifts industry growth. Share prices of Chinese semi raw material companies have corrected by 30-40% from peak in 3Q22, but have recovered recently by 10-20%, reflecting the market debate on the negative impact from capex slowdown vs. an urge for localisation, in our view.

MOST FAVOURED

Stock	UBS rating	Comment
GlobalWafers	Neutral	Benefit in the long term for its investing in US for 12" silicon wafer, although the ultimate subsidy they could get remains to be seen
Air Liquide	Buy	Growth in order books for electronic gases in US and Europe
Air Products	Buy	Growth in order books for electronic gases in US and Europe
Linde	Buy	Growth in order books for electronic gases in US and Europe
Wacker Chemie	Buy	Increased opportunities in polysilicon in US and Europe
DuPont	Buy	Materials benefit of new fab build outs; potential for ex-China share gains

Source: UBS estimates
Note: This list contains stocks that may be impacted by specific scenarios. The scenarios described herein may play out over a multiyear period, whereas UBS equity analysts' base-case views are based on the next 12 months. All ratings are current, as shown in the most recent published UBS Research report relating to each company. These reports are available on UBS Neo.

LEAST FAVOURED

Stock	UBS rating	Comment
SUMCO	Neutral	Near term demand distraction in 6" silicon wafers
Nippon Sanso HD	Neutral	Risk of losing share in global electronics gases to other players

Source: UBS estimates
Note: This list contains stocks that may be impacted by specific scenarios. The scenarios described herein may play out over a multiyear period, whereas UBS equity analysts' base-case views are based on the next 12 months. All ratings are current, as shown in the most recent published UBS Research report relating to each company. These reports are available on UBS Neo.

Andrew Stott	andrew.stott@ubs.com	+44-20-7567-9227
Amily Guo	amily.guo@ubs.com	+86-10-5832-8845
Geoff Haire	geoff.haire@ubs.com	+44-20-7568-8327
Shunta Omura	shunta.omura@ubs.com	+81-3-5208-6244
Priyanka Patel	priyanka.patel@ubs.com	+44-20-7568-0016
Joshua Spector	joshua.spector@ubs.com	+1-212-713-6188

Part I: Why and how did the Technology industry become so globalised?

Investors and economists tend to think that "Tech" and "Globalisation" have always been going hand-in-hand. But it was not always like that. In fact, innovation kicked off in a fairly localised ecosystem (the Silicon Valley) in the 1950s partly under the impetus of the US aerospace and defence industry - the very opposite of globalisation. From there followed three decades (1970s-1990s) when vertically integrated conglomerates, mostly divided around geographic lines. Those conglomerates were often instrumental in driving tech innovation an scaling: Siemens, Philips, Motorola, IBM, HP, Lucent, Mitsubishi, NEC, Toshiba, Sony, Samsung etc...

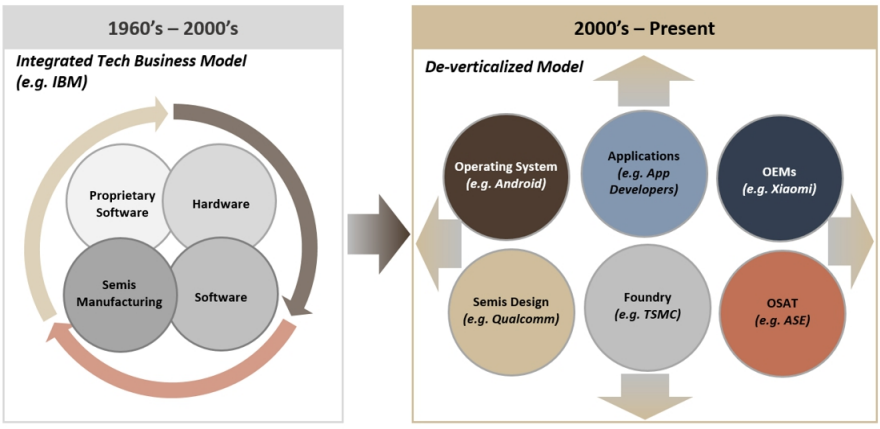
Later on, three key forces lead to a the the emergence of a globalised, highly specialised, and de-verticalised business model for Tech. 1/ The development of semiconductor foundries and fabless IC vendors; 2/ the rise of Taiwan and China in hardware outsourcing and; 3/ the dominance of third-party operating systems, not attached to an OEM ecosystem (Apple being a notable exception) . This is what was taken for granted as Status Quo since then; until recently.

What has made Tech Globalisation so compelling? How did this happen? What supply chain landscape did this lead to? In this section, we map out in the web of the global technology ecosystem and the imbalances it may have created over time.

A short history of Tech Globalization

The tech supply chain is one of the most global, specialised, and de-verticalised industries there is. Over the last 30 years, the emergence, and dominance, of third-party operating systems (Microsoft, Android etc), the software explosion driven by internet and cloud service providers, in parallel to the de-verticalisation of the hardware and semis supply chain lead to maximised globalisation, clusterization and specialisation. In contrast, tech conglomerates used to develop their own software, semiconductors (and manufacture them - including some of their own equipment) and systems.

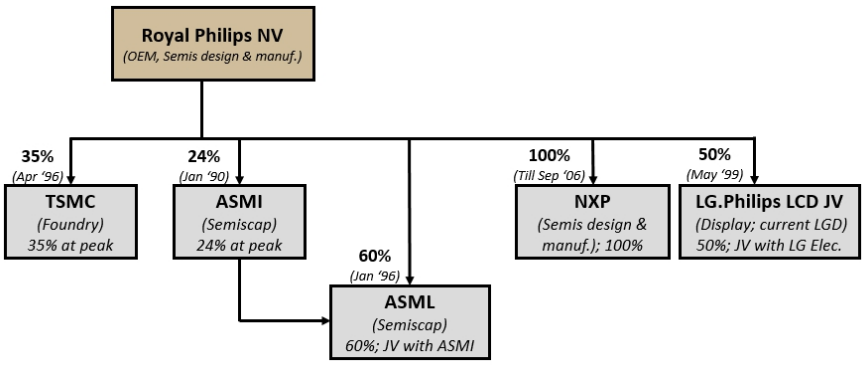
Figure 15: How the tech supply chain moved from vertically integrated to de-verticalised



Source: UBS

In some cases, those conglomerates contributed to create and fund some of the key enablers of today's de-verticalised tech ecosystems. Take the example of Philips, which contributed to incubate both TSMC and ASML.

Figure 16: Philips' historical ownership (at peak) in key technology companies



Source: Company data, UBS

During the course of the 1990s and 2000s, the technology industry cemented the foundations of what it is today. Internet companies came to dominate the application software ecosystems. Some of them became hyperscaler players - most notably Amazon, Microsoft, Google and Meta, which leverage datacenter computing capabilities to grow their respective application fields whilst continuing to develop new ones. In contrast, only a few OEMs have kept large enough critical mass - Apple, Samsung, Dell, HP and Lenovo most notably. Underpinning all of this are: 1/ contractors - one, Hon Hai, distances away from all others; 2/ Component suppliers - a lot more fragmented across key segments (cameras, passive components etc); 3/ the semiconductor supply chain - itself highly specialised across fabless ICs, foundries, integrated device manufacturers, manufacturing equipment suppliers etc.

Globalisation, Specialisation, and Clusterization

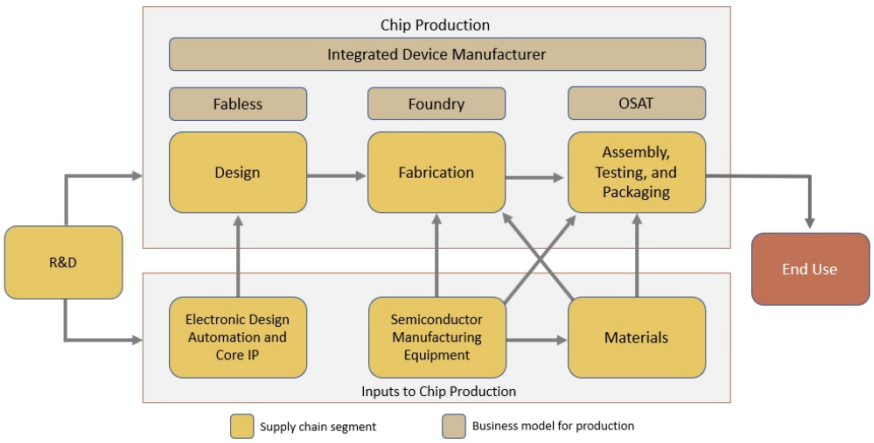
Globalisation, Specialisation and Clusterization are the three key characteristics that define a global tech industry

Emerging from this evolution path, three key characteristics came to define the global technology industry:

- **Globalisation:** From design to an end product, most application markets see the involvement of multiple companies across several countries. As an example, an iPhone is designed in the US, manufactured in China by a Taiwanese EMS partner, with passive components coming from Japan, using chips designed in the US and manufactured in Taiwan, and with memory devices from Korea.
- **Specialisation:** Most component and semiconductor suppliers are highly specialised, as R&D intensity and manufacturing complexity, especially for semis, significantly grew over time. In the past, Intel used to do DRAM memory (in fact, invented it), Infineon had memory and logic manufacturing, etc... In contrast now, within semis, memory, logic and analog are largely separated supply chains.
- **Clusterization:** This refers to specific activities - R&D or manufacturing - being highly concentrated in one geography. After initial de-clustering from the Silicon Valley, the tech industry re-created some significant clusters: Taiwan - where the vast majority of leading edge foundry semis manufacturing occur; Korea - which dominates memory semis. At the company level, c. 90% of TSMC manufacturing is in three sites in Taiwan which are within 2 hours of train connection; 81% of Samsung semis capacity is in Korea also within a 2 hour range. This leads to efficiency benefits: as an example, a specialised process engineer can easily be called into one site from another to help solve a specific issue. In addition, company clusters also attract support and services clusters (eg. for equipment support for semis fabs), and the ability to sustain talent pools from university to suppliers / competitors. Meanwhile, the Silicon Valley significantly expanded into a broader tech ecosystem ranging from semis, systems, internet and software.

The semiconductor industry in particular evolved into a highly specialised web of inter-related key technology providers, including semiconductor design, electronic Design Automation (EDA) and core IP, fabrication, semiconductor manufacturing equipment, raw material suppliers, and assembly, testing and packaging. This is a far departure from the origins of the industry where integrated device manufacturers (IDMs) used to develop their own manufacturing equipment. This all makes it even more difficult to potentially de-entangle.

Figure 17: Semiconductor supply chain overview



Source: UBS

A few systematically critical players emerged over time

Another result of this hyper-specialisation is that a few key players have become truly systematically essential to the technology supply chain. With elevated market shares, high barriers to entry or replacement costs, if one was to wake up to a world without that company, the overall technology supply chain would not be able to function. A contrario, other players may have strong positions, but could be ultimately be substituted by others - eg. AMD replacing Intel, Qualcomm / Mediatek, Azure / AWS etc.

Hyper-specialisation has resulted in a few systematically critical technology providers: ASML, TSMC and Samsung

We would argue that there are three such systematically critical technology providers: ASML, with 89% market share in semis lithography tools; **TSMC**, 57% share in semis foundry and 77% for 16nm and below (leading edge) segment; and **Samsung**, 38% share in DRAM/NAND flash memory combined. All three of them are in the semiconductor supply chain; none are US companies. Out of those three, it can be argued that either Micron or SK Hynix could "replace" Samsung any time for memory as they have comparable and competitive technology. But the cost of "replacing" Samsung's memory capacity, if re-built from scratch would amount to about US$200bn.

Figure 18: Systematically important companies in Tech

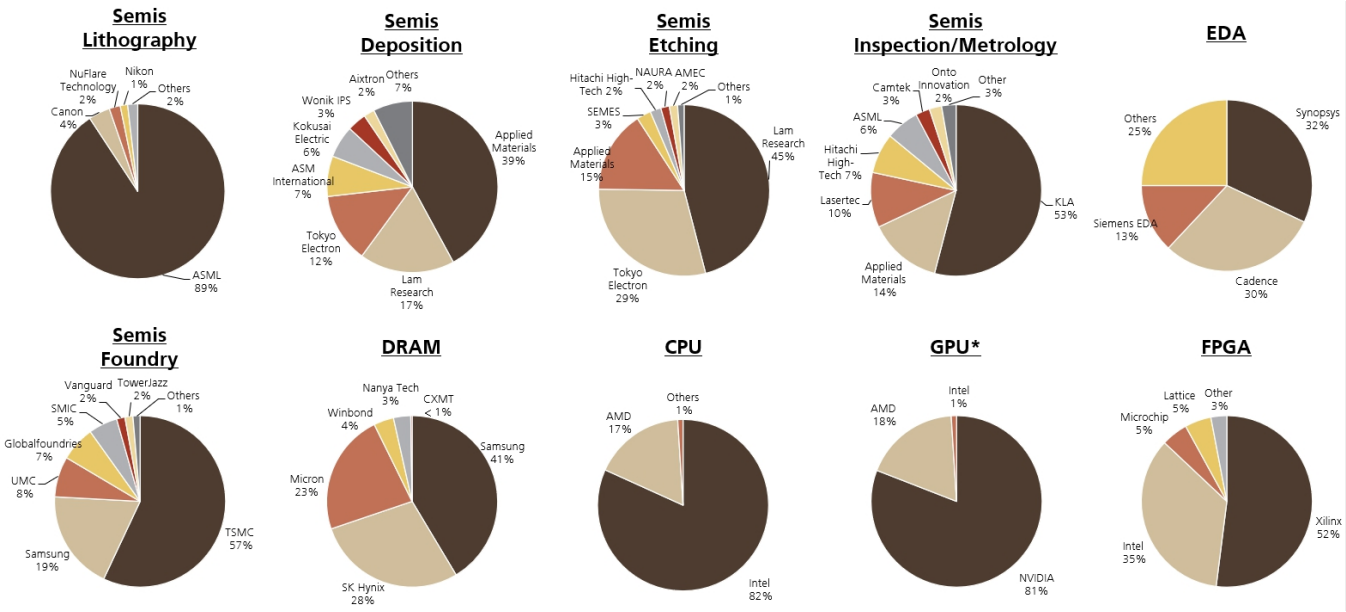
SAMSUNG – **41%/35%** revenue market share in DRAM/NAND flash, **39%** of global memory wafer production capacity, **15%** of global semis revenues

tsmc – **57%** foundry revenue market share, **23%** of global semis (ex-memory) production capacity (**77%** share in leading edge* capacity)

ASML – **89%** revenue market share in semis lithography equipment (**100%** in EUV equipment), **18%** of global wafer fab equipment (WFE) revenues

Source: Gartner, UBS - All numbers are 2021; *16 nm and below

Figure 19: Several market segments within Semis are characterised by high market share concentration

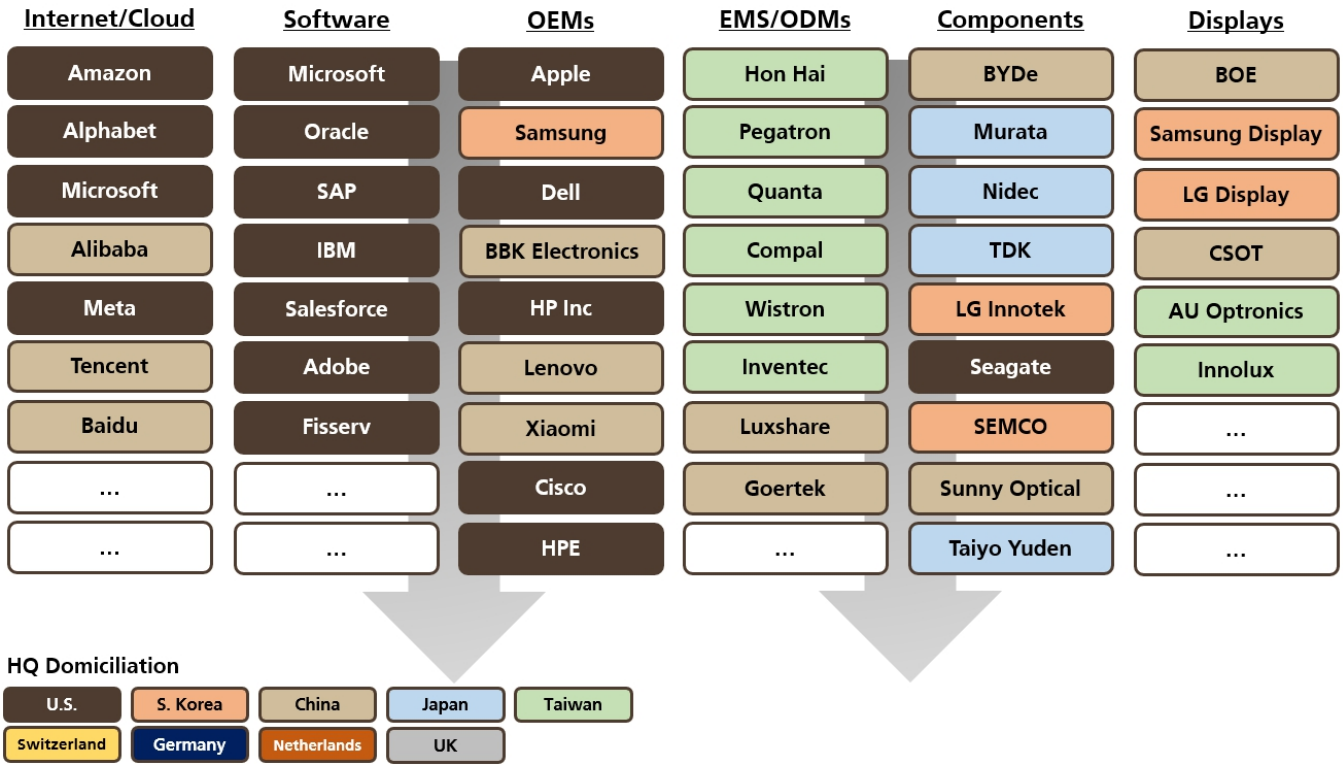


Source: Company data, Gartner, Mercury, UBS - as of 2021; * Discrete only

Mapping the Tech industry across the globe

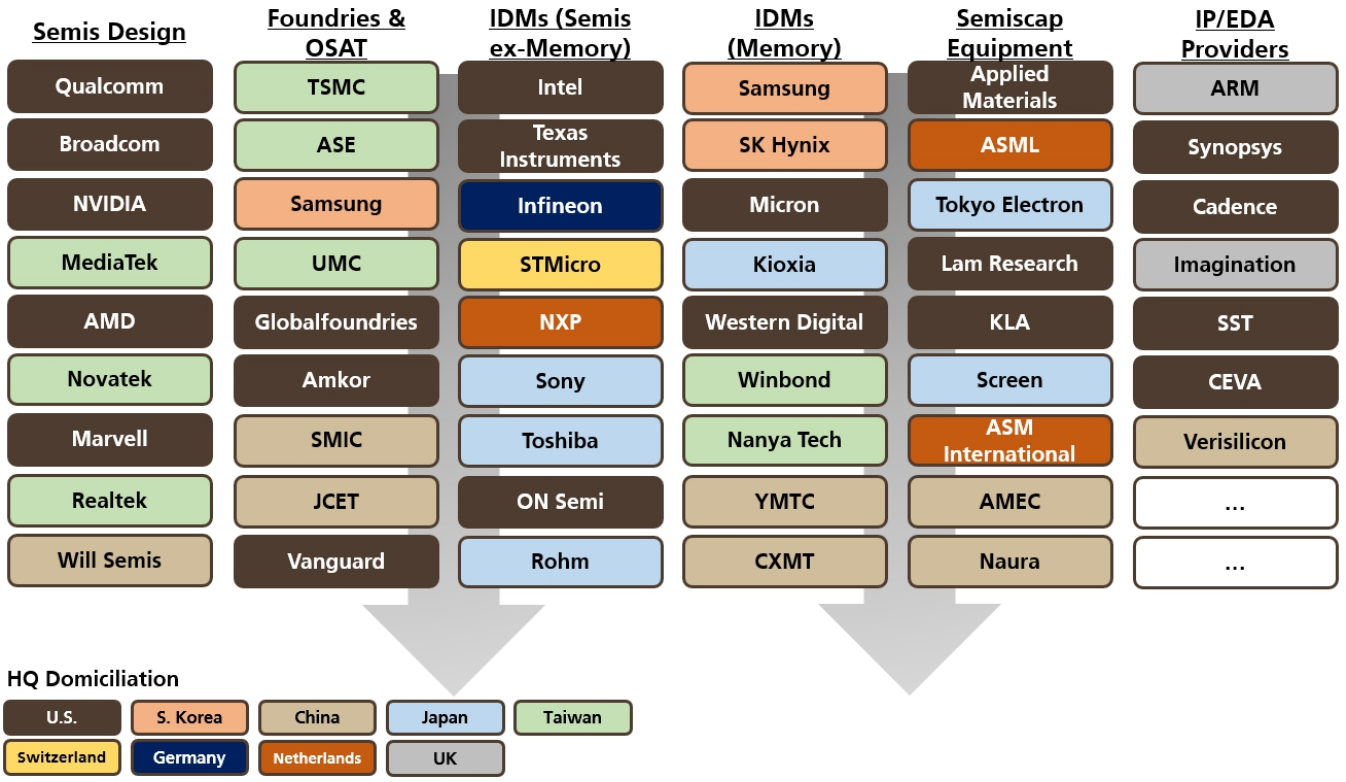
Over time, this lead to specific geographies dominating some of the key technology verticals , whilst in other cases, the competitive landscape remains quite spread-out. Also note that we show here the grouping per country of headquartering - with for instance all Taiwanese EMS/ODM companies having the majority of their manufacturing in China (Figure 34).

Figure 20: Key tech leaders by verticals and geographies in declining revenue order - Software & Hardware



Source: Company data

Figure 21: Key tech leaders by verticals and geographies in declining revenue order - Semis



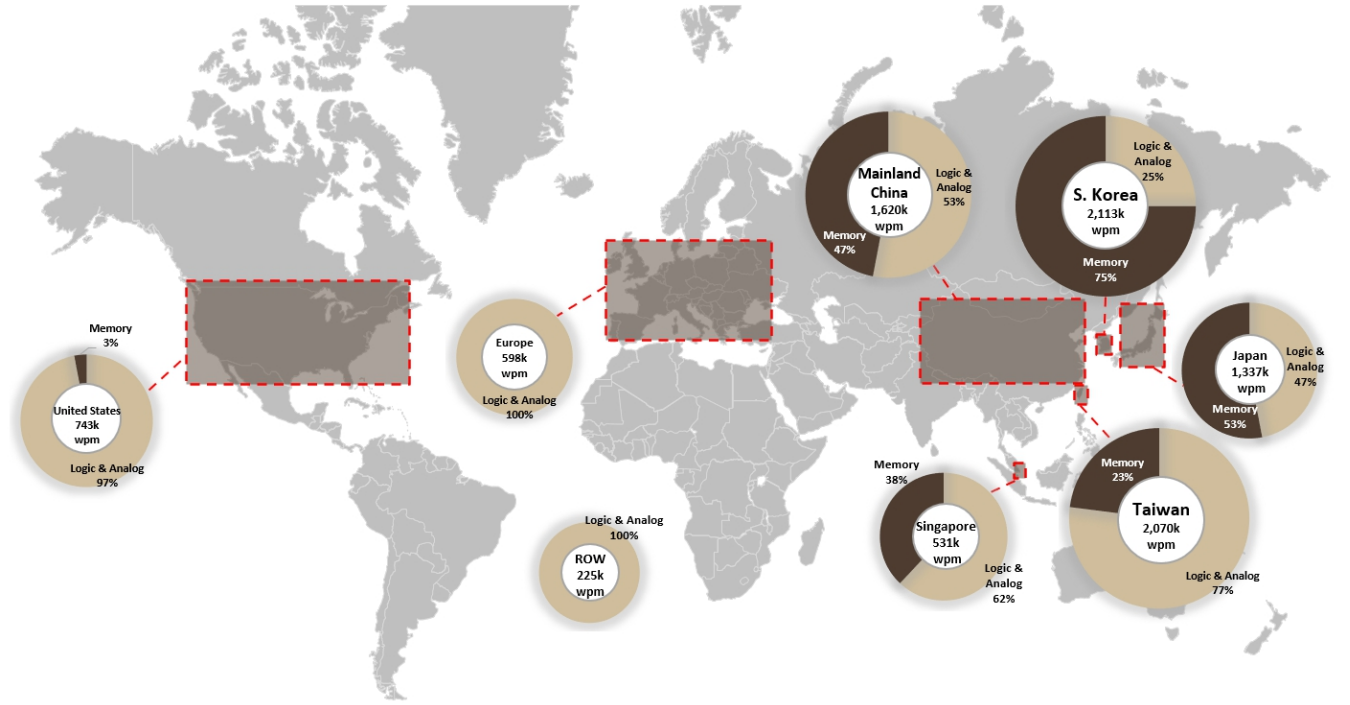
Source: Company data

The semis industry created clusters across its supply chain

Over time, **semiconductor manufacturing capacity also got more and more concentrated in Asia, which we estimate in 2022 will account for 83% of total global wafer capacity.** This is split between South Korea and Taiwan both accounting for 23%/22% of total global wafer capacity respectively, followed by China 18%, Japan 14% and Singapore 6%. In contrast, the US and Europe account for only 8% / 6%. It is, however, worth noting that **57% of China semiconductor manufacturing capacity are from fabs from foreign companies** (SK Hynix, Samsung, TSMC, UMC etc). We represent below the various geographic clusters for semiconductor manufacturing, overall and also for some of the key geographies: South Korea, Taiwan, mainland China.

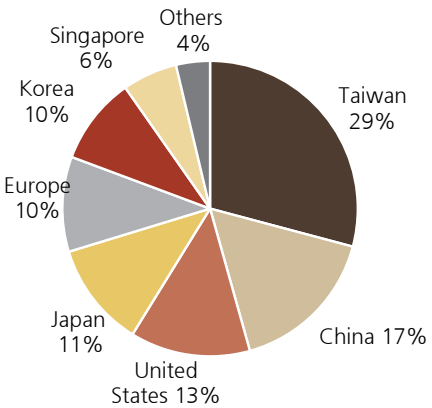
Semis manufacturing capacity has increasingly been concentrated in Asia; est. 83% of global wafer capacity is in Asia as of 2022

Figure 22: Global semis production capacity breakdown (k wpm, 12 inch equivalent) by country/regions (2022E)



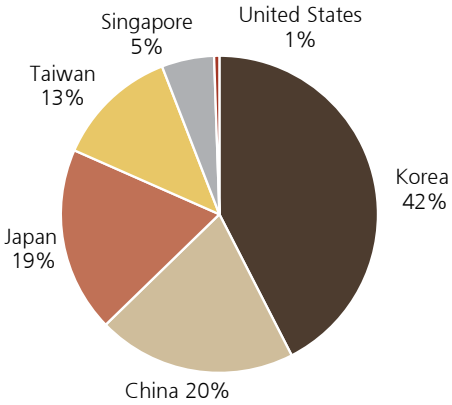
Source: Company data, UBS estimates

Figure 23: Logic and analog semis installed capacity by country of fab locations (2022YE)



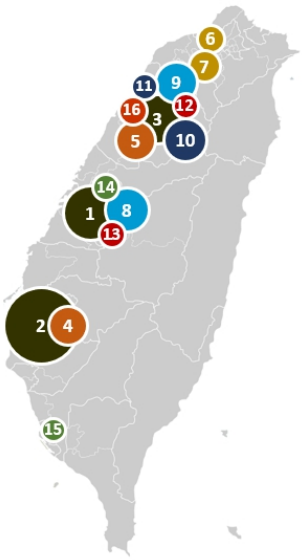
Source: UBS estimates

Figure 24: Memory semis installed capacity by country of fab locations (2022YE)



Source: UBS estimates

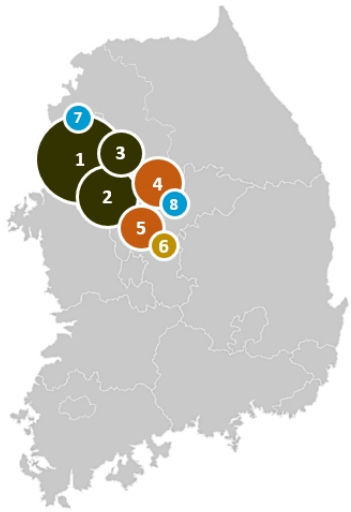
Figure 25: Semis production capacity breakdown in Taiwan (k wpm, 12 inch equivalent, 2022E)



TSMC			
1	Taichung	(Foundry)	310k wpm
2	Tainan	(Foundry)	542k wpm
3	Hsin-Chu	(Foundry)	292k wpm
UMC			
4	Tainan	(Foundry)	100k wpm
5	Hsin-Chu	(Foundry)	115k wpm
Nanya Tech			
6	New Taipei City	(DRAM)	20k wpm
7	Taishan	(DRAM)	55k wpm
Micron			
8	Taoyuan	(DRAM)	150k wpm
9	Taichung	(DRAM)	90k wpm
Powerchip Semi			
10	Hsin-Chu	(Foundry)	143k wpm
11	Zhunan	(Foundry)	22k wpm
Vanguard			
12	Hsin-Chu	(Foundry)	64k wpm
13	Taoyuan	(Foundry)	36k wpm
Winbond			
14	Taichung	(Specialty DRAM)	57k wpm
15	Kaohshiung	(Specialty DRAM)	10k wpm
Macronix			
16	Hsin-Chu	(Specialty DRAM)	63k wpm

Source: Company data, UBS estimates

Figure 26: Semis production capacity breakdown in South Korea (k wpm, 12 inch equivalent, 2022E)



Samsung			
1	Hwaseong	(Memory + Foundry)	841k wpm
2	Pyeongtaek	(Memory)	490k wpm
3	Giheung	(Foundry)	213k wpm
SK Hynix			
4	Icheon	(Memory)	278k wpm
5	Cheongju	(Memory)	167k wpm
Key Foundry			
6	Cheongju	(Foundry)	36k wpm
Dongbu Hitek			
7	Bucheon	(Foundry)	36k wpm
8	Sangwoo	(Foundry)	27k wpm

Source: Company data, UBS estimates

Figure 27: Semis production capacity breakdown in Mainland China (k wpm, 12 inch equivalent, 2022E)

Samsung			
1	Xi'an	(NAND Flash)	277k wpm
SK Hynix			
2	Wuxi	(DRAM)	210k wpm
3	Dalian	(NAND Flash)	70k wpm
Yangtze Memory (YMTC)			
4	Wuhan	(NAND Flash)	100k wpm
Changxin Memory (CXMT)			
5	Hefei	(DRAM)	100k wpm
UMC			
6	Suzhou	(Foundry)	36k wpm
7	Xiamen	(Foundry)	27k wpm
SMIC			
8	Beijing	(Foundry)	152k wpm
9	Tianjin	(Foundry)	79k wpm
10	Shanghai	(Foundry)	68k wpm
11	Shenzhen	(Foundry)	36k wpm

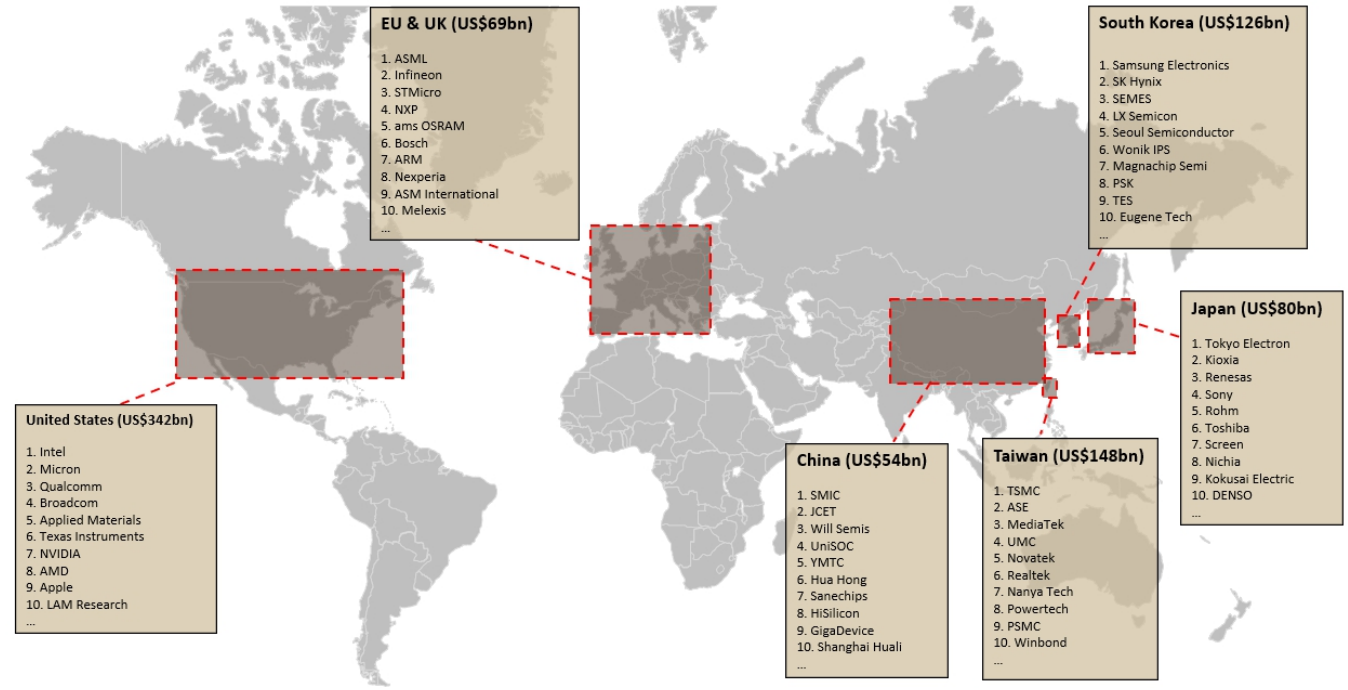
TSMC			
12	Nanjing	(Foundry)	45k wpm
13	Shanghai	(Foundry)	40k wpm
Hua Hong			
14	Shanghai	(Foundry)	79k wpm
15	Wuxi	(Foundry)	68k wpm
Shanghai Huali			
16	Shanghai	(Foundry)	40k wpm
Others			
	Hefei Jiangsu Qingdao Shanghai Sichuan ...	(Foundry)	238k wpm

Source: Company data, UBS estimates

Beyond physical location, **when considering countries of headquartering (and where most of the IP is residing), and the revenues associated to those companies, the US continues to emerge as a significant force within the semiconductor industry.** US companies accounted for 42% of total semiconductor industry revenues in 2021 (including semisap, IP, foundries, OSAT). This is out of what wee can account for, ie missing undisclosed revenues of private companies and hence likely under-representing China in particular. This in part due to the global share US companies continue to command within fabless IC companies as well as semis manufacturing equipment.

The US remains the dominant force within semis when considering HQ based revs and where the IP is ultimately residing at

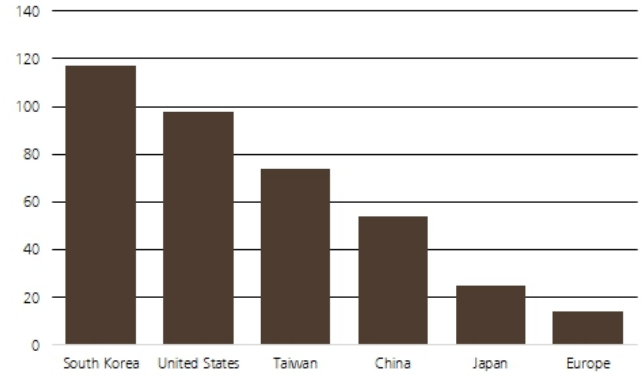
Figure 28: Global semis revenues by location of headquarters * (2021)



Source: Company data, UBS estimates * Does not include all unlisted companies

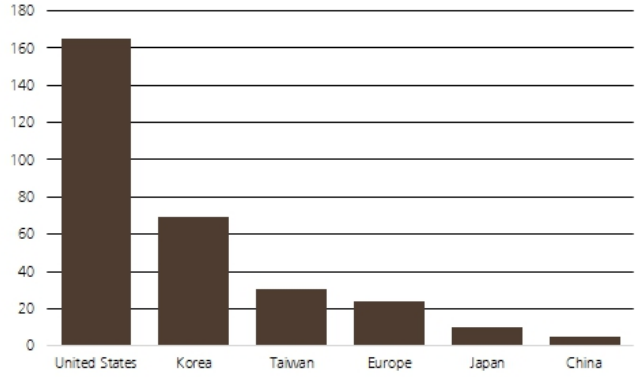
Similarly when considering total capex spent over the past 3 years within the semis industry, Taiwan and Korea headquarted companies were the main locations, whilst Samsung, TSMC and Intel combined were 50% of total. For R&D unsurprisingly again the US was first with 54% of total, whilst Samsung, Intel and Qualcomm combined were 52% of total R&D spend.

Figure 29: Cumulative semis capex spent from '19-21 by geographic location (US$bn, incorporated HQ basis)



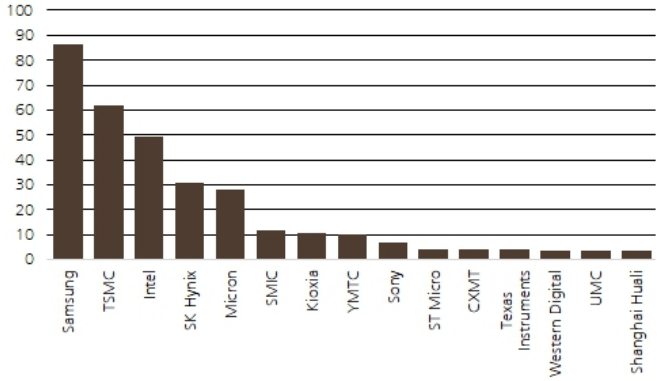
Source: Company data, UBS estimates

Figure 30: Cumulative R&D spent from '19-21 by geographic location (US$bn, incorporated HQ basis)



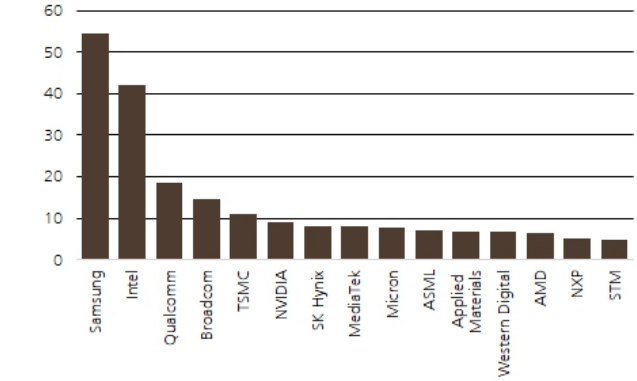
Source: Company data, UBS estimates

Figure 31: Top semis capex spenders (US$bn) 2019-2021



Source: Company data, UBS estimates

Figure 32: Top semis R&D spenders (US$bn) 2019-2021



Source: Company data, UBS estimates; Note: Samsung is total company R&D

Tech hardware supply chain is also globalized

Apple suppliers – Production shuffling towards India/ Vietnam

Apple has been diversifying its supply chain outside of China into India and Vietnam

Given the challenges in global supply chain management and local governments incentive programs for electronic suppliers, **Apple has been setting up supply chains in India and Vietnam on top of their existing production lines in China.** The largest iPhone assembler - Hon Hai - has already set up iPhone assembly lines in India, and Pegatron expects to ramp its Indian facility in 2023. China mainland suppliers are benefiting from expansion into Vietnam, but currently have made less progress in India. Luxshare has set up plants in Vietnam and offices in India with plans to ramp production in India. GoerTek has also been moving its AirPods capacity to Vietnam, and its revenue and net profit from Vietnam sites have reached 20%/34% of total in H122.

The Indian government has shown great ambition to be the next "world's factory" and has offered attractive subsidies to encourage tech suppliers to expand in India through a "production-linked incentive" scheme. **We expect to see increasing iPhone production from India while Vietnam ramps production for other Apple products including AirPods, Apple Watch, and NB/PC, etc.** We expect EMS capacity in India will continue to diversify risks. We estimate iPhone assembly in India made up less than 5% of total iPhone production in 2022, but will gradually increase.

Figure 33: List of key Apple suppliers in Mainland China / Taiwan / Hong Kong

Company Name	HQ Location
AAC Acoustic Technologies Holdings Incorporated	Mainland China
Beijing Zhong Ke San Huan High-Tech Co., Limited	Mainland China
Biel Crystal Manufactory Limited	Hong Kong
BOE Technology Group Company Limited	Mainland China
BYD Company Limited	Mainland China
Catcher Technology Company Limited	Taiwan
Compal Electronics Incorporated	Taiwan
Compeq Manufacturing Company Limited	Taiwan
Crystal-Optech Co., Limited	Mainland China
Delta Electronics Incorporated	Taiwan
Dynapack International Technology Corporation	Taiwan
Flexium Interconnect Incorporated	Taiwan
Genius Electronic Optical Company Limited	Taiwan
GigaDevice Semiconductor Incorporated	Mainland China
GoerTek Incorporated	Taiwan
Hon Hai Precision Industry Company Limited (Foxconn)	Taiwan
Inventec Corporation	Taiwan
JCET Group Company Limited	Mainland China
Largan Precision Company Limited	Taiwan
Lens Technology Company Limited	Mainland China
Lite-On Technology Corporation	Taiwan
Luxshare Precision Industry Company Limited	Mainland China
Nanya Technology Corporation	Taiwan
Pegatron Corporation	Taiwan
Quanta Computer Incorporated	Taiwan
Sharp Corporation	Taiwan
Shenzhen Desay Battery Technology Company Limited	Mainland China
Shenzhen Everwin Precision Technology Company Limited	Mainland China
Simplo Technology Company Limited	Taiwan
Sunwoda Electronic Company Limited	Mainland China
Suzhou Anjie Technology Company Limited	Mainland China
Taiwan Semiconductor Manufacturing Company Limited	Taiwan
Tianma Micro-Electronics (Hong Kong) Limited	Mainland China
Tongda Group Holdings Limited	Hong Kong
TPK Holding Company Limited	Taiwan
Tripod Technology Corporation	Taiwan
Unimicron Technology Corporation	Taiwan
Unitech Printed Circuit Board Corporation	Taiwan
Wingtech Technology Co., Limited	Mainland China
Wistron Corporation	Taiwan
Yageo Corporation	Taiwan
Zhen Ding Technology Holding Limited	Mainland China
Others....	...

Source: Company data

NB ODMs – NB production shifts in progress; evident ramp in Vietnam

Currently we estimate 90%-95% of NB production are still in China in 2022, mainly from Taiwan ODMs' production in China. Recent geopolitical tensions and supply chain disruption resulted from COVID lockdown measures have pushed manufacturers to reevaluate and accelerate their production sites diversification, where Vietnam has been one of the focused areas. Hon Hai has indicated Vietnam now is its largest NB and tablet production outside of China with over 60,000 employees on campus. Compal announced an investments of US$60m in Q322 for capacity expansion in Vietnam and Quanta has also expressed interests in Vietnam and recently started to survey their employee' willingness to relocate. We estimate China NB production will likely reduce to 50-60% in 2024E and we expect ODMs will continues to diversify production out of China, most notably toward Vietnam and also in Thailand, India, and Taiwan.

COVID lockdowns and supply chain disruption has pushed NB ODMs to accelerate their production site diversification into Vietnam

Figure 34: EMS/ODM key manufacturing sites in order of revenue exposure

	Hon Hai	*Pegatron*	*Compal*	*Quanta*	*Inventec*	*Wistron*	*Luxshare*	*GoerTek*
1.	Zhengzhou	Shanghai	Kunshan	Chongqing	Shanghai	Zhongshan	Kunshan	Weifang
2.	Shenzhen	Kunshan	Chengdu	Shanghai	Chongqing	Kunshan	Ji'an	Vietnam
3.	Chengdu	Chongqing	Chongqing	Taiwan	Nanjing	Chongqing	Vietnam	Dongguan
4.	Kunshan	Suzhou	Nanning	Changshu	Nanchang	Chengdu	Dongguan	Yishui
5.	Tianjin	Vietnam	Vietnam	Thailand	Taiwan	Taizhou	Chuzhou	Rongcheng

Source: Company data, UBS

Server ODMs – US CSPs speeding up the reshoring process

Part of server final assembly has long been conducted in manufacturing sites adjacent to the local markets as full server racks can be bulky and heavy. **In 2022, we estimate 55-60% of global server shipment final assembly are still manufactured in China.** However, due to growing concerns over data security and the importance of vicinity to global cloud service provider, the server supply chain have accelerated their fab expansion outside of China. Quanta aims to produce over 60% of its server in Taiwan this year and has stepped up its SMT production in Thailand. Wiwynn announced investments plan in Mexico (US$34m) and Malaysia, targeting to manufacture over 50% of server motherboard outside of China by 2023. We believe the percentage of server final assembly made in China will continue to decline, shifting to Taiwan, Thailand, and Mexico, etc.

Figure 35: Non-China capacity of key ODMs

Company	Non-China Capacity
Hon Hai	Overall 25%
Pegatron	Around 5% in Taiwan and Vietnam
Compal	Unknown
Quanta	Server over 60% in Taiwan, NB < 20%
Inventec	Server MB 30% in Taiwan, NB < 10%
Wistron	Over 20-25%, Server over 60% in Mexico

Source: Company data, News, Digitimes, UBS estimate

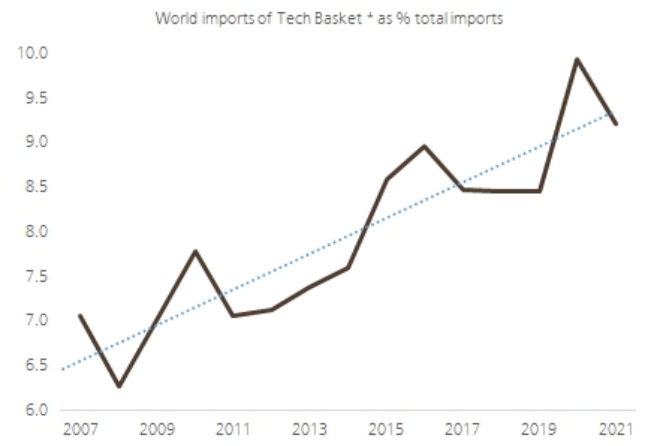
A macro perspective: identifying country import/ export flows of tech products over time

Industrial developments of the technology industry, such as specialization and clusterization; intertwining with macro developments, such as the increasing degree of openness of China through joining WTO, significant growth of China's purchasing power and more recently the rise of Vietnam's manufacturing capacity; play a significant role in shaping country-level, regional and global trade dynamics.

Specialization, Clusterization and Globalization, tech-products' share in global trade has been trending up.

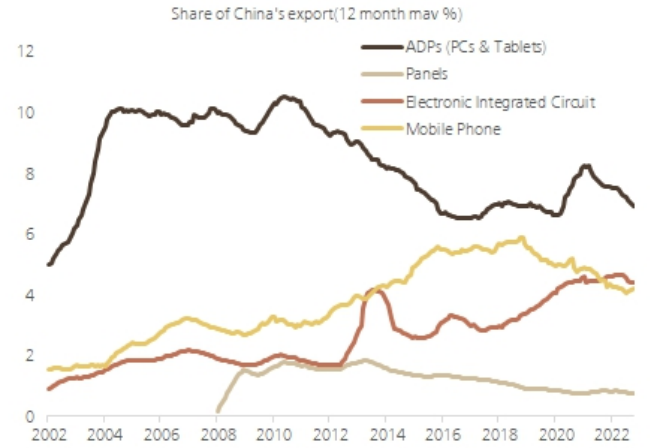
The constructed basket of key tech-related products, is now taking more than 9 % of global trade, vs. 7% two decades ago. During 2020, this basket's share in global trade even reached close to 10% given work/study from home brought significant demand to tech products. Still, this could be an underestimation given we only define the basket to include items with easy data availability, including **phones** (including mobile phones), **ADPs** (Automatic Data Processing machines including PCs and tablets etc.), **EICs** (Electronic Integrated Circuits - ie Semis), **panels and PCBs** (Printed Circuits). Large amount of other tech related components is not included in this basket. The fact that other bulk items, e.g., hard commodities like steel and metals are easier to be identified and tracked in trade data, may also result in underestimation by this ratio for tech's share in global trade.

Figure 36: Tech's share in the world's import has been increasing



Source: UBS, UN Comtrade

Figure 37: 15% of China's export are the basket of key tech goods



Source: UBS, UN Comtrade

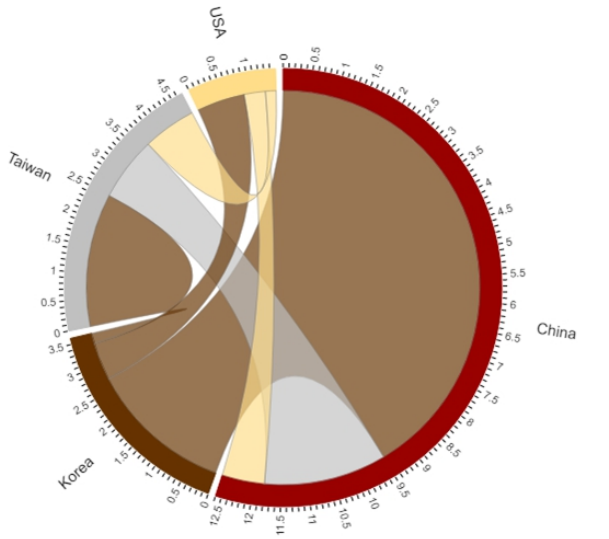
At the macro level, **the joining of China into global tech trade, especially after its joining of WTO in 2001, has been an important macro factor in shaping global tech supply chain**. The large-scale labour force and large and growing scale domestic market helped China attracting a large group of global technology players. Simultaneously, the globalization of technology industry is one of the important drivers behind China's trade growth. Hon Hai is the biggest contractor within the tech supply chain as we described in the earlier session. Its growth and footprint in mainland China demonstrates such dynamic. China has become the leading manufacturing hub for many global tech players. As of now, the basket of technology products, including PCs, tablets, EICs as well as mobile phones, is occupying more than 15% of China's total exports.

China has been important part of tech globalization; tech has been important driver of China's trade.

Still, the weights of different tech products in China's total trade have changed significantly over time, reflecting significant changes of China's industrial structure changes and the way it connects to the global tech supply chain. ADPs (Automatic Data Processing machines including PCs and tablets etc.) started to gain significant shares in China's total export since 2002, reflecting China's gain of manufacturing capacity during the period. However, the share started to decline around 2011. The share of phones (including mobile phones) in China's exports started to trend up since around 2004 and seemed to be peaking out around 2018. Restrictions imposed by the US on Huawei could be a factor behind, on top of the earlier development that Samsung shifted their mobile phone manufacturing to other economies such as Vietnam. The

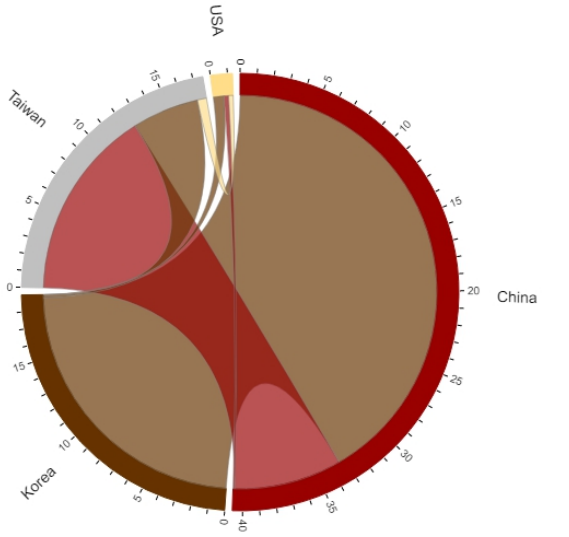
former factor is partly a reflection of de-globalization, but the latter factor seems to be a sign reflecting another emerging economy – Vietnam's increasing engagement into the globalization of tech supply chain.

Figure 38: Memory trade flow in 2010



Source: UN Comtrade , UBS Calculations

Figure 39: Memory trade flow in 2021



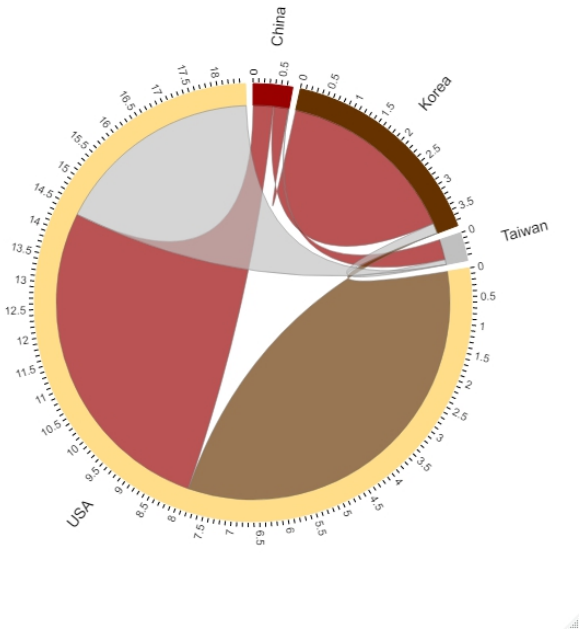
Source: UN Comtrade , UBS Calculations

Interestingly, whereas other key tech products mostly started to present peaks and declines in China's trade shares in recent years. The share of EICs in China's exports has presented a clear upward trend since 2018 despite the US-China trade war. This reflects increasing production capacity in mainland China, one of the factors behind could be large global companies expanding compacity in mainland China, for example, Samsung's memory production capacity in Xi'an. Other large tech production economies in Asia, for example, Korea and Taiwan, have been importing more EICs from the mainland China in recent years.

The fact that tech products are taking much larger share in China's export trade over the past decades, is also a part of wider dynamic of globalization of the tech industry. Figure 38 and Figure 39 present the trade flow of memory between four large tech producing economies, China, Korea, the US and Taiwan; in 2010 and in 2021. Korea has remained as the biggest memory exporter for both periods. China has been the biggest importer for both periods. However, there have been significant changes of Taiwan and the US's position in the supply chain. Back in 2010, the export flow of memory from US to China, Taiwan as well as Korea were much visible than there were in 2021. In the meantime, the US is importing less memories from Asia too. Taiwan was a net exporter of memory to mainland China in 2010, however, it became a net importer. This reflects more memory manufacturing capacity has been building up in the mainland China over the period. Korea has been retaining leading position in global memory exports.

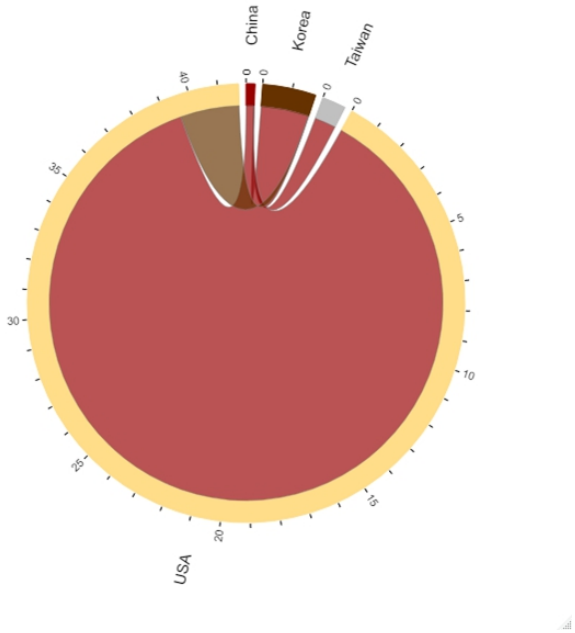
The way that key economies, such as mainland China, Korea, Taiwan, and the US engaged in tech globalization has also been evolving over time.

Figure 40: Mobile phone trade flow in 2010



Source: UN Comtrade , UBS Calculations

Figure 41: Mobile phone trade flow in 2021



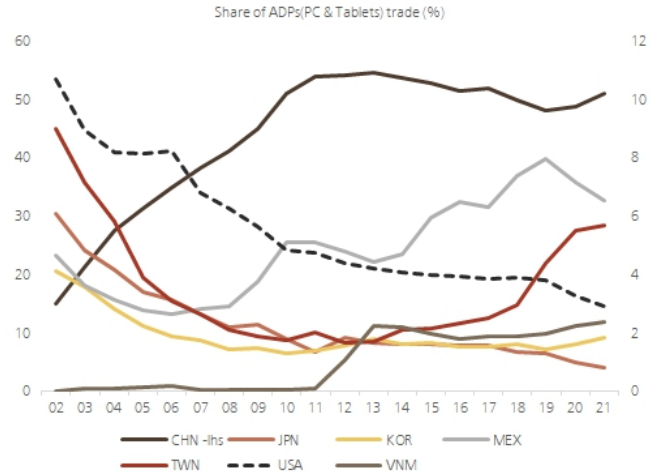
Source: UN Comtrade , UBS Calculations

Phone production (including mobile phones) is another area displaying significant shifts of macro trade flow comparing amidst globalizations. Figure 40 and Figure 41 present the phones trade between the four large tech players, China, Korea, Taiwan and the US. The US has remained as the biggest importer for mobile phones; however, the supply structure has changed substantially.

Back in 2010, Korea, China and Taiwan were all large exporters of phones to the US, which the former two taking larger share. By 2021, **China has become the dominant exporter of mobile phones to the US**. Korea is still a supplier, but its share has fallen substantially whereas Taiwan has largely excited the market. Apple holds the leading market share of mobile phone markets in the US. The trade flow changes at the macro level, reflect the globalized smartphone supply chain at micro level – "Designed by Apple in California, Assembled by Foxconn in China". The significant decline of Korea's share is reflecting the manufacturing of Korea's smartphone brand has shifted to other places, for example, Vietnam. The fall of Taiwan reflects the decline of Taiwan's own smartphone brand as well as shifting manufacturing base.

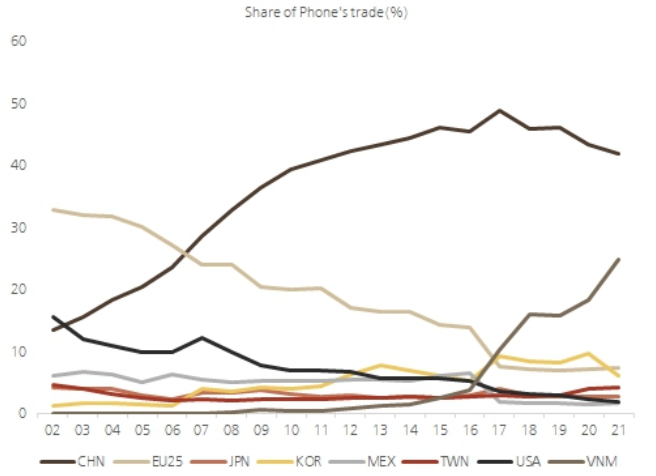
The geographic distribution of mobile phone manufacturing has changed significantly vs. two decades ago.

Figure 42: China's increase in exporting computers to the world at the expense of the US, Mexico increasing



Source: UN Comtrade , UBS Calculations

Figure 43: China's increase in exporting phones to the world at the expense of the EU, but peaked as Vietnam grew



Source: UN Comtrade , UBS Calculations

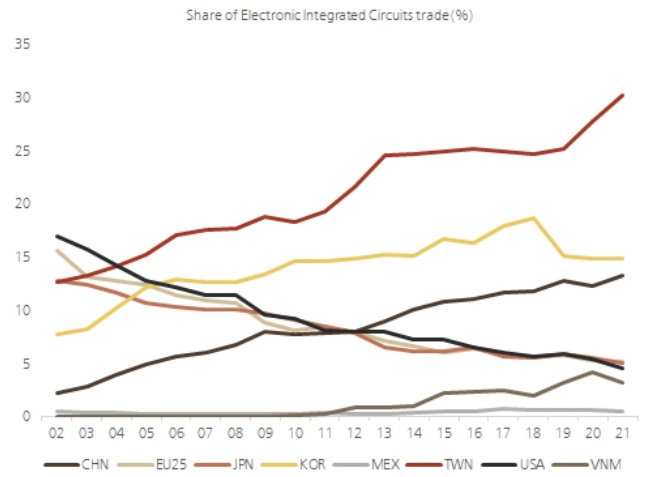
Comparing market shares by each economy in global tech trade probably can help to give a comprehensive comparison of how the global trade of key tech goods evolve overtime , therefore, how globalization of the tech supply chain impact on key economies. Figure 42 is the market share of global export of ADPs. China grew its global market share from just above 10% to close to close to 55% at the peak around 2012. Its market then started to decline, until a mild rebound recently during COVID. The rise of mainland China's market share is reflecting the decline of market share of the US and Taiwan, as manufacturing process shifted to mainland China given its advantages in cost, scale, clusterization as facilitate by contractors such as Hoi Hai.

China grabbed trade share of PCs from the US and Taiwan, but Taiwan might have gained on "reshoring" since the trade war.

Mexico also gain market share over time and its market share stepped up amidst US-China trade ward, a sign of "nearshoring" of supply chain given the additional tariffs imposed by the US on exports from China. The market share of Taiwan also went up after the US-China trade war, a sign of "reshoring" as some of the manufacturers might have moved some of the related productions to Taiwan given the additional tariffs. Supply chain shock during the pandemic took down Mexico and US's market shares further, while that of mainland China and Taiwan went up, as production was less distorted by COVID in both mainland China and Taiwan. Vietnam's market share stepped up between 2011 and 2013 and gradually climbed in recent years, reflecting its growth as new manufacturing base.

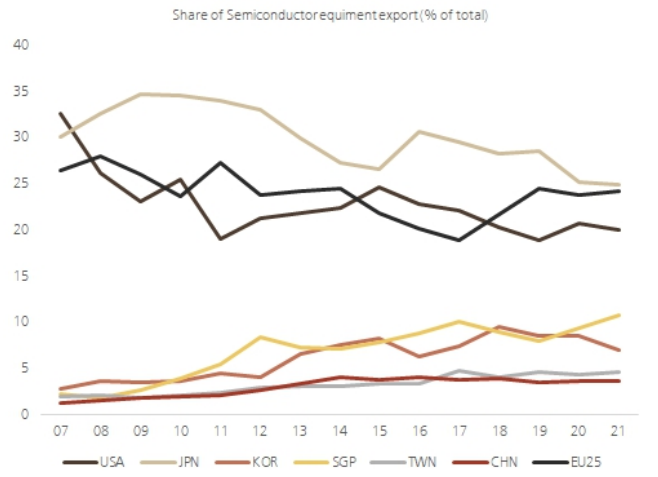
…Mexico's export share of PCs has been on the rise in recent years, a sign of "nearshoring".

Figure 44: Taiwan leads in Semiconductor exports, mainland China has been climbing fast



Source: UN Comtrade , UBS Calculations

Figure 45: The developped economies dominate the supply of semiconductor equipment



Source: UN Comtrade , UBS Calculations

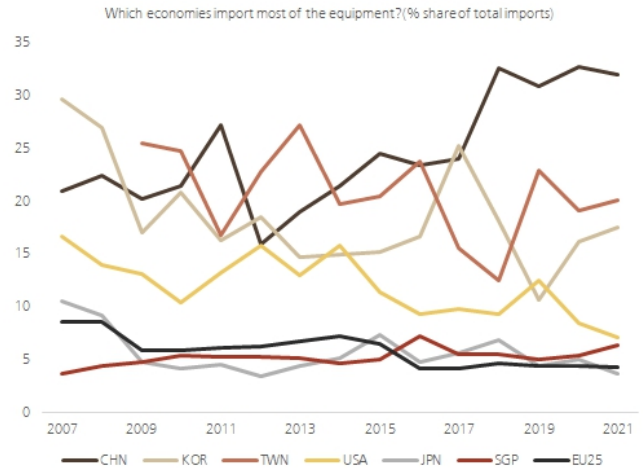
Mainland China is still the top phone exporter, despite the joining of Vietnam driven by Samsung's relocation.

The dynamic of global trade market share of phones (including smart phones) is presented in Figure 43. Like the dynamics of ADPs, China is still the top exporter now. Its market share trended up from 2002, peaked around 2017 followed by gradually decline in recent years. Unlike the case for ADPs, the economy losing market share significantly over time is no longer the US, but the EU25. This could be reflecting that at the industrial level, companies from the EU were leading phone suppliers at the time and the manufacturing was based in the EU two decades ago. Vietnam, managed to grow its market share from below 5% in 2016, to above 25% by 2021, securing its position as the world's second phone exporter. The relocation of Samsung's mobile phone production to Vietnam is a clear driver behind. The market share of the US also declined overtime, like its dynamic for ADPs, however, the starting point was lower as the US was not the top phone exporter back in 2002.

Taiwan and Korea are the top 2 exporter of EICs, reflecting the dominating positions of TSMC and Samsung.

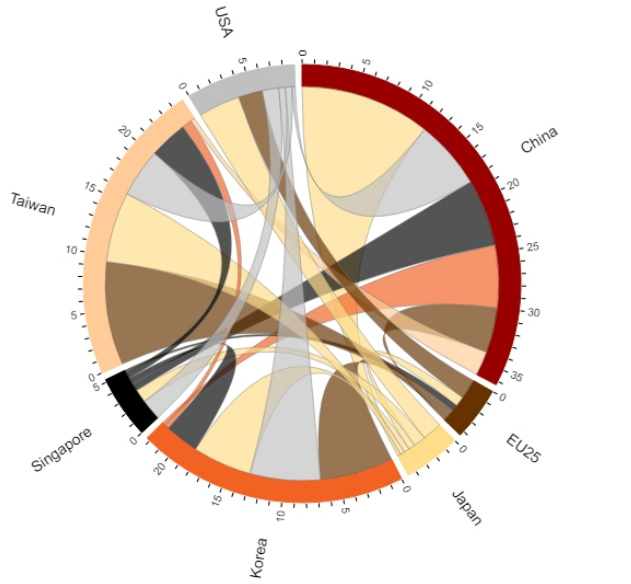
The evolution of the global trade market shares of EICs (ie. Semis) appears to be different compared to the more consumer-end goods such as phones and computers (Figure 44). China still managed to grow its share in global trade from below 5% to more than 10% between 2002 and 2021, China did not managed tog grab the top position like it does for computers and phones. Instead, the North Asia Dual, Taiwan and Korea managed to hold the top two position in global export share. **Taiwan holds more than 30% of global export share of EICs by 2021, more than double of its share in 2002.** This strength at macro level is reflecting the growing strength of corporates at the industrial level. For example, the growing position of TSMC as the global leading semiconductor foundry as we described in the earlier session. Similar, Korea's number 2 position is micro-founded by Samsung, the leading corporate in memory business. However, unlike Taiwan, data shows that Korea's share stepped down sharply in 2018/19. This could be to do with Korea's corporates developing production capacity offshore. Indeed, as presented earlier, many Taiwan corporates were building production capacity to manufacture EICs in the mainland China. Similar, Samsung has invested large scale memory production plant in Xi'an. Production capacity invested by overseas corporates is an important factor driving China's market share gains in global EICs trade overtime.

Figure 46: The North Asia - 3 have been key importers of Semiconductor equipments



Source: UN Comtrade , UBS Calculations

Figure 47: Semiconductor equipments main trade flows in 2021



Source: UN Comtrade , UBS Calculations

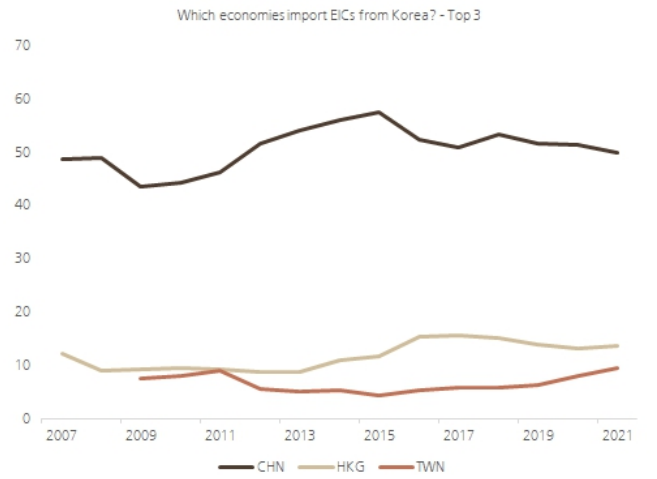
The de-globalization trend, whereas the existing production capacity in the mainland China may not be affected, reshoring of future capacity expansion may impose constraint on China's further gains of global trade share, in terms of speed of such gain or in terms of level, as we could observe in computers and mobile phones. **The US is the economy showing declining trend of its share of EICs exports over time. Japan also recorded significant declines in its share in EICs exports**. The reshoring trend may help both the US and Japan stabilize its global trade shares ahead.

The leading position of Japan, the EU and the US in semiconductor equipment exports have remained intact. Figure 10 shows that, Japan, the EU, and the US are the top 3 exporters of semiconductor equipment exporters in 2021. This is similar to 2007, the starting point of the data. The key change has been, the US has fallen from the top 1 position to top 3, the EU managed to climb from number 3 in 2007 to number 2 in 2021. Japan managed to climb to number 1 in 2021 from number 2 in 2007. Despite some share losses from this top 3 as whole, these three economies still managed a substantial lead comparing to other economies in exporting semiconductor equipment to the rest of the world. It is important to note, different to the cases for consumer tech products and EICs, both mainland China and Taiwan only managed to grow incremental market shares. Singapore steeped up visibly in terms of exporting semiconductor equipment. To a lesser extent, Korea also managed to grow its share.

Despite all the changes above, Japan, the EU and the US have retained as top suppliers of semiconductor equipment over time.

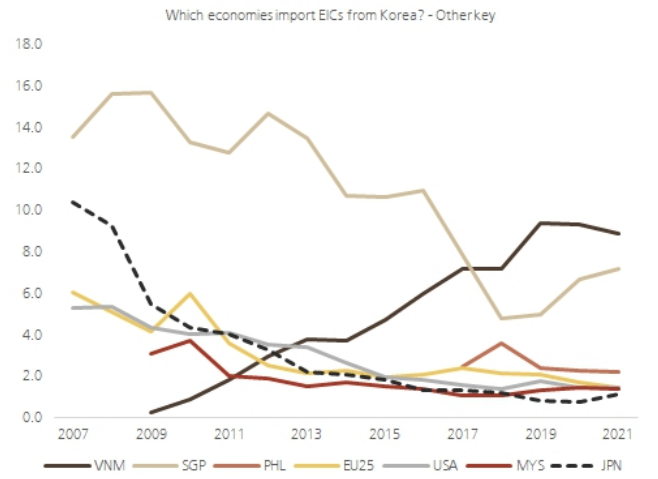
Which economy imports more semiconductor equipment? The top 3 importers were mainland China, Taiwan and Korea, for both 2021 and 2007. On the other hand, the ranking within these 3 top importers shifted. The mainland China became the top importer of equipment in 2021, while it was number 2 in 2007. Korea imported 30% of global semiconductor equipment imports in 2007, its share dropped to around 15%, below Taiwan. These shifts are consistent with other trade patterns. For example, China's increase of global EICs export share over time.

Figure 48: Which economies import EICs from Korea? - The top 3 …



Source: UN Comtrade , UBS Calculations

Figure 49: …and other top importers of Korea's EICs



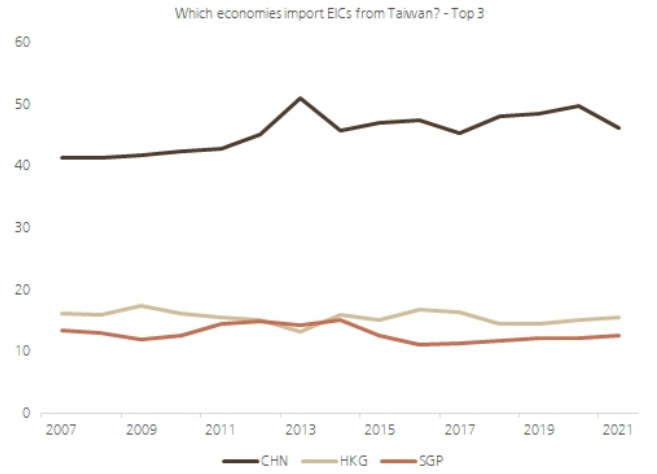
Source: UN Comtrade , UBS Calculations

De-globalization? Re-shoring? Evolving trade pattern ahead? The above analysis of macro trade flows shows that each economy's position in the global trade flow of tech products evolved in the past decades, driven by both industrial developments and macro developments.

The key backdrop of this report is that the tech industry has now moved to the center of national ambitions and geopolitics. There have been more export restrictions towards China from the US (Figure 3) and more incentives have been given by many of the major economies to attract investment from tech industry to their domestic economies. As we argued in the rest of the report, TSMC from Taiwan and Samsung from Korea have been and will remain as the key global semiconductor technology providers. Systematic corporates' future production and investment plans should continue to be a key factor the macro tech trade flows ahead, together with other factors for example, macro fundamentals.

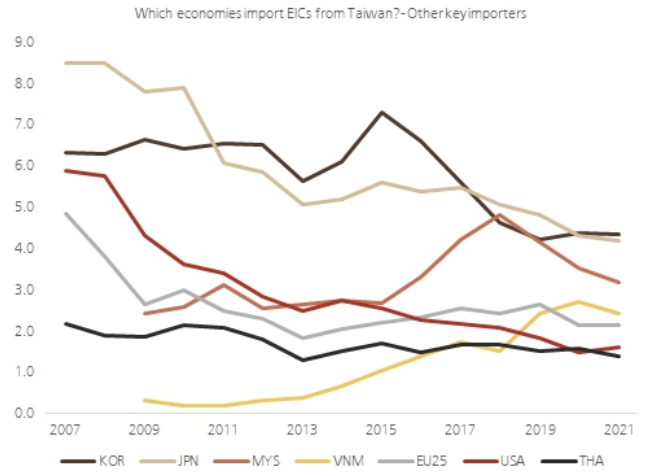
At the sector level we assume more capacity from TSMC and Samsung outside Taiwan and Korea while no changes to China's existing capacity (Figure 8 and Figure 9). On the other hand, the headquarter economies, i.e., Taiwan and Korea, will continue to host the biggest portion of production capacity. **Therefore, we expect at the macro level, both Taiwan and Korea shall continue to be the leading semiconductor exporting economies for the coming years.**

Figure 50: Which economies import EICs from Taiwan? - The top 3 …



Source: UN Comtrade , UBS Calculations

Figure 51: …and other top importers of Taiwan's EICs



Source: UN Comtrade , UBS Calculations

For those economies gaining new capacity from leading corporates, their needs to import from Korea and Taiwan could moderate, reducing the related trade flow. For example, TSMC and Samsung's capacity developments in the US may reduce some of the export flows from Taiwan and Korea (and other related production bases) to the US. However, as illustrated in by Figure 48to Figure 51, the US is currently not the biggest direct importer of semiconductors from Taiwan and Korea, although some transit/ further process through Hong Kong and Singapore may leading to higher shares. It is probably too early to judge if the outputs would be consumed solely domestically or there would be further exports from the new capacity to other importers.

For the capacity expansion, more semiconductor equipment shipment flows may be diverted to the economies hosting the capacity. Shown in Figure 42, the leading semiconductor equipment exporters have been Japan, the US, the EU in the past decades, despite of the reshuffling of the downstream sectors. **For new semiconductor capacity expansions within these economies, the use of locally produced equipment would no longer be reflected in the international trade data.**

Also reflected in Figure 48 to Figure 51, the mainland China has been top importer of EICs (Semis)from both Taiwan and Korea for the past decades. This reflects mainland China is one of the biggest manufacturers of technology products, one of the biggest markets of technology products and the biggest exporters of tech products e.g., Figure 42 and Figure 43. With the large economy size and population base, the mainland China will likely remain one of the biggest markets for tech products. Assuming no further restrictions on trade, then it is likely that the mainland will remain as a key importer of semiconductors from Korea and Taiwan in the near term. As stated earlier, mainland China's export shares of ADPs (computers and tablets) had started gradual moderation pre-COVID, with the stepping up of Mexico and Taiwan. Its share of phones exports has continued to decline in the past years with the stepping up of Vietnam. **These reshufflings of manufacturing process away from China, if continue, may depress mainland's demand for imported semis.** Though for Taiwan and Korea, that would be redirection of shipments to the new production base, for example, Vietnam's took close to 10% of Korea's semis exports by 2021 from 0% in 2009 due to Samsung's production arrange shift.

Part II: De-globalisation in action: Re-shoring, subsidies and exports control

If we were to trace the turning point of the "globalisation era" of the technology industry, we would probably go back to the middle of last decade. A combination of more assertive national tech policies and emerging protectionism lead to some key pivotal events:

- **In 2015, the Chinese government laid out plans for "Made In China 2025", with a target for c. 70% self-sufficiency for semiconductors by 2025** (link). The growing US restrictions targeting the China semiconductor industry have since laid bare some of the value chain points where China is particularly reliant upon external technology providers.
- In July 2015, Tsinghua Unigroup, the then premier China semiconductor investment fund and holding company, indicated its intention to acquire Micron. It also, later, placed a formal bid for 15% of Western Digital, who shortly after announced its intent to buy SanDisk. Unigroup in both cases abandoned the deals around concerns of possible CFIUS (Committee on Foreign Investment in the United States) negative reviews.
- Soon after, in 2018, the Trump administration briefly imposed sanctions on ZTE (link). The events after - Huawei, CHIPS Act, etc… All followed from this general direction - a risk we pointed out back then. Since then, **the US government rolled out an expanding range of export restrictions, mostly related to semiconductor technology.**

The rise of "nationalistic" policies regarding the technology industry is to some extent reminiscent to the wave of protectionism which developped in the 1920s in the US and Europe, cutting through an economy which til then was getting more connected. The parallel to the Cold War is not as relevant, as economies back then, including for technology, were operating in two largely distinct competing spheres. **For the technology industry, the rise of "nationalistic " policies present opportunities - such as subsidies - but also significant risks, as it followed a long period of globalisation.**

The rise of "nationalistic" policies offers opportunities in the form of subsidies but also risks potentially unwinding the efforts made in globlisation

In this section, we review **three key policy forces at play which will define, within the next few years, to what extent will the technology industry "de-globalise"**:

1. **How re-shoring is taking place**, most notably for the semis industry, and what will be the impact on industry clusters;
2. **What are the consequences of the US export control** mechanisms regarding sensitive technologies such as semis, and what could be the direction of travel from here;
3. **How could China re-think its tech industry policy** as a consequence.

Re-shoring drive & subsidies plans

Over the past couple of years, we have seen the re-emergence of national policies to drive the re-shoring of the technology industry, especially semiconductors. For the US, this could be better qualified as a new trend altogether, as prior to this, subsidies were initially largely indirect (in the 1950s and 1960s - through the aerospace and defence programmes) and since, non-existent. For some countries like India, the idea of subsidising the semis industry is novel; for Europe or Japan, a re-emergence of former practices; and for China, South Korea, Taiwan and Singapore - a continuation of well established policies.

Those policies start from a common realisation that the semiconductor industry is both crucial to the broader economies as well as strategic nature. This particularly came to light when COVID-19 contributed to create well-documented chip shortages from 3Q20 til 2Q22.

We recap the key initiatives in place to drive re-shoring of semiconductor production as well as ongoing subsidisation practices. We leave aside China, which we will discuss later.

US Chips Act

After years of semiconductor production shifting to Asia, the US government decided to introduce measures dedicated to revitalise their domestic semiconductor production. The US Congress passed the Creating Helpful Incentives to Produce Semiconductors (or CHIPS) Act in July '22 before it was officially signed into law by president Biden on Aug '22.

The CHIPS Act of 2022 aims to provide both direct funding and tax credits to incentivize semis manufacturing and R&D in the US and hence further the programs within the CHIPS for America Act by providing **1/ a total of US$54.2bn in appropriations which would be divided under different funds (each with specific purpose/goals) while spread out over multiple years supplemented by 2/ a 25% investment tax credit (ITC) for qualified investments related to semis manufacturing.**

The CHIPS Act of 2022 offers US $54.2bn in appropriations to directly fund semis manufacturing as well as an investment tax credit

How does the CHIPS Act work in practice?

Figure 52: US CHIPS Act - Summary table

No.	Summary of US CHIPS Act
1	Allocated $50bn through America Fund to incentivize semis manufacturing and development.
2	Funds allocated over span of 5 years under DoC Manufacturing incentives and DoC R&D and Workforce Development
3	Under Manufacturing incentives of $39bn and $11bn under R&D and workforce development.
4	To avoid misconduct, 2% of the funds reserved for salaries, expenses and admin.
5	Within $39bn of manufacturing incentives, $19bn allocated for FY22 and $5bn each year from FY23-26.
6	$2bn from FY22 sum will be used for legacy nodes.
7	Among $11bn for R&D and WD, $5bn used in FY22 and remaining fund distributed over FY23-26
8	Designated $2bn for America Defense Fund to increase nation wide network to onshore and facilitate semi technology for Dept of Defense applications
9	Allocated $500mn under America International Tech security and Innovation fund to co-ordinate joint development of semis technology with foreign partners.
10	Allocated $200mn for America Workforce and Education Fund to the National Science Foundation which estimate to add 90k additional workers by 2025.
11	Allocated $1.5bn in Public Wireless Supply Chain Innovation Fund through DoC NTIA to spur tech development and growth in US mobile broadband market.
12	Moreover, provision of 25% investment tax credit (ITC) provided to promote investments in Semis manufacturing.
13	Further to the above, the CHIPS ACT has certain criterions to qualify for either of funding /subsidies or related tax credits.

Source: UBS

(1) CHIPS for America Fund (US$50bn)

A total of US$50bn in appropriations is set to be distributed under the CHIPS for America Fund and is the main funding vehicle to incentivize semis manufacturing/ development in the US. The US$50bn sum is set to maintained by the US Department of Commerce (DoC) and will be allocated over the span of 5 years under two separate directives (the 'DoC Manufacturing Incentives' and 'DoC R&D and Workforce Development'). As a checking measure to prevent fund misuse, for each FY, up to 2% of the funds will be available for salaries, expenses and admin with funds under each category remaining available for the FY until expended (specific details below).

- **(A) DoC Manufacturing Incentives (US$39bn)** under the CHIPS for America Fund is the directive that directly aims to incentivize and fund semis manufacturing capacity in the US. A sum of US$39bn will be allocated over 5 years with US$19bn allocated for FY22 and a further US$5bn allocated each year from FY23-26.

The DoC Manufacturing Incentives directive directly aims to fund semis manufacturing capacity in the US

- Part of the sum set for FY22 (US$2bn) will be set aside with a focus on legacy nodes (defined as semis technology 28nm or higher for logic with the scope for memory/analog/packaging net yet defined but up to the discretion of the Secretary of Commerce), essential to auto/military/industrial applications.
- As part of the fund, the Secretary of Commerce may use up to US$6bn for FY22 for cost of loans / loan guarantees provided that the cost of modifying the loan guarantees follows Congressional Budget and also provided it is used to subsidize gross obligations not exceeding US$75bn.

- **(B) DoC R&D and Workforce Development (US$11bn)** as the second directive under the CHIPS for America Fund, a total of US$11bn will allocated for the R&D of specific semis technology applications with US$5bn appropriated for FY22 and the remainder of the fund divided over FY23-26.
  - US$5bn will be allocated for FY22 within which US$2bn will be set aside for the DoC's National Semiconductor Technology Center (NSTC), public-private partnership center set up to conduct advanced semis manufacturing R&D and prototyping as well as to expand workforce training. US$2.5bn will also be set aside to develop advanced packaging with the remaining US $500m set aside for R&D related purpose.

The DoC R&D and Workforce Development is focused around funding advanced semis manufacturing R&D, workforce training as well as advanced packaging abilities

(2) CHIPS for America Defense Fund (US$2bn): the CHIPS for America Defense Fund sets aside US$2bn to foster a nation wide network to onshore and facilitate lab-to-lab transition of semiconductor technology specific for the Department of Defense (DoD) applications. This portion of the fund will be maintained by the DoD with US$400m appropriated every year from FY23-27.

(3) CHIPS for America International Tech Security and Innovation Fund (US $500m): Related to coordinating the joint development of semis technology with foreign partners, the CHIPS for America International Tech Security and Innovation Fund will allocate US$500m over FY23-27 (US$100m annually) with a goal to foster sharing of international info and communications security related technology in addition to semis supply chain activities. The funds will be maintained jointly with the Department of State, US Agency for International Development as well as the Export-Import Bank.

(4) CHIPS for America Workforce and Education Fund (US$200m): A sum of US $200m is set to be allocated over the span of 5 years to the National Science Foundation to promote the growth of the semiconductor workforce in the US, given the needs to add c. 90k additional workers by 2025.

(5) Public Wireless Supply Chain Innovation Fund (US$1.5bn): US$1.5bn is further set to be appropriated through the DoC National Tele-communications and Information Administration (NTIA) to spur technology development and movement to an open-architecture, software based wireless technologies - funding the technology development in the US mobile broadband market.

(6) Investment tax credit (ITC) for qualified investments: In addition to the appropriations set out above, the CHIPS ACT also includes a provision to provide a 25% investment tax credit (ITC) for investments related to semis manufacturing, which would include in scope the semis manufacturers but also the semsicap WFE providers.

CHIPS Act also includes a 25% Investment tax credit (ITC) for 'qualified' investments related to semis manufacturing

- The credit will be provided for property/assets which will be placed in service after Dec 31, 2022 for which construction begins before Jan 1, 2027. In order to qualify for the tax credits, the investments will have to be made in the US with foreign entities of concern barred from accessing the credit in with a limitation stating any investments in China or other foreign country of concern will be barred following the 10 years after the tax credit has been claimed.
- As to what semis related investments qualify for the tax credits will be identified by the Secretary of Commerce with an applicable percentage placed year for the related qualified investments that are eligible for the credits suggesting the tax credits will not be a blanket approach applicable to all; ie. only 40% of qualified service/facility related investments or expense made before Jan 1, 2025 will receive tax credits and 30% for those made in 2025 and 20% in 2026.

- In order to prevent the misuse of the credits, any fund received may not be used for purposes of stock (including buybacks) or dividend payments.

Allocation Decision Making & Restrictions

The CHIPS Act also lays out specific criterions in order to qualify for either of the funding/ subsidies or related tax credits as well as how the allocation process will be made.

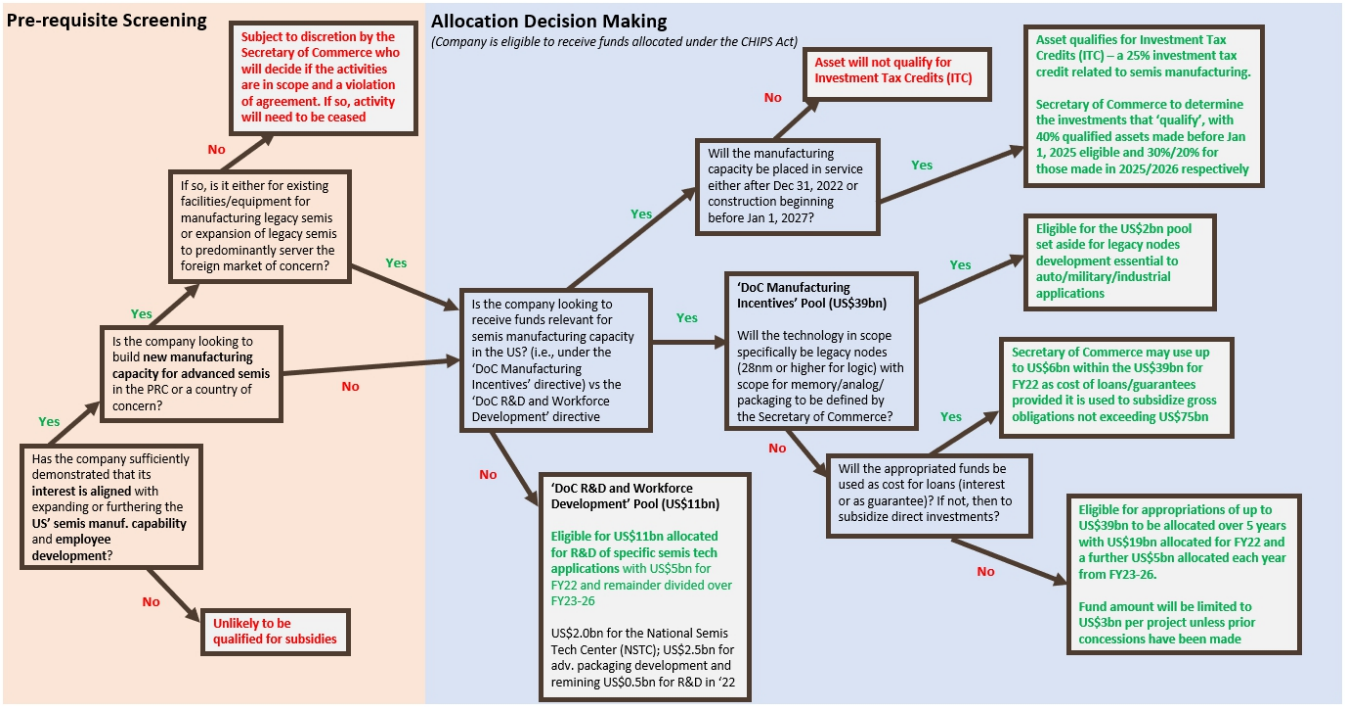
- Under the details found in the William M. Thornberry National Defense Authorization Act, an entity must submit an application to and will receive approval from the Secretary of Defense - with projects given priority according to the extent they support the resiliency of the US semis supply chain and critical industries.
- In addition, an applying entity must demonstrate that it's interest is aligned with expanding or furthering the US' semis manufacturing capability in addition to commitments made to employee development.
- While the appropriate amount and funding type will be determined by the Secretary, the size of any federal investment in any project will be limited to US $3bn unless prior concessions had been made between Congress and the President.

Restrictive measures limit recipients from building new semis manufacturing capacity for certain advanced semis in China and countries of concern

Recipients of incentives will be prohibited from building new manufacturing capacity for certain advanced semis in specific countries (ie. countries deemed to present a threat to US national security) for which the scope will regularly be updated by the Secretary of Commerce and Secretary of Defense:

- A covered entity during the 10 year period beginning on the date of award may not engage in transaction involving the material expansion of semis manufacturing capability in the PRC or country of concern though exceptions apply for:
  - Existing facilities or equipment of a covered entity for manufacturing legacy semis;
  - Significant transactions involving the material expansion of legacy semis that produces legacy semis and predominantly serves the market of the foreign country of concern.
- Any planned transactions involving the material expansion in semis manufacturing capacity in the PRC will further need to be informed to the Secretary of Commerce who will decide if the transaction would be violation of the above stated agreement and if so will need to be ceased or may result in the full recovery of assistance provided.

Figure 53: CHIPS Act appropriation allocation decision making chart



Source: BIS, UBS

Related Fab Announcements

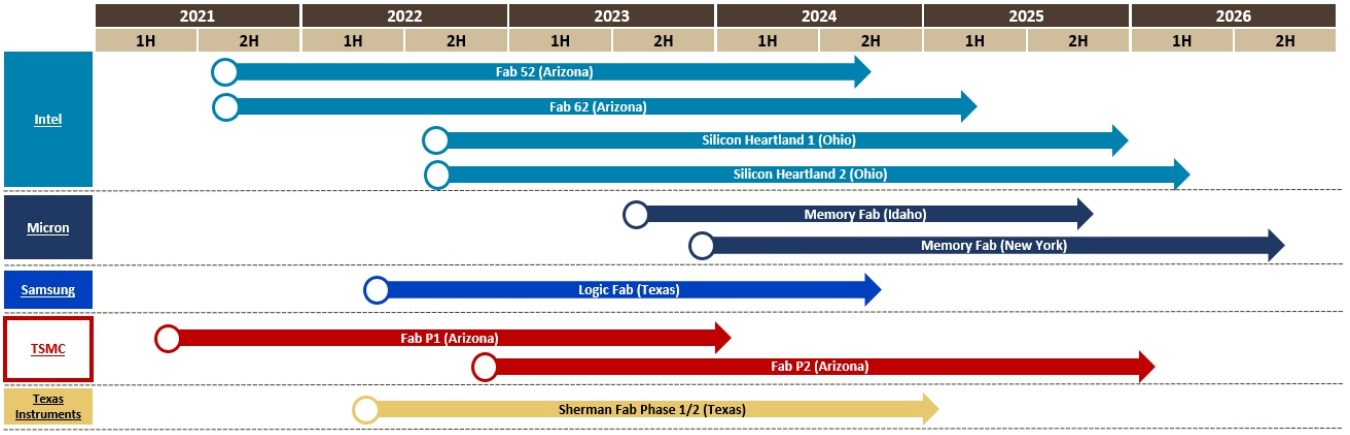
Since the CHIPS Act got enacted, several semiconductor companies announced that they will participate. In Leading edge Logic semis, those include Intel, TSMC and Samsung; in trailing edge and Analog, GlobalFoundries and Texas Instruments; and in Memory, Micron.

Figure 54: Fab announcements related to US CHIPS Act

Company	Location	Technology	Capacity	Investment Plan (US$bn)	MP Timing	Comments
Intel	Chandler, Arizona	Intel 20A	TBA	10.0	2H24E	Likely to begin production with 4nm; both IFS & internal products
	Chandler, Arizona	Intel 20A	TBA	10.0	2025E	Likely to begin production with 4nm; both IFS & internal products
	Licking County, Ohio	Intel 20A/18A	TBA	10.0	2025E	'Mega fab' project; 6-8 modules to cost upto US$120bn in total
	Licking County, Ohio	Intel 20A/18A	TBA	10.0	2026E	'Mega fab' project; 6-8 modules to cost upto US$120bn in total
Micron	Clay, New York	Leading edge (Memory)	TBA	20.0	2026/27E	To invest US$100bn over 20 years (US$20bn by 2030); US$5.5bn in incentives
	Boise, Idaho	Leading edge (Memory)	TBA	15.0	2026E	Plan to build US$15bn memory plant in Boise, Idaho
Samsung	Taylor, Texas	5nm	TBA	17.0	2H24E	
TSMC	Phoenix, Arizona	4nm	c. 20k wpm	12.0	2024E	Announced Nov. 2020; site plan shows 6 fabs
	Phoenix, Arizona	3nm	c. 30k wpm	28.0	2026E	Announced Dec. 2022; mass production of 3nm process technology in '26
GlobalFoundries	Malta, New York	TBA	c. 13k wpm	1.0	2023E	Adding extra capacity to Malta Fab 8; additional 150k wafers per year
	Malta, New York	TBA	TBA	7.0	TBA	Preliminary site work and permitting underway; TBD subsidies
Texas Instruments	Sherman, Texas	45-130nm	TBA	14.0	2025E	Ground breaking on May '22; local property tax abatements
	Sherman, Texas	TBA	TBA	14.0	TBA	Upto US$30bn spend for 4 fabs
IBM	Poughkeepsie, New York	TBA	TBA	20.0	TBA	US$20bn investment over 10 years for semis manuf, cloud, AI etc.

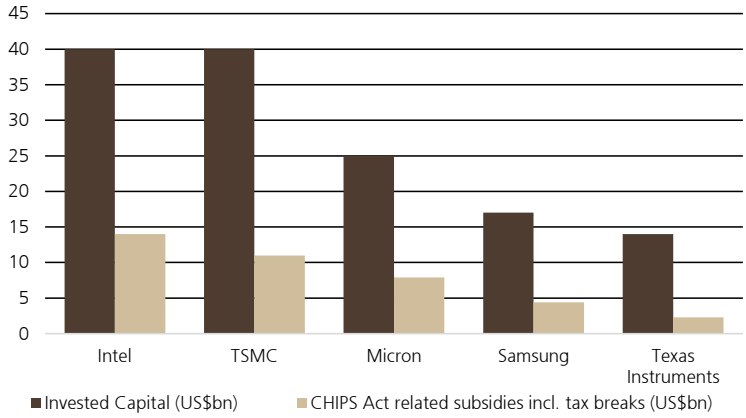
Source: Company data, UBS estimates

Figure 55: Timeline of announced US CHIPS Act projects



Source: Company data, UBS estimates; Note: Only includes announced/confirmed projects

Figure 56: Subsidies associated with US CHIPS Act projects per recipients including tax breaks (til 2026, projects announced)



Source: UBS

So far, Intel has been the potential main beneficiary of CHIPS Act subsidies, followed by TSMC and Micron. In turn, this would suggest that **the success of the CHIPS Act in leading edge Logic semis is also somewhat dependent upon Intel's own success regarding its "IDM 2.0" strategy and the execution of its process technology roadmap.**

Figure 57: What is Intel IDM 2.0?

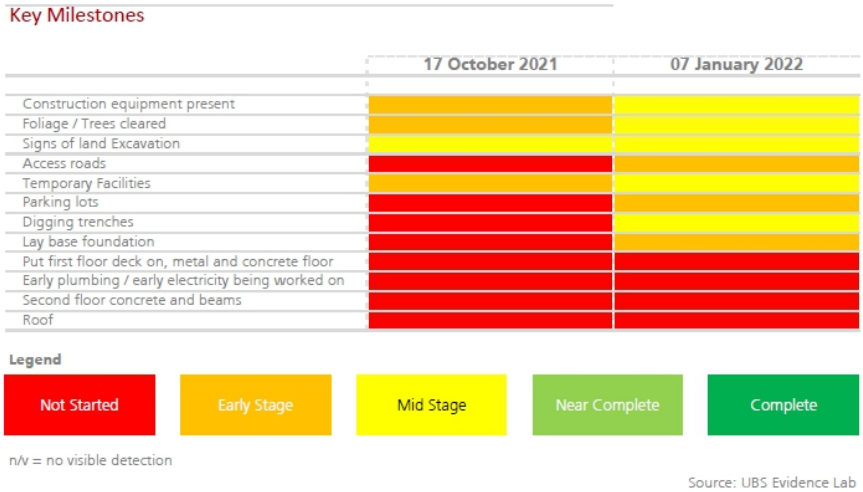
Intel IDM 2.0 – What is it and understanding the process tech roadmap

Soon after Pat Gelsinger's return as the CEO in early 2021, Intel announced the "IDM 2.0" strategy with a **renewed emphasis on process roadmap and re-entry into the foundry business.** Till then, Intel had a more stringent process migration for 10/7nm, which had resulted in significant challenges in technology complexity and production yields, but also delays.

- Intel's process roadmap strategy is now closer to TSMC and Samsung, with less aggressive node to node targets. Performance enhancement goal now set at 10-20% for new nodes (was 20-30% for 10nm and earlier nodes).
- Despite less aggressive shrink node to node, Intel still plans for aggressive process migration for the next couple years—five nodes in four years—to catch up and exceed TSMC and Samsung Foundry by 2024-25.
    - **Intel 7** (the original 10nm Enhanced SuperFin) production for client CPUs (Alder Lake) began in late-2021. Production for server CPUs (Sapphire Rapids) began in 1H22; we expect meaningful ramp up into 1H23.
    - **Intel 4** will be Intel's first EUV node with production scheduled to begin in 2023. Intel plans to leverage the node for client CPU (Meteor Lake) in its computing tile, with part of other tiles (i.e., GPU, base tile) based on TSMC's 3nm.
    - **Intel 3** – EUV transition will be key in Intel's migration beyond Intel 4 as both TSMC/Samsung Foundry have gone through a long learning curve for EUV production. Risk production for Granite Rapids, the next gen server CPU based on Intel 3, is expected to begin in early 2023 with mass production set for 2024.
    - **Intel 20A/18A** – Beyond the Intel 3 roadmap, Intel currently plans to move to GAA (or RibbonFET) from Intel 20A (2nm) onwards in 2024.
- So far Intel has demonstrated firm commitment to their new plans, aggressively planning to expand capacity scale to support its own production and foundry business. New fab announcement locations include Arizona (US), Ohio (US), Ireland and Magdeburg (Germany) over the upcoming years, supported by various government subsidies.

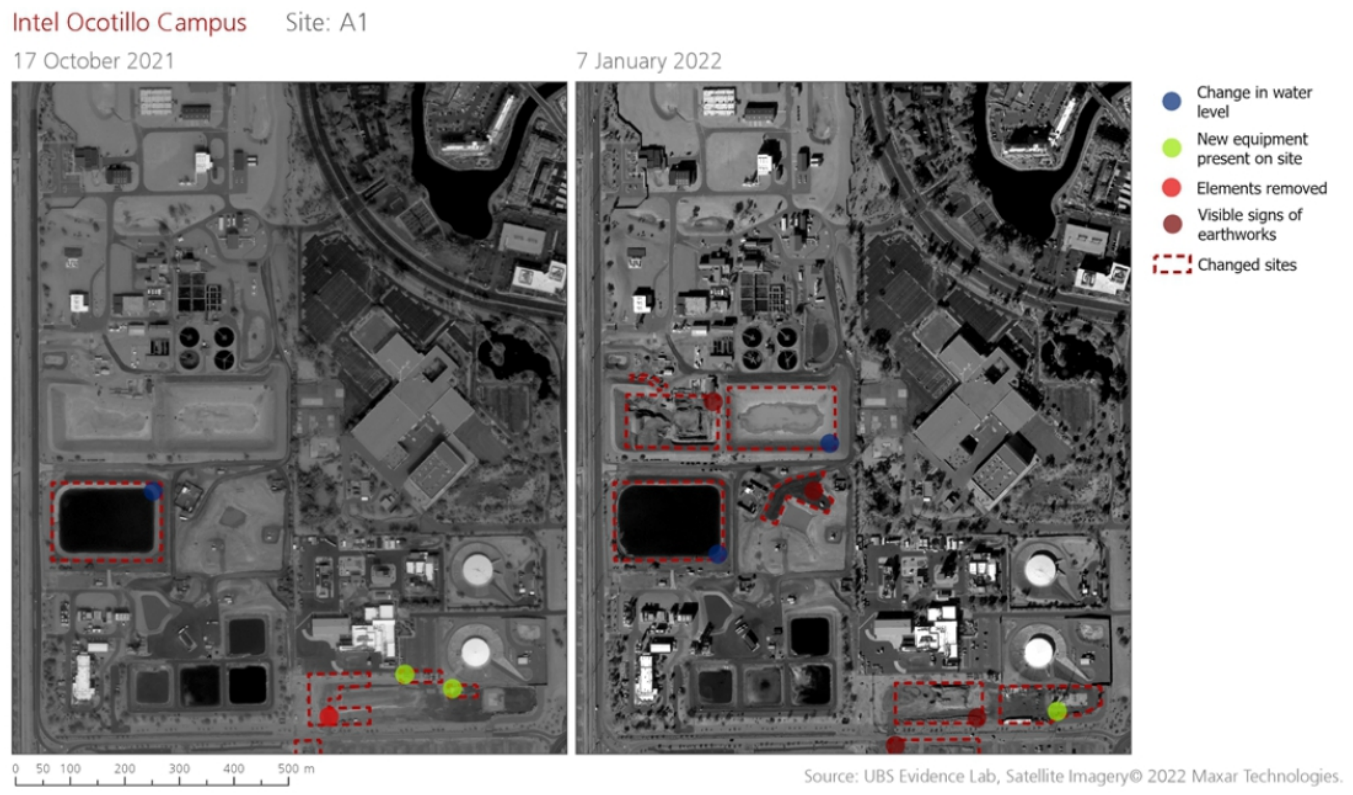
Source: Company data, UBS estimates

Figure 58: INTC - Key Milestones (As of Jan 7, 2022)



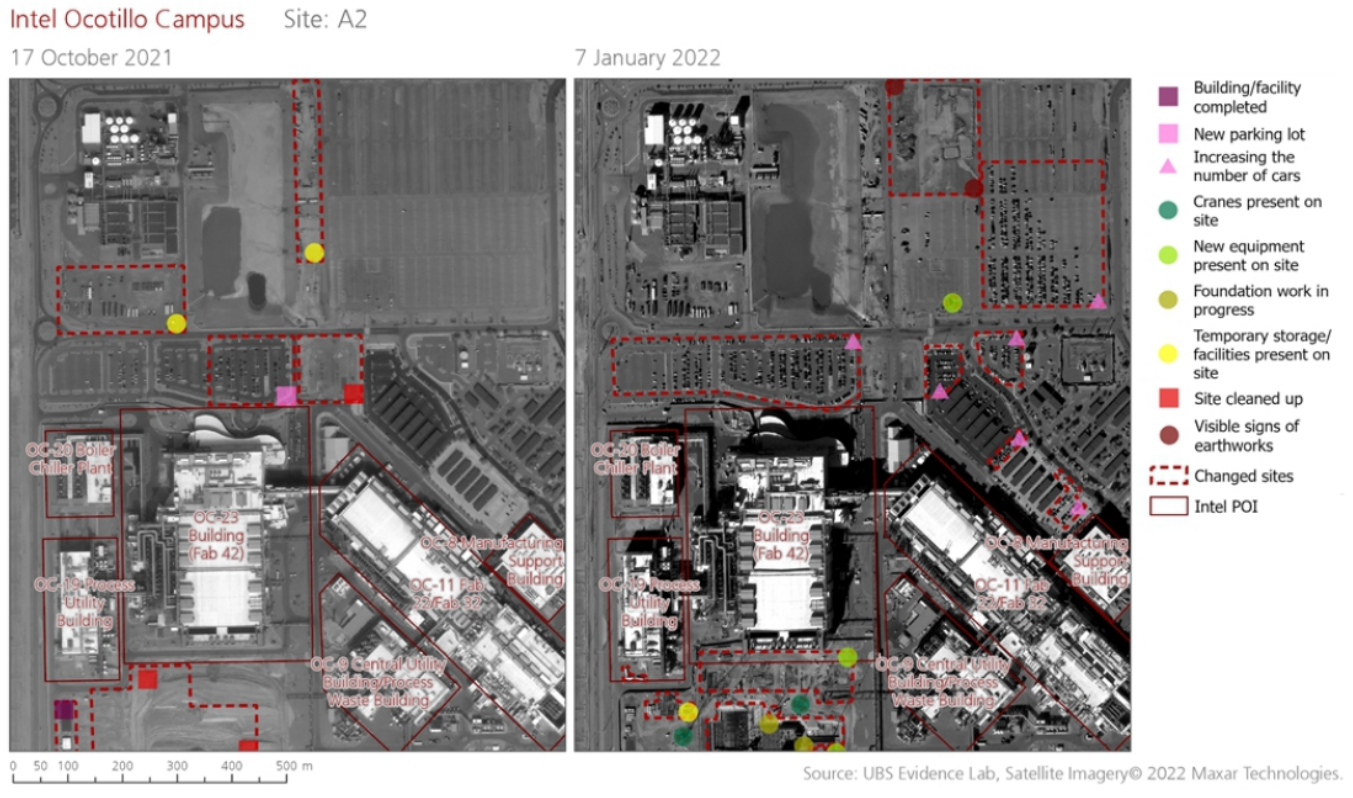
Source: UBS Evidence Lab

Figure 59: US Intel Chip Plant (Arizona) - Geospatial Analysis (1)



Source: UBS Evidence Lab

Figure 60: US Intel Chip Plant (Arizona) - Geospatial Analysis (2)



Source: UBS Evidence Lab

There are mitigating factors to this relative reliance upon Intel for "America-made" leading edge Logic semis. First, other leading edge Logic investments are planned under the CHIPS Act: Samsung at 3nm, TSMC at 5nm and possibly 4nm and 3nm (link). Of

note though is that those will be N-1/N-2 nodes by then, and bound by the rules for process technology transfers both South Korea and Taiwan have. Second, in the event that Intel eventually de-emphasizes manufacturing (not the company's base case obviously), one could also consider that other foundries (by implication: TSMC or Samsung), may end up operating those assets.

It also clear, looking at the projects announced, that **trailing edge logic and analog is part of the intent of the CHIPS Act. In fact, with some of the more serious chip shortages during COVID having been in trailing edge nodes, securing adequate supply in this segment clearly can be viewed as important for securing supply chain.** This is especially true within the Automotive and Industrial supply chains, as those use a higher portion of trailing edge chips vs Computing and Mobile.

The CHIPS Act also intends to address trailing edge logic and analog production capacity given the serious shortages faced during COVID

Any implications for TSMC, Samsung in their ability to operate in China coming from the CHIPS Act?

On the surface, the provisions regarding limitations of investments in China for recipients of CHIPS Act subsidies could affect Samsung, which has memory fabs in Xi'an, and TSMC, which operate fabs in Nanjing. That said, we believe both companies' operations in China can call upon several exceptions:

The implications for both TSMC and Samsung on their ability to operate in China will be limited

1. Both do not plan at this stage to build new fabs. Samsung also does not plan to grow capacity in China, and has no meaningful floor space left in its current clean rooms in Xi'an. TSMC is currently adding capacity in Nanjing, but trailing edge (28nm).
2. Both companies operate under "N-1" rules from their respective governments, which in essence pre-empt them to roll out in their fabs in China the most leading edge process technologies. TSMC, in fact, only goes down to 12nm in Nanjing compared starting 3nm mass production in Taiwan.
3. Domestic demand can be deemed to absorb all of TSMC's capacity in Nanjing in terms of end use, with the vast majority of loading coming also from Chinese fabless IC companies. Samsung's NAND flash output from Xi'an could more or less address the portion of end-use of its total NAND business which is China.

European CHIPS Act

Whilst still in early stages with details related to the exact amount and funding means still to be decided, **initial talks over a potential 'European CHIPS Act' aims to mobilise over c. €43bn in both public and private investments by 2030 are underway**. The Act aims to put in place a framework to increase Europe's semiconductor production capacity share to 20% (from currently estimated 10%) of the global market by 2030. With some EU member states having announced their plans related to the act, the tentative timeline for a cohesive 'European CHIPS Act' remains yet to be decided.

There has been ongoing discussion over a potential 'European CHIPS Act' to increase Europe's semis production capacity share to 20% by 2030

The European Commission's proposal for the Regulation on the 'European Chips Act' will be sent for the approval of the European Parliament and member states, who will discuss it in the ordinary legislative procedure. Member states are encouraged to immediately start coordination efforts in line with the recommendations.

- **Germany:** The German government has so far been a proponent of a 'European CHIPS Act' having announced their intention to attract chip makers with a proposed €14bn in subsidies. In-line with the support , Intel has also announced their intention to build a new US$19bn chip making complex in Magdeburg, Germany as part of a stated investment in Europe expected at US$88bn.
- **France:** France has also stated its intention to provide €6.7bn in subsidies related to semis manufacturing. In accordance with the policy, STM and Globalfoundries announced plans to build a new semis manufacturing fab in Crolles, France, expected to reach full production capacity by 2026.
- **Spain:** The Spanish government has also announced approved plans to provide up to €12.3bn in public investments to further their self-sufficiency in semis manufacturing which includes €9.3bn in support for fab fabrication as well as subsidies specific to R&D (€1.1bn) and chip design (€1.3bn).

Figure 61: Fab announcements related to the European CHIPS Act

Company	Location	Technology	Capacity	Investment Plan (US$bn)	MP Timing	Comments
Intel	Magdeburg, Germany	TBA	TBA	9.5	2026E	Intel looking for US$7.3bn in subsidies for two fabs
	Magdeburg, Germany	TBA	TBA	9.5	2027E	Intel looking for US$7.3bn in subsidies for two fabs
	Vigasio, Italy	Back-end Manuf.	TBA	4.4	TBD	Back-end manufacturing facility, TBD confirmation
	Leixlip, Ireland	Intel 4	2x current capacity	11.8	TBD	To double current manufacturing capacity
STMicro + GlobalFoundries	Crolles, France	>18nm	c. 52k wpm	5.8	2024E	Joint facility GF 58%, STM 42% of output; seeking incentives
GlobalFoundries	Dresden, Germany	TBA	TBA	TBA	2025E	Applying for funding under IPCEI-2; TBD approval
TSMC	Dresden, Germany	TBA	TBA	TBA	TBA	*Press reports TSMC in talks with German government for potential fab
Bosch	Reutlingen, Germany	Developent Center	TBA	3.1	TBA	Part of the IPCEI funding program
Infineon	Dresden, Germany	Analog/Power semis	TBA	5.1	2026E	TBD funding from the EU Chips Act

Source: Company data, UBS estimates; *Note: press report (link)

So far, the announcements related to the European CHIPS Act relate, to the exception of Intel, to trailing edge logic / analog. This makes in our view strategic sense: 1/ Europe has more existing critical mass in those segments, as well IP and engineers / workforce; 2/ They are important for the Auto and Industrial supply chains, themselves particularly important to the European economies and in particular Germany. In fact, **we believe that targeted subsidies for Power Semis (IGBT, SiC) would and should be a priority for Europe.**

Targeted subsidies for power semis would and should be a priority for Europe

Japan

While Japan remains a critical supplier of raw materials and equipment in semiconductor production, the Ministry of Economy, Trade and Industry of Japan (METI) is aware of Japan's declining position in global semiconductor production share (from over 50% in 1988). It has proposed a few initiatives to rejuvenate the domestic semiconductor industry, including investments in R&D and manufacturing facilities. In May 2021, the Japanese government first approved a ¥19bn package (US$141m) to fund TSMC's advanced packaging and testing R&D centre in Ibaraki Prefecture.

It also made further strides through the roll-out of **"Emergency Strengthening Package"** in late 2021. The short-term objective would be to subsidise domestic and foreign semiconductor makers to build new capacity or refurbish existing equipment in Japan for IoT semiconductor devices, given the condition of continued production activities for at least 10 years.

Japan Advanced Semiconductor Manufacturing (JASM), the joint venture between TSMC and Sony, is one of the targets with ¥400bn fundings out of a ¥617bn budget, and the remainder of budget could go to facility investment by Kioxia, Micron, etc.

In addition METI expects joint R&D with the US in next generation semiconductor technologies. In November 2022, METI announced **plans for 2nm Logic devices by 2027**, through a leading edge semiconductor leading edge technology center for R&D, and an associated company - Rapidus - to execute the project. Rapidus includes 8 shareholders: Kioxia, Sony, Softbank, Toyota Motor, Denso, NTT, NEC and Mitsubishi UFJ Bank. It will get 2nm process technology from IBM. Japan had effectively exited leading edge Logic manufacturing a while back when its former "mini fabs" from IDMs became uncompetitive. Whether this venture will succeed in putting it back on the map will be interesting to follow, but it is also clear that hurdles are significant.

The Rapidus consortium aims to bring back leading edge Logic manufacturing capacity back to Japan

Figure 62: Fab announcements related to Japan's semiconductor incentive package

Company	Location	Technology	Capacity	Investment Plan (US$bn)	MP Timing	Comments
Kioxia	Yokkaichi	NAND Flash (112/162L)	c. 20k wpm	NA	2022E	US$680m subsidy from Japan government
Micron	Hiroshima	DRAM (1-beta)	TBA	7.0	2024E	Received subsidy of US$320m from Japan government
TSMC, Sony, Denso JV	Kumamoto	22/28nm	c. 30k wpm	8.6	2024E	Japan gov't to provide US$3.5bn total in incentive
Rapidus consortium	TBD	2nm	TBD	0.6	2027E	Consortium consists of 8 JP tech firms and government funding
Renesas	Kai City	Power semis	TBD	0.6	2024E	Reopening fab closed in 2024; 300mm fab for power semis

Source: Company data, UBS estimates

India

In December 2021, India's Ministry of Economic Affairs allocated c. US$10bn incentive scheme for Semis and Display manufacturing facilities. The government intends to fund nearly 50% of project cost to build fabs across any technology nodes including leading edge computing chips, power, telecom and auto parts.

Although this programme has attracted quite a bit of press, we note that so far, **none of the announced sponsors are leading semiconductor players.** Possible hurdles include the lack of existing semiconductor ecosystems and logistics. Whilst India trains many engineers (and a number of them made it to top management of global companies), the pool is traditionally more centered around software than semis.

While we have seen a few announced semis projects in India, none of the announced sponsors are leading semiconductor players

Figure 63: Fab announcements related to India's semiconductor incentive package

Company	Location	Technology	Capacity	Investment Plan (US$bn)	MP Timing	Comments
Vedanta & Foxconn	Gujarat	28nm	TBD	7.6	2025/26E	Project to set up semis (US$7.6bn) and displays (US$12.0bn) production
ISMC JV	Karnataka	40-65nm	TBD	3.0	2026/27E	Upto US$1bn in incentives; JV between Next Orbit Venture & Tower Semis
IGSS Ventures	Tamil Nadu	>28nm	TBD	3.5	2026/27E	Signed MOU with Tamil Nadu; 28nm or older nodes manufacturing

Source: Company data, UBS estimates

South Korea

Whilst yet to receive consent from the National Assembly and hence the exact details pending, Korea government is also looking to provide a policy support of its own for semis, dubbed "**K Chips Act"**. In essence, the policy mainly looks to expand tax exemptions granted for semis-related capital spending (for large corporates, up to 10-20% from currently 6%) and R&D spending (for large corporates, up to 45-50% from currently 30%), along with additional peripheral support. That said, the overall incentive magnitude seems relatively limited and immaterial, compared to the more aggressive spending plans from other regions such as US, Europe etc.

Taiwan

The Taiwan government has long been operating tax credits to support investment in its semiconductor industry. This has has been, like in South Korea, very effective at helping the private sector developing a cutting edge semis industry at scale, while letting companies do the vast bulk of the financing.

Recently, **the Taiwan Ministry of Economic Affairs plans to raise tax benefits for companies R&D efforts to a 25% rebate on costs compared with existing 15%**. The ministry also plans to eliminate tax deduction limit of $33.63mn on newly acquired advanced equipment and considering 5% limit on overall new equipment spending as payable income taxes for that year. Royalty payments to foreign companies for imported new production technologies or products that use patents, copyrights, or other special rights owned by foreign companies is, with the approval of the Industrial Development Bureau, MOEA, exempt from the corporate income tax.

Singapore

The semiconductor industry was identified as a key driver for the Singapore economy after its independence in 1965. The first wave of semiconductor investments (backend) in the 60s and 70s includes National Semiconductor, Fairchild, Texas Instruments, SGS UK (ST Microelectronics, STM), Infineon, Philips, Siemens (now NXP) and Hewlett Packard. In the 80s, key efforts to grow the semiconductor ecosystem was to expand into wafer fabrication and IC design. This led to STM setting up the first wafer fab in Singapore, and STM/Fairchild setting up IC design centers. The EDB supported the creation of Singapore's own wafer fab, Chartered Semiconductors in a joint venture with Sierra Semiconductor and National Semiconductor. Singapore continues to attract wafer fab investments swith the help of incentives which includes pioneer tax, development and expansion and investment allowance. Key Front End fabs include Micron, GlobalFoundries, UMC and STM.

Figure 64: Summary of Singapore's investment incentives

Category	
Pioneer tax incentive	Applies to approved products with high tech content or qualifying services. 5-15 years tax exemption for each project under pioneer program. Reduced tax rates under post-pioneer period available.
Development and expansion incentive	New, expansion, upgrading or incremental investments in high-value-added projects after pioneer period can be granted reduced tax of not less than 5% for up to 10 years.
Investment allowance	Tax exemption on profits based on a percentage (up to 100%) of capex for qualifying projects or activities within a period of up to 5 years.
Incentives for internationalisation	Allows companies expanding overseas to claim a double deduction for eligible expenses for specified market expansion and investment development areas.
Intellectual Property Development Incentive	Eligible for a reduced tax rate of either 5% or 10% on a percentage of qualifying income derived from the commercialisation of certain IP.

Source: Singapore Economic Development Board (EDB)

Malaysia

The Penang state government, in consultation with federal agencies including the Economic Planning Unit (EPU), started Malaysia's first Free Trade Zone in Bayan Lepas in 1972. This led to the establishment of assembly plants by multinational companies, which was pioneered by the "Eight Samurai" comprising of National Semiconductor, AMD, Intel, Osram, Hewlett Packard, Bosch, Hitachi and Clarion. The following 50 years saw Penang evolve into a cluster for backend assembly and test operations. The government continues to play a key role in attracting high value-added foreign investments through a variety of incentives including pioneer tax treatment, investment tax allowances and relocation incentives. This has led to recent new/expansion investments by MNCs such as Lam Research, Intel and Infineon.

Figure 65: Summary of Malaysia's investment incentives

Category	
Pioneer tax incentive	Applies to projects with national and strategic importance involving heavy capex and high tech nature, high tech companies in new and emerging tech, specialised machinery and equipment. 100% exemption of statutory income for 5-10 years.
Development and expansion incentive	Applies to similar natured projects as Pioneer Status but incentives are against 60-100% of qualifying capex for 5-10 years.
Investment allowance	Resident company in operation for <36 months that incurs capex to expand, modernise, automate or diversify its operations is entitled to reinvestent allowance within 15 years of first claim, 60% of qualifying capex to offset 70% of statutory income.
Incentives for internationalisation	To encourage investment and relocation of manufacturing/services: 0% tax rate for 10/15 years for new investments of >RM300m/RM500m; 100% ITA for 5 years for existing companies with investments >RM300m.
Intellectual Property Development Incentive	Resident companies are entitled allowances of 10-100% of the value of incremental exports deductable against up to 70% of statutory income.

Source: Malaysia Investment Development Authority (MIDA)

Overview: US exports controls towards China

Conversation with experts suggest the US export control measures are likely to continue to expand

Since the initial (and shortly abandoned) restrictions towards ZTE in 2018, the US government has adopted wider-ranging as well as increasingly specific restrictions regarding exports and use of key US technologies towards China and/or specific Chinese corporations. Those measures have had so far wide support across the aisle in the US Congress. Our conversations over the past few weeks with experts is that **US export control measures are likely to continue to expand**, with the ultimate aim to limit China's competitiveness in advanced technologies. **So for now, investors should assume that 1/ those measures are here to stay; 2/ they may develop further and; 3/ they will re-shape the China technology industry.**

In this section, we review:

1. **What are the key mechanisms in place**, to control the exports or use of US technologies by specific countries and/or corporates;
2. **What are the most recent developments and their implications;**
3. **What could happen next**.

How do the US technology exports controls work: Entity List, De Minimis rules and company-specific measures

The main mechanisms for US exports control rules for technology are now well established. The Department of Commerce (DoC) , through the Bureau of Industry and Security (BIS), has for mission to "advance U.S. national security, foreign policy, and economic objectives by ensuring an effective export control and treaty compliance system and promoting continued U.S. strategic technology leadership". The important nuance here is that "economic objectives" are included. This opens a corridor, over time, for measures potentially been taken to support US' competitiveness in those areas, not just to protect security. At times though, the Department of Defence can get involved, as was the case for SMIC (link), when it sees, for instance, a case for indirect use of US technology for devices or systems used by the defense system of a country at risk.

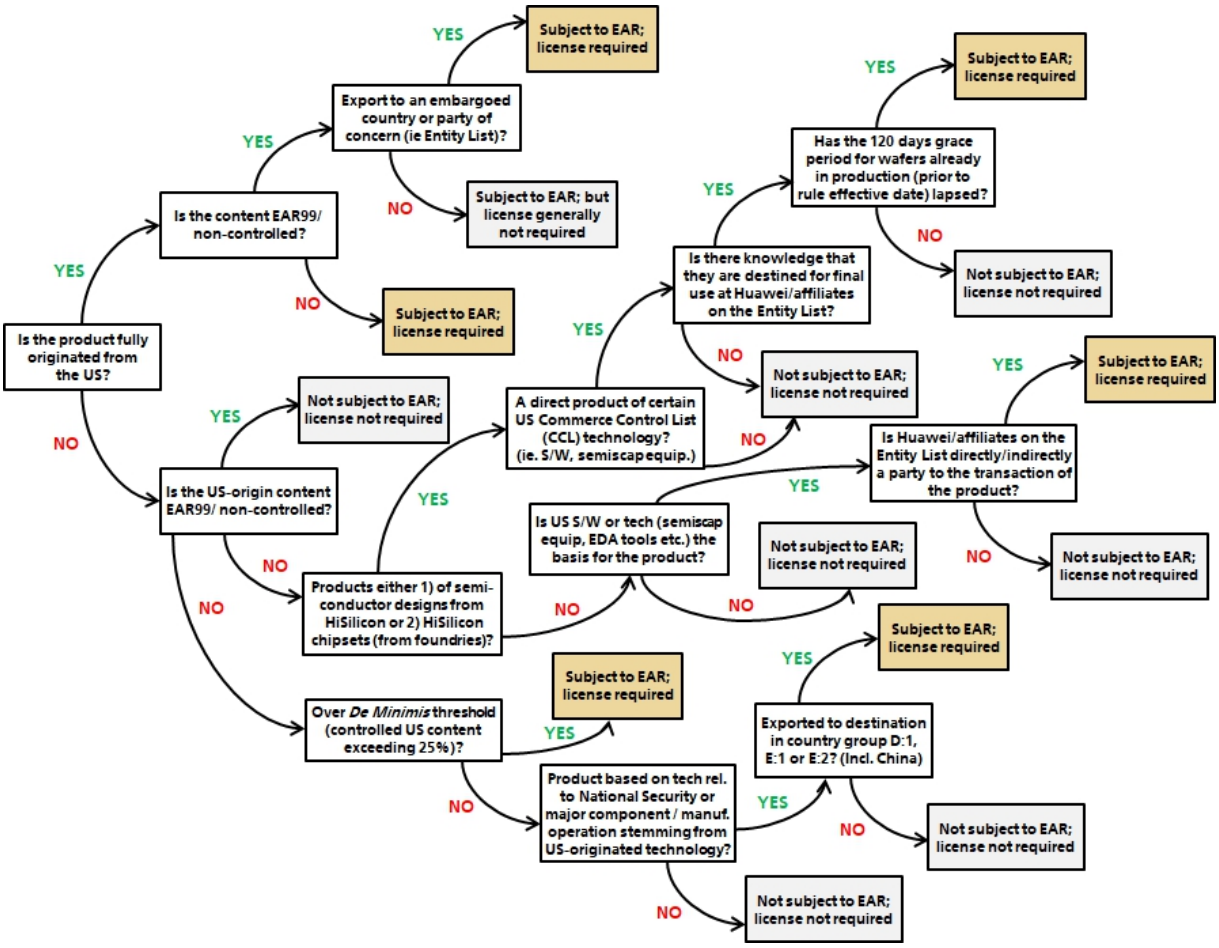
The BIS publishes specific directives regarding export controls and manages the Entity List and Unverified Lists. A company or entity present in the Entity List triggers specific licensing requirements from BIS for their suppliers. This does not only concern US suppliers, but also those in other locations (or foreign subsidiaries of US firms) under specific circumstances: 1/ Under the Exports Control Regulation (EAR) if 25% or more of the value add comes from the US (the "De Minimis" rule); 2/ In specific cases if using core US technology to develop or manufacture a product for a specific customer subject to exports control. An example of the later is Huawei/Hi Silicon, with restrictions for foundries to manufacture ICs for Hi Silicon (Huawei's internal fabless IC vendor) using US semis manufacturing equipment - in effect blocking them to do it at all.

Figure 66: Lexicon of main terminology for US export restrictions

Term	What it is / what it means
BIS	Bureau of Industry and Security, is an agency of the US Department of Commerce that deals with issues involving national security and high technology. Its mission is to "advance US national security, foreign policy, and economic objectives" by "ensuring an effective export control" and "promoting continued US strategic technology leadership".
EAR	Export Administration Regulations, administered by BIS under US DoC; regulates export and export restrictions.
CCL	Commerce Control List, is a limited list of items within the scope of the EAR that require attention due to potential dual-use - commercial and military.
EAR99	Items not designated under CCL; typically include low-technology consumer goods that do not require export licenses in most situations
De Minimis rule	Governs which products manufactured outside the US but incorporating US content fall within the scope of US export control law under the EAR. If the foreign-made item includes less than the de minimis level (25%) of US content, then this is considered outside the scope of the EAR.
Foreign Direct Product (FDP) rule	If a foreign-produced item is produced directly from certain US-origin technology or software that is subject to national security controls, then this is subject to the EAR.
Denial Order (or Denied Persons List, DPL)	List of names, both US and foreign, who are not allowed to participate in export transactions. The standard denial order includes prohibition of the listed persons from participating directly or indirectly in any export subject to the EAR.
Entity List (EL)	List of names of certain foreign persons - including businesses, governments or other types of legal persons - involved in activities contrary to the national security or foreign policy interests of the US. Once added, the parties are subject to specific license requirements for export, reexport and/or transfer of specific items such as US technologies that are independent of, and in addition to, license requirements imposed elsewhere in the EAR.
Unverified List (UVL)	List of names where the BIS or federal officials acting on its behalf cannot verify the legitimacy and reliability of end-use and end-users of items subject to the EAR. The parties named are ineligible to receive items subject to the EAR by means of a license exception. Parties can be delisted once the bona fides are reviewed and verified by the BIS.
Military End User (MEU) List	List of foreign parties that are determined by the US government to be 'military end users' and represent risk of use in or diversion to 'military end use' or 'military end user' in China, Russia, or Venezuela. The parties are prohibited from receiving items described in Section 744.21 unless the exporter secures a license.

Source: BIS, UBS

Figure 67: US export controls - Decision Tree

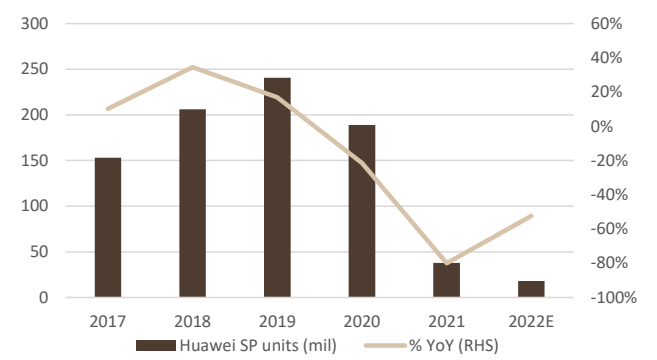


Source: BIS, UBS

Over time, suppliers have in some case been granted licenses to supply companies on the Entity List, An example of this has been suppliers to SMIC, which have been able to supply equipment and materials for 28nm and above process technology (link). This can deceptively lead to believe that those measures can have a diluted impact once applied. In fact in many cases, they have had a material to significant influence on the China tech industry. Take Huawei for example, which saw its position as a smartphone supplier moving from #2 worldwide in units to a marginal player within two years . This stemmed from the restrictions imposed upon US suppliers as well as HiSilicon effectively losing the ability to use its main foundry partners, notably TSMC, for which it had become a strategic customer before.

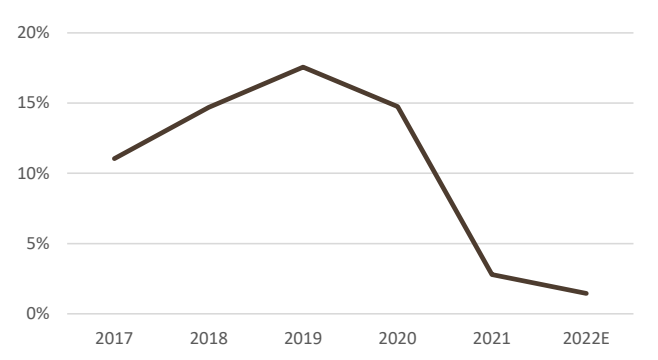
Suppliers over time have been granted licenses to supply to companies such as SMIC on the Entity List

Figure 68: Huawei smartphone units (mil) and YoY growth (%)



Source: Company data, UBS estimates

Figure 69: Huawei smartphone unit market share (%)



Source: Company data, UBS estimates

Figure 70: List of key Chinese companies under the Unverified List (UVL) and Entity List (EL)

Unverified List (UVL)	Entity List (EL)
Beijing Naura Magnetoelectric Tech	Action Global
Beijing Zhonghehangxun Techn	Anvik Tech
Boson Technology	Beijing Cloudmind Technology
Brilliance Technology	Beijing Opto-Electronics Tech
CCIC Southern Electronic Product Testing	Beijing Sensetime Technology
Chengde Oscillator Electronic Technology	BOP Opto-Electronics Tech Company
Chongqing Xinyuhang Technology	BVI Electronics
Dandong Nondestructive Electronics	Changsha Jingjia Microelectronics
Dongguan Durun Optical Technology	Chengdu Haiguang Integrated Circuit
Dongguan Huiqun Electronic	Chipwinone Electronics Co Ltd
E-Chips Technology	Chitron Electronics Company
Emax Technology	Chuangxinda Electronics Tech
Fussion Electronics	CloudWalk Technology
Guangdong Guanghua Sci-Tech	Dahua Technology
Guangxi Intai Technology	FiberHome Technologies
Guangzhou Hymson Laser Tehnology	Fujian Jinhua Integrated Circuit Co.
Heshan Deren Electronic Technology	Hangzhou Hikvision Digital Technology
Jin Yan Technology & Development	Higon
Lianqi (HK) Electronics	HiSilicon Technologies
Voyage Technology	Huawei and Huawei affiliates
Lion Chip Electronics	ICSOSO Electronics
Nanjing Gova Technology	IFLYTEK
Nano Tech International	Intellifusion
Narpel Technology	Laurel Technologies
Phonai Electronics	Longtek Company
Powersun Electronics	Megvii Technology
Shanghai Micro Electronics Equipment	Nanchang O-Film
Shenzhen Winthought Tech	Nanjing FiberHome Starrysky Communication
Shuang Xiang (Fujian) Electronics,	NetPosa
Sino Superconductor Technology	Panda Int'l Information Tech Co.
Sur-Link Technology	Qihoo 360 Tech Company
Toptech Electronics	SenseNets
TRI Microsystems	Shanghai Nova Instruments
Winthought Company	Skyeye Laser Technology
Wuxi Hengling Technology	SMIC Holdings Ltd
Xian Zhongsheng Shengyuan Technology	Tanyuan Technology
Yangtze Memory Technologies Co (YMTC)	Tenco Technology Company
Yogone Electronics	Winninc Electronic
ZhongJie Electronics	Yitu Technologies
Zhuzhou CRRC Special Equipment Technology	Yutron Technology

Source: BIS

Heightened US exports controls since July 2022

Recent US export restrictions will make it challenging, if at all possible, for China to continue to develop a leading edge semis manufacturing industry

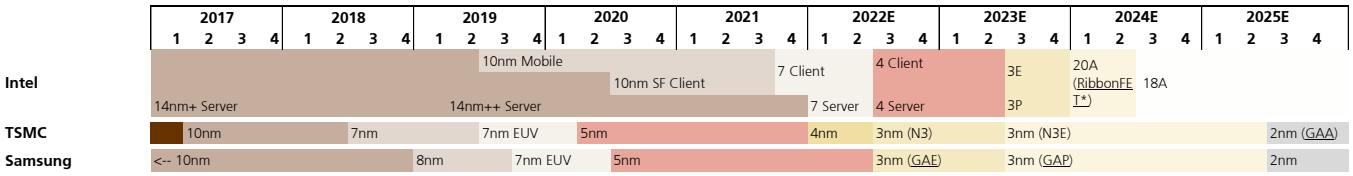
After the Biden administration took office in 2021, we initially went through a period of status quo regarding US tech exports controls to China, This broke off in July 2022, when BIS directly contacted key US wafer fab equipment vendors to request to halt shipments to China of tools enabling 14nm and below production. This was shortly followed by two specific measures towards EDA tools and AI accelerator cards, and then on October 7 2022, a raft of additional restrictions were announced. **Those measures will effectively make it very challenging, if at all possible, for China to continue to develop and grow a leading edge semiconductor manufacturing industry.**

EDA tools restrictions to make sub 3nm IC development challenging

On August 12 2022, BIS announced incremental export controls for EDA tools for the design if ICs using Gate-All-Round (GAA) transistors (link). GAA refers to a transistor structure where the gate is wrapped around the channel. It improves performance and scaling, and has been introduced by Samsung already (3nm) and is planned to be rolled out by TSMC for 2nm (mass production expected in end of 2025) and Intel (20A/18A process technologies). Hence by 2026, the most leading edge Logic processes will all use GAA.

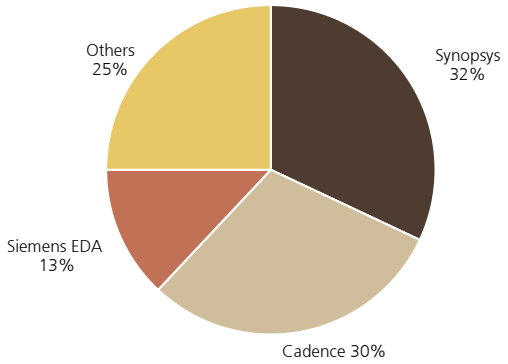
EDA software tools are essential to design ICs. In the advanced Logic space, three US companies dominate the market: Cadence, Synopsys and Siemens EDA (in effect a US company - Mentor Graphics - owned by Siemens). Chinese EDA tool providers do not have solutions in this market segment.

Figure 71: Logic process tech roadmap summaries - Intel, Samsung, TSMC



Source: Company data, UBS estimates
Note: RibbonFET and GAA are comparable structures; Intel's roadmap for 7nm and beyond is based on its company target for five nodes in four years

Figure 72: EDA tool vendors market shares (2021)



Source: Gartner

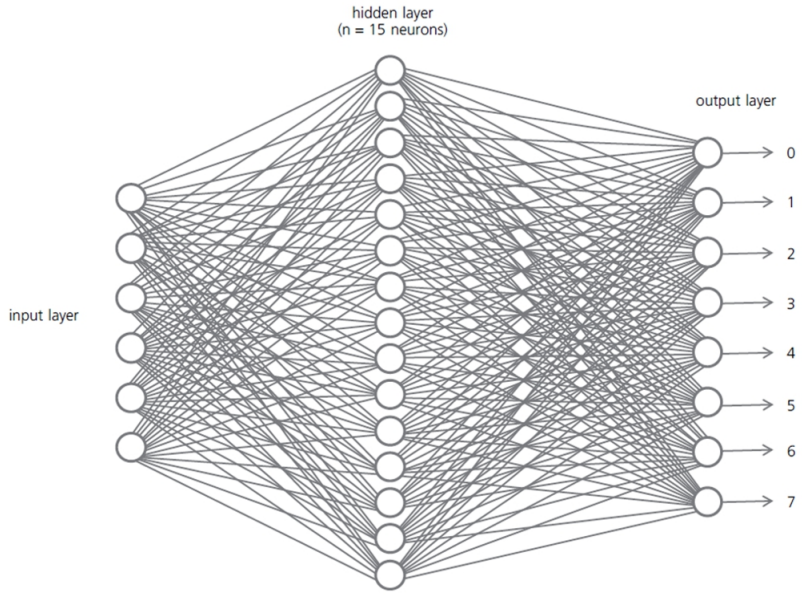
Several Chinese fabless IC vendors have been active in working on Logic ICs using leading edge process technologies - notably for AI accelerators, crypto ICs and GPUs. Those will over time - by 2026 onwards - want to use such processes to offer competitive solutions. Without EDA tools enabling the design process, it will prove to be very challenging.

Restrictions on high end AI accelerators will affect AI Machine Learning

On August 2022, Nvidia revealed in a SEC filing (link) that BIS introduced new licensing requirements for its A100 and H100 GPUs, which are aimed at AI machine learning (ML), for exports to countries at risk including China. **The same directive was issued to AMD for the MI200 solution.**

In theory, machine learning can be achieved without GPU accelerators using CPUs, GPU have the advantage of parallel computing to process a lot of data "in parallel", also known as distributed processing. This speeds up the completion speed and tasks performance for ML. Not having access to high end GPUs may materially slow down ML computing efficiency at Chinese hyperscale customers.

Figure 73: Parallel computing concept



Source: UBS

Figure 74: Nvidia / AMD data centre GPU accelerators comparison

	Nvidia						AMD		
	A2	**A10**	**A30**	**A800***	**A100**	**H100**	**MI210**	**MI250**	**MI250X**
FP64 (TFLOPS)			5.2 / 10.3	9.7 / 19.5	9.7 / 19.5	26 / 51	22.6	45.3	47.9
FP16 (TFLOPS)	18 / 36	125 / 250	165 / 330	312 / 624	312 / 624	1513	181	362	383
INT8 (TOPS)	**36 / 72**	**250 / 500**	**330 / 661**	**624 / 1248**	**624 / 1248**	**3,026**	**181**	**362**	**383**
GPU memory	16GB GDDR6	24GB GDDR6	24GB HBM2	40GB HBM2 or 80GB HBM2e	80GB HBM2e	80GB	64GB HBM2e	128GB HMB2e	128GB HBM2e
GPU memory bandwidth	200 GB/s	600 GB/s	933 GB/s	1555 GB/s (40GB PCIe) 1935 GB/s (80GB PCIe) 2039 GB/s (80GB SXM)	1935 GB/s (PCIe) 2039 GB/s (SXM)	2 TB/s (PCIe) 3.35 TB/s (SXM)	1638.4 GB/s	3276.8 GB/s	3276.8 GB/s
Interconnect	PCIe gen4 x8	PCIe gen4 64GB/s	NVLink 200 GB/s PCIe gen4 64GB/s	NVLink 400 GB/s PCIe gen4 64GB/s	NVLink 600 GB/s PCIe gen4 64 GB/s	NVLink 600/900 GB/s PCIe gen5 128 GB/s	PCIe gen4 100 GB/s	PCIe gen4 100 GB/s	PCIe gen4 100 GB/s

Source: Company data, UBS

Consequently, and as can be expected, Nvidia has reportedly (link) been marketing an alternative, lower end solution (A800) to customers in China. The main difference is a chip-to-chip data transfer rate of 400 gigabytes per second vs. 600 for the A100. The A800 cannot be programmed to execute speed over this threshold. Whether those restrictions would then get tighten a notch or not remains to be seen.

Potential for increased scope of restrictions around high end AI accelerators will limit China's Ai Machine Learning development

Further US exports control measures announced last October to have significant implications

On October 7 2022, BIS announced new export control rules around US semiconductor capital equipment, supercomputing solutions, and "US Persons" in China. Out of those, the restrictions regarding equipment effectively block on their tracks the attempts of China to further develop and scale up a leading edge semis manufacturing industry. The impact of the "US Persons" rule appears more challenging to fully assess. The rules around supercomputing systems are a lot narrower in scope, but may also be, combined with the restrictions discussed above regarding higher end AI accelerators, Stage 1 and 2 of further developments.

US exports restrictions regarding semis manufacturing equipment for leading edge Logic and Memory processes:

BIS now requires US semiscap equipment vendors to obtain a license before shipping equipment for advanced memory/logic makers operating in China. We recap below the key provisions:

New restriction requires US semiscap equipment vendors to obtain a license to ship equipment for advanced memory/logic makers operating in China

- **The licenses required are for equipment used to produce 16/14nm and below Logic (FinFet+GAA), 18nm or below DRAM and 128L or above NAND flash chips.**
- There is a presumption of denial for shipments to domestic Chinese memory makers including Yangtze Memory Technologies Co. (YMTC) and ChangXin Memory Technologies (CXMT).
- **YMTC was also added to the Unverified List (UL).** This implies that if within 60 days, YMTC needs to give access to its facilities to US government inspectors to verify the end-use of the technology. If not, or if the report indicates risks of misuse, YMTC will be added to the Entity List (EL).
- Licenses to sell to foreign companies operating in China will be reviewed on a case by case basis, while a one-year reprieve has been granted to both Samsung, SK Hynix and TSMC.

New restrictions also prevents 'US persons' and in turn US WFE vendors and affiliates from providing service to leading edge Chinese customers

- **The new restrictions also placed in scope any 'US persons'** and in turn semiscap vendors from providing equipment (incl. software support) used to produce at those technologies. This not only applies to US WFE vendors and affiliates, but also "US persons" (as in "individuals" in this case - see below for more details) working at non-US vendors in China. This triggered ASML to pull out their "US persons" employees from leading edge Chinese customers (link); we believe AMSI, amongst others, also took similar measures.
- With semiscap equipment usage often overlapping/ reused for different nodes - ie. semiscap equipment or software possibly also for 19nm also used for 17nm DRAM production, this may have prompted US equipment vendors to initially stop servicing CXMT (link) though currently neither on the EL or UVL . Regarding YMTC being in the UVL list, servicing would have stopped.

No full substitutes available for US semis manufacturing equipment in leading edge and hence China memory semis makers likely to face significant operational challenges

The implications of those rules are fairly profound, in our assessment, for the China leading edge semiconductor manufacturing industry:

1. **No full substitute for US semis manufacturing equipment in the leading edge:** We are still asked many times if Chinese semis manufacturers cannot simply "make do" with Chinese, Japanese, Korean and European substitutes to equipment from AMAT, LAM Research and KLA Tencor. Whilst there are more opportunities in etching, cleaning and deposition (AMAT and LAM) than for metrology and inspection (KLA), those would by no mean cover the whole process flow. A process flow missing key equipment for specific process steps means that one cannot complete the manufacturing of a semiconductor device. Furthermore, the prospects of the Chinese semis manufacturing equipment industry developing full substitutes to those tools is still quite distant, if at all possible (link).
2. **China memory semi makers facing significant operational challenges:** Those rules, if no licensing granted, will lead to China not being in a position to gain scale and go up the process technology curve in both NAND flash and DRAM. YMTC was planning to ramp up 128L NAND flash capacity in the course of 2023 with a whole new fab (Wuhan Fab 2), and CXMT 17nm DRAM over the next 2 years. This will not be possible. Moreover, the operations of existing installed production lines - 64L and 128L NAND flash for YMTC, 26nm and 19nm DRAM for CXMT - are severely complicated by the field engineers from US equipment vendors having been pulled out, the broader US Person rule, the likely cutting off of software feeds onto the US tools, and no provision of spare parts. This will likely lead to a decline in wafer output over the next couple of years, possibly accelerated if this leads to cash flow pressure, as we expect a memory downturn til 2Q23 (link). Note that GigaDevice (link) procures DRAM from CXMT.
3. **Foundries only impacted in the leading edge, at least for now:** 14/16nm is a small portion of China foundry capacity, with c. 15k wpm at SMIC (14nm). Current capacity additions plans for Chinese foundries, including SMIC, are at 28nm and

Impact to foundries limited to leading edge for now but will impact competitiveness in trailing edge

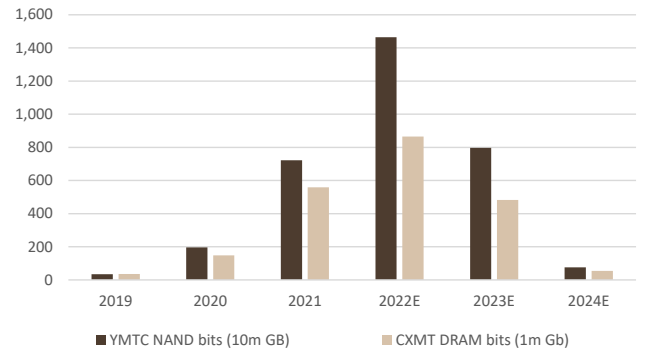
above so not in scope. Hence the immediate impact is limited. That being said, what we do not know is it is a fixed threshold for the foreseeable future or not. If it is, within the next 5+ years, 14-16nm will be trailing edge. Hence, it may start to impact Chinese foundries for their competitiveness in trailing edge, at least for those segments where pure line width shrink matters to the value offering to customers (ie when cost or power consumption matter).

going forwards

4. **The China wafer fab equipment ecosystem also negatively impacted:** As we detailed in our recent China semiscap coverage initiation (link), China WFE vendors are disproportionately exposed compared to global peers to China memory vendors (Figure 67). They will therefore be negatively impacted by the coming shortfall in spending. Moreover, they face the prospects of having in the future no natural ecosystem proximity to leading edge customers.

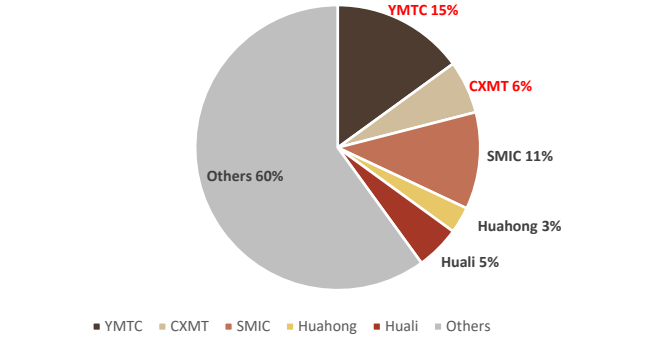
China WFE ecosystem negatively impacted with potentially no proximity to leading edge customers in the future

Figure 75: YMTC and CXMT bit shipment estimates



Source: UBS estimates

Figure 76: China memory companies' share of China overall WFE market in 2021

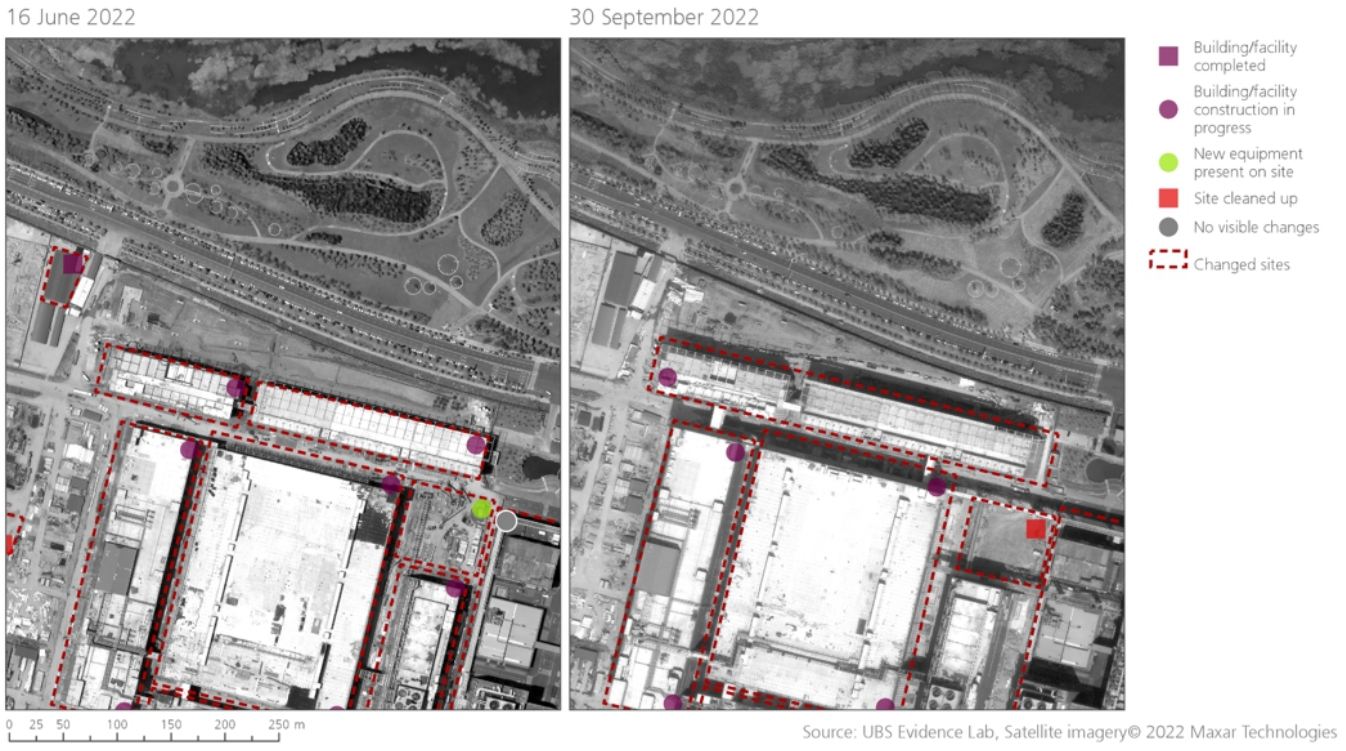


Source: Gartner, UBS estimates

Figure 77: YMTC (Wuhan) - Key Milestones (As of September 30, 2022)

Source: UBS Evidence Lab (>Access Dataset), Digital Globe, ESRI

Figure 78: YMTC's Wuhan fab (1) – Construction Milestone (September 30, 2022) - Second floor deck construction along the upper half of Fab 2 appear to be nearing final stages



Source: UBS Evidence Lab (>Access Dataset), Digital Globe, ESRI

Figure 79: YMTC's Wuhan fab (2) – Construction Milestone (September 30, 2022) - Second floor deck along the bottom half of Fab 2 showing continued progress; concrete layering near complete

Source: UBS Evidence Lab (>Access Dataset), Digital Globe, ESRI

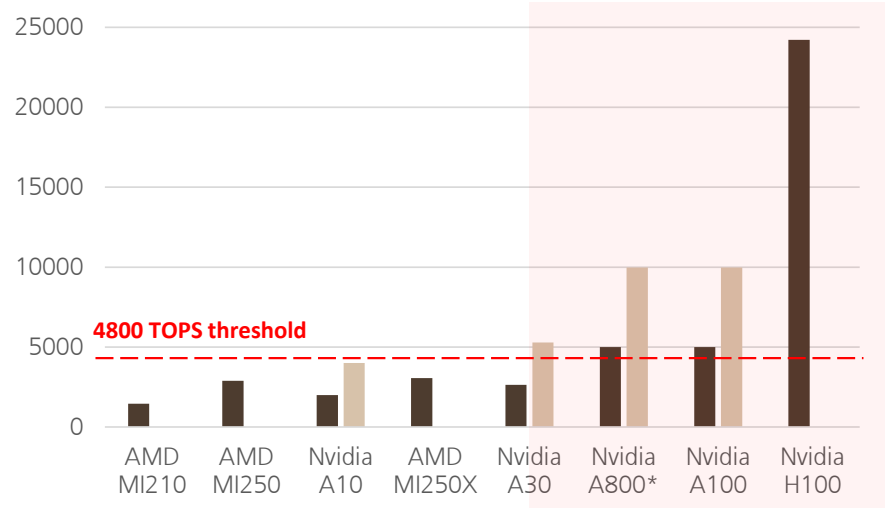
US exports restrictions for supercomputing systems:

The new control rules also expanded or rather 'clarified' the restrictions that were placed earlier in September restricting both NVIDIA and AMD from shipping SKUs of certain leading edge AI chips (ie. NVDA A100) - restricting both super computing ICs (chips) and supercomputers under new Foreign Direct Product (FDP) rules that were specified according to set performance parameters with new Export Control Classification Numbers (ECCN).

- Under ECCN 3A090, **controlled ICs in scope includes one or more digital processor units with a combined processing performance exceeding 4800 tera operations per second (TOPS)**' with ECCN 4A090 also included to cover commodities containing ICs specified under 3A090.
- For **supercomputers**, the term is defined as a computing system having a maximum compute capacity of 100 petaflops (64-bit) or more within a 41,600ft3 volume space.

The main targeted segment is indeed supercomputers, which can be used in defense applications. Looking at the level of performance, it may also put in scope some of the most advanced AI accelerators.

Figure 80: Computing chips which may meet the 4800 TOPS threshold



Source: Company data, UBS

Defining the scope of the "US Persons" rules

How BIS defines "US Persons" is as follows:

The scope of "US Persons" includes individuals but also corporations and/or any other entity or organisation that is incorporated to do business in the US

- **Individuals:** 'Any juridical person under US law', permanent residents - which captures US passport or Green Card holders.
- **Legal entities / corporations:** "US persons" also refers to "any corporation, business association... or any other entity, organisation or group that is incorporated to do business in the United States" which would effectively place in scope the US semiscap vendors incorporated in the US but also overseas branches (eg. AMAT China).

"US persons" are required to get a license from BIS for shipping, transmitting, or transferring (in-country) to or within the PRC any item not subject to the EAR that that person know may be used for the development or production of ICs either 1/ using leading edge semiconductor processes (as in 128L or above NAND Flash, 18nm or below DRAM and 16/14nm or below Logic) **or 2/ which may be used for restricted applications** such as Military or Nuclear. Note that those rules are in effect similar to those applying to US Persons working in the aerospace/defense/nuclear industries.

Initially this rule created some confusion within the semiconductor industry, as 1/ the scope was subject to some degree of interpretation; 2/ many executives at Chinese semis companies are "US persons" as in having studied/worked in the US, and then subsequently come / come back to China with a US passport / Green Card. The scope was further clarified (link); from that we would draw the following conclusions, noting that actual implementation may lead to further clarifications:

- **Semis manufacturers:** US Persons working at semis manufacturers in China are subject to licensing if involved in the process development or actual manufacturing of leading edge semiconductor devices (as defined above).
- **Semis equipment manufacturers:** US Persons involved in the development, supply, support of those tools. This includes non-US equipment vendors and in fact, Chinese equipment vendors.
- On the other hand, **fabless IC vendors who may develop ICs using leading edge semis processes (such as 16/14nm or below Logic) are not in scope. Back End (assembly and test) subcontractors are also not in scope.**
- If the end-use is Military/Nuclear and in that case a US Person at a fabless IC company, back end contractor or an IDM / foundry using trailing edge processes would need a BIS license.
- There is an exclusion for "administrative" staff, and we understand that this may have lead some to believe that this means that "non-technical" staff is not in scope, including management. However, a CEO or COO (for instance) of a semis manufacturer would have knowledge and/or influence on technology development and production. Hence by definition, which would also place them in scope.

Where could US policies towards China Tech go from here?

Clearly, the direction of travel over the last few years has been towards: 1/ broader scope of restrictions; 2/ much more targeted measures, and likely more effective as a consequence; 3/ more "presumption of denial" or stringent BIS licensing criteria, as opposed initially to many licenses being granted; 4/ moving further away from "defence" and "security" themes towards considering Technology as strategic in itself, and hence, ultimately, key to driving economic development.

Broad, bipartisan support in the US that support the current sanctions suggest we may see more to come

Furthermore, it is also quite clear that there remains a broad consensus across political parties in the US to support such sanctions. Hence, we should assume for now that we may see more sanctions, rather than less, over the next few years. The question in then more along the lines of: where to from here?

1/ The US may seek other countries to "fall in line"; but would that really make a material difference?

The US DoC already commented (link) that it will propose technical parameters to be added to the Wassenaar Agreement in 2023, so far for Military end-use. It is also under the Wassenaar Agrement (link) that the Dutch government requires export licenses for EUV lithography tools to China, with so far none granted. On the other hand though, the Dutch government also recently commented (link) that it will make its own decisions regarding in particular sales of ASML's DUV lithography tools to China.

Another framework the US government has been promoting is the **Chip 4 Alliance** (US, Taiwan, South Korea and Japan) - with some considerations from South Korea in particular (link) around the need for economic cooperation with China.

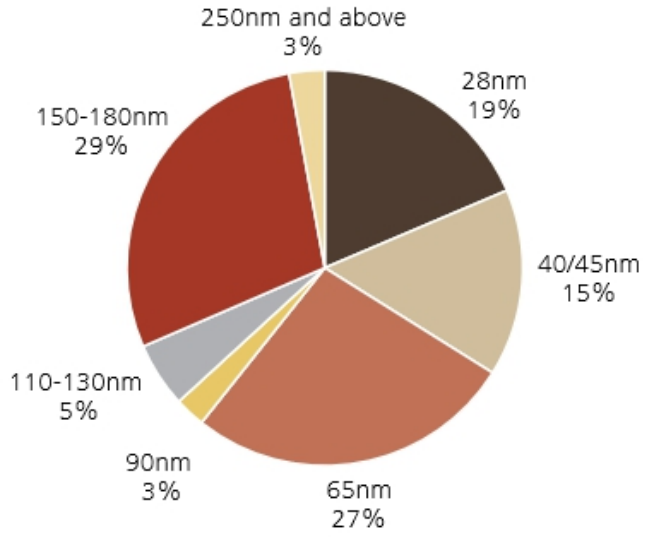
Ultimately, if we zoom back onto wafer fab equipment, we view any of those developments as redundant: If for example a leading edge China semiconductor maker cannot get tools from AMAT, LAM Research or KLA Tencor, it actually does not matter much if it can procure equipment from Tokyo Electron or ASML; Either way, it cannot complete a full process flow and operate a fab at those leading edge nodes.

2/ Unlikely to see further US restrictions vis-à-vis China semis manufacturing, in our view

As we have seen above, it will be very challenging for China to develop to scale a leading edge semiconductor manufacturing industry if licenses to US suppliers are routinely denied. On the back of our calls with government policy experts, we think that going forwards, it is unlikely that the **US DoC will further widen restrictions related to semis manufacturing.**

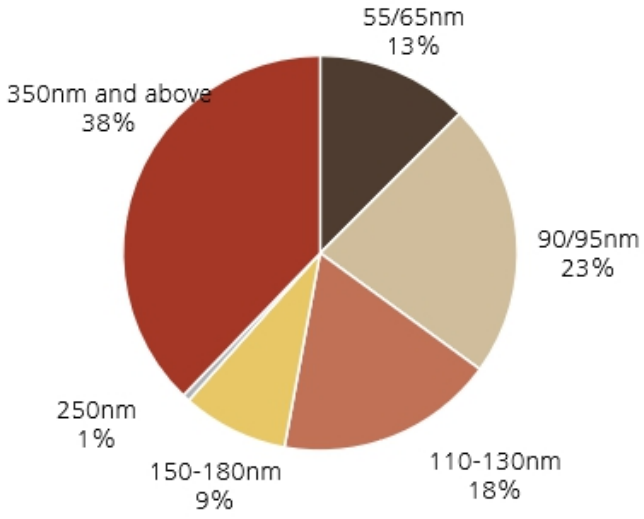
Should those restrictions extend to 28nm and below, for instance, they would have a fairly significant impact on the ability of Chinese foundries to operate as 28nm is a fairly meaningful process technology node. But 1/ the actual rationale woud not be obvious to us; 2/ it is not the line the US government has drawn for SMIC, even with SMIC on the EL, so far, as US equipment vendors have had no issues delivering tools for 28nm.

Figure 81: SMIC process technology node revenue mix (as of 4Q21)



Source: Company data

Figure 82: Hua Hong process technology node revenue mix (as of 3Q22)



Source: Company data

An extreme view, echoed by some US lawmakers (link) would be a full licensing process for any US WFE sales to China - but our discussions with experts indicate so far a lack of political consensus, and one would imagine, pushback from the US WFE industry at large. So we would assign, also, a low probability to this scenario.

3/ Further AI chipsets restrictions could be a possible scenario

BIS already rolled out both product-specific restrictions for AMD/Nvidia AI accelerator solutions as well as more broadly for supercomputing systems. **This raises the question as to whether the DoC could broaden restrictions to all AI chipsets**. Back in November 2018, the US DoC examined the possibility of controlling export of AI chipsets (link).

While additional restrictions to semis manufacturing seems unlikely, further restrictions to AI chipsets a possible scenario

Two directions could be adopted going forward, which although we have no indications they will be, could be deemed consistent with precedents: 1/ BIS requiring a license for all AI accelerators solutions developed by US vendors and/or; 2/ the manufacturing (at foundries) of AI accelerators being subject to BIS licensing as using US WFE, and/or the availability of US EDA tools for such applications for end-use in China. This would impact the ability of China to develop and manufacture AI accelerators. In that extreme scenario, China's access to AI accelerator solutions would be materially impacted - and by implication, software innovation, notably for China hyperscaler companies.

4/ Beyond Semis: Could software be next?

Beyond semis, next areas could be AI and data analytics software tech

The November 2018 Advanced Notice of Proposed Rulemaking we referred to re. AI chipsets (link) also identified AI and data analytics software technology including neural networks, AI could technologies, automated analysis algorithms, context-aware computing etc. This could be viewed an extension of prior AI and supercomputing restrictions.

There are however two major limitations to the efficiency of such possible measures. 1/ China has its own, fairly mature and in some areas, world-leading software ecosystem in those verticals; 2/ Controlling software use is a lot more difficult that actual supply and use of hardware and semis.

Figure 83: Tech-related representative categories indicated under the US DoC ANPRM, November 2018

Categories
Artificial intelligence (AI) and machine learning technology
Neural networks and deep learning
Reinforcement learning
Computer vision
Expert systems
Speech and audio processing
Natural language processing
Audio and video manipulation technologies
AI cloud technologies
AI chipsets
Position, Navigation, and Timing (PNT) technology
Microprocessor technology
Systems-on-Chip (SoC)
Stacked Memory on Chip
Advanced computing technology
Memory-centric logic
Data analytics technology
Visualization
Automated analysis algorithms
Context-aware computing
Quantum information and sensing technology
Quantum computing
Quantum encryption
Quantum sensing
Robotics
Micro-drone and micro-robotic systems
Swarming technology
Self-assembling robots
Molecular robotics
Robot compliers
Smart Dust
Advanced surveillance technologies
Faceprint and voiceprint technologies

Source: BIS

Part III: How far could Tech de-globalisation go?

The drive for regaining national sovereignty in an industry as strategic as Technology is understandable. But at the same time, the global economy has significantly benefited from globally integrated supply chains. So, if the world to some extent goes into reverse mode, how would those supply chains evolve? And can China fence off US restrictions?

How China's technology strategy could evolve?

At first glance, the obvious response from China to facing growing restrictions from the US regarding Tech and specifically Semis will be to reiterate and accelerate its drive towards semiconductor self-sufficiency. In practice though, this will be very challenging to achieve for leading edge semiconductor manufacturing.

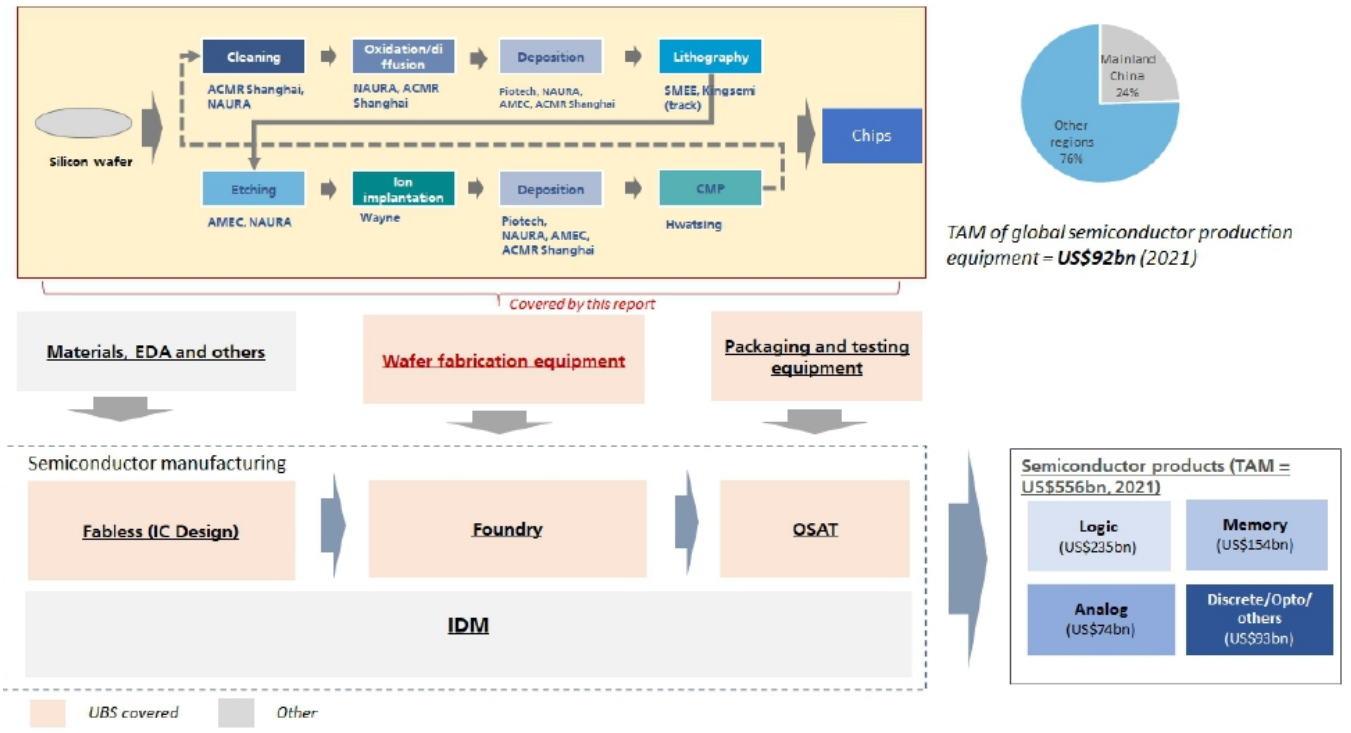
That being said, the most recent restrictions do not materially affect the ability of the China semis industry to continue to develop for trailing edge logic / analog and related segments. We expect a continued push to expand China's self-sufficiency in those segments.

Expect China to continue develop self-sufficiency in trailing edge logic / analog segments

China's reassessment of the 2025 plan

The 'Made in China 2025' plan was a national strategic plan introduced in May 2015 that outlined China's plan to bolster its manufacturing capabilities in various industries. The plan highlighted 10 key areas that were in focus (ie. IT, new energy vehicles, biotech etc.) with an added emphasis that was placed on semis development and self-sufficiency - the goal was to meet 70% of local semis needs via domestic supply by 2025.

Figure 84: Overview of China's semiconductor supply chain



Source: UBS and UBS-S, Gartner. Note: EDA = electronics design automation, OSAT = outsourced semi assembly and test, IDM = integrated device manufacturing

To spur investments from corporates, the Chinese government increased investments by state-backed funds with the largest fund the China Integrated Circuit Industry Investment Fund also referred commonly as the 'Big Fund'. The 'Big Fund' set up in 2014 was the primary vehicle tasked with supporting the 'Made in China 2025', having initially raised 140bn yuan in its first round of fund raising with another 200bn yuan in 2019. Recently, press reports emerged of executives of the "Big Fund" facing graft probes (link).

Another key investment vehicle / holding company was Tsinghua Unigroup, which once held stakes / acquired assets such as Omnivision, Spreadtrum, RDA and YMTC. Since then, Tsinghua Unigroup filed for bankruptcy, was subsequently taken over by Beijing Zhiguangxin, and completed its financial restructuring.

Taking it all together, considering that China has invested c. US$80-100bn since the "Made in China" plan was announced, we could deduct that how the semiconductor drive is funded, by whom, and directed to which key technology verticals, is in the process of being re-assessed. How long this will take still remains to be seen.

China has so far invested an est. c. US $80-100bn since the "Made In Chin" plan was announced

Figure 85: Major upcoming foundry/IDM projects in China

No	Company	Fab	Shareholding structure	City/Province	Wafer size	Fab type	Node	Planned capacity (k wpm)	Total investment (US$ m)	Construction start year	Planned completion year
1	**SMIC**	Lingang new fab	SMIC (66.45%), **gvt and related fund (33.55%)**	Shanghai	12"	Foundry	28nm and above	100	8,870	Jan. 2022	2027
		Beijing new JV fab (SMIC Jingcheng)	SMIC (56.54%), **gvt and other related funds (43.46%)**	Beijing	12"	Foundry	28nm and above	100	7,600	Jan. 2021	2024
		Beijing new fab (phase 2)	SMIC (51%), **gvt and related funds (49%)**	Beijing	12"	Foundry	45~28nm	70	NA	NA	2023
		Shenzhen 12" fab	SMIC(49.74%), **gvt and other related funds (51.26%)**	Shenzhen	12"	Foundry	28nm and above	40	2,350	July 2021	2023
		Tianjin 12" fab	NA	Tianjin	12"	Foundry	28nm and above	100	7,500	Sept. 2022	2025 and beyond*
2	**SEMC**	Phase 1	SMIC(19.57%), others(80.43%)	Shaoxing	8"	Foundry	0.35um	158	938	2022	2023
		Phase 2	SEMCS(27.67%), **gvt and related funds (25%)**, others(47.33%)	Shaoxing	8"	Foundry	0.35um	70	1,571	2021	2023
		Compound fab	SMIC(19.57%), **gvt and related funds (22.7%)**,others(57.73%)	Shaoxing	6"	Compound	0.35um	20	714	2022	2023 and beyond
3	**NSEMII**	N2	SMIC (15.85%), **gvt and related funds (28.39%)**	Ningbo	8"	Foundry	0.25um	27.5	571	2021	2022-2023
4	**Hua Hong**	Fab 7	Hua Hong (51%), **gvt and related funds (49%)**	Jiangsu	12"	Foundry	90/65-55nm	94.5	1,800	2021	2022-2023
		Fab 8	Hua Hong (51%), **gvt and related funds (49%)**	Jiangsu	12"	Foundry	55nm	90	5,000	TBD	2025-2026*
		Fab 8	Hua Hong (51%), **gvt and related funds (49%)**	Jiangsu	12"	Foundry		83	6,700	2023	2025-2026*
5	**GTA Semi**	Lingang fab phase 2	Huada (32.88%), **gov and related funds (44.58%)**, others (22.54%)	Shanghai	12"	Foundry	65nm	50	3,824	2022	2023
6	**CanSemi**	Phase 1+2	**Gov and related funds (24.8%)**, others (75.2%)	Guangzhou	12"	Foundry	180-55nm	40	770	2018	2023
		Phase 3	**Gov and related funds (24.8%)**, others (75.2%)	Guangzhou	12"	Foundry	55nm and below	40	1,530	2022	2025-26
7	**Nexchip**	Fab2	Powerchip (27.44%), **gov and related funds (31.14%)**, others (41.42%)	Hefei	12"	Foundry	55nm and above	40	2,647	2020	2023-2024
8	**Yandong Micro**	12" Fab	**Gov and related funds (87.82%)**, others (12.18%)	Beijing	12"	Foundry	65nm	40	1,071	2021	2025
9	**Nexperia (Wingtec)**	Lingang fab	WingSky (100%)	Shanghai	12"	IDM (analog/power)	250nm	30	1,800	Aug. 2020	2023
10	**CR Micro**	Chongqing Fab	CR Micro (19%), **gov and related fund (66%)**	Chongqing	12"	IDM (Discrete/power)	350nm	30	1,079	Aug. 2021	2023
		Shenzhen 12" fab	CR Micro (75%), **gov and others (25%)**	SHenzhen	12"	IDM (power/analog)	40nm and above	40	3,143	Oct. 2022	2025*
11	**Sien**	12" Fab	Aucma(69.98%), **Gov and related funds (4.92%)**, Others(25.1%)	Qingdao	12"	Foundry	40~16nm	20	2,206	2021	2022
12	**Fullsemi**	Hangzhou Fab	**Gov and related fund (44.45%)**, others(55.55%)	Hangzhou	12"	Analog/Power	90nm~55nm	50k	5,882	2020	2023
	Total								**67,567**		

Source: Company data, government website

Does the China wafer fab equipment industry hold the keys to self-sufficiency?

We remain of the view that and as our industry discussion & analysis suggests, that **there is no meaningful avenue and hence breakthrough that has been made in China's lithography and process control (e.g. metrology and inspection).** In contrast, we note that China has made notable progress in other sub segments (including etch, deposition, cleaning, etc.), especially for the trailing edge and/or non-critical/semi-critical applications. As a result, it is possible that local WFE makers may increasingly get more opportunities for penetrating into trailing-edge critical

While China's WFE industry has made notable progress in areas such as etch, deposition and cleaning, there has been no meaningful breakthrough made in lithography and process control

applications on the basis of supply chain security reason. However, we note that longer term progress and development will be hindered by the lack of local leading edge customers in China. For more details, please refer to our recent China WFE initiation (link).

Despite China's leading edge foundry and memory production efforts now largely on hold, we still note and remain optimistic on pockets of areas within China semiscap including etch and cleaning, especially for trailing edge and/or non-critical/semi-critical applications with bottom up analysis suggesting that Chinese vendors have the capability to cover major processing steps in etch, deposition, cleaning and thermal process equipment for 28nm and above nodes.

China WFE vendors have narrowed some of the technology gap with multinational peers as well as expanded the coverage range in trailing edge applications:

- **Widening coverage:** Other than lithography and process control, our analysis suggest Chinese vendors already cover etching, deposition (i.e. PECVD, LPCVD, etc.), Ion Implantation, cleaning, thermal process, track, etc.
- **Technology maturity:** On the basis of our supply chain discussion as well as company disclosure, we believe Chinese vendors are capable to cover most non-critical/semi-critical process of etching and deposition applications (e.g. 70-80% of total processes), and 80%+ cleaning process for trailing edge chip.

Figure 86: Competitive landscape of WFE sub-segments

Major process	Entry barrier	Market size (2021, U$bn)	As % of total WFE * (2021)	Market conentration* (2021)	Major Chinese players	Chinese vendors' global mkt share (2021)	Chinese vendors' mkt share in domestic market (2021) *
Lithography	Extre high	16.1	19%	ASML (90%+)	SMEE	0%	*0%*
Dry etch	High	18.7	22%	**LAMR (46%)**, TEL (29%), **AMAT (16%)**	AMEC, NAURA	3%	*13%*
Deposition	High	19.4	22%	**AMAT (42%), LAMR (18%)**, TEL(13%)	Piotech, NAURA, AMEC, ACM Research	1%	*4.9%*
Cleaning*	Medium	4.8	6%	SCREEN (40%), TEL (25%), SEMES (16%)	ACM Research, NAURA	5%	*20%*
Thermal Process	Medium	2.5	3%	**AMAT (45%)**, Kokusai (19%), TEL (19%)	NAURA, ACM Research	1%	*6%*
CMP	Medium	2.8	3%	**AMAT (68%)**, Ebara(26%)	Hwatsing	4%	*14%*
Photoresist processing	Medium	3.5	4%	TEL (89%), SEMES (7%)	Kingsemi	2%	*8%*
Ion Implant	High	2.0	2%	**AMAT (64%), Axcelis (22%)**, SMIT (9%)	Kingstone	1%	*4%*
Process control	High	9.8	11%	**KLA (54%), AMAT (13%),** Hitachi High-tech (7%)	Jingce, etc.	NA	*NA*
Other equipment	Miedum	7.1	8%				
Total		**86.5**	**100%**	Top 5 vendors (78%)		<3%	<15%

Source: Gartner, company data, UBS-S; Note: * we assume the % of different WFE segment in China being similar to the % of WFE in global market; 2) ** This is mainly for Chinese vendors' market share in domestic fabs

Figure 87: Major Chinese WFE vendors' technology capability and coverage

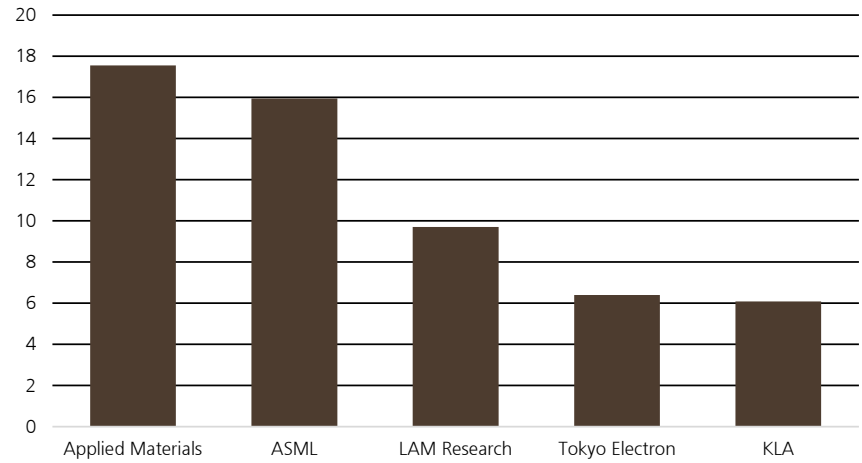
Process/ Company	NAURA	AMEC	ACMR	Piotech	Wanye	Kingsemi	Huatsing	Pnc Process	E-town	SMEE
Lithography										**90nm (R&D and qualification)**
Etch	**Yes**	**Yes**								
- Conductor etch	28nm (non/semi-critical)	28nm (non/semi-critical)								
- Dielectric etch		5nm (non-critical)								
Deposition	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**					
- PVD	28nm (50%+ applications)									
- PECVD				28nm (c80% applications)	R&D					
- LPCVD	Under qualification / small volume shipment	R&D								
- Other CVD	Under qualification			Under qualification	R&D					
- ALD	Under qualification	R&D	R&D	Under qualification						
- Epi	Small volume shpment	R&D								
- MOCVD		For LED/mini-LED application								
- ECD			28nm							
Cleaning	**Yes**		**Yes**			**Yes**		**Yes**		
- Single wafer	28nm (non-critical)		28nm (non/semi-critical)			For back-end application		28nm (non-critical)		
- Wet Bench	65/55nm		65/55nm					65nm		
- Backside			28nm							
- Scrubber						Yes				
Thermal process	**Yes**		**Yes**						**Yes**	
Track						**Yes**				
Ion Implantation					**Yes**					
CMP and related			**For TSV and FOWLP (under qualification)**				**28nm**			

Source: Company data, UBS-S

Even with that in mind, **this still leaves significant gaps in critical WFE segments.** Those are essential to not only leading edge semiconductor manufacturing, but also for some of them, trailing edge. Amongst those are:

- **Lithography:** this is probably the hardest WFE segment to enter for Chinese equipment vendors. ASML now has a quasi-monopoly, invested EUR18.5bn in R&D over the past 20 years alone, and has c. 13,000 R&D engineers. SMEE in China has been developing litho tools but still at the R&D stage, and our industry discussions suggests it is still c.10 years away from having production-worthy DUV lithography tools. Even then, ASML is not staying static in DUV and continues to invest in perfecting tools (iLine, KrF and ArF), for which it started developing technology 30 to 40 years ago. Hence not adopting those (or in some case Canon or Nikon's) would lead to a major competitive penalty. EUV lithography had been more than 30 years in making til it finally got in mass production in 2019.
- **Metrology and inspection:** KLA Tencor and AMAT also command a fairly high combined share. As in litho, optical technology as well as software are key enabling technologies, Those solutions effectively benefit from the decades of data gathered at customers' site to improve solutions. Hence barriers to entry are also very high.
- **Deposition and etching:** For critical steps, non-Chinese companies retain a full stronghold. While at time the parallel with the Korean deposition equipment industry is made, we note that those companies (Wonik IPS, Jusung, Eugene Tech, TES, etc) benefit from close collaboration with leading edge customers (Samsung and SK Hynix). For some of the key critical segment like most (not all) of Atomic Layer Deposition (ALD) and deep aspect ratio etching, barriers to entry are significant. There as well, the sheer amount of data the established players have available is a significant edge, especially with now the use of AI.

Figure 88: Accumulated R&D spend (US$bn) by the top 5 (current) WFE vendors (2012-2021)



Source: Company data, UBS

Even if China would fill up all the (still considerable) gaps in its coverage of process steps, the rest of the world, coming from a strong incumbent position, is not standing still. All leading wafer fab equipment vendors and their supply chains have accumulated significant IP and know-how over the last decades. They continue to develop new iterations of tools for mature technologies too, widening the productivity and process control gap vs possible newcomers. **So the risk is that Chinese semis equipment makers continue to try to play catch up with the industry leaders widening the technology gap.**

Which semiconductor segments will likely remain largely unaffected by the US restrictions?

Whilst US restrictions will likely have a profound impact on leading edge semis capabilities in China, several segments are on the other hand likely to be relatively unaffected. Those include we believe:

Fabless ICs, trailing edge foundries and OSATs all expected to see minimal impact from the US restrictions

- **Fabless ICs: Mostly unaffected.** In the leading edge, China fabless IC vendors can continue to develop products with no restrictions as long as they keep the access to non-China foundry sources such TSMC. The continuity of that access though remains essential. In the trailing edge and Analog, fabless ICs continue to benefit from having access to both Chinese and non-Chinese foundry sources. Some of the China GPU/CPU fabless IC suppliers may however cross the performance threshold on supercomputing performance. . Biren and Alibaba T-Head in particular have suspended tapeout plans at TSMC (link).
- **Trailing edge foundries: Unaffected.** Any operations at 28nm and above is not in scope, and in our view, unlikely to be so.
- **OSATs (assembly and test subcontractors): Limited indirect impact.** Most of the revenues from China OSATs come from trailing edge ICs, so the indirect impact is limited. Payton Tech and Tongfu do supply though CXMT, and Huatian and JCET supply YMTC. For Huatian we believe the exposure to YTMC is below 5% of total revenues, and for JCET below 2%. Also note that JCET (China's #1 OSAT player) also has sizeable operations outside of China (STATS-ChipPAC).

Will M&A regulatory approvals continue to be a key policy priority?

Over the past few years, MOFCOM (China's Ministry of Commerce; now called SAMR - State Administration for Market Regulation) M&A regulatory approval process has had to review multiple potential deals involving US semiconductor assets. The triggers for such reviews are: (1) Aggregate global turnover of US$1.5bn per year and least tow undertakings each with revs above US$63m in China (in previous financial year); and (2) aggregate turnover in China of US$315m per year and least tow undertakings each with revs above US$63m in China (in previous financial year); or if the transaction "may result in the elimination or restriction of competition in China".

Some major transactions involving US semis assets did not receive approval over the past 8 years. We expect the SAMR review process to remain, going forward, a key hurdle for M&A within the tech, and most specifically, semis, industry.

Figure 89: MOFCOM/SAMR review process involving US semis companies (2014 to date)

Year	Acquirer	Acquiree	Deal Amount	Current status / MOFCOM response
2021	Broadcom	VMware	US$ 61.0bn	Currently pending
2020	SK Hynix	Intel's NAND flash business	US$ 9.0bn	Approved; SAMR approved with a condition of ban on written or verbal contracts eliminating or restricting competition
2020	NVIDIA	Mellanox	US$ 7.0bn	Approved; SAMR approved after one year investigation focused on conglomerate effects
2020	Infineon	Cypress	US$ 10.0bn	Abandoned; SAMR imposed FRAND remedies
2020	Analog Devices	Maxim	US$ 20.8bn	Approved; MOFCOM approval came with unconditional clearance
2020	AMD	Xilinx	US$ 35.0bn	Approved; conditional approval under no forced tie-in sales permited
2019	KLA Tencor	Orbotech	US$ 3.4bn	Approved; SAMR approved the merger with antitrust clearance.
2017	ASE Semis	Siliconware	US$ 4.3bn	Approved; MOFCOM approved with the two year "hold-separate" condition.
2017	Broadcom	Brocade	US$ 5.5bn	Approved; MOFCOM approved the case with conditions.
2017	Bain Capital	Toshiba Memory	US$ 18.0bn	Approved; MOFCOM approval came after significant (one year) delay
2016	Qualcomm	NXP	US$ 44.0bn	Abandoned; MOFCOM did not approve the deal before set deadline
2015	KLA Tencor	Lam Research	US$ 10.6bn	Abandoned; MOFCOM cited less competition
2014	Applied Materials	Tokyo Electron	US$ 9.3bn	Abandoned; MOFCOM insisted divesture assets sold to a chinese firm; US regulators defined on security concerns

Source: Company data, MOFCOM

How far can de-clusterization and parallel tech supply chains materialise?

The net impact of re-shoring will be over time some degree of de-clusterization, and the emergence of parallel supply chains. As examples:

- A US OEM may decide to favour "made in the USA" chips either to secure its supply chains, or as political appeasement;
- The portion of components and assembly coming from the same region as where the product is expected to ship may increase.
- Some degree of duplication between those supply chains occur over time.

How far could this feasibly go?

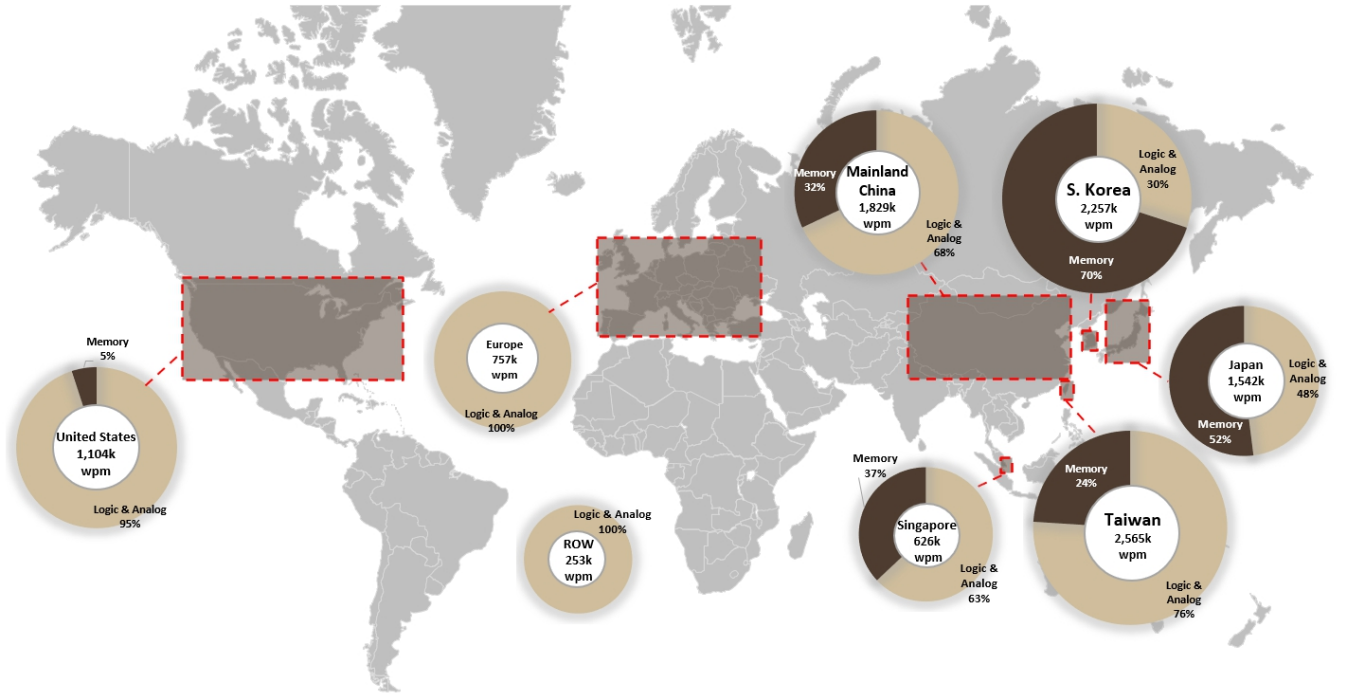
Will re-shoring re-shape the global mapping of the semiconductor supply chain?

With US$180-210bn expected to pour in through from the various re-shoring plans (ex China) in the semis industry, will this actually change the course of the industry, and steer the balance away from Taiwan and South Korea in particular? We theorize that this will be the result of two opposite forces at play: (1) Pulling away will be the subsidies, any national preference in purchasing (e.g. OEMs preferring "made in the USA" chips) , talent pool diversification and political will. (2) Pulling back will be the strength of the existing clusters and the strong capital base of the two main Asia players (TSMC, Samsung).

Re-shoring incentives via subsidies unlikely to meaningfully change the balance between existing semiconductor ecosystems

Combining the planned fabs through re-shoring programmes with our forecasts for other fabs expected to be built and equipped over the next 5 years, we note that the US in particular will increase the most in total installed semiconductor capacity (Figure 82). Nevertheless, **by 2026, the US would still only account for 55% of forecasted semis wafer capacity in China, 46% of South Korea and 43% of Taiwan .**

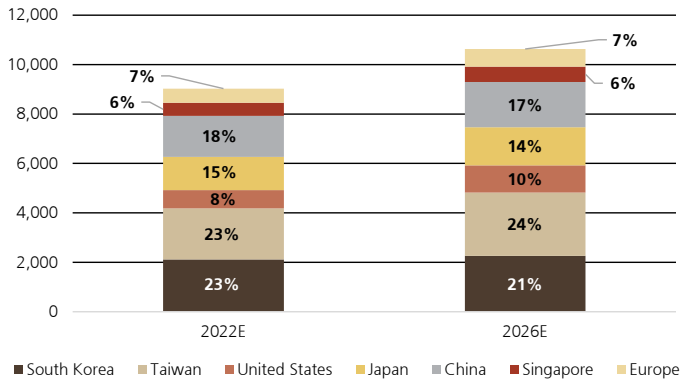
Figure 90: Global semis production capacity breakdown by country/regions (k wpm, 12 inch equivalent, 2026E)



Source: Company data, UBS estimates

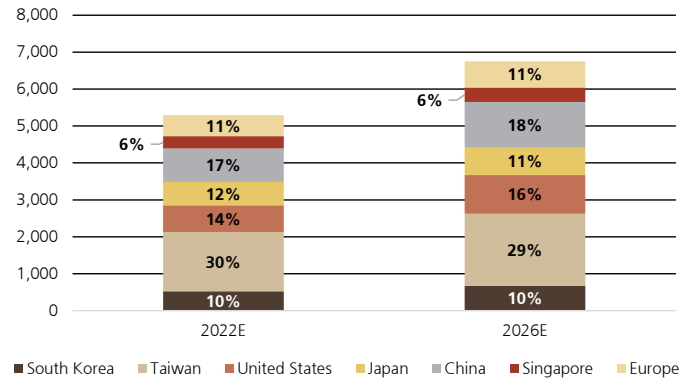
Arguably this does not tell the full story has memory inbalances some of those calculations. Focusing on Logic / Analog, then the US could get to a second position to Taiwan by then. But on balance, our analysis does suggest that **re-shoring initiatives are unlikely to dramatically change the balance between the existing semiconductor ecosystems.**

Figure 91: Global semiconductor installed wafer capacity (k wpm) per region (and % of total) - 2022-2026E



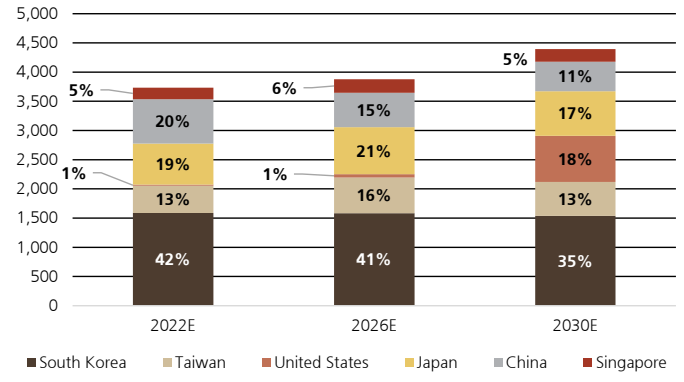
Source: Company data, UBS estimates

Figure 92: Global non-memory semiconductor installed wafer capacity (k wpm) per region (and % of total) - 2022-2026E



Source: Company data, UBS estimates

Figure 93: Global memory semiconductor installed wafer capacity (k wpm) per region (and % of total) - 2022-2030E *



Source: Company data, UBS estimates; * Note Micron's new US capacity is expected to ramp in 2026-2030

Can parallel supply chains really exist: smartphones case study

Conceptually, this may look like this:

Figure 94: Conceptual example of a parallel smartphone supply chain in the US and China

	Made in US	Made in China
Smartphone Design	Designed in US	Designed in China
Foundry		
Leading Edge	TSMC (Arizona fab)	TSMC (Nanjing fab)
Trailing Edge	TSMC (Arizona fab)	SMIC
Modem	Qualcomm	No alternative
RF/Cellular	Broadcom, Qualcomm, Qorvo, Skyworks...	UNISOC, Maxscend, Vanchip, OnMicro...
Memory	Micron (Idaho fab)	Samsung (Xi'an) / SK Hynix (Wuxi)
CMOS image sensors	No alternative	Will Semi
MLCCs / passive	No alternative	Three-Circle, Fenghua, EYANG
Casing	Jabil	FII, Lens Tech, Luxshare
Camera lens	No alternative	Sunny Optical
Displays	No alternative	BOE Displays, CSOT, Tianma
EMS/assembly	No alternative	Hon Hai, Pegatron, Luxshare

Source: UBS

Even so, and leaving aside costs considerations for now, there are a certain number of components which may still come from a limited number of suppliers in specific locations. Out of the smartphones example for instance, we would single out:

Even with re-shoring, there are multiple component verticals where it will be unlikely to see full localisation

- **RF Front End:** The list of key suppliers for key RF components is limited with Broadcom, Qorvo, Qualcomm and Skyworks dominating the sector. Manufacturing is either insourced and in the US (Qorvo, Skyworks) or outsourced mostly in Taiwan. Local China substitution exists (link) but is still limited in scope.
- **CMOS sensors:** Sony and Samsung dominate the higher end segment, with internal manufacturing in Japan and South Korea respectively.
- **MLCCs:** All suppliers are Japan and Asia-based, and so is manufacturing.
- **Camera lenses:** Suppliers are all Asia-based; Largan still commands a high share in the higher end.
- **Displays:** All display makers are Asia-based; Samsung Displays remains the dominant OLED display supplier to Apple.

In other words, **re-shoring may increase the percentage of value-add generated closer to where a system maker is located, or selling its end-products. But there are multiple component verticals where concentration and existing localisation is such that it will unlikely to see full localisation in the forseeable future.**

What parallel tech supply chains would lack the most?

Ultimately, it is difficult to see how fully parallel supply chain could be implemented. The US may not be able to re-shore whole supply chains, and China to fully create its own, separate, ecosystem. Leaving aside costs considerations, we recap below some of the most obvious gaping holes in the existing supply chains. Those are not exhaustive lists:

Figure 95: What the US and China technology supply chains may lack of

US		China
	Advanced EDA	X
	Lithography	X
	Metrology / Inspection	X
X*	Leading edge foundry	X
	CPUs and GPUs	X
	Leading-edge memory semis	X
X	Displays	
X	Passive components	
X*	Camera supply chain	
X*	EMS assembly	

Source: UBS ; *Note: Marks where we think it is difficult to onshore at sufficient scale

What could be the cost of re-shoring?

Re-shoring will carry costs to OEMs and ultimately, end-users. Some of those could be higher manufacturing costs in re-shored locations, either directly, or related to lesser economies of scale. Others could be hidden, such as lesser innovation coming from less concentration (and free circulation) of engineers. While both are fairly difficult to assess, our discussions within the industry and experts validate that those are major concerns for the industry going forward.

Re-shoring will increase costs for OEMs and ultimately end-users primarily from lesser economies of scale

Assessing the direct cost impact of re-shoring

In our cost analysis simulation, we take an example out of iPhone 14 Pro to see how much total build cost increase we could see, in the scenario of a more extreme production relocation for semis, components, and EMS assembly. The cost assumptions largely are leveraging our prior works on TSMC's US fab cost / margin simulation, and components / EMS cost relocation scenario of moving away from China. Our cost increase assumptions reflect the scenario of 1) all of leading-edge semis (application processor) being produced in the US, and 2) EMS full relocation away from China, and 3) partial relocation for components away from China where applicable. Reflecting the above, our analysis points to iPhone 14 Pro BOM cost / total build cost potentially increasing by c. 4.1% / 4.9% respectively, assuming all else equal. This may not seem high, but f**or a smartphone OEM, 5% difference in bills of material costs is significant, as it also needs to cover R&D, SG&A, logistics and warranty costs.**

Figure 96: Assessing the cost impact - iPhone 14 Pro build cost case study

(US$)	iPhone 14 Pro	iPhone 14 Pro - simulated	% increase	Remark
Cost impact assumptions				
Leading-edge foundry			*10%*	
Components			*3-12%*	
EMS assembly			*18%*	
Cost by components				
Cellular	51	51		
Connectivity	14	14		
AP / BB	105	115	*9.1%*	*Assuming full relocation to US fabs*
Other semis	19	19		
Cameras	104	107	*3.0%*	*Assuming partial relocation to EMS site*
Audio	6	7	*12.0%*	*Assuming full relocation to EMS site*
Sensors	3	3		
Memory	36	36		
Display	75	75		
Casing	35	39	*12.0%*	*Assuming full relocation to EMS site*
PCB	9	10	*12.0%*	*Assuming full relocation to EMS site*
Others	32	34	*4.0%*	*Assuming partial relocation to EMS site*
Total BOM	**489**	**509**	*4.1%*	
EMS assembly	30	35	*18.0%*	*Assuming full relocation to India/Mexico*
Total build cost	**519**	**544**	*4.9%*	

Source: UBS estimates

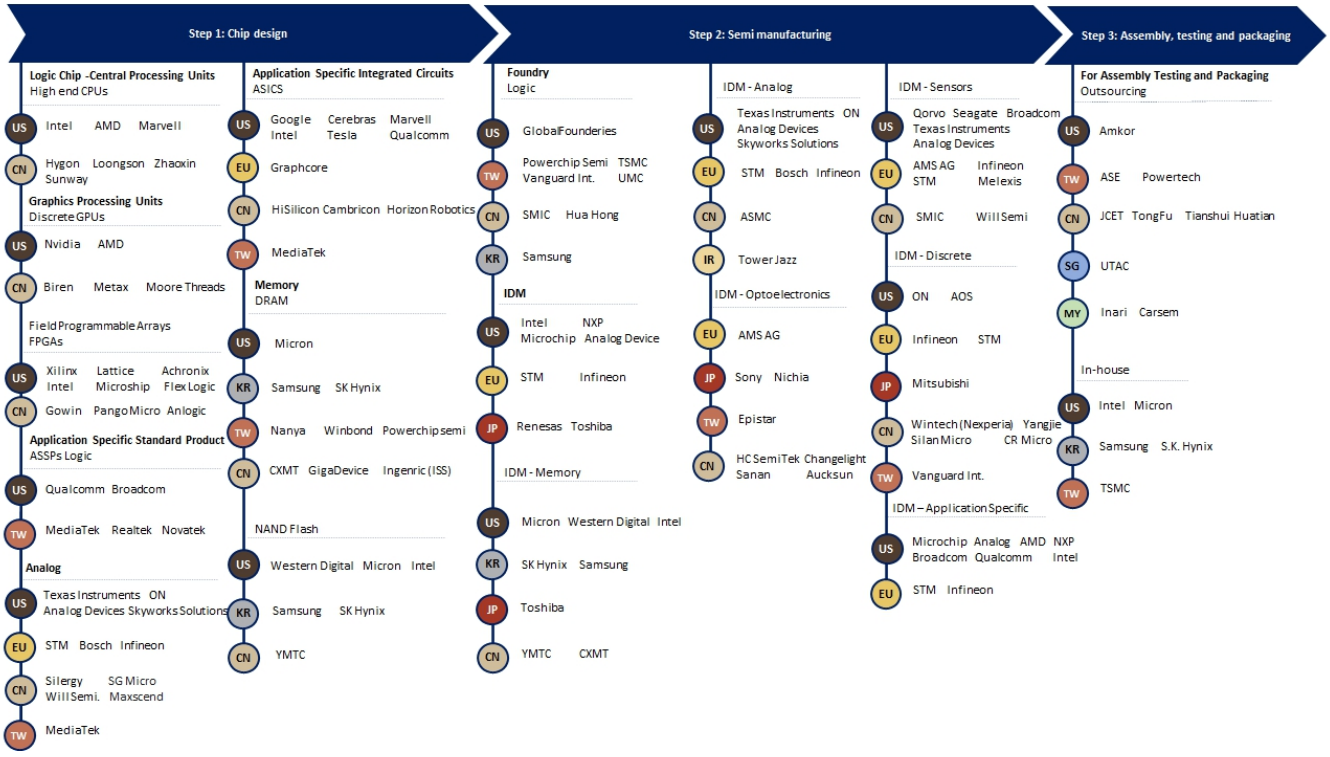
What could be the potential impact on innovation?

Harder to quantify but important will be impact on de-clusterization and a more nationalistic approach to Technology on innovation overall. What could be the penalty coming from a lesser physical concentration of engineering talent in a given place? At the opposite end of this, are there longer opportunity costs in graduates being more reluctant to travel to study and work, and talent to move around? Overall, we believe the answer is Yes.

- **De-clusterisation and innovation:** One of the key benefits of a strong cluster such as Taiwan for semis (and specifically TSMC) is a very high concentration in one place of experienced engineers for both process development and manufacturing. This helps training new talent, and solving crucial engineering problems. In leading edge semis fabs, those challenges do occur at a high frequency, with every different design from different customers on different technology nodes and process flavours. The main mitigating factor to this is that the core of TSMC's operations would still reside in Taiwan.
- **The great engineering talent e/immigration:** Many of the top talent and management in the Silicon Valley have been over the past 30 years foreign students/undergrads - with strong representations from Mainland China, Taiwan, India and South Korea - moving to undergrads/postgrads in the US, and then starting working there. Many of those then at some point change location, including coming home, and help set up new technology companies. Limiting this flow of talent voluntarily or not (eg. as a more negative perception of studying overseas may develop) would have an impact on how engineering and managerial talent develops, and ultimately, on innovation.

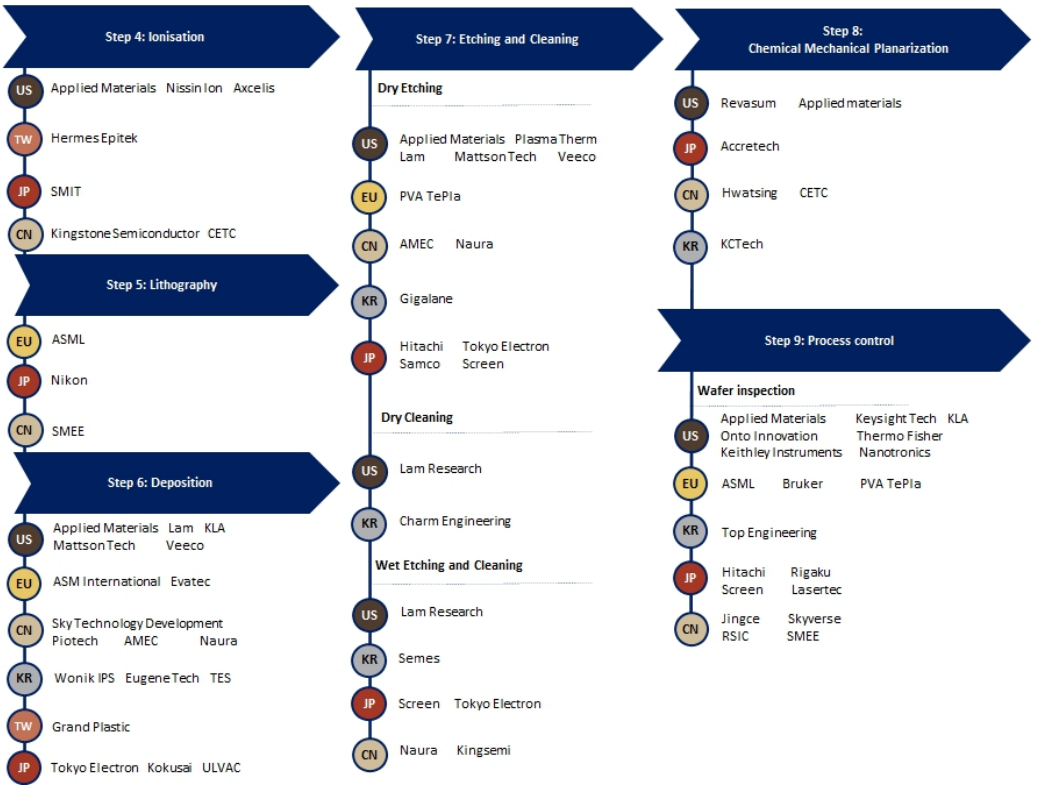
Appendix

Figure 97: Overview of the main chip design, R&D and chip manufacturing players



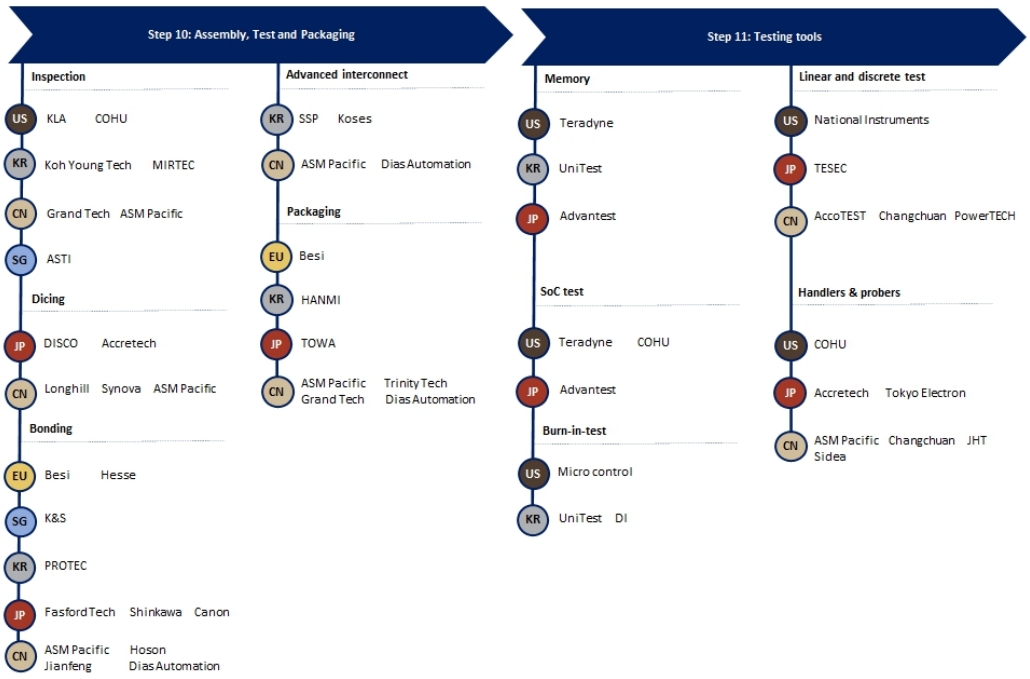
Source: UBS

Figure 98: Main global players in the various processes of the chip manufacturing



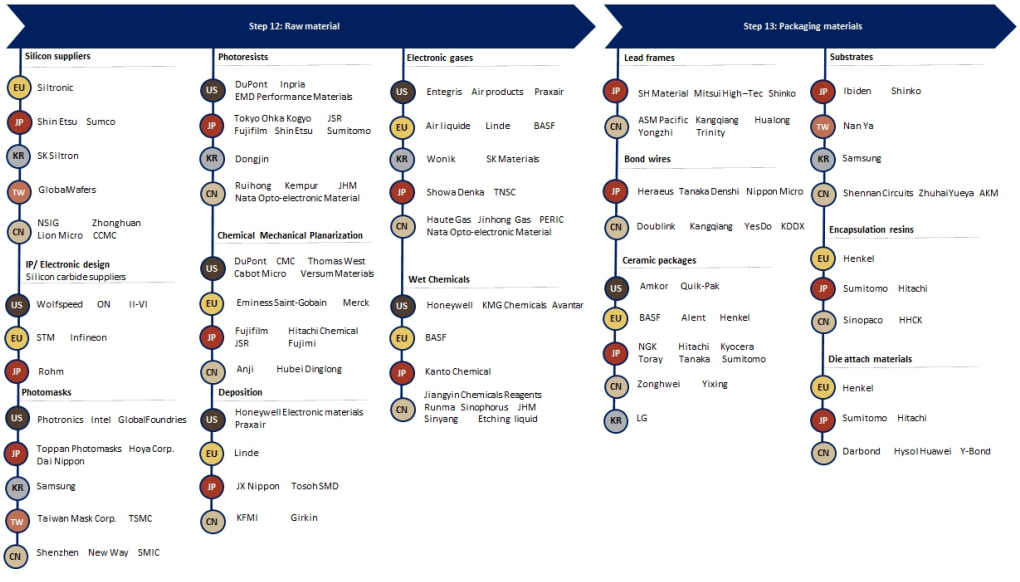
Source: UBS

Figure 99: Main global players in the back-end; assembly, testing and packaging



Source: UBS

Figure 100: Main global raw material and packaging materials



Source: UBS

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Buy	FSR is > 6% above the MRA.	56%	26%
Neutral	FSR is between -6% and 6% of the MRA.	35%	22%
Sell	FSR is > 6% below the MRA.	9%	18%
Short-Term Rating	**Definition**	**Coverage[3]**	**IB Services[4]**
Buy	Stock price expected to rise within three months from the time the rating was assigned because of a specific catalyst or event.	<1%	<1%
Sell	Stock price expected to fall within three months from the time the rating was assigned because of a specific catalyst or event.	<1%	<1%

Source: UBS. Rating allocations are as of 30 September 2022.
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2:Percentage of companies within the 12-month rating category for which investment banking (IB) services were provided within the past 12 months.
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4:Percentage of companies within the Short-Term rating category for which investment banking (IB) services were provided within the past 12 months.

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Company Name	Reuters	12-month rating	Price	Price date
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ASM International	ASMI.AS	Buy	€273.25	09 Dec 2022
ASML[16b]	ASML.AS	Buy	€577.30	09 Dec 2022
Advanced Micro Devices Inc[20a,16b]	AMD.O	Buy (CBE)	US$68.59	09 Dec 2022
Advanced Micro-Fabrication Equipment[18b]	688012.SS	Neutral	Rmb108.22	12 Dec 2022
Air Liquide	AIRP.PA	Buy	€136.84	09 Dec 2022
Air Products and Chemicals[3,16b]	APD.N	Buy	US$314.41	09 Dec 2022
Alibaba Group[16a,16b]	BABA.N	Buy	US$91.34	09 Dec 2022
Alphabet Inc.[7,6b,16b]	GOOG.O	Buy	US$93.07	09 Dec 2022
Apple Inc.[7,6b,16b]	AAPL.O	Buy	US$142.16	09 Dec 2022
Asustek Computer Inc.	2357.TW	Sell	NT$273.00	12 Dec 2022
BYD Company Limited[18a,16a]	1211.HK	Buy	HK$211.20	12 Dec 2022
Baidu, Inc.[7,16a,16b]	BIDU.O	Buy	US$119.99	09 Dec 2022
Beijing Huafeng Test & Control Tech	688200.SS	Neutral	Rmb308.00	12 Dec 2022
Cisco Systems Inc.[16b]	CSCO.O	Neutral	US$48.46	09 Dec 2022
Compal Electronics	2324.TW	Neutral	NT$21.95	12 Dec 2022
Corning Inc[16b]	GLW.N	Buy	US$33.02	09 Dec 2022
Dell Technologies[4,7,6a,6b,6c,16b]	DELL.N	Buy	US$41.83	09 Dec 2022
DuPont de Nemours Inc[16b]	DD.N	Buy	US$68.89	09 Dec 2022
Element Solutions Inc[4,7,16b]	ESI.N	Buy	US$18.83	09 Dec 2022
GigaDevice Semiconductor	603986.SS	Sell	Rmb106.70	12 Dec 2022
GlobalWafers	6488.TWO	Neutral	NT$463.00	09 Dec 2022
GoerTek	002241.SZ	Neutral	Rmb18.09	12 Dec 2022

Company Name	Reuters	12-month rating	Price	Price date
HP Inc[12,7,6b,6c,16b]	HPQ.N	Neutral	US$28.21	09 Dec 2022
Hangzhou Hikvision Digital Technology[18b]	002415.SZ	Neutral	Rmb34.39	12 Dec 2022
Hewlett Packard Enterprise[20a,7,16b]	HPE.N	Neutral (CBE)	US$16.15	09 Dec 2022
Hon Hai Precision	2317.TW	Buy	NT$102.00	12 Dec 2022
Inspur Electronic Information Industry[18b]	000977.SZ	Neutral	Rmb22.77	12 Dec 2022
Intel Corp.[7,6b,16b]	INTC.O	Neutral	US$28.24	09 Dec 2022
Inventec	2356.TW	Neutral	NT$24.80	12 Dec 2022
JCET Group	600584.SS	Buy	Rmb24.42	12 Dec 2022
JD.com[13,4,7,6a,6b,16a,16b]	JD.O	Buy	US$58.32	09 Dec 2022
KLA Corporation[16b]	KLAC.O	Neutral	US$393.41	09 Dec 2022
Keyence	6861.T	Buy	¥55,950	12 Dec 2022
LAM Research Corp[16b]	LRCX.O	Buy	US$450.20	09 Dec 2022
Lenovo Group[16a]	0992.HK	Neutral	HK$6.21	12 Dec 2022
Lens Technology	300433.SZ	Sell	Rmb11.00	12 Dec 2022
Linde plc[7,16b]	LINI.DE	Buy	€318.15	09 Dec 2022
Luxshare Precision Industry	002475.SZ	Sell	Rmb32.80	12 Dec 2022
Maxscend Microelectronics	300782.SZ	Neutral	Rmb117.18	12 Dec 2022
Mercedes-Benz Group AG[4,7,6b]	MBGn.DE	Buy	€64.79	09 Dec 2022
Meta Platforms[16b]	META.O	Buy	US$115.90	09 Dec 2022
Micron Technology Inc[16b]	MU.O	Buy	US$54.87	09 Dec 2022
Mitsubishi Electric	6503.T	Neutral	¥1,365	12 Dec 2022
NAURA Technology Group	002371.SZ	Sell	Rmb243.96	12 Dec 2022
NVIDIA Corp[16b]	NVDA.O	Buy	US$170.01	09 Dec 2022
NetEase[16a,16b]	NTES.O	Buy	US$70.17	09 Dec 2022
Nippon Sanso Holdings	4091.T	Neutral	¥2,181	12 Dec 2022
Omron	6645.T	Neutral	¥6,988	12 Dec 2022
Pegatron	4938.TW	Neutral	NT$63.20	12 Dec 2022
Pinduoduo Inc[16b]	PDD.O	Buy	US$89.71	09 Dec 2022
Quanta	2382.TW	Buy	NT$72.50	12 Dec 2022
Renault[20a,7]	RENA.PA	Neutral (CBE)	€34.41	09 Dec 2022
SK Hynix	000660.KS	Buy	Won81,100	12 Dec 2022
SMC	6273.T	Neutral	¥62,610	12 Dec 2022
SUMCO Corporation	3436.T	Neutral	¥2,001	12 Dec 2022
Samsung Electronics	005930.KS	Buy	Won59,500	12 Dec 2022
Semiconductor Manufacturing Intl Corp[20a,18b,16a]	0981.HK	Sell (CBE)	HK$16.58	12 Dec 2022
Silergy Corporation	6415.TW	Buy	NT$486.00	12 Dec 2022
THK	6481.T	Sell	¥2,658	12 Dec 2022
Taiwan Semiconductor Manufacturing[16b]	2330.TW	Buy	NT$475.00	12 Dec 2022
Tencent Holdings[4,5,16a]	0700.HK	Buy	HK$317.60	12 Dec 2022
Tesla, Inc.[20b,16b]	TSLA.O	Buy (CBE)	US$179.05	09 Dec 2022
The Chemours Company[20a,16b]	CC.N	Neutral (CBE)	US$29.54	09 Dec 2022
Universal Scientific Industrial	601231.SS	Buy	Rmb16.80	12 Dec 2022
Volkswagen[2,4,5]	VOWG_p.DE	Neutral	€137.24	09 Dec 2022
Wacker Chemie	WCHG.DE	Neutral	€121.95	09 Dec 2022

Company Name	Reuters	12-month rating	Price	Price date
Western Digital Corp[16b]	WDC.O	Neutral	US$35.71	09 Dec 2022
Wiwynn[2,4]	6669.TW	Buy	NT$911.00	12 Dec 2022
Xiaomi[7,18b,16a]	1810.HK	Buy	HK$11.18	12 Dec 2022
Yaskawa Electric	6506.T	Sell	¥4,625	12 Dec 2022
Zhejiang Dahua Technology	002236.SZ	Neutral	Rmb12.37	12 Dec 2022

Source: UBS. All prices as of local market close. Ratings in this table are the most current published ratings prior to this report. They may be more recent than the stock pricing date.

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