Freeze-in-Place: The US Scales up Tech Controls on China

Appendix 1 - Summary of Tech Controls

Policy objective	Approach	Key Modalities
Impair China's development in advanced computing and supercomputing	**List-based technology controls** focused on advanced computing and supercomputing inputs, products that contain those components, and associated software and technology **"Regional Stability"** justification for controls requiring license to export, reexport, transfer to or within China; "**Anti-Terrorism"** justification expanded for revised ECCNs **Extraterritorial controls:** Entity List FDPR applied 28 entities tied to supercomputing **New end-use control:** For certain CCL items destined for "supercomputers" **New FDPR rules:** targeting supercomputing entities, Advanced Computing technologies, Supercomputing technologies	New **ECCN 3A090** controlling integrated circuits (ICs) for advanced computing, defined as 600 Gbyte/s or more in aggregate bidirectional transfer rate over all inputs and outputs or from integrated circuits other than volatile memories New **ECCN 4A090** computers, electronic assemblies, and components that contain ICs that exceed the 3A090 limits New **ECCN 4D090** controlling software specially designed/modified for development/production of ECCN 4A090 Amended **ECCN 3D001** and **3E001**for software or technology, respectively, associated with 3A090 Amended **ECCNs 5A992** and **5D992** for items that exceed performance levels of 3A090 or 4A090 Amended **ECCN 3A991** to cover processing performance of 8 Tera Operations Per Second ("TOPS") or more, or an aggregate bidirectional transfer rate over all inputs and outputs of 150 Gbyte/s or more to or from ICs other than volatile memories. Amended **ECCN 4A994** to cover items that contain ICs that exceed revised 3A991 limit **Expanded Entity List FDPR** targeting 28 supercomputing entities **Advanced Computing FDPR** applied to non-US items that meet ECCN 3A090 or 4A090 performance requirements **Supercomputer FDPR** **Supercomputer end-use controls** (744.23)

Freeze in place China's semiconductor industry	**CCL additions** to cover SME (list goes well beyond specially designed for leading edge to include mature tech) **Anti-Terrorism** and **Regional Stability** justification for new ECCNs **New (broad) end-use control for any item "when you know" the item will used in:** **The production or development of advanced semiconductors in PRC (including if you can't determine whether a fab in PRC is making chips that meet this criteria); *advanced semiconductors defined as logic ICs at 16/14nm or below or using non-planar transistor architecture; memory ICs with 128 layers or more for NAND and 18nm half-pitch or less for DRAM)* **ECCN-controlled products covering testing, inspection, production, equipment; materials; software; technology for the development of advanced semiconductor production in China **The "development" or "production" in PRC of any "parts," "components," or "equipment"(*covering comprehensive list of SME-related ECCNs and subject to licensing approval for partner countries*) **Broad restriction on "U.S. persons" activities in the development or production of ICs** on presumption that leading edge ICs "could support" WMD end-uses. Licenses granted on case-by-case basis and controls apply to US citizens, permanent residents, and "any person in the United States" **Activities include shipping, transmitting, or transferring, facilitation to or within China, or servicing, any item that meets leading edge criteria **Items not subject to EAR and that meets parameters of relevant SME ECCNs *regardless of end-use or end user*	New **ECCN 3B090** for semiconductor manufacturing equipment (*comprehensive list to enable US with transparency and blocking power on US SME to China)* **ECCN 3D001** and **3E001** for software or technology, respectively, associated with 3B090 End-use controls for development and production of advanced semiconductors and SME (**744.23 of EAR**); SME list includes ECCNs 3B001, 3B002, 3B090, 3B611, 3B991, or 3B992 **Advanced Computing and Semiconductors Rule covering US persons activities** (744.6(b) of EAR); Covers SME-related ECCNs: 3B090, 3D001, 3E001
Facilitate blacklisting of Chinese entities	**Shift compliance burden to China on end-use:** Give Chinese entities notice via unverified list that their non-compliance with BIS end-use checks will earn them a spot on Unverified List: **Failure to meet 60-day compliance deadline would likely result in BIS Entity listing **YMTC memory chipmaker and Chinese SME players like Naura included on UVL	**31 additions (and 9 removals) to Unverified List (final rule)** **Entity List FDPR footnote 4 applied to 28 entities tied to supercomputing** (§ 734.9(e)(1)

	Expand Entity List FDPR designations	
Compel foreign tech partners to fall in line behind US on tech controls	**Increase firepower of Entity List FDPR** by covering foreign-produced items that are the direct product of tech/software subject to EAR in advanced computing/supercomputing (*or produced by a plant or major component of a plant that contains US origin tech*) and could apply to WMD end-use activities . **Apply Entity List FDPR to supercomputing and advanced computing targets** **Broadly restrict US persons activities** linked to development and production of leading edge IC *and* any item covered by SME ECCNs	**FDPR Footnote 4 designation** may cover any transaction involving targeted entity linked to WMD and related computing (covering semiconductors, computers, telecom, information security applications) **Expansion of FDPR Entity List** targeting 28 supercomputing entities **Advanced Computing FDPR** **Advanced Computing and Semiconductors Rule covering US persons activities** (744.6(b) of EAR); Covers SME-related ECCNs: 3B090, 3D001, 3E001

Appendix 2 – Methodology for Estimating the Impact of New Controls

To quantify the direct cost to the US SME industry of these measures, we use two approaches: a top-down and a bottom-up approach.

Top-down approach

First, we estimate lost sales to top US SME firms using a top-down assessment of their revenues in China. This approach very schematically assumes that US SME firms' lost sales in China will be proportionate to the share of China's semiconductor capacity at or below 22nm (32%). We use 22nm as our threshold here—instead of 14nm as stated in the new controls—because this is the last process node where chips are designed based on planar-transistor architecture. As such, any fab currently at or below 22nm, and looking to upgrade their manufacturing capacity, will need switch to FinFET (fin field-effect transistor) technology, which can be used to fabricate leading-edge semiconductors, as defined in the new controls, and thus may be subject to restrictions.

TABLE 1
Estimated Lost Revenue to US SMEs From New Controls
US millions

Company Name	Low-End Estimate	High-End Estimate	Total China Revenue	Global Revenue
Applied Materials	$666	$2,409	$7,535	$23,063
LAM Research	$478	$1,730	$5,412	$17,227
KLA	$235	$850	$2,660	$9,213
Teradyne	$56	$202	$632	$3,703
Total	**$1,435**	**$5,191**	**$16,239**	**$53,206**

Source: Rhodium Group. Revenue data pulled from each companies' latest annual report.

Using this top-down approach, we find that US SME firms could lose **$1.4 billion *annually*** as a result of the new controls. The assumption here is that the US only restricts sales to Chinese-owned fabs at process nodes ≤22nm. However, if the US were to apply controls on all fabs in China ≤22nm, regardless of nationality (e.g. to include SK Hynix and Samsung production facilities in China), the cost could reach **$5.2 billion in annualized sales**.

There are several clear caveats to this approach. First, we assume that lost sales are proportionate to the share of capacity that is at or below 22nm, meaning that we do not account for differences in SME spending between more mature and advanced process nodes, or among those, between different fabs. We also assume, for the sake of simplicity, that US SME firms would have maintained their share of the China market. Finally, due to lack of sufficient data, we are not able to separate out these firms' China revenues coming from non-SME sales (like Applied Material's small substrate manufacturing business). Lastly, this does not account for the scenario that US SME suppliers would simply sell equipment to other fabs outside of China since most SME suppliers currently have substantial backlogs of more than 12 months.

Bottom-up approach

We also estimate lost sales to US SME companies using a bottom-up analysis of expected SME spending in China. Using data from SEMI, a global industry association representing equipment, software and material suppliers in the semiconductor industry, we find that *Chinese-owned* fabs at or below 22nm spent **$5.0 billion in 2021 on SME** and are expected to spend another **$5.1 billion in 2022** and **$4.6 billion in 2023**. When applying US companies' market share to these number, we find that US SME firms could lose $3.1 billion and $2.8 billion in sales in 2022 and 2023, respectively.

Broadening our analysis to both Chinese and foreign-owned fabs at or below 22nm, we estimate SME spending of **$14.8 billion in 2021, $7.6 billion in 2022** and **$7.8 billion in 2023**. Applied to US companies, this could result in $4.6 billion and $4.7 billion in lost sales in 2022 and 2023, respectively.

TABLE 2
Estimated SME Spending in China, 2021 - 2023
US millions

	2021	2022	2023
Total SME Spending	$24,336 *(100% of 2021 sales)*	$21,608 *(100% of 2022 sales)*	$15,354 *(100% of 2023 sales)*
SME Spending: ≤22nm	$14,849 *(61% of 2021 sales)*	$7,631 *(35% of 2022 sales)*	$7,801 *(51% of 2023 sales)*
SME Spending: Chinese Firms ≤22nm	$4,955 *(20% 2021 sales)*	$5,140 *(24% of 2022 sales)*	$4,629 *(30% of 2023 sales)*

Source: SEMI, Rhodium Group.

Our bottom-up estimates differ from our top-down estimates primarily because Chinese-owned fabs at or below 22nm are expected to contribute to a greater share of SME spending than their share of China's wafer capacity. For example, in 2022, Chinese fabs at or below 22nm are expected to contribute to 24% of China's SME spending, despite having only 8.8% of China's total wafer capacity. This disparity is probably attributable to Chinese fabs ramping up their capacity and because semiconductor manufacturing equipment for leading edge nodes tends to be more expensive. This disparity is expected to continue into 2023—meaning a greater loss of sales for SME firms in our low-end, bottom-up estimate than in our low-end, top-down estimate. Conversely, our high-end top-down estimate is greater than our high-end bottom-up estimate because foreign fabs operating in China at or below 22nm are expected to spend relatively less than their Chinese-owned counterparts, based on their share of capacity.