

Chipmaking market overview

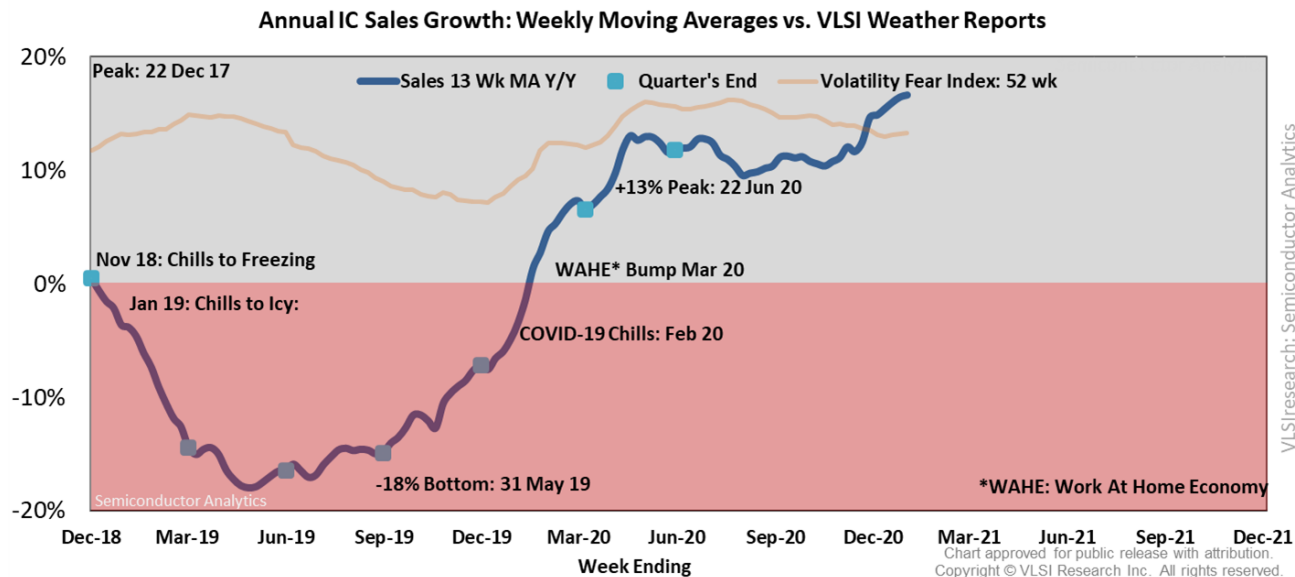


Andrea Lati

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Integrated Circuit Trend

- Growth has accelerated since Nov, as component shortages strengthened prices
- Recovery became broad-based in 2H20



Weekly Semiconductor Sales Growth

DRAM, NAND, Logic, Auto, Analog & Power

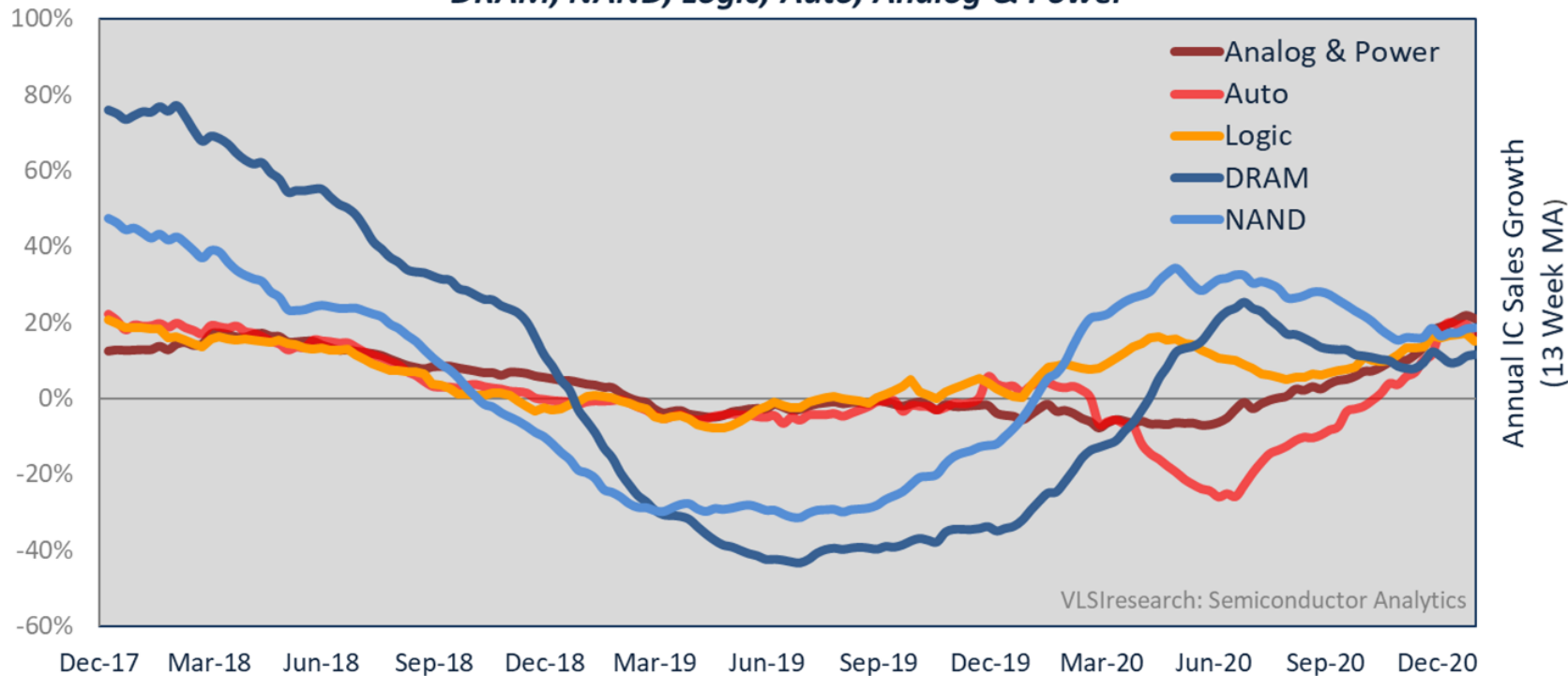


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IC Supply/Demand Heat Map

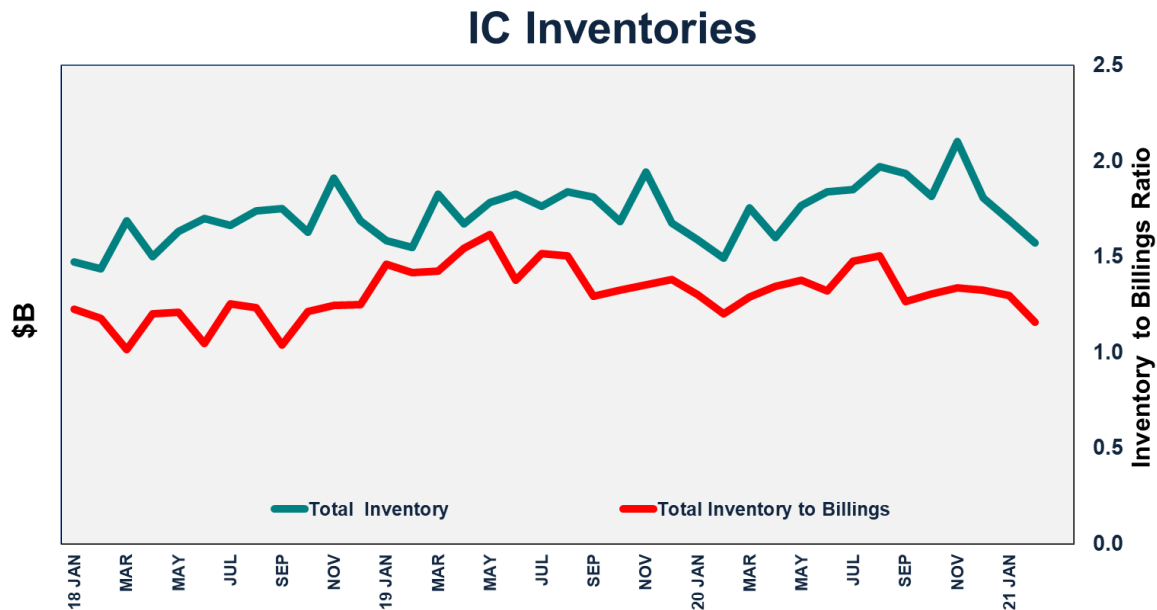
Qtr or Week	Overall	DRAM	NAND/NVM	IDM	Foundry	OSAT	Analog & Power
1Q 2019	Glut	Saturated	Glut	Tight	Glut	Saturated	Saturated
2Q 2019	Saturated	Glut	Tight	Balanced	Glut	Loose	Balanced
3Q 2019	Balanced	Saturated	Tight	Tight	Balanced	Balanced	Balanced
4Q 2019	Balanced	Saturated	Balanced	Tight	Tight	Tight	Balanced
1Q 2020	Tight	Shortage	Tight	Balanced	Shortage	Shortage	Balanced
2Q 2020	Tight	Saturated	Balanced	Tight	Shortage	Shortage	Tight
3Q 2020	Tight	Tight	Balanced	Tight	Tight	Tight	Tight
4Q 2020	Tight	Shortage	Balanced	Tight	Tight	Tight	Tight
1Q 2021 NowCast	Shortage	Shortage	Tight	Tight	Tight	Tight	Balanced
30-Oct-20	Tight	Tight	Tight	Balanced	Tight	Tight	Tight
6-Nov-20	Tight	Tight	Balanced	Tight	Tight	Shortage	Tight
13-Nov-20	Tight	Tight	Balanced	Tight	Tight	Shortage	Tight
20-Nov-20	Tight	Tight	Balanced	Tight	Balanced	Tight	Tight
27-Nov-20	Tight	Tight	Balanced	Tight	Balanced	Tight	Tight
4-Dec-20	Tight	Shortage	Balanced	Tight	Tight	Shortage	Tight
11-Dec-20	Tight	Shortage	Tight	Tight	Balanced	Tight	Tight
18-Dec-20	Tight	Shortage	Tight	Tight	Loose	Tight	Balanced
25-Dec-20	Tight	Shortage	Tight	Tight	Saturated	Balanced	Balanced
1-Jan-21	Tight	Shortage	Tight	Tight	Glut	Glut	Saturated
8-Jan-21	Tight	Shortage	Tight	Tight	Tight	Balanced	Balanced
15-Jan-21	Tight	Shortage	Tight	Tight	Tight	Tight	Tight
22-Jan-21	Shortage	Shortage	Tight	Tight	Shortage	Shortage	Tight
29-Jan-21	Shortage	Shortage	Tight	Tight	Shortage	Shortage	Tight
Range:	Shortage	Tight	Balanced	Loose	Saturated	Saturated	Glut

*CC: CryptoCurrency **Complex SoC: SoC with RF/mmW & Sensors

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IC Inventories are improving

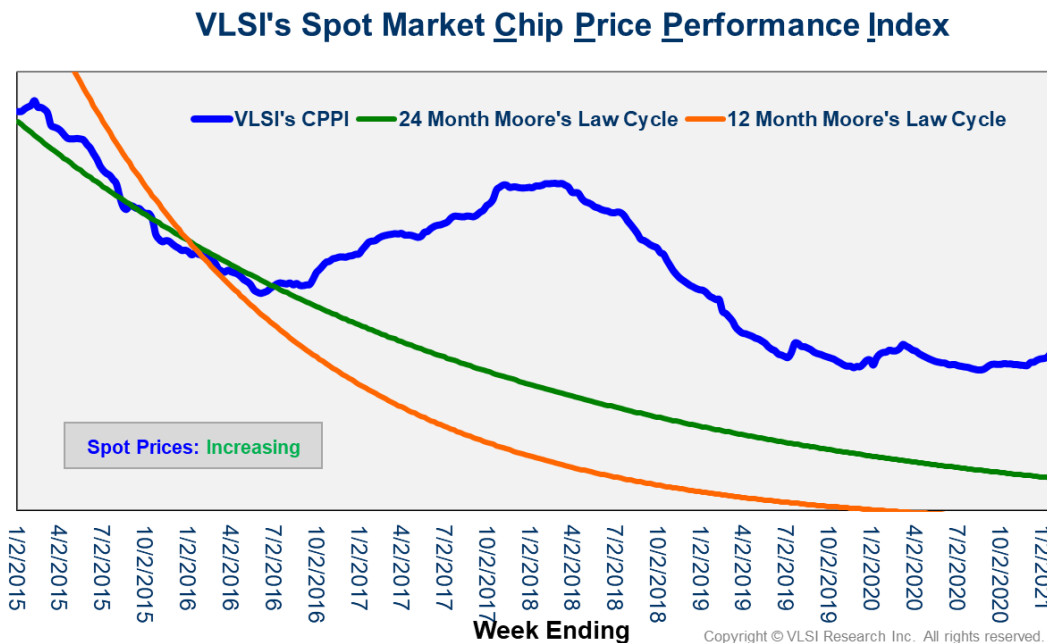
- OEM IC Inventories are in normal territory
- Die Bank Inventories improving
 - Logic IC healthy
 - Analog, Discrete, & Power tightening
 - Memory mixed
 - Much of the inventory “problem” has actually been a feature of the COVID economy where Just-in-Case inventory control displaced Just-in-time



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Chip Price Performance Index

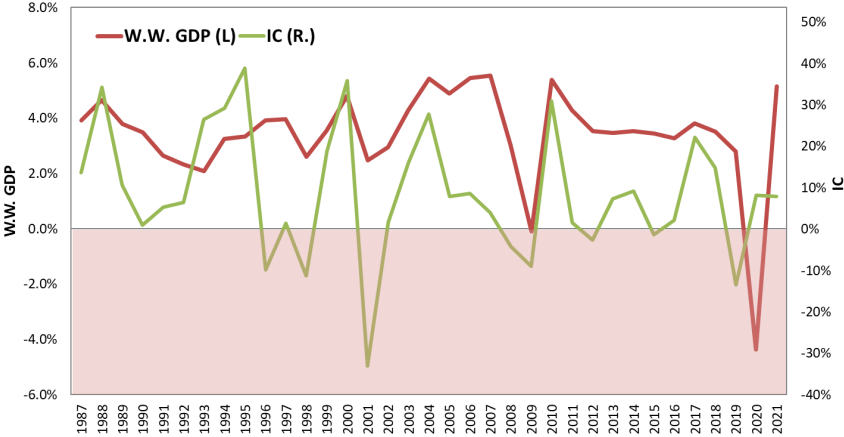
- CPPI was relatively flat in 2020 despite high inventories in Memory
- Steady increase in 4Q20 bodes well for this year's prospects



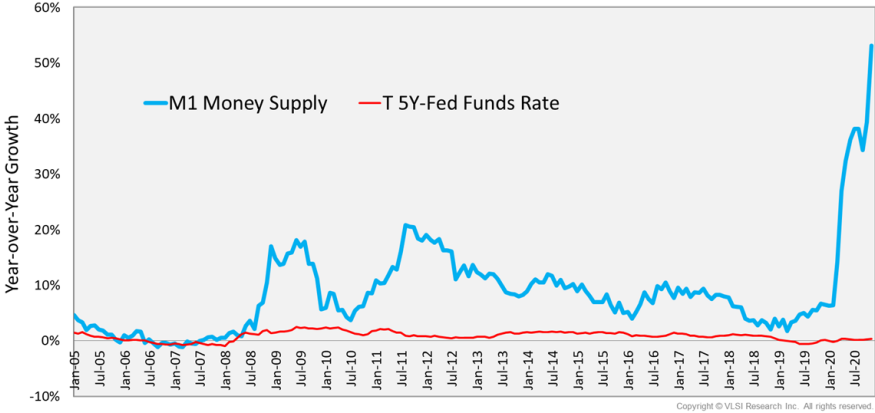
2021 Semi Industry Drivers

Continued W.W. GDP growth in CY21 from 2H20

W.W. GDP vs. IC Growth



U.S. Money Supply Growth vs. the Yield Curve

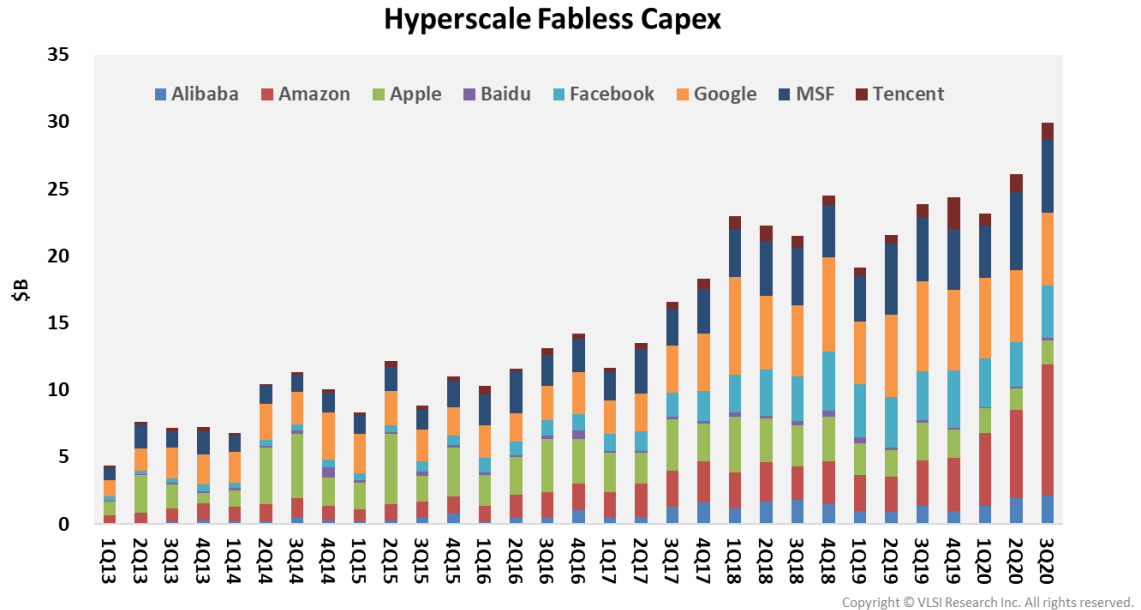


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2021 Semi Industry Drivers

Cloud/Hyperscale Datacenter

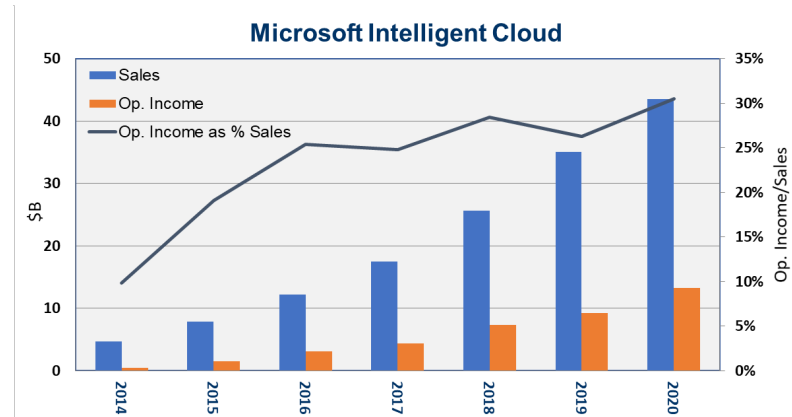
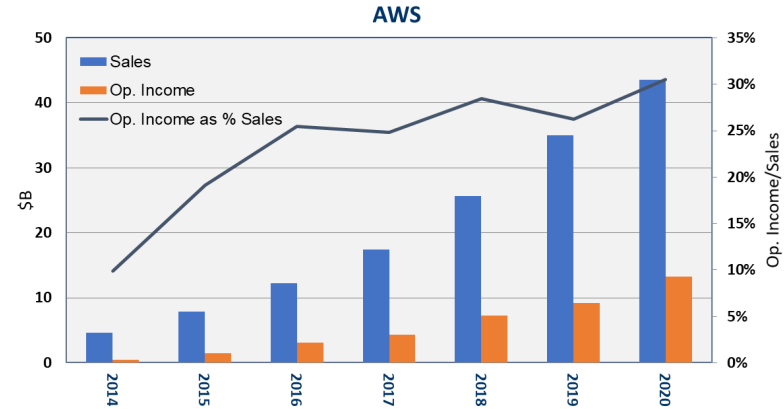
- Hyperscale Capex spending at an all time high, up 23% YTD
 - Amazon driving much of the growth



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Accelerating Public Cloud Adoption

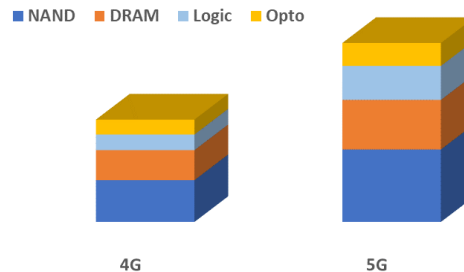
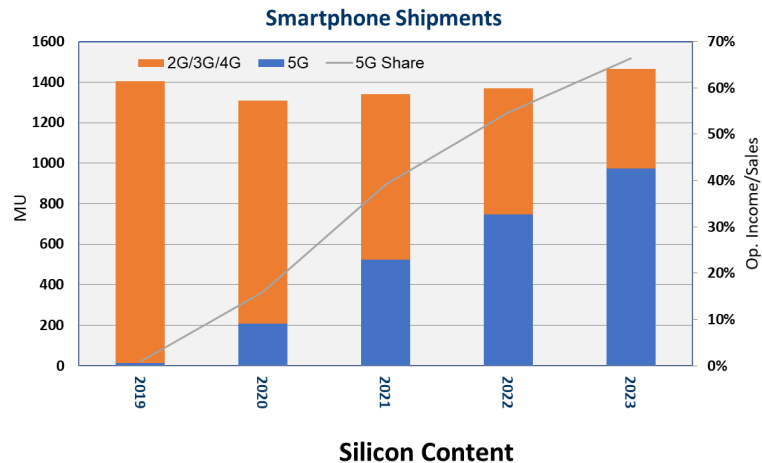
- Cloud investments supported by strong financial performance
 - Expansions supported by strong sales and profitability



2021 Semi Industry Drivers

5G Proliferation

- 5G Smartphone shipments will double in 2021
 - Significant increases in silicon content
- Increasing 5G base station deployments



Semiconductor Forecast

- Memory will lead the way as its recovery gains more traction in 2021
- Continued recovery in Auto, Industrial, and Macro will boost DAO growth
- 5G ramp and Cloud expansion will extend Logic gains
 - GPUs will stay hot

SEMICONDUCTOR SALES

(worldwide sales, \$B, calendar year)

	2019	2020	2021
Analog	56	58	64
	-4%	3%	11%
DRAM	63	67	81
	-37%	7%	20%
NAND	41	50	58
	-25%	24%	15%
MPU	56.2	62.4	67.7
	2%	11%	9%
Other Logic	132	145	158
	-2%	9%	9%
Discrete, Opto & Other	82	83	93
	3%	2%	12%
Total Semiconductor	430	466	522
	-11%	8%	12%

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Capex

- Capex remains top-heavy despite increased spending by Chinese Manufacturers
 - Top 6 accounted for 74% in 2020
- Four Chinese companies in the top 10 accounting for 13% of spending last year, up from 8% in 2019

2021 TOP IDM & FOUNDRY CAPEX SPENDERS

(Capital expenditures by company, \$B, ranked by 2021 Forecast)

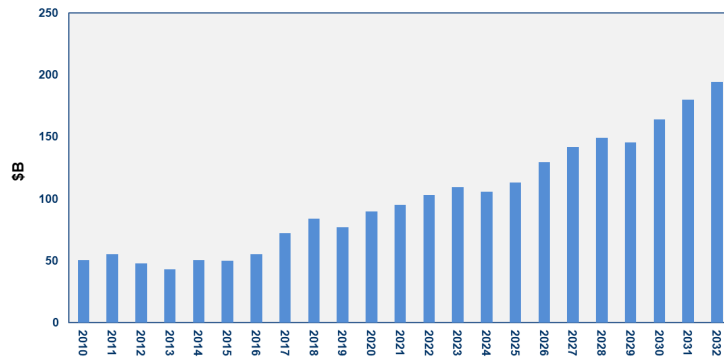
	2018	2019	2020P	2021F
Samsung	21.6	19.3	28.1	27.0
TSMC	10.5	14.9	17.2	26.5
Intel	15.2	16.2	14.3	15.1
SK hynix	14.6	12.0	8.4	11.2
Micron Technology	8.8	8.6	8.8	9.0
Toshiba/WD	3.2	2.9	3.6	5.9
SMIC	1.8	2.0	5.9	3.7
XMC/YMTC	2.4	2.1	3.0	3.3
Innotron	1.3	1.4	2.5	2.5
Huahong Group	2.2	2.0	2.2	2.4
Sony	1.4	2.3	2.1	2.3
STMicroelectronics	1.3	1.2	1.3	2.0
Infineon	1.4	1.3	1.2	1.6
UMC	0.7	0.6	1.0	1.5
GLOBALFOUNDRIES	1.2	0.7	0.8	1.5
Nexchip	0.8	0.6	0.8	0.8
Others	12.1	9.3	8.1	10.4
Total	100.3	97.2	109.1	126.7
<i>y-o-y growth</i>	<i>8%</i>	<i>-3%</i>	<i>12%</i>	<i>16%</i>

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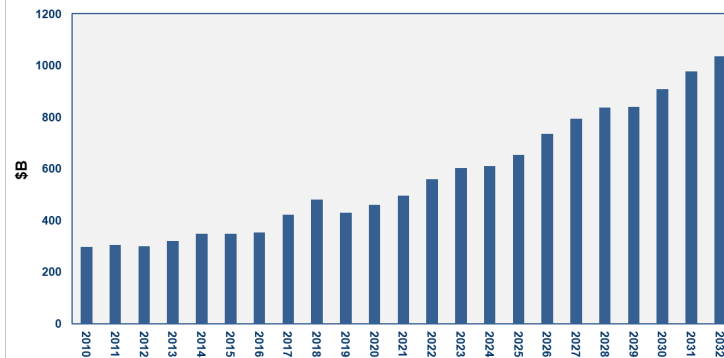
Summary

- Semiconductor and Equipment recovery is on track despite the ongoing uncertainty from the pandemic and the U.S. China tech war
 - Drivers
 - buildout of IT Infrastructure, the 5nm demand ramp, 5G proliferation, memory capacity buildout, and Central Banks pouring Vodka in the Punchbowl
 - Potential disruptors
 - fallout from the US/China decoupling, the potential for a Made-in-China capacity glut, the COVID bump turning out to be a roman candle
- Equipment sales are expected to hit \$200B and Semis \$1T in the early 2030's

Worldwide Semiconductor Equipment Sales



Worldwide Semiconductor Sales



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Zooming in on critical IC market

Semiconductor Sales Nowcast*

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IC Supply/Demand Heat Map

Overall	DRAM	NAND	MEM	IoT	For
Capex Moving	Capex Moving	Capex Moving	Capex Moving	Capex Moving	Capex Moving
Capacity Up	Capacity Up	Capacity Up	Capacity Up	Capacity Up	Capacity Up
Prices, Shrinks & Yield	Prices, Shrinks & Yield	Prices, Shrinks & Yield	Prices, Shrinks & Yield	Prices, Shrinks & Yield	Prices, Shrinks & Yield
Storage	Storage	Storage	Storage	Storage	Storage
Capacity & Yield	Capacity & Yield	Capacity & Yield	Capacity & Yield	Capacity & Yield	Capacity & Yield
AI, Cloud, PC, IoT strong	AI, Cloud, PC, IoT strong	AI, Cloud, PC, IoT strong	AI, Cloud, PC, IoT strong	AI, Cloud, PC, IoT strong	AI, Cloud, PC, IoT strong
2-Nov-18	Glut	Glut	Glut	Shortage	
9-Nov-18	Glut	Glut	Glut	Tight	
16-Nov-18	Glut	Glut	Glut	Tight	
23-Nov-18	Glut	Saturated	Glut	Tight	
30-Nov-18	Glut	Glut	Glut	Tight	
7-Dec-18	Glut	Glut	Glut	Tight	
14-Dec-18	Glut	Saturated	Saturated	Tight	
21-Dec-18	Glut	Saturated	Saturated	Tight	
28-Dec-18	Glut	Saturated	Loose	Tight	
4-Jan-19	Glut	Balanced	Balanced	Tight	
11-Jan-19	Saturated	Balanced	Saturated	Tight	
18-Jan-19	Saturated	Loose	Saturated	Tight	
3Q 2017	Shortage	Shortage	Shortage	Shortage	
4Q 2017	Shortage	Shortage	Shortage	Shortage	
1Q 2018	Tight	Shortage	Tight	Tight	
2Q 2018	Balanced	Balanced	Tight	Tight	

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Semiconductors

Sales (\$M)

Sales (M Units)

Pricing (\$)

Silicon Demand

CapEx Distribution

Packaging Demand

Electronics & Macroeconomy

Reticles

Design Completions

Historical Ratios & Utilization Rates

Diffusion Rates of Chip Making

TCI Graphics

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Chip Market Research Services
Equipment Database

Mkt Shr & Fest	Suppliers >	
▶ Total		
▶ WFE	MS Yr	MS Qtr
▶ ATE	MS Yr	MS Qtr
▶ Assembly	MS Yr	MS Qtr

Forecast Raw Data

Regional Equipment Consumption

WFE By Applications

Advanced Packaging Equipment

Captive Equipment Supplier

Equipment Unit Shipments

Background Material

Equipment Appraisals

Revenue History by Supplier

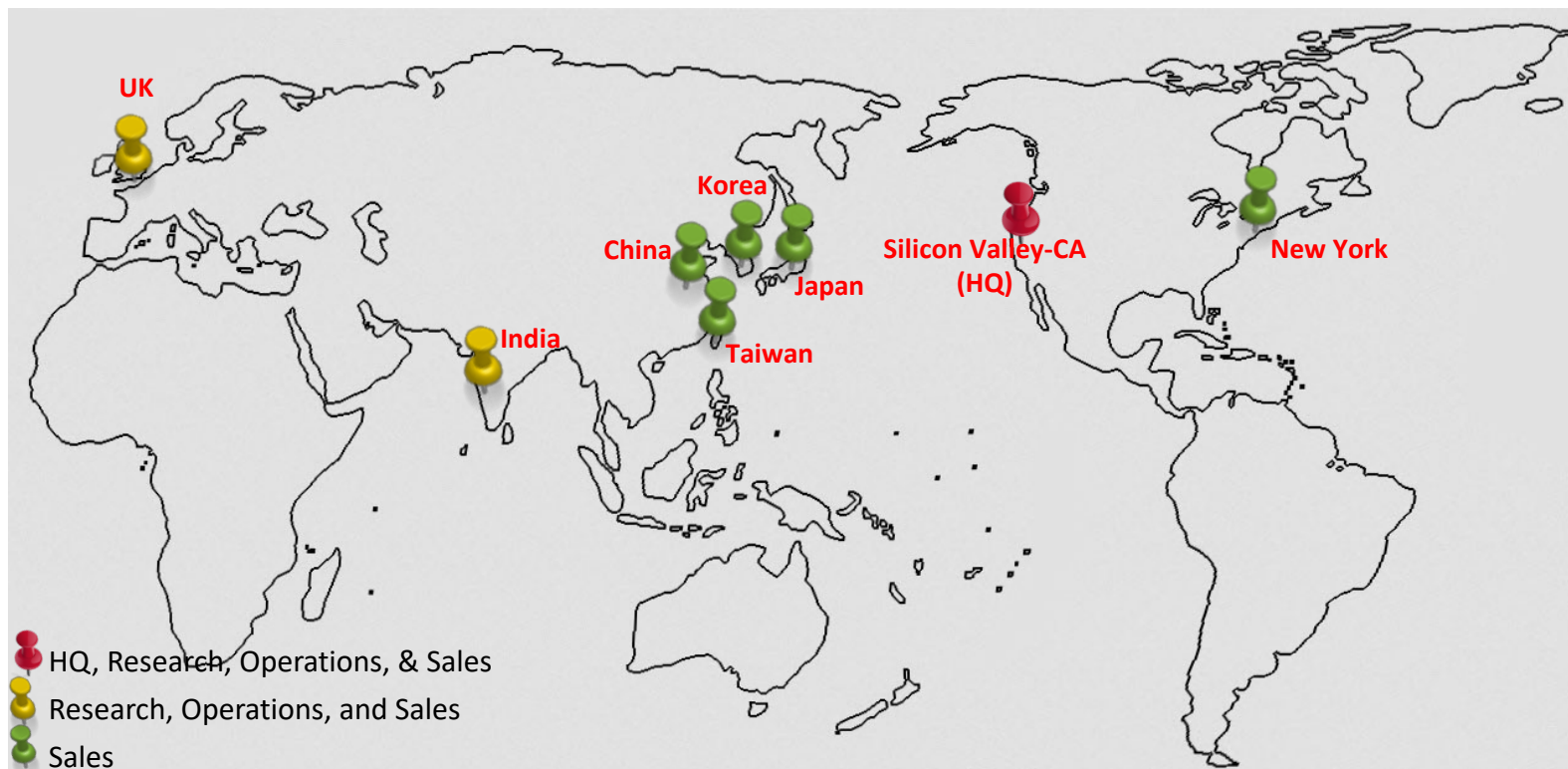
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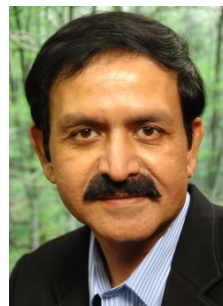
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