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Global Auto, Tech, Health-Care Supply Chains Face Long Reckoning

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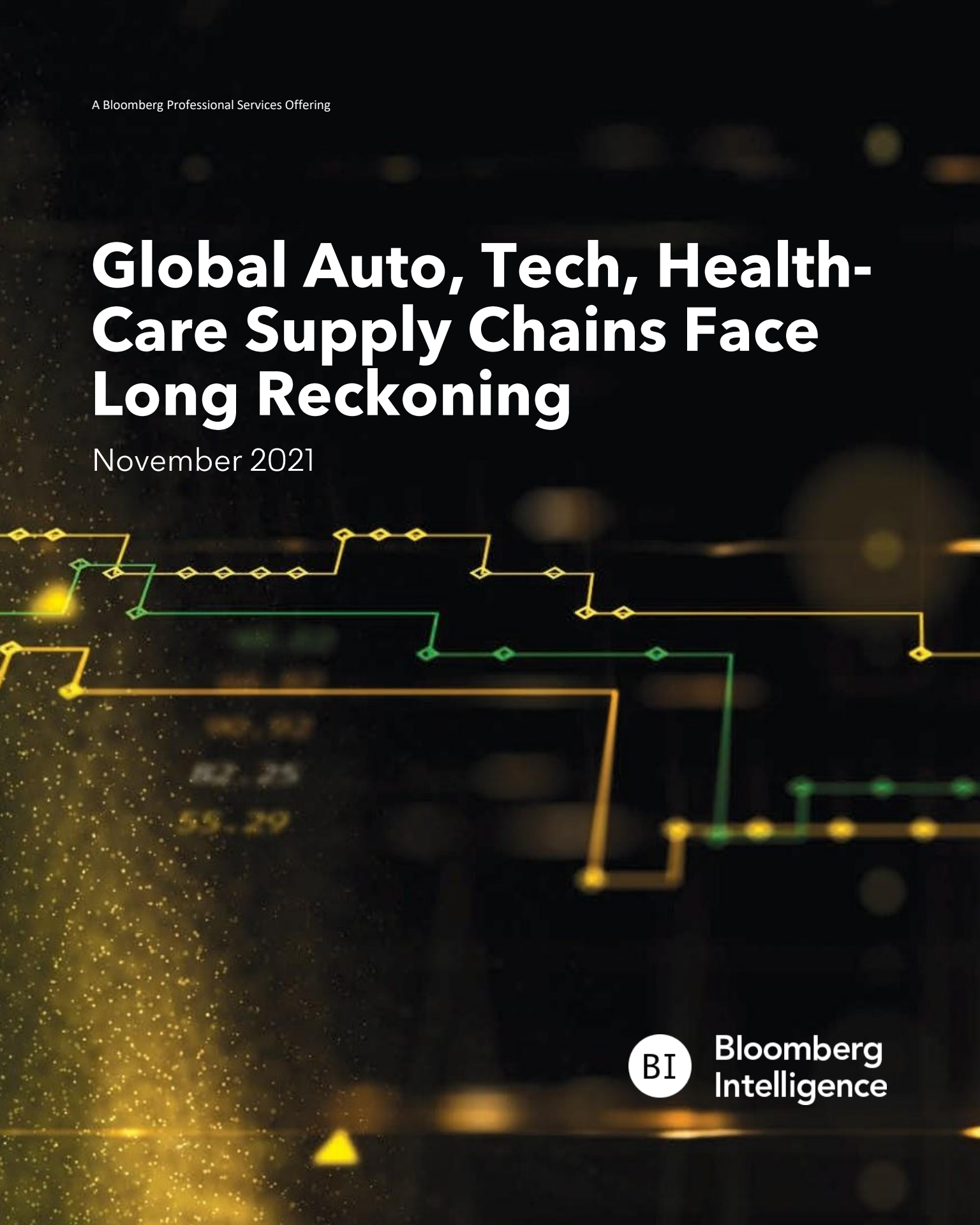

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Global Auto, Tech, Health-Care Supply Chains Face Long Reckoning

The U.S.-China trade rift and the prolonged global pandemic have wrought havoc on industry supply chains, with pain especially acute in the automobile, health-care and technology manufacturing networks. Companies such as Apple, Taiwan Semiconductor, Volkswagen and Teva have responded by diversifying manufacturing sites and should no longer consider only costs when scaling these efforts.

Though China will remain central to many manufacturing programs, Malaysia, India, Vietnam, Thailand and others should expand their factory presence. Adjusting concentration risk and policy changes are key to this effort. The tedious work of building distributed scale with flexibility will take time and capital spending, but sub-scale attempts in the near term will carry higher costs.

There's No Easy, Quick Answer to Semiconductor Supply Shortages

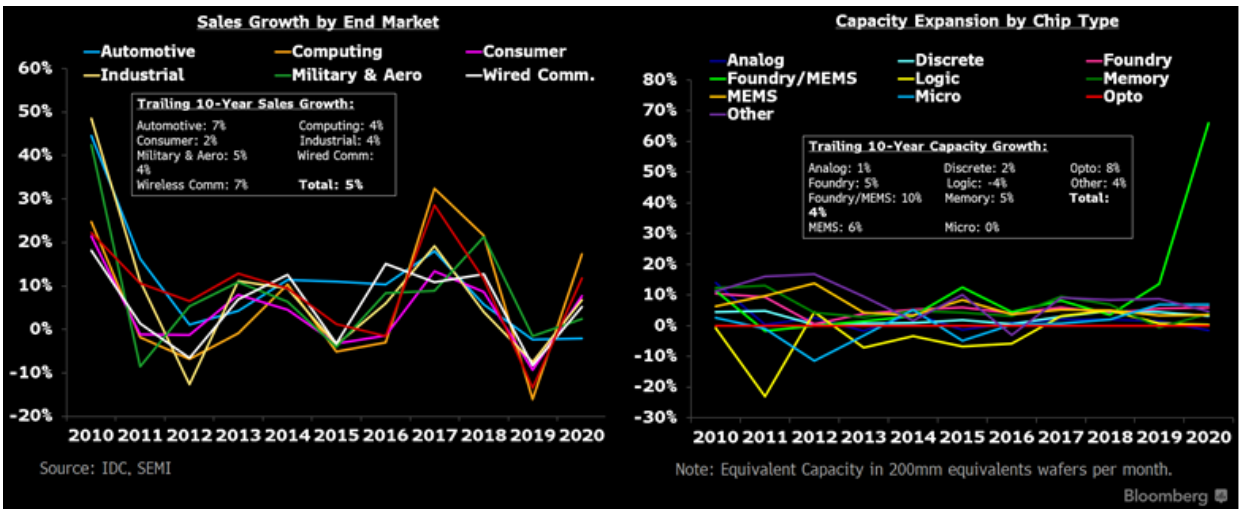
Chip supply crunches are unlikely to ease soon after building for several years, as capacity expansion just can't catch up to sales growth. Demand weakness seems unlikely, with sales and margin risks appearing only at or after 2H22. Computing and wireless communication may absorb nearly 65% of estimated 2022 chip demand, while autos, industrials and wired communications nears 22% of sales.

Supply-Demand Imbalance Was a Long Time Coming

Semiconductor manufacturing capacity shortages have developed over several years, making a fix more elusive. The pandemic lulled -- then amplified -- demand drastically, without allowing capacity to catch up. Sales growth has averaged about 5% annually over the past decade, while expansion of wafer-manufacturing capacity averaged 4%. Transistor shrinkage and density expansion of chips can offset capacity gains in many instances, especially in memory and logic, but not by a wide magnitude for a long period.

Wafer capacity growth is now likely to expand in most categories, and while this may overshoot demand in the near term, the scale of the excess may be smaller and product output tightly controlled so as to not overwhelm demand and substantially weaken prices.

End-Market Sales, Capacity Expansion



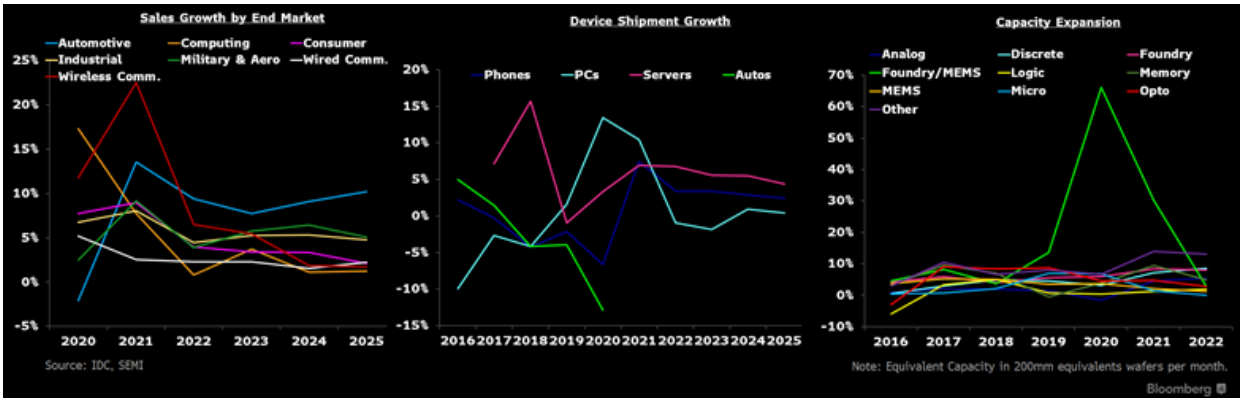
Source: Bloomberg Intelligence, IDC, SEMI

Demand Growth May Balance Capacity Expansion

Despite expansion plans at Intel, Taiwan Semiconductor, other integrated device manufacturers (IDMs) and foundry chipmakers, demand still may absorb capacity growth over the next two years. Capacity -- measured by 8-inch wafer equivalents -- should rise 7%, according to SEMI. This isn't the only way expansion happens (transistor and die shrinkage, or layering expansion in memory density are others), yet it's the most common for many lagging-edge digital and analog chips. Semiconductor sales are set to gain 8% in the next two years, faster than capacity growth.

Phones and PCs may rise 7-10% in 2021, followed by modest declines in PCs and low-single-digit growth for phones over the following two years. Server units may expand 6-8%, while auto's shipment growth is heavily augmented by chip content gains of 3-4% each year.

Capacity, Device Shipments, Chip Sales



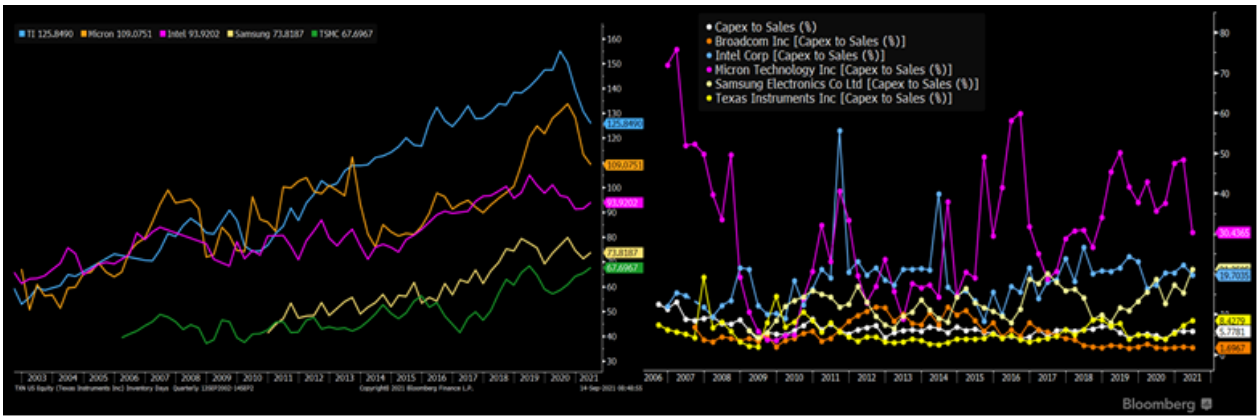
Source: Bloomberg Intelligence, IDC, SEMI

Chip Output Expansion Likely Steady

Companies may be reticent to sharply boost chip output amid high demand, long visible sales pipelines and elevated prices and margins. Satisfying end-market demand and inventory backfills in the distribution channel too quickly might lead to a glut and the need to cut prices. Though that looks unlikely, a combination of binge buying by cloud providers such as Amazon.com and Microsoft, and inventory stocking by distributors for generic parts, may extend a cycle of weaker demand as existing products must be cleared out first.

Capital spending will likely rise steadily after nearing multiyear lows. Advanced logic chips should still be made at outsourced foundries, while incremental capital spending on memory may come from new companies in China. Analog capex, rising at Texas Instruments, likely will be firmly restrained.

Inventories, Capital Spending



Source: Bloomberg

Just-In-Case Manufacturing Is Key

Post-pandemic views of risk management may structurally change inventory patterns if companies switch from a just-in-time manufacturing model to something more like "just-in-case." The move to a more diversified, smaller device assembly location may also drive chipmakers, assemblers and original design manufacturers to carry more inventory, especially if smaller, less-efficient locations outside China are in the mix.

Analog chipmakers, which make products with long shelf lives and lead times in a fragmented market, carry the most inventory. Capacity expansion is likely to be the slowest here. Logic and memory chipmakers stack up at the other end of the scale, with fabless or fab-lite chipmakers Broadcom, Samsung, AMD and Mediatek all at 39-78 days of inventory, while Rohm, TI and Analog Devices are at 111-172.

Autos, Industrials, Corporate IT Are Drivers

Autos, industrials and corporate IT are large, slow-moving spending categories. Wider consumption of semiconductors in these segments, which include electric vehicles, Internet of Things and more powerful servers, is likely to push demand even as the pandemic stretches on. As long as computing and communications-oriented demand doesn't weaken starkly, the other smaller categories may be able to buoy semiconductor demand to support at least mid-single-digit growth.

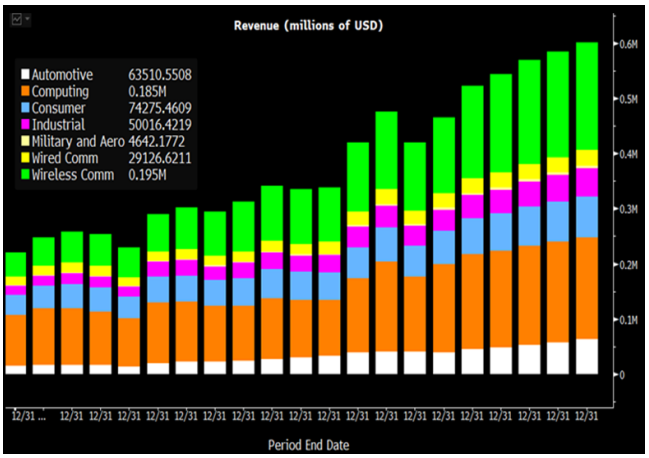
Inventory Days, BISEMIGT Peers

Peer Group: BI Global Semiconductors Top Peers | Currency

	Name	Current Ratio	Quick Ratio	Inventory Growth	Inventory Days
100	NVIDIA Corp	4.09	3.56	50.89%	82.16
101	Samsung Electronics Co ...	2.62	2.06	13.31%	73.82
102	Intel Corp	1.91	1.24	-1.69%	93.92
103	Broadcom Inc	1.87	1.56	7.31%	38.63
104	Texas Instruments Inc	4.28	3.34	-13.11%	125.85
105	QUALCOMM Inc	2.14	1.75	33.72%	76.13
106	Advanced Micro Devices ...	2.54	1.80	33.31%	77.63
107	Analog Devices Inc	1.84	1.31	7.32%	111.21
108	Micron Technology Inc	2.71	1.75	-16.06%	109.08
109	SK Hynix Inc	1.83	1.05	7.09%	97.37
110	Infineon Technologies AG	2.08	1.28	-7.31%	115.77
111	NXP Semiconductors NV	2.14	1.51	-9.12%	90.93
112	MediaTek Inc	2.03	1.69	71.55%	77.66
113	Microchip Technology Inc	0.89	0.53	4.05%	115.99
114	STMicroelectronics NV	2.49	1.70	0.31%	99.84
115	Xilinx Inc	6.00	5.39	-1.77%	101.92
116	Skyworks Solutions Inc	5.17	3.05	15.83%	116.60
117	Maxim Integrated Produ...	5.05	4.63	-8.56%	103.72
118	Renesas Electronics Corp	1.40	1.04	-7.27%	86.31
119	Rohm Co Ltd	7.57	5.61	4.70%	171.85

Source: Bloomberg Intelligence

End-Market Revenue Composition



Source: Bloomberg Intelligence, IDC

Regional Concentrations Don't Risk-Adjust Costs of Chipmaking

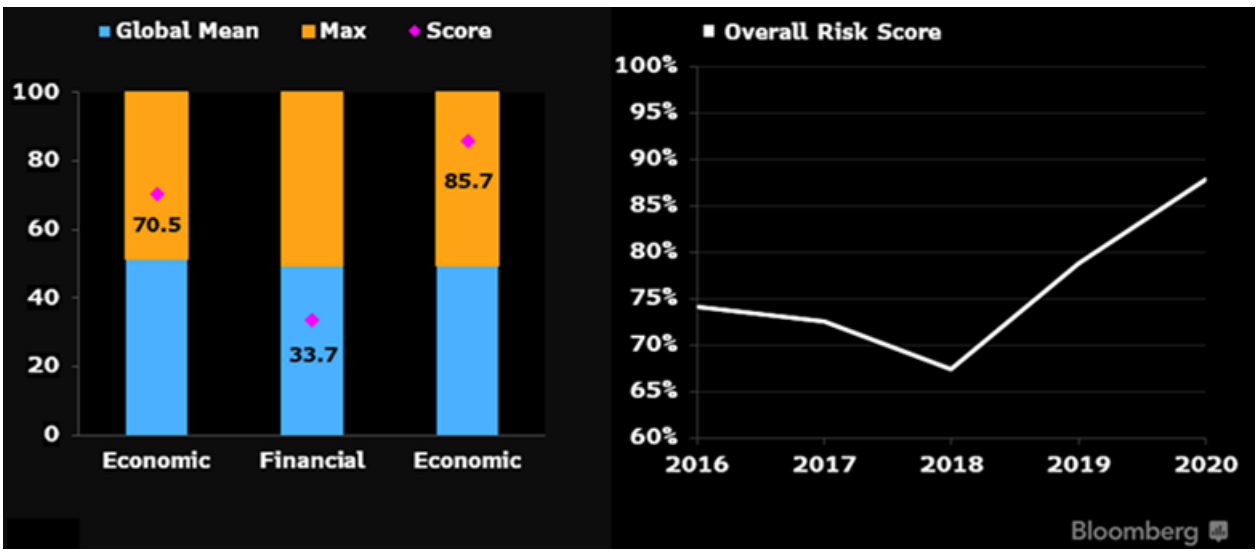
Country risk models may not be industry-specific enough to factor in the concentration of electronics-assembly and semiconductor-manufacturing plants, and thus may not accurately assess risk-adjusted manufacturing costs. Fabless chipmakers Qualcomm, Nvidia and Advanced Micro Devices are highly exposed to TSMC's Taiwan focus and Apple to Hon Hai's mainland China locations. If successful, Intel's plans for U.S.-based foundries may diversify long-term risks.

Regional Risk Models Ignore Industry Concentration

Regional risk models may not factor in the concentration of specific industries, even after trade tensions between the U.S. and China. An equally weighted model of economic, financial and political factors shows Taiwan to be notably less risky than the U.S. and mainland China, which in turn are safer than Vietnam and India. Yet the high concentration of electronics assembly in mainland China and of TSMC's chipmaking fabs in Taiwan has raised risks to the point that assemblers have expanded rapidly in Vietnam and India, despite their much weaker costs and logistics profiles.

The electronics supply chain is geographically fragmented but concentrated across certain components in Taiwan and mainland China. Many tech products cannot be shipped if any one supply-chain point collapses.

Taiwan Risk Score

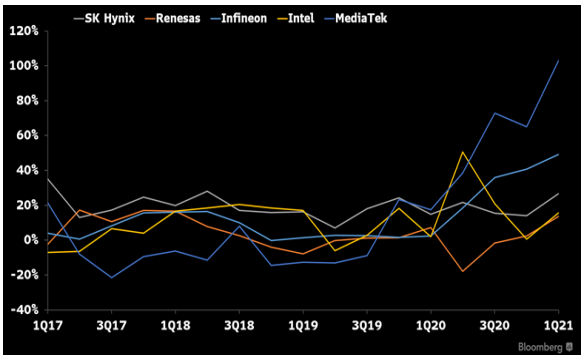


Source: Bloomberg Intelligence

Stronger Sales Push Costs More Than Inflation

Cost of revenue for most key chipmakers, when adjusted for country risk, has increased over the trailing one-, three- and five-year periods. This is due more to sales and costs rising in tandem than to cost inflation in any particular region or company. Decoupling supply chains will add another layer of costs, requiring time and effort to achieve competitive scale in their respective industries and components, even if it doesn't match today's average costs. Materials, equipment and front-end foundry services for advanced-logic semiconductor manufacturing may prove particularly expensive when regionally separated.

Country-Risk Adjusted Cost of Sales



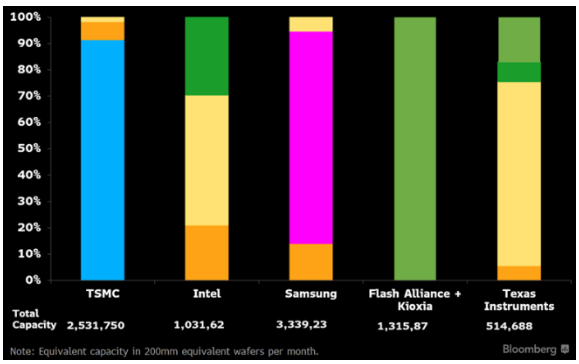
Source: Bloomberg Intelligence

Companies Expand Noncore Locations to Cut Risks

Companies drive chip-factory scale higher to reduce costs, even as it concentrates their risk. Co-locating even similar products cuts costs amid greater wafer output. Locations are chosen based on favorable capital and operating costs and tax treatment, local deregulation, and access to and cost of semi-skilled and skilled labor. These can be favorable when the location is already a hub for chip manufacturing or its adjacencies.

It's not surprising that all of Samsung's factories are in South Korea, all of Toshiba's are in Japan, most TSMC fabs are in Taiwan and Intel's in the U.S. Their dominance of specific end-markets has driven this concentration, and it will require a persistent effort by these companies to diversify to and scale up their noncore sites to reduce location risk.

Regional Capacity Mix by Company



Source: Bloomberg Intelligence, SEMI

Global Chipmaking Capacity Faces Multiple Regional Bottlenecks

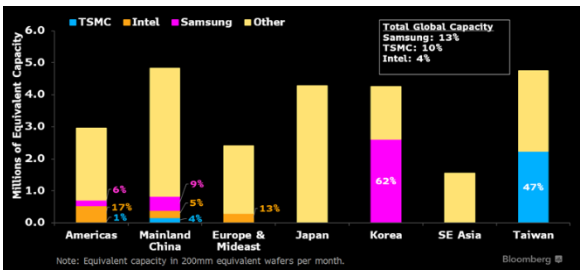
Amid global shortages, semiconductor chipmaking capacity will likely remain regionally skewed, creating supply chokepoints across product types. Taiwan, Korea, Japan and the U.S. are capacity leaders in advanced logic, memory and MEMS chips, with TSMC and Samsung critical in foundries and memory in Asia. Intel's foundry expansion in logic-chip manufacturing can help, but only in the longer term.

TSMC, Samsung, Intel Lead Regional Chipmaking

Distribution of global semiconductor manufacturing capacity is highly lopsided, with little change in the next year or two. Asia has many concentrated manufacturing locations, with the skew becoming more acute when parsed by the type of chip. In 1Q, the Americas had 12% of overall semiconductor capacity, less than mainland China and Taiwan's 19% and Japan and Korea's 17% each. Mainland China expanded its overall capacity by 16% in the 12 months at 1Q-end, while most other regional capacity rose in the single digits. Not all capacity is made equally -- there's more value in advanced logic such as microprocessors (MPUs). Supply and demand in commodity areas such as memory make its value more volatile.

Most regional capacity is dominated by few players -- Intel in MPUs, Samsung in memory and TSMC in outsourced chipmaking, or foundry.

Regional Wafer Capacity With Top Players



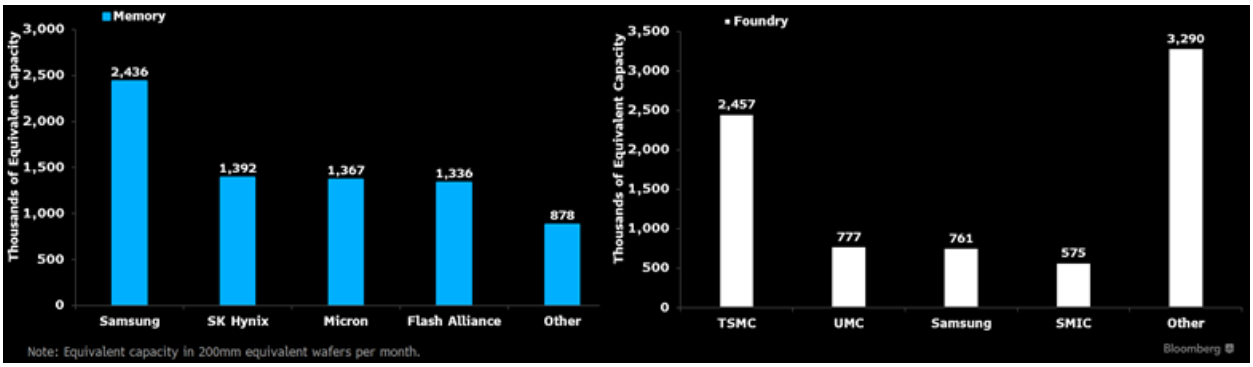
Source: Bloomberg Intelligence, SEMI

Memory, Foundry Dominated by Asian Factories

Memory and foundry capacity, which are large segments of global chipmaking, are heavily Asia-centric. Outsourcing capacity is centered in Taiwan, where foundries such as TSMC make mostly logic chips for fabless chipmakers such as Nvidia. Discrete and analog chips, which in total account for 19% of 1Q's 200-mm-wafer-equivalent capacity, typically operate on more lagging transistor nodes. The Americas leads in analog and microprocessor manufacturing, led by chipmaking strength from Intel and Texas Instruments in those sectors. The Americas have 19% exposure in foundry capacity, but most is from GlobalFoundries and Samsung.

Foundry capacity in mainland China rose 14% in the 12 months at the end of 1Q, with specialty fabs from SMIC, Hua Hong and CR Microelectronics making up about 56% of mainland China's foundry capacity.

Memory, Foundry Capacity by Top Players

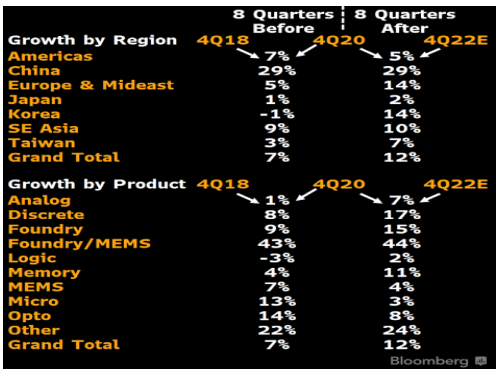


Source: Bloomberg Intelligence, SEMI

Post-Pandemic Demand Uses Up Slow-Growing Capacity

Total semiconductor manufacturing capacity was only set to rise 6% this year but accelerated capital spending and the pull-in of expansion plans could double that. If the demand boost can be sustained, this capacity will likely reach high utilization levels. Mainland China remains the largest expander of capacity, with 16% growth in 8-inch wafer-equivalent capacity per month in 2020 and another 16% expected this year. All other regions were set to expand capacity by single-digit percentages, with Taiwan at 4% and the Americas at 3% in 2021. On a product basis, foundries are the largest growth area, with a bulk of the expected expansion.

Capacity Growth



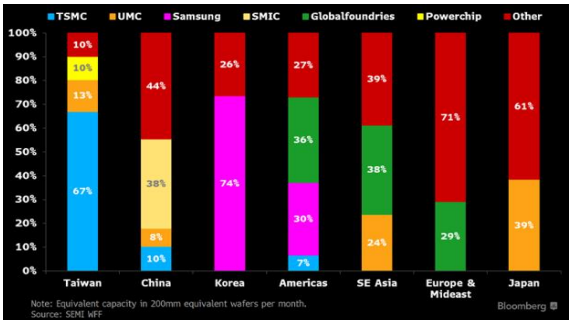
Source: Bloomberg Intelligence, SEMI

TSMC Is Key Chokepoint for Nvidia, Apple

Foundry, or outsourced, manufacturing across chip categories is a key chokepoint, particularly given the sector's high exposure to advanced-logic chipmaking for Apple, Nvidia, Qualcomm, Advanced Micro Devices, Amazon.com and others. Taiwanese foundries such as TSMC, which dominate the advanced-logic market, were set to expand capacity about 4% in 2021, but this may now rise faster. TSMC is so big that large upticks in demand are unlikely to be made up by another company or region. TSMC accounts for 63% of Taiwanese foundry capacity, followed by UMC's 13% and Powerchip's 9%.

Korean foundry capacity, of which Samsung dominates at 67%, is in total less than 25% of Taiwan's capacity, though is set to expand 10% this year.

Regional Foundry Capacity by Top Players



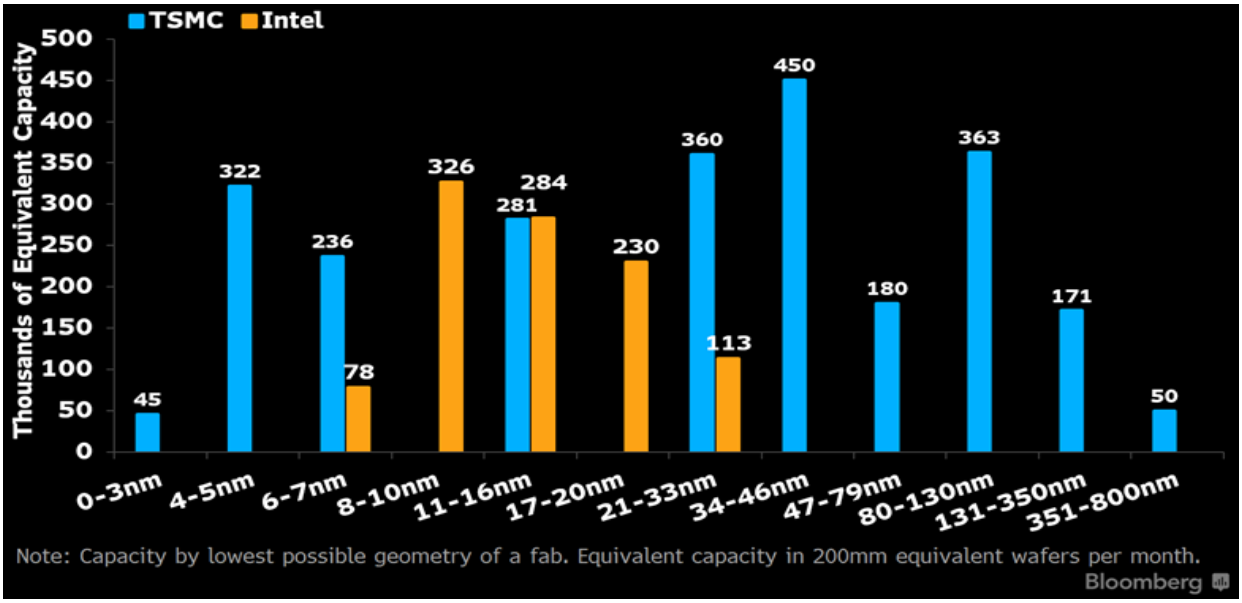
Source: Bloomberg Intelligence, SEMI

Intel's Expansion Offers No Near-Term Respite

Intel's factory expansions of $10 billion apiece for its two Arizona facilities and $3.5 billion in New Mexico will offer little relief to the near-term supply crunch across various semiconductor types. Data from SEMI show that Intel's capacity was set to expand about 2% in monthly 8-inch wafer equivalents in 2021, less than the global average of 6% and compared with TSMC's 5% expansion.

Intel's success in capacity expansion is also highly contingent on its transistor-pitch shrinkage. According to SEMI data, Intel had 8% of its equivalent capacity in 7nm-node products in 1Q, which may rise to 15% by 4Q. TSMC has 25% of its equivalent capacity devoted to leading-edge nodes (3nm-7nm), with 27% expected by 4Q.

TSMC vs. Intel Capacity by Process Node



Source: Bloomberg Intelligence, SEMI

Deep Dive Into Chipmaking's Fab Five Location Hubs

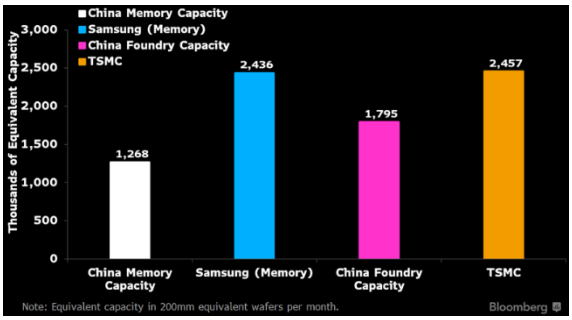
Mainland China's chipmakers have the largest share of global capacity, yet still trail companies with factories in Korea, Japan, Taiwan and the Americas with only about 7% of global sub-20-nanometer capacity, besting only Europe and Southeast Asia. Even as its domestic electronics demand is about 20% of the market, China's chipmaking capacity focuses on foundry, memory and discretes.

Advanced Chipmaking Unremarkable Through 2025

Chinese companies are unlikely to seriously contend for advanced chipmaking leadership over the next few years in memory or foundry. The group's largest expansions, mostly in memory, have been subscale when compared with Samsung's, and its foundry capacity, mostly through SMIC, has been weaker than behemoth TSMC. Government support can help start projects but is unlikely to subsidize longer runs of reduced margins. Bans on U.S. and European capital equipment and software needed to make chips further muddy China's roadmap to high-volume production.

SMIC, China's largest foundry, has total 8-inch wafer capacity that's about 18% that of Samsung. China's capacity footprint is about 19% of the global total.

Memory, Foundry Capacity: China vs. Titans



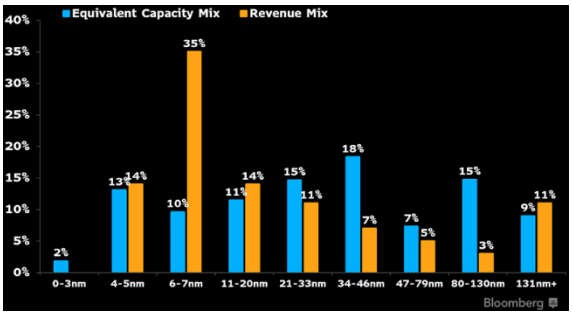
Source: Bloomberg Intelligence, SEMI

Global Capacity Is Well Distributed by Nodes

Global chip capacity is well distributed across leading- and lagging-edge nodes even amid lopsided sales. Chips made on less than 20-nanometer (nm) pitch transistors make up about 30% of global capacity. The middle tier, 21-130 nm, represents 38%. This diverse tier features analog, discrete and logic chips, suiting a wider range of applications, especially in higher-volume products. The lagging edge of greater than 130-nm chips likely has analog, discrete and wide-band-gap chips for power applications. Capacity for sub-10-nm-based chips is 5%.

Advanced foundry (for logic) and memory occupies most capacity below 20 nm. Discretes, optoelectronics, analog and MEMS make up 75% of the lagging edge.

TSMC Wafer Capacity vs. Revenue Mix by Node



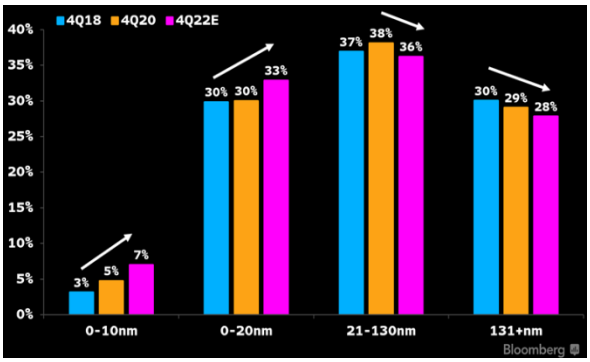
Source: Bloomberg Intelligence, SEMI

Transistor-Shrinkage Roadmap Critical

TSMC is the only company capable of producing chips at the most advanced transistor geometry of 3 nm. Samsung is likely a few quarters behind, while Intel might be one to two years away. Wafer capacity on 10-nm transistors and below is 5% of global chipmaking capacity but produces more revenue, given the complexities' pricing power. Advanced-logic chips made by Apple, Qualcomm, Nvidia and Advanced Micro Devices for processing workloads such as graphics, AI and communications use these nodes. Intel, TSMC and Samsung may remain the only chipmakers at these nodes for the next few years.

TSMC's pricing is based on counts of layers on the chip, along with transistor node size. A successful migration roadmap is critical because it technologically and economically paves the way for other less-complex chips.

Transistor Node Capacity Distribution Over Time



Source: Bloomberg Intelligence, SEMI

Wider Lens Presents More Complex Data

Even as manufacturers in Taiwan have a lock on high-end foundry capacity that's critical for advanced-logic chips using small-pitch transistors, other regions have equal dominance in different segments. Korea makes up 40% of global memory-chip capacity, while 53% of microprocessor capacity for PCs and servers is from the Americas. Japan accounts for 28-53% of optoelectronics, discretes, MEMS and general-purpose logic chips. Mainland China has the largest share in discretes, at 32% of global capacity.

Should the U.S.-China rift expand to companies in Taiwan, this will affect capacity for high-end processors and logic for smartphones, AI and graphics, but Japan and Korean exposure matter as well. SEMI data show the significant interconnectedness of chipmaking. No single region made up more than 20% of global wafer capacity in 1Q.

Regional Capacity Mix by Chip Product Type

	Analog	Discrete	Foundry	Foundry / MEMS	Logic	Memory	MEMS	Micro	Opto	Other	Grand Total
Americas	35%	5%	7%	32%	17%	6%	40%	53%	8%	12%	12%
Mainland China	6%	32%	23%	22%	5%	17%	3%	0%	28%	19%	19%
Europe & Mideast	25%	19%	5%	33%	21%	0%	15%	33%	3%	44%	10%
Japan	14%	28%	2%	6%	53%	21%	35%	15%	36%	2%	17%
Korea	2%	5%	11%	0%	0%	40%	3%	0%	7%	9%	17%
SE Asia	18%	8%	6%	0%	0%	4%	4%	0%	5%	10%	6%
Taiwan	0%	3%	45%	6%	3%	11%	0%	0%	12%	5%	19%
Grand Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Bloomberg

Source: Bloomberg Intelligence, SEMI

Auto-Chip Shortage May Be Resolved in 2022, Risk of Delay

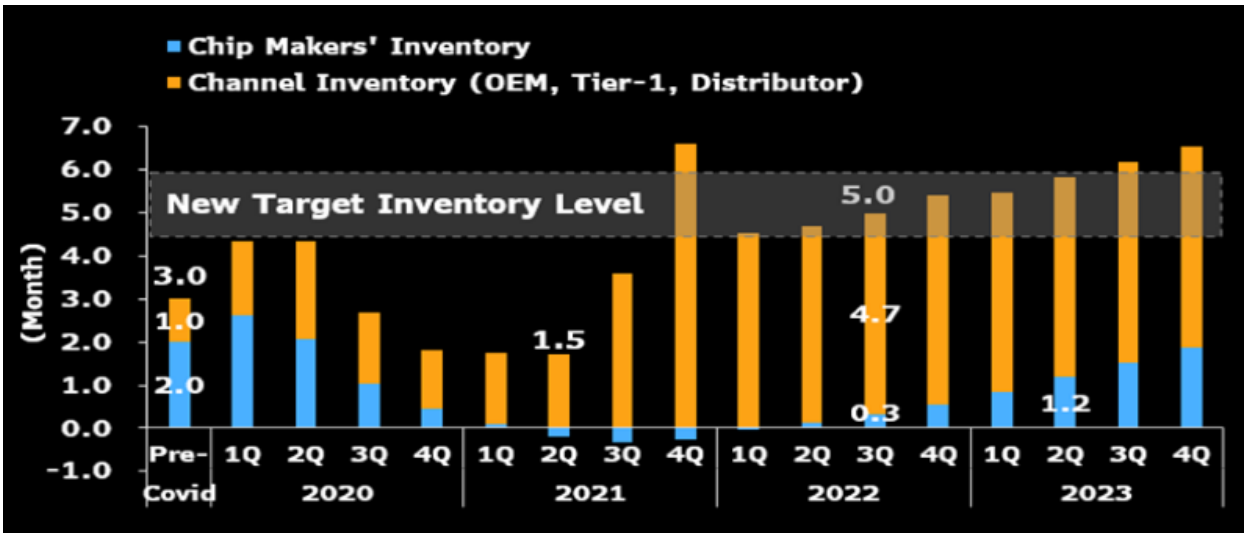
Chip-shortage issues may be resolved in 3Q22 for the entire auto supply chain due to an output increase, in our scenario analysis. Using our slow-recovery scenario, this would take place in 2Q-3Q23, while our early recovery scenario positions it in 1Q22. An output increase from chipmakers such as Renesas Electronics and NXP Semiconductors may be key.

Chip Inventories May Normalize in 3Q22 -- Scenario

Inventories of automotive chips throughout the supply chain may reach a sufficient level in 3Q22, based on our scenario analysis. Months of inventory -- the sum of chipmaker inventories and channel stocks, those held by automakers, tier-1 part makers and distributors -- could normalize at a new level of five to six months. Supply-chain inventory may reach five months in 3Q22, based on our scenario analysis. Yet chipmakers could face insufficient stocks, while output may stay strong until 2023. Despite cuts in automobile production due to Covid-19, channel inventories remain high as of 3Q, as chipmakers continue to ship products. There may be inventory shortages again due to automakers' plans to raise output starting in 4Q.

Our analysis assumes that total months of inventory was three before the pandemic.

Auto Supply-Chain Inventory, Scenario Analysis



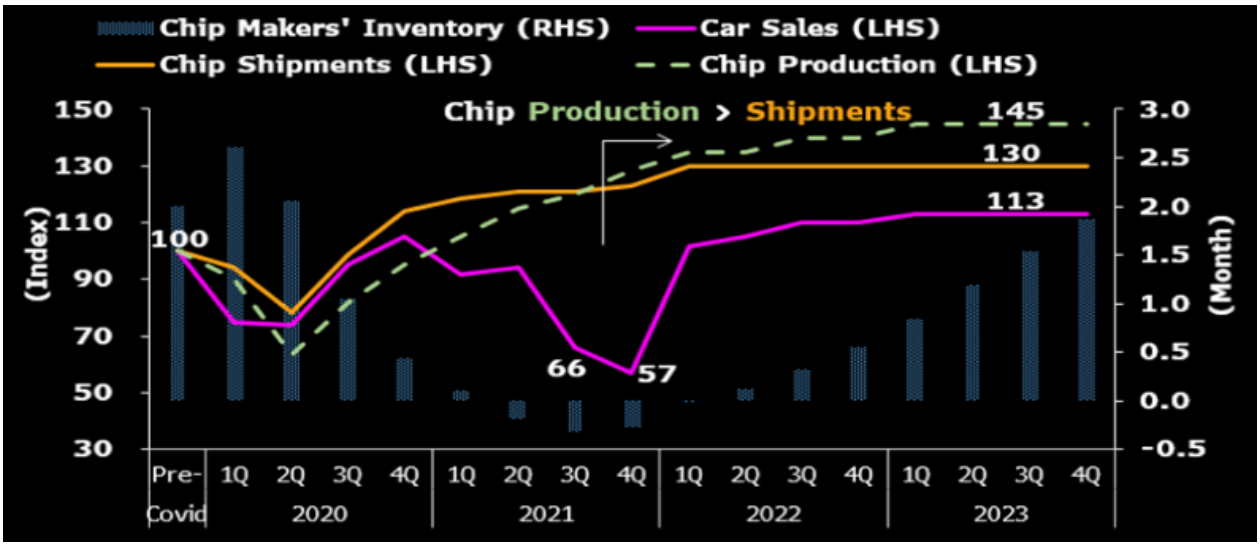
Source: Bloomberg Intelligence

Auto Chip Output May Exceed Shipments

Chip production in 2021 may fall short of shipments through 3Q, leading to a decline in inventories, though these could be replenished as output exceed shipments from 4Q in our scenario. Chipmakers' stocks may be too low in 2021-22 -- therefore, assuming 100 in 2019, chip production may rise to 117 in 2021, 138 in 2022 and 145 in 2023. High factory utilization rates could continue at Renesas Electronics, NXP Semiconductors and others, boosting profit margins. Assuming 2019 sales of 100, car sales could bottom out at 57 in 4Q and may rise to 113 in 2023. If 2019 car sales were 90 million units, 2022 sales may be 96 million units.

Given the pace of car-production increase, channel inventories may reach sufficient levels by about 1Q22, in which case chip shipments may not sequentially rise from 2Q22.

Car Sales, Chip Production, Shipments, Inventory



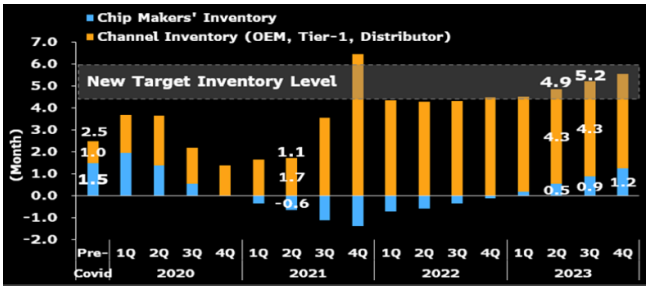
Source: Bloomberg Intelligence

Chip Stocks May Be Normalized in 2Q23 -- Slow Scenario

For automotive chips that were already low in inventory before the Covid-19 pandemic and production growth has been slow (our slow recovery scenario), supply-chain inventories may rise to 5-6 months in 2Q-3Q23. Supply-chain stocks, which include chip-manufacturer inventories and channel inventories -- those of automakers and Tier 1 part manufacturers -- could reach 4.9 months in 2Q23. Renesas Electronics and other chipmakers may have to boost output rapidly through 2023. Chip-supplier inventories could be one month or more in 4Q23. For chips with little inventory, it may take 9-12 more months to replenish inventories compared with our case.

This assumes chipmakers had two months of inventory before the pandemic (our case) vs. 1.5 months in the slow recovery case and that 2021-22 chip production is 2-3% lower than the base case.

Chip Inventory in Slow-Recovery Scenario



Source: Bloomberg Intelligence

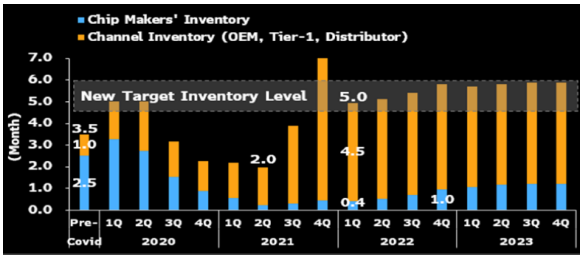
Problems May Be Resolved Soon -- Early Scenario

If chip manufacturers held larger inventories before the pandemic (our early recovery scenario), automotive supply-chain inventories may reach an appropriate level in 1Q22. Supply-chain inventories, which include chip manufacturers and channel -- inventories of automotive and Tier-1 part manufacturers -- may reach the target of five months in 1Q22. Yet until 4Q, when chip-manufacturer inventories reach one month, they may issue comments regarding inventory shortages, and production could increase.

Inventories may total 5.7 months in 1Q23 -- 1.1 months for chip manufacturers and 4.6 months for channel inventories -- and then increase gradually thereafter.

The issue of inventory shortages of chips, of which there were high inventory levels before the pandemic, may be resolved in 2022.

Chip Inventory Analysis for High Inventory Chips



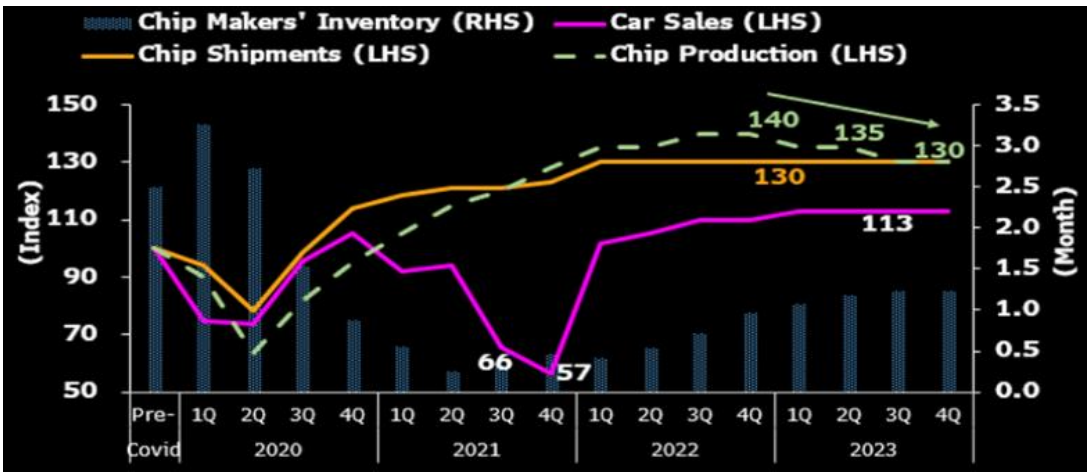
Source: Bloomberg Intelligence

High Inventory Chip Output May Decline in 2023

For chips that have enough inventory, output may increase to replenish safety stock through 4Q22 and then decrease from 2023. Chip manufacturers could produce more chips than they ship, starting in 4Q, making it possible to boost inventories to one month in 4Q22 from 0.5 months in 2Q21. Once inventories reach the target level, production may be cut to the level of shipments, so production could rise from 135 in 1Q22 to 140 in 4Q22, then decline to 135 in 1Q23 and 130 (the same level as shipments) in 3Q23. Production value, shipments and car sales in 2019 were set at 100 as an index.

Chip shipments could stay flat at 130 from 1Q22, after channel inventories stop rising, through 4Q23. Chip manufacturers see the risk of utilization decrease in 2023, despite an expected increase in shipments and utilization gains in 2022.

Production, Shipments for High Inventory Chips



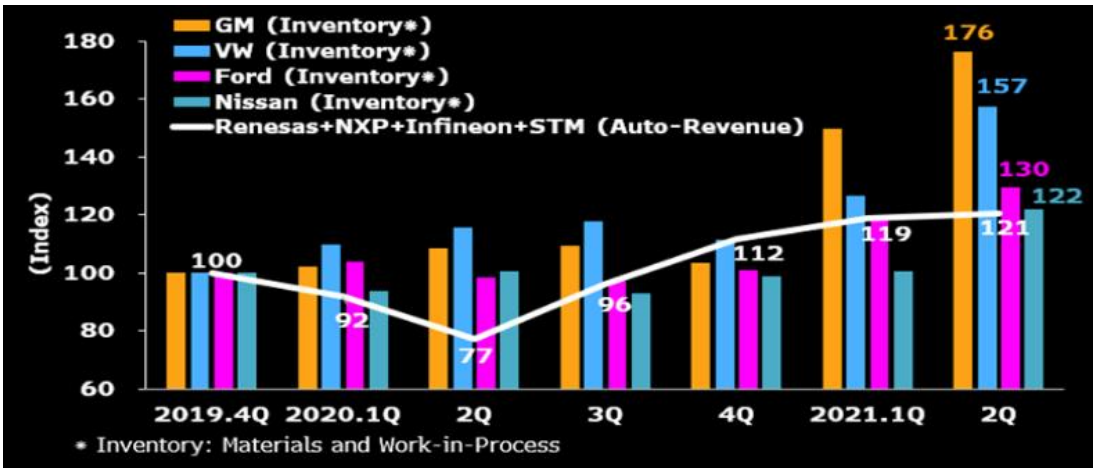
Source: Bloomberg Intelligence

Mixed Inventories Make Analysis Difficult

The analysis results depend on various factors, and one difficultly is that the degree of excess or shortage depends on the chip type. Production of certain chips was unlikely to increase due to low inventories and limited supply capacity even before the pandemic. Chipmakers such as Renesas and NXP Semiconductors are seeing greater sales, which shows that chips are being delivered to automakers and tier-1 parts suppliers. As automakers' balance sheets show larger raw-material inventories due to production cuts, it's difficult to confirm from financial data that chipmakers' insufficient supplies are leading to cuts in automobile production.

Final demand for automobiles, greater use of chips per vehicle due to car electrification, regional differences and other factors also affect the analysis.

Car Makers' Material Inventory, Chipmakers' Sales



Source: Bloomberg Intelligence

Auto Supply Chain Too Complex to Skirt Chip Shortage

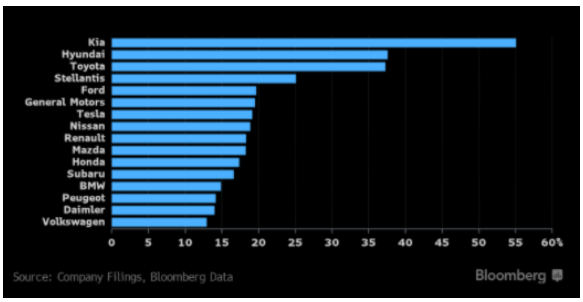
Automakers have few options to prevent supply disruptions such as the global chip shortage that has dwindled new-vehicle supply -- most seriously in the U.S. -- though Volkswagen may have more flexibility and Tesla and Toyota the least. The complexity, collaboration and cost involved in changing out any of the thousands of top-tier suppliers raises risk, while the high-quality grade of parts for autos rules out easy alternatives.

Auto-Grade Parts Need Supply-Chain Expertise, Stability

The global semiconductor shortage that may reduce new-vehicle assemblies by 8 million units worldwide in 2021 -- and North America retail revenue by $100 billion -- can't be skirted by swapping suppliers in the middle of a production cycle. Supply-chain relationships and chip design, requirements and integration with other systems have been developed over years and involve guaranteed contracts. Domestic manufacturers would need years and prohibitive expense to flip to new suppliers that would introduce many unknowns, including quality and durability needs far greater than what's acceptable in other consumer-electronics applications.

Ford has $4.2 billion in total purchase obligations and 1,400 tier 1 suppliers, while General Motors counted purchase orders with more than 5,000 direct and indirect parts providers in 2020.

% of COGS Automakers Pay Top 10 Suppliers



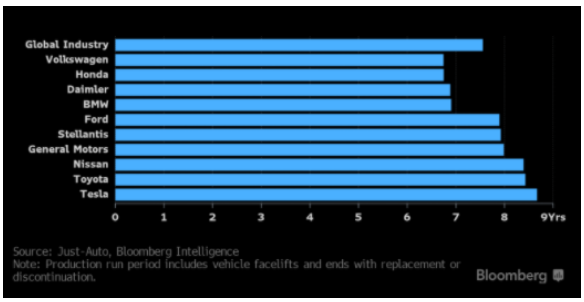
Source: Bloomberg Intelligence

Eight-Year Vehicle Production Cycle Begets Less Supplier Churn

The global auto industry's tendency to maintain eight-year production runs for vehicles -- broken up by a midcycle refresh or facelift -- is an indicator of the obduracy of parts contracts between manufacturer and supplier. Pandemic-idled production and the worldwide chip shortage has hamstrung the recovery, though only expiring contracts and vehicle plans not yet in production are the real opportunities for automakers to regionalize their supplier base. Of the largest global automakers, Volkswagen averages the shortest production runs, while Tesla -- though lacking global scale -- and Toyota maintain the longest, above eight years each.

Europe-based automakers average 6.7 years per production run, shorter than either U.S. or Asian manufacturers -- which are above 7.4 years.

Average Production Run Duration by Automaker



Source: Bloomberg Intelligence, Just Auto

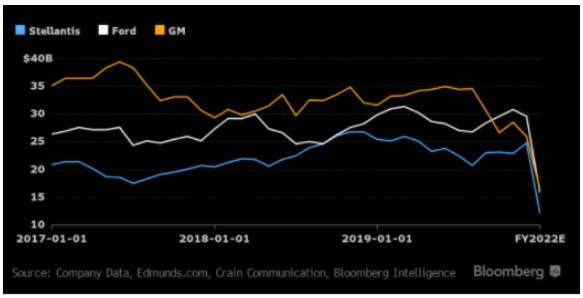
Automaker Move to Less Inventory Needs Faster Supply Chain

Structural changes in the supply and demand balance across the global auto industry that's driving prices higher and margins wider will manifest as a reduction in capital-sapping stockpiled parts and vehicle inventory. Ford's goal of reaching double-digit pretax margins is based on trimming supply to 50 days in the U.S. -- from an average of 77 in 2014-19 -- slashing supply by 337,000 units and freeing up $15 billion from slower-selling models. More constrained output of vehicles at General Motors and Stellantis -- from more

than 80 days pre-pandemic -- will firm pricing and shift leverage away from consumers to manufacturers and dealers.

The lack of U.S. supply has reduced discounts from MSRP by $2,500 per vehicle in favor of dealerships in 2021, while manufacturers are spending $1,700 less in factory incentives.

Inventory Value in U.S.



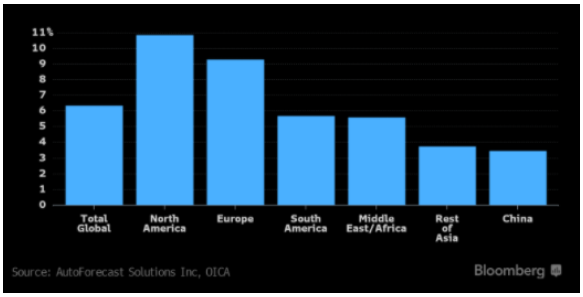
Source: Bloomberg Intelligence, Edmunds.com, Crain Communication

Chip Supplier Shuffle Not Feasible for Autos

North America-based automakers face the highest potential production losses of any region due to the chip shortage, as they are overly dependent on the domestic market. U.S. semiconductor producers generate $12 billion in revenue from the auto industry, 37% more than European peers and only 12% less than Asia chipmakers. Ford, GM and Tesla generate a relatively small revenue pool, 72% less than Asia-based rivals and 52% below European peers. This shows that U.S. automakers will remain committed to domestic suppliers, as they lack the revenue scale to secure contracts with foreign chipmakers.

Texas Instruments, ON Semiconductor, Micron and Microchip Technology all generate more than $1 billion from the auto industry; none get more than 34% of revenue from vehicle manufacturing.

Projected Lost Production Compared With 2019



Source: AutoForecast Solutions, OICA

Chip Dearth Saps Ford Supply, Adds Millions in Profit

Ford's depleted inventory can still deliver $1.4 billion of pretax profit improvement vs. 2Q20, as discounting is at a record low and prices are higher than ever. The company's 782 bps of margin expansion would drive most of the gain. General Motors has less margin upside and a $33 billion inventory shortfall that may be too large to overcome with firmer pricing, possibly pulling profit $1 billion short of a year ago.

Price, Margin Swings Turn Slim Supply to Plump Profit

Retail auto buyers in the U.S. are lamenting a 6% increase in transaction prices since summer 2020, accompanied by a lack of consumer bargaining power that has pushed the average sale to within 3.1% of MSRP, the tightest range since at least 2014. Automakers haven't yet been stung by the low supply -- down 58% in June from a year earlier -- as the seasonal sales rate above 17 million in 2021 is the highest five-month reading since 2016. Pricing and margin may add $122 million in pretax profit to automakers selling in the U.S. in 2Q compared with a year earlier, as the manufacturers with lower margins through the early stages of the pandemic stand to make the largest gains.

Ford could add $1.4 billion in pretax income while Nissan's margin advance could bring the company $295 million closer to profitability in 2Q.

Financial Indicators by Company

	Profit Gain/(Loss)	Profit Potential of Inventory	Adj Margin Change (in bps)	Retail Revenue Value of Inventory	Inventory Units % Change	Inventory Units
Total	$122	$5,523	520	$60,695	-58.0%	1,490,546
Ford	1,405	908	782	7,577	-68.3	165,636
Nissan	295	-12	177	3,919	-45.5	127,823
BMW	260	416	680	2,967	-27.2	49,006
Hyundai Kia	212	345	432	4,596	-34.6	154,648
JLR	147	50	-82	817	-57.7	10,632
Mazda	72	78	441	1,216	-51.7	39,607
Mitsubishi	45	-8	277	328	-56.0	13,503
Mercedes-Benz	-8	205	852	2,331	-46.5	37,637
Volvo	-61	74	66	1,195	-24.6	23,597
Volkswagen	-78	311	1,532	4,133	-41.5	87,529
Subaru	-105	15	532	1,332	-57.4	41,444
Stellantis	-110	588	322	8,112	-63.1	188,493
Honda	-264	432	-373	6,129	-47.4	182,338
Toyota	-594	777	767	5,624	-58.2	153,376
General Motors	-1,095	1,345	377	10,419	-72.4	215,277

Source: Company Data, Edmunds.com, Lot.lnx, Bloomberg Intelligence
Note: Financial values in million USD.
Bloomberg

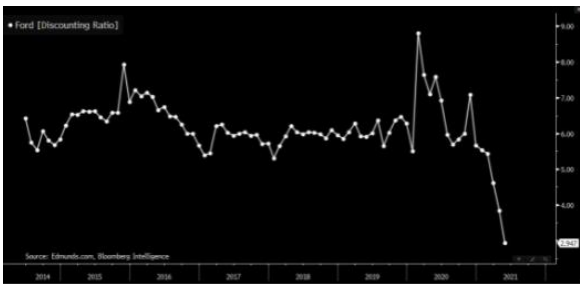
Source: Bloomberg Intelligence, Edmunds.com

Ford Margin Surge May Aid EPS Despite Supply Drag

Sustaining an adjusted pretax margin in the range of 1Q's 12% -- vs. a negative number in 2Q20 -- could add $1.4 billion in pretax profit year-over-year for Ford despite having $16 billion less in inventory value at its dealerships in mid-June. The company's supply of pickup trucks -- F-Series plus Ranger -- is 60% of the year-ago level and could start to be an earnings drag in 2H if the seasonal sales rate is sustained at the 17.1 million logged through May. Ford's pricing in the U.S. has firmed, as transactions are less than 3% off MSRP, amounting to $1,887 per vehicle of retained revenue for the dealer.

Ford managed an adjusted pretax loss of $842 million in 2Q20, snapping back in 1Q to its best profit margin since before the 2008-09 recession, underpinning a raised outlook for 2Q adjusted Ebit.

Ford Transaction Prices Nearing MSRP



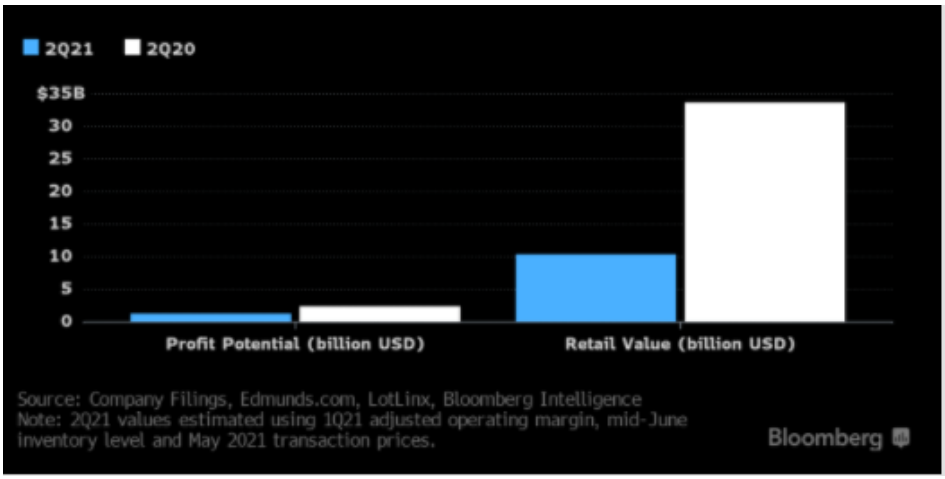
Source: Bloomberg Intelligence, Just Auto

GM Profit Hit $1 Billion on Shrunken Supply

The computer chip shortage has sapped $23 billion worth of U.S. retail revenue potential and $1.1 billion in adjusted pretax profit at current margins from GM--more than 3x that of any competitor -- in 2Q. Factories were idled in 2Q20 and buyers avoided the showrooms, muting GM's average adjusted pretax margin to 7.2%. Tighter supply and a demand resurgence have since boosted margin by 570 bps and pushed the ratio above 10% in two of the previous three quarters -- a feat not achieved since the company's IPO in 2010. Yet the margin gain isn't enough to overcome the 69% year-over-year decline in inventory value.

Transaction prices in the U.S. are 4% higher year-over-year, while pretax margin has expanded 523 bps for global automakers.

GM Retail Revenue, Pretax Profit Potential



Source: Bloomberg Intelligence, Edmunds.com, LotLinx, Company Filings

Supply-Chain Risks May Make U.S. Pharma Feel More Domestic Again

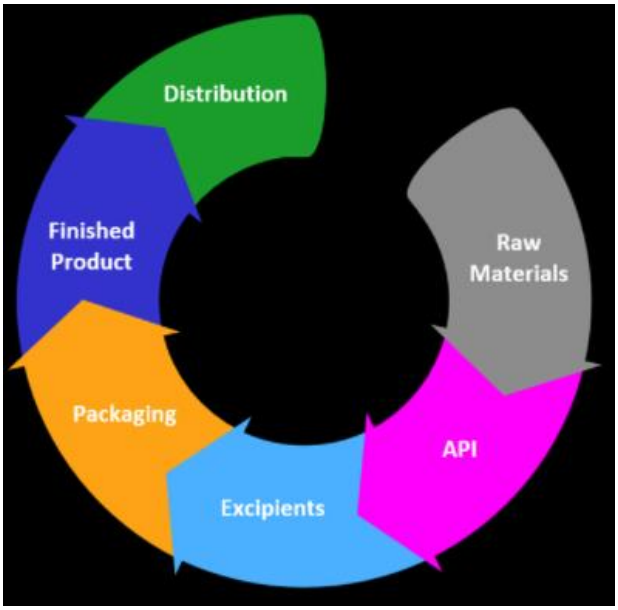
U.S. pharma companies weighing the costs of pandemic supply-chain disruptions may shift to more domestic production of critical ingredients after years of rising imports from China and India. Their decisions could be swayed by congressional pressure, the FDA focus on foreign inspections and growing use of biologic and gene therapies with stringent temperature requirements.

Heightened Focus on Cold-Chain Shipping

As complex biologics and gene therapies become more prevalent, we believe cold-chain shipping may become a bigger factor in the pharmaceutical supply chain and accelerate U.S. companies' shifts to more localized manufacturing. Total biologics and gene therapies have grown at a compound annual rate of 13% over the past 10 years, according to Symphony Health data, and typically must be maintained at very low temperatures during shipping until they are thawed immediately before use.

In the supply chain, raw materials are developed into the critical active pharmaceutical ingredients (APIs), which are added with excipients, or non-active ingredients, and then measured for dosing and packaged to create finished drugs.

Pharmaceutical Manufacturing Chain Hinges on API



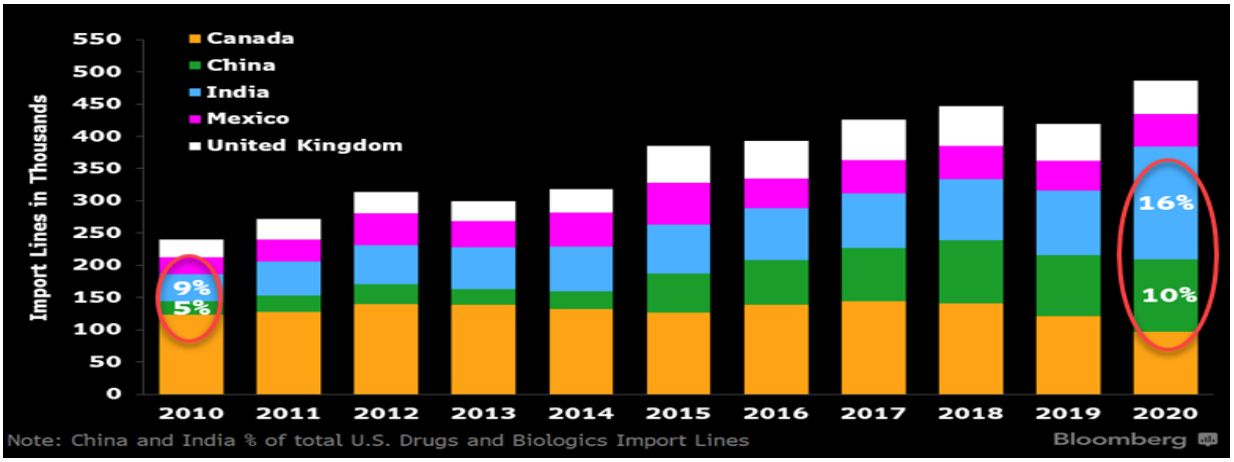
Source: Bloomberg Intelligence

Reliance on China, India Could Ease

The share of U.S. pharmaceutical imports from China and India has risen significantly in the past decade but could see some reversion as pandemic-related supply-chain disruptions attract government scrutiny and raise questions about the costs of foreign manufacturing. The two countries combined comprised less than 15% of all U.S. pharmaceutical import lines in 2010 -- which had almost doubled by 2020, based on FDA data. Some of that growth could abate under President Joe Biden's American Jobs Plan, which calls for more than $52 billion in investments in domestic manufacturers as well as $30 billion to prepare for future pandemics and onshore API manufacturing

Canada, Mexico and the U.K. account for other major pharmaceutical import lines, representing 9%, 5% and 5%, respectively, of total U.S. import lines in 2020.

Pharmaceutical Manufacturing Chain Hinges on API



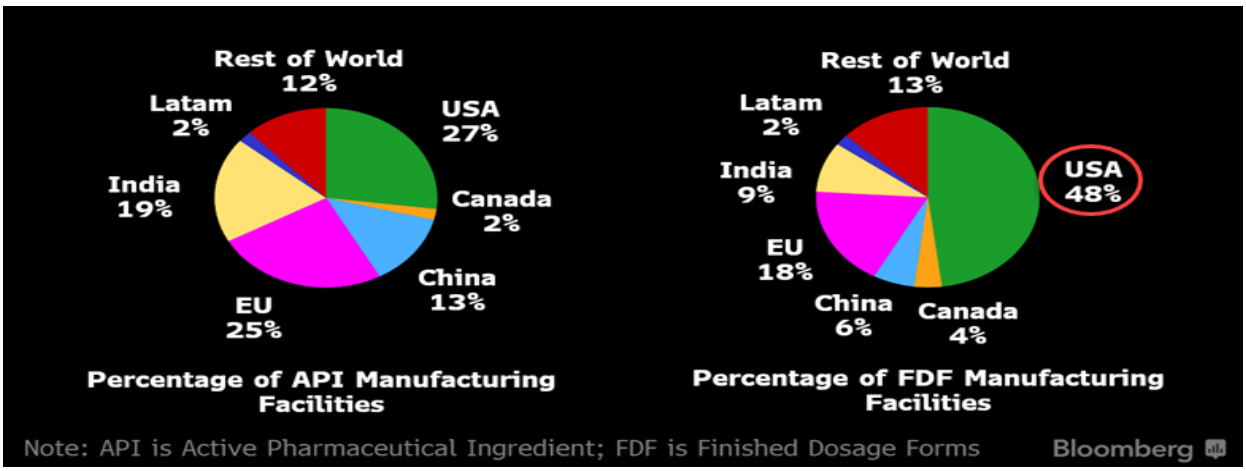
Source: FDA; Bloomberg Intelligence

Onshoring May Concentrate More on API

Nearly half of finished dosage forms (FDFs) are already produced in the U.S., so we expect onshoring efforts may focus more on active pharmaceutical ingredient (API) facilities. FDA data show China and India make up only 15% of FDF plants, compared with over 30% of API facilities. By contrast, the U.S. represents 48% of FDF plants and only 27% of API facilities.

The API market is produced about 60% in-house globally, with the remaining 40% purchased on the merchant market from third-party suppliers, according to Clarivate Analytics. It's common for large pharmaceutical manufacturers to purchase at least a portion of their APIs on the merchant market, even if they produce much of their API in-house. We estimate about three-quarters of U.S. APIs purchased on the merchant market are for branded drugs.

China, India Accounted for 15% of Finished Dosage Forms in 2020



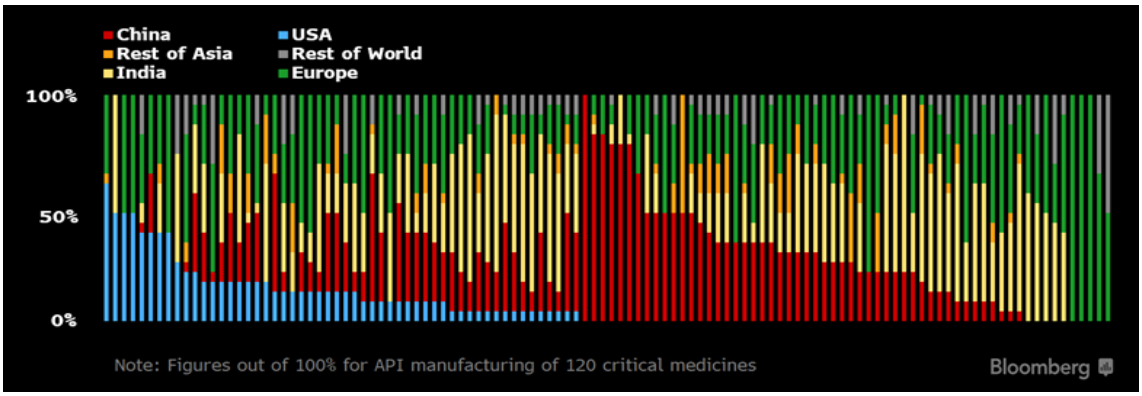
Source: FDA; Bloomberg Intelligence

Onshoring Could Raise Costs of Key Generics

Despite the U.S. government's focus on domestic manufacturing, it could take years for the industry to ramp up and at hefty costs, as nearly half of key drugs on the FDA's List of Essential Medicines lack U.S. API manufacturing sites. Published in October, the list includes well-known medications like aspirin, penicillin, ibuprofen, morphine and epinephrine -- all considered critical for acute care and medical countermeasures during public health emergencies.

Upgrading manufacturing facilities could take about a year. Building new ones may take up to five years, require significant upfront investment and lead to higher annual operating costs. Such operating costs in India could be under $15 million per facility, but at least $40 million in the U.S., according to pharmaceutical manufacturing consultant Boyd.

China, India Have Majority of Key Medication API (Jan-June 2021)

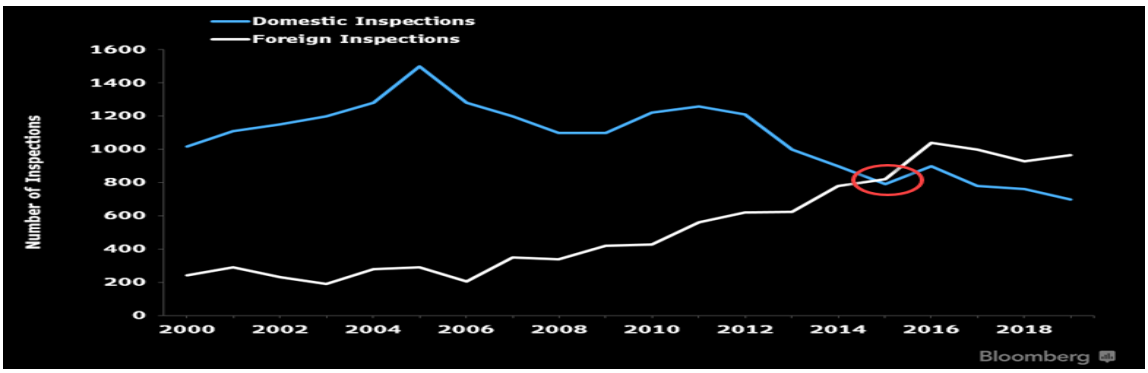


Source: White House Report; Bloomberg Intelligence

Domestic Shift May Reduce Regulatory Burden

Increased onshoring could ease the burden of the FDA's international inspections, which have become a weight on cost and staffing capacity. As foreign-based API manufacturing has expanded, so has the number of more expensive international inspections. Foreign-facility inspections surpassed domestic ones for the first time in 2015, and they represented almost 60% of the FDA's total in 2019. In 2005, the FDA implemented a risk-based approach to inspections of facilities, targeting those that would have the greatest potential for public health risk should they fail to comply with quality standards. The agency measures that potential based on the facility type, patient exposure, inspection history and hazard signals, among other criteria.

Foreign Inspections Outnumbered Domestic in 2015



Source: FDA; Bloomberg Intelligence

Pharma Manufacturing May Retrace Westward on ESG, Declining Cost

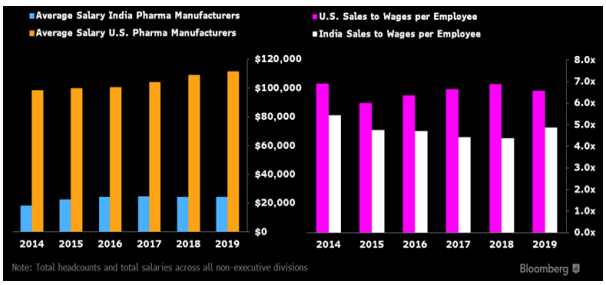
Declining cost differentials between U.S./European and Asian pharmaceutical manufacturers could abate some of the recent shifts toward Asian facilities by key companies. Renewed Western manufacturing may also be spurred by a rising focus on environmental, social, and governmental (ESG) consciousness, which is proving feasible alongside operational improvement.

Regional Cost Gap May Be Shrinking

Higher costs for pharmaceutical manufacturing in Western nations have driven much work to China and India, similar to other industries, but the gap may be shrinking and could eventually become less of an incentive. Wages of U.S. pharma manufacturing employees averaged $110,000 in 2019, or near 4.4x the $25,000 earned in India, according to the U.S. Bureau of Labor Statistics. That ratio has narrowed from 5.5x higher wages in 2014. Over that time, U.S. company wage inflation had a compound annual growth rate of 2%, while it was almost 6% for Indian counterparts

We see a corresponding trend on a revenue-adjusted basis, with Indian sales-to-wages declining to 4.9x in 2019 from 5.4x in 2014, while U.S. sales-to-wages have remained more constant at 6.6x in 2019 and 6.9x in 2014.

Average Indian Wages Have Grown 6% Annually



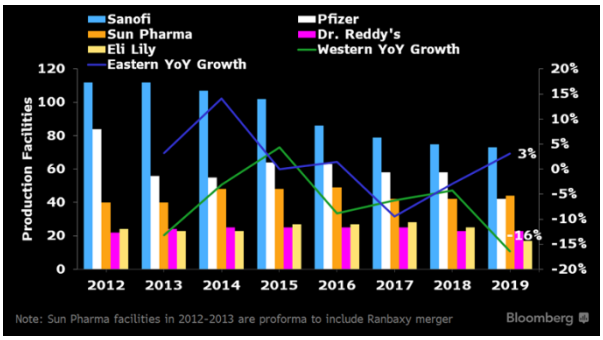
Source: Company Filings; Bureau of Labor Statistics; Bloomberg Intelligence

Facility Declines May Be Due to Rising CMO Usage

Western-based drug companies have reduced the number of manufacturing facilities they operate at the same time that the use of third-party contract-manufacturing organizations (CMOs) has risen. The total number of production sites operated by key Western drug manufacturers Sanofi, Pfizer and Eli Lilly has declined 7% a year since 2012, while major Indian concerns Dr. Reddy's and Sun Pharmaceuticals added facilities at a pace of about 1% a year.

The value of mergers and acquisitions involving CMOs ballooned to $12 billion in 2016 from $5.5 billion in 2014, an Ernst & Young report said, the result of what we believe were largely strategic buyers focused on the manufacturing of small-molecule active pharmaceutical ingredients. The CMO market is highly diversified, with each company only generating low-single-digit market share.

Western Companies Cutting Total Facility Numbers



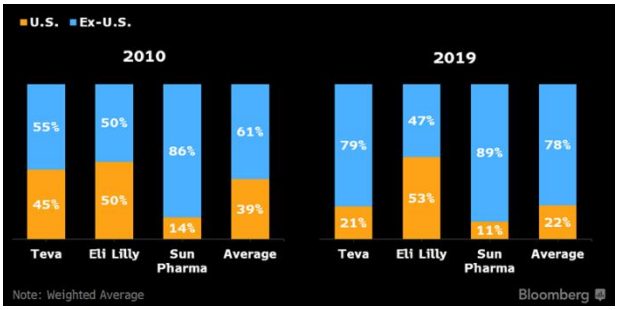
Source: Company Filings; Bloomberg Intelligence

Generics Driving Manufacturing Out of U.S.

Detailed data on manufacturing volume and capacity are lacking, but in the past decade the number of facilities outside the U.S. as a percentage of the total increased for key pharmaceutical producers. Much of this was driven by generic drug companies and has created a supply chain heavily dependent on India and China. The weighted average percentage of non-U.S. facilities operated by major manufacturers Teva, Eli Lilly and Sun Pharma rose to almost 80% in 2019 from about 60% in 2010.

Israel-based generic manufacturer Teva accounted for much of the shift, with its non-U.S. facilities increasing to almost 80% from 55% in 2010-19, while India's generic drugmaker Sun reached almost 90% by 2019. Branded manufacturer Eli Lilly was the outlier, expanding its U.S. facilities to 53% of the total over that period.

Ex-U.S. Growth as Percentage of Total Facilities



Source: Company Filings; Bloomberg Intelligence

Renewable Energy Sources Don't Hinder Operations

Investors are increasingly focused on environmental, social and governance (ESG) issues, which we believe companies can address alongside operational improvement. Renewable sources, including purchased and produced electricity as well as biomass, comprised about 12% of Teva's total energy consumption in 2020, according to the company's most recent ESG report. Teva didn't use renewables until 2014, and the rise of these new sources hasn't had any negative effects on its margins or operations.

Teva's total energy consumption has increased at a compound annual rate of less than 1% since 2012. Natural gas represents its largest energy source, at over 40% of total megawatt hours and is growing about 3% a year.

Renewable Sources 12% of 2020 Energy Consumption

Source: Company Filings; Bloomberg Intelligence


97.04
72.81
36.84
64.16
2.57
19.84
30.91
12.73
20.37

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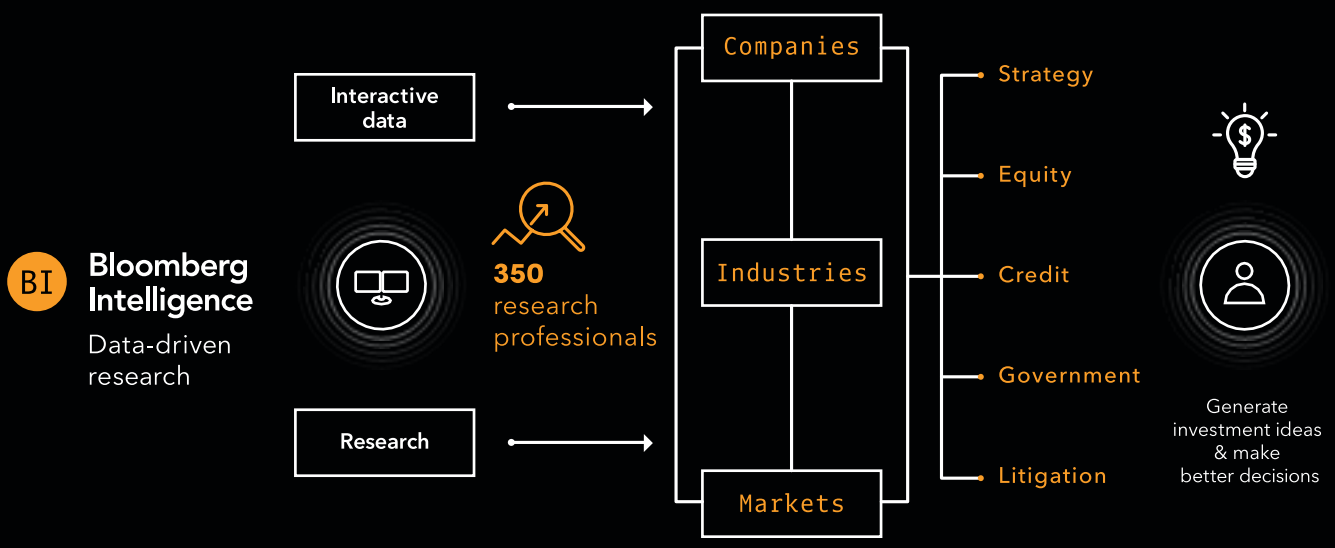
21
markets covered



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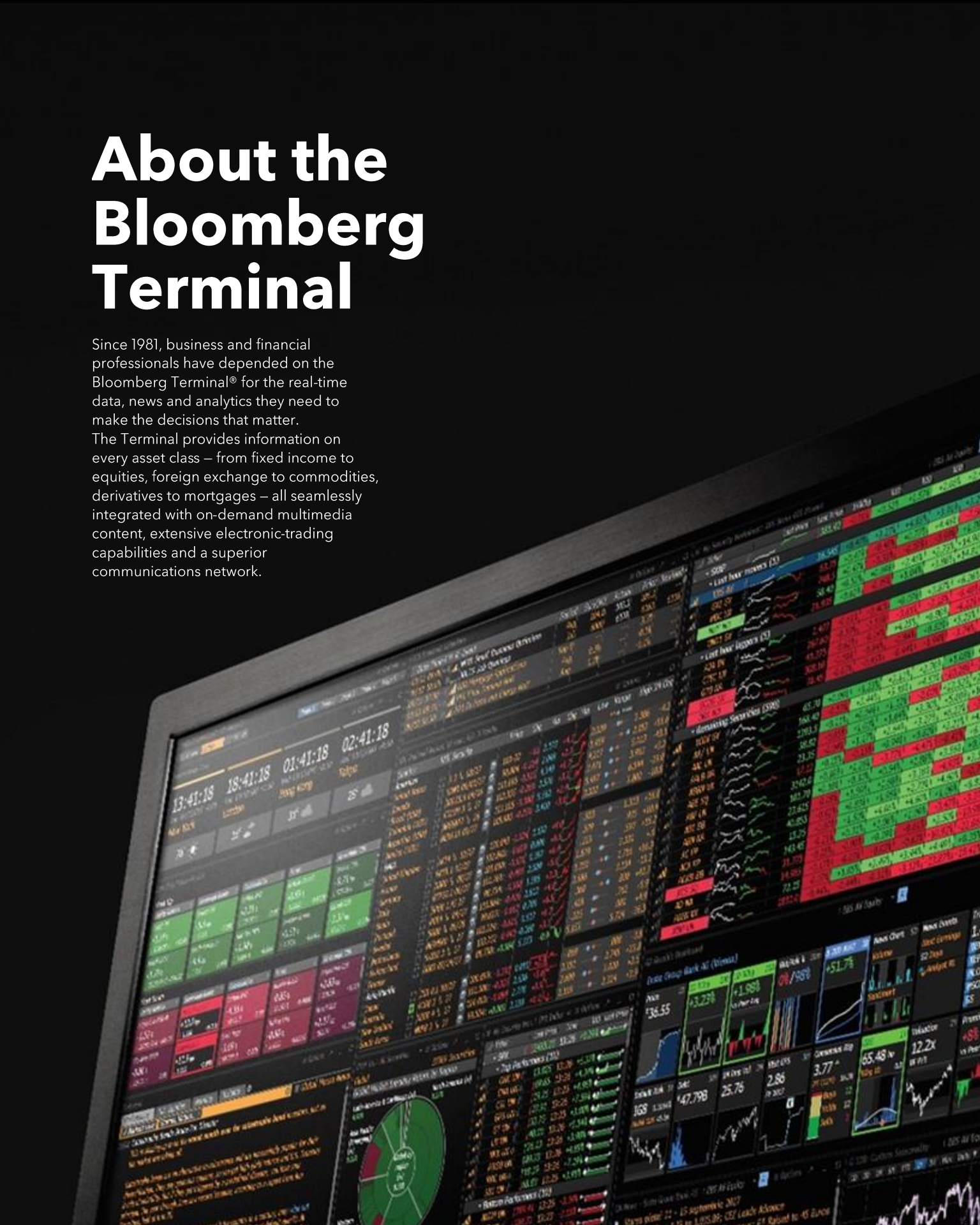
The Terminal provides information on every asset class – from fixed income to equities, foreign exchange to commodities, derivatives to mortgages – all seamlessly integrated with on-demand multimedia content, extensive electronic-trading capabilities and a superior communications network.



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