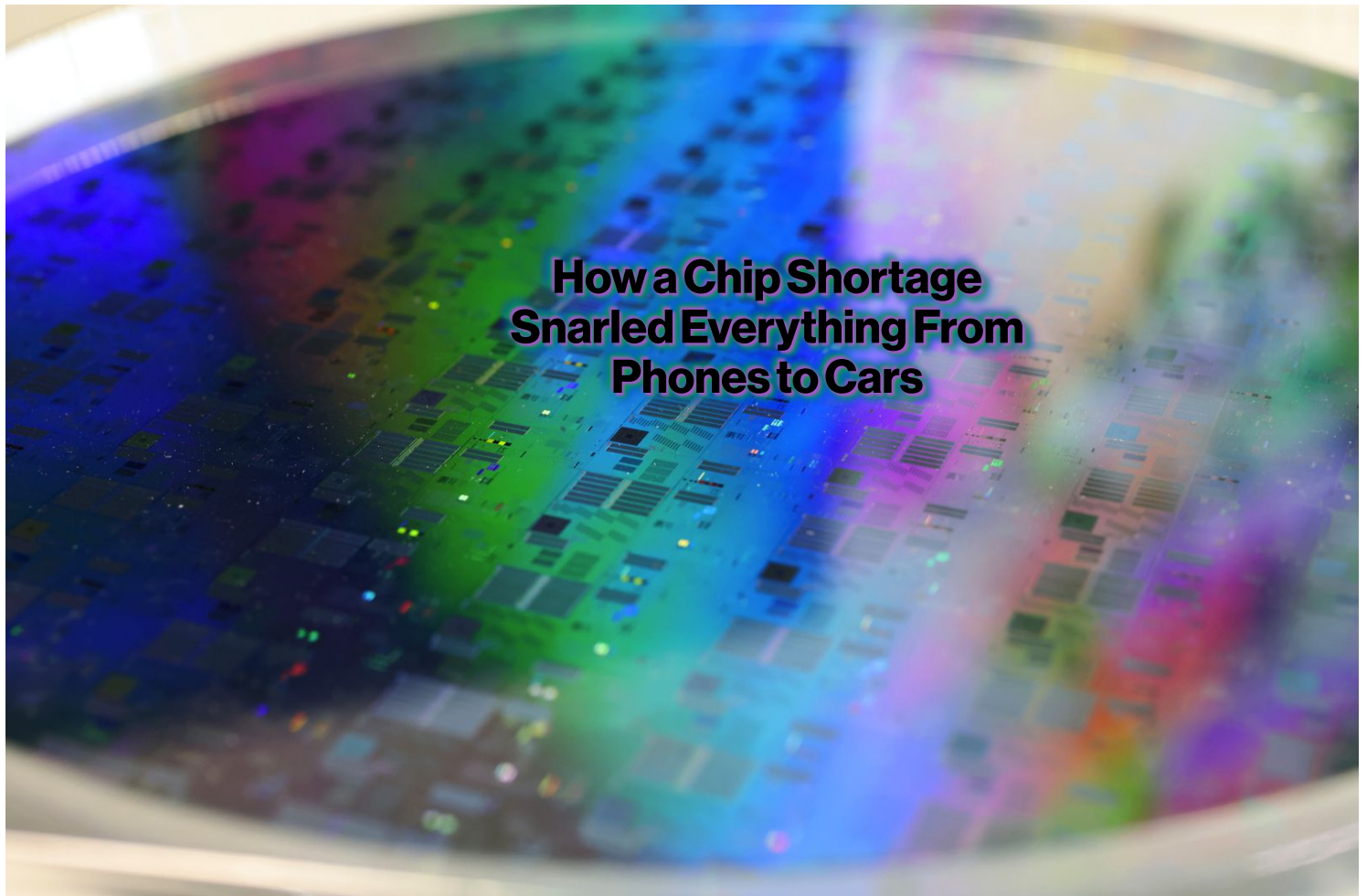


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## How a Chip Shortage Snarled Everything From Phones to Cars

Silicon wafers are ultra-flat, irregularity-free disks where circuit patterns are printed to build chips. Here's a 300 millimeter silicon wafer at a Globalfoundries plant in Germany. Source: Bloomberg

By [Jan King](#), [Debby Wu](#) and [Demetrios Pogkas](#)  
29 марта 2021 г.

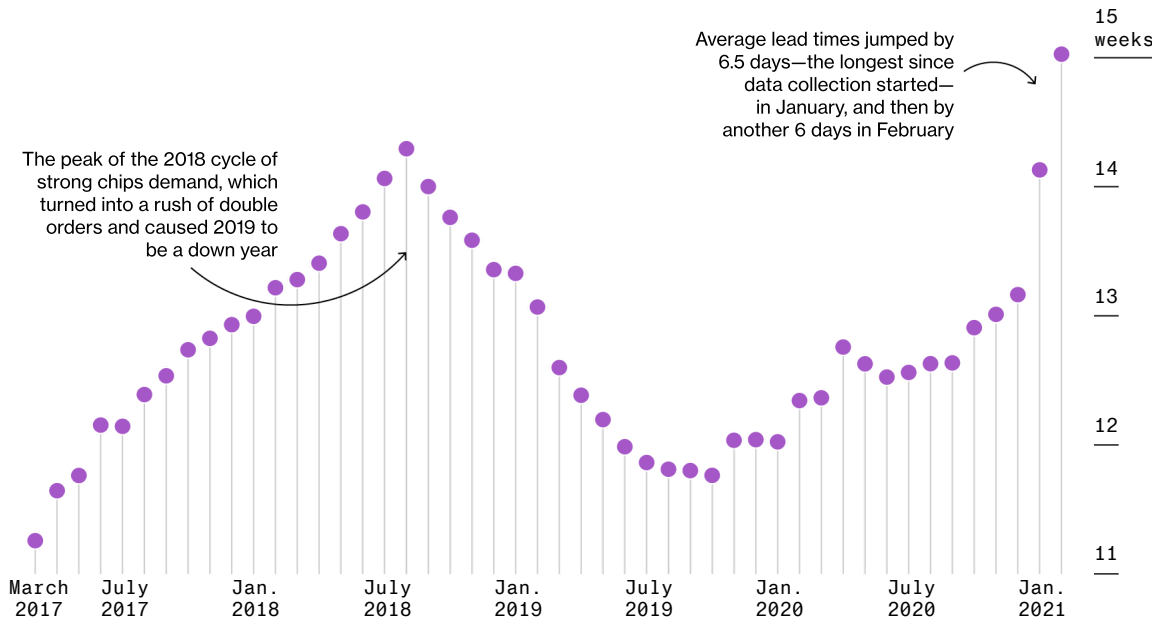
A six-decade-old invention, the lowly chip, has gone from little-understood workhorse in powerful computers to the most crucial and expensive component under the hood of modern-day gadgets.

That explosion in demand—unexpectedly goosed during the Covid-19 pandemic for certain industries like smartphones and PCs—has caused a near-term supply shock triggering an unprecedented global shortage.

In February, lead times—the duration between when an order for a chip is placed and when it actually gets filled—stretched to 15 weeks on average for the first time since data collection started in 2017, according to industry distributor data from Susquehanna Financial Group. Lead times for Broadcom Inc.—a barometer for the industry because of its involvement across the supply chain—extended to 22.2 weeks, up from 12.2 weeks in February 2020.

### Patiently Waiting

Lead times for chips surpassed their 2018 peak in February



Note: Averages calculated on data from four different distributors. Source: SFG Research

The crunch has sideswiped the General Motors and Volkswagens of the world and swung politicians from Washington to Beijing into crisis control. It's also catapulted Taiwan Semiconductor Manufacturing Co. and Samsung Electronics Co. to the top of investor and government agendas. Asia's two largest chipmakers are responsible for making the vast majority of the world's most advanced silicon, yet don't have the capacity to sate all demand. It's a bottleneck that could last several quarters—or into next year.

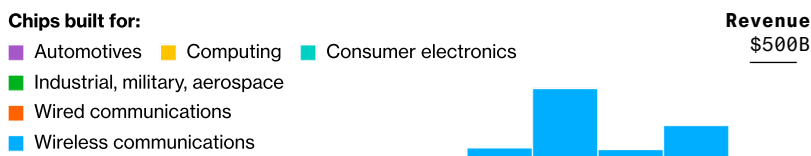
Alarm bells are ringing. A growing number of industry players from Continental AG to Innolux Corp. and Renesas Electronics Corp. have in recent weeks warned of longer-than anticipated deficits snarling production—potentially well past the summer. Samsung flagged a “serious imbalance” globally, the largest company so far to warn of fallout from the crunch. Broadcom Chief Executive Officer Hock Tan in March said his company is sold out this year and customers were “willing to book out for delivery of those products out through the rest of 2021.” And on Friday, Nio Inc.—the Chinese EV company sometimes compared with Tesla—became the first high-profile automaker from the country to suspend production because of shortages.

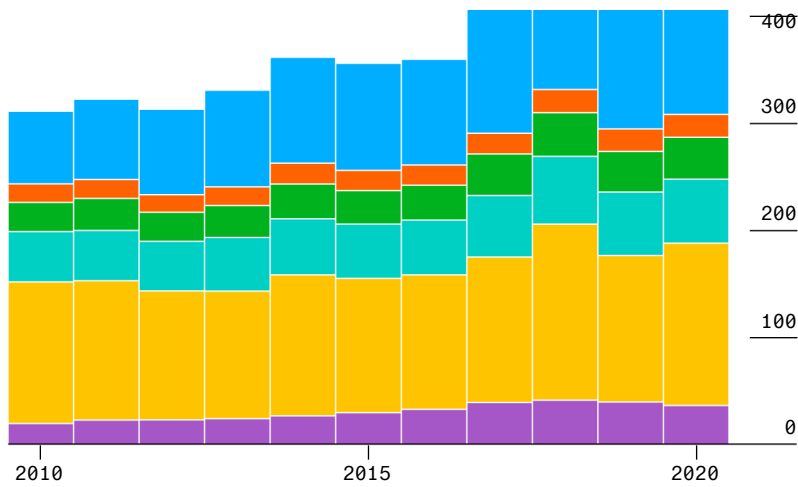
**A Pandemic that Reshaped Demand**

Overall demand for semiconductors of all stripes—from basic microcontrollers and memory chips to the most sophisticated high-performance processors—has grown over the past decade, as smartphone usage and computing power boomed. A steady rise in semiconductor sales faltered in 2019, but was then boosted 5.4% by 2020's shelter-in-place demand for home gadgets, IDC data shows.

**Need for Chips**

Sales of semiconductor have grown over the past decade



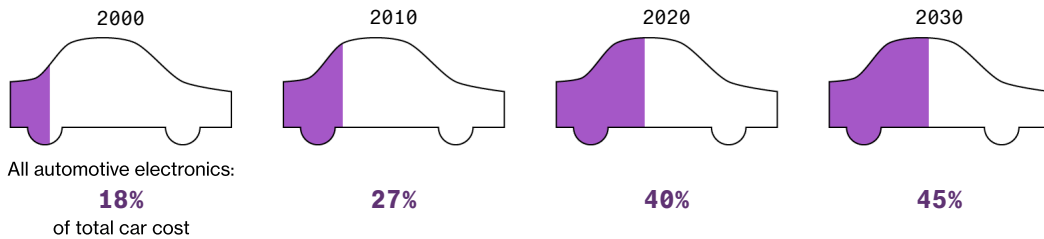


Note: Data does not include foundry-only businesses such as TSMC or Globalfoundries.  
Source: IDC

At the same time, once largely mechanical machines like cars have become smarter, entailing the use of many more chips. Automotive electronics, which may include everything from displays to in-car systems, are set to account for an estimated 45% of a car's manufacturing cost by 2030, according to a Deloitte report. The cost of the semiconductor-based components used in those electronics is estimated to jump to \$600 by 2030 from \$475 in 2020.

**From Horsepower to Chip Power**

Modern cars are relying more on electronics that include semiconductors



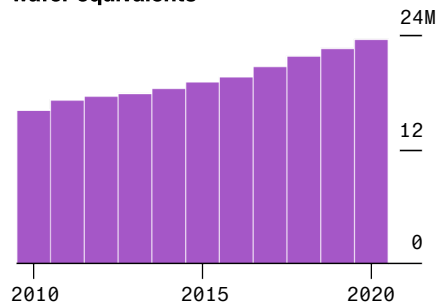
Note: Forecasts as of April 2019.  
Source: IHS, Deloitte analysis

On the other end of the supply chain, chipmaking capacity has kept pace with the growth in sales over past years, according to SEMI data, suggesting buyers are taking up capacity as soon as it comes online—a sign that semiconductor demand has in general been on par with available production resources. But advanced manufacturing has become concentrated in the hands of fewer and fewer players.

Industry experts say an imbalance is particularly apparent in so-called 200 millimeter wafers, from which lower-end chips are made. Those include power management chips and display ICs (or integrated circuits), required in a wide range of sectors from automotive to consumer electronics, but are in a short supply at the moment.

Uncertainties caused by the pandemic also led to sharp swings in orders last year, which in turn muddled the waters for chipmakers trying to match capacity with demand. That's why carmakers have had to halt production in 2021 and why Playstations and Xboxes are getting harder to find in stores.

**Installed capacity of 200 millimeter wafer equivalents**



Source: SEMI

Carmakers got hit first in part because of poor inventory planning. The

industry underestimated vehicle consumption and thus the amount of chips they needed when the pandemic hit. They are now expected to miss out on \$61 billion of sales this year alone. But TSMC executives said on their two most recent earnings calls that customers across many sectors have been accumulating more inventory than normal to hedge against the unknown.

*The World Is Short of Computer Chips. Here's Why: QuickTake*

The problem gets further magnified by the fact that the cost of chipmaking and keeping pace with technology advancements has increased exponentially this decade –making the business of manufacturing semiconductors a rarefied field for the deepest of pockets. As an illustration, TSMC raised its envisioned capital expenditure for 2021 by as much as 63% to \$28 billion, while Samsung is earmarking about \$116 billion on a decade-long project to catch its Taiwanese arch-rival.

## Industry Bottlenecks

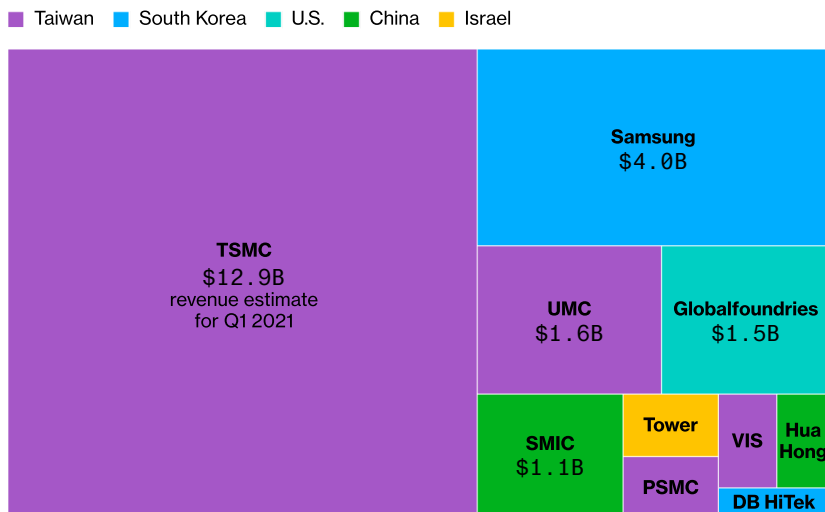
The most complex and expensive pieces of silicon these days are logic chips from Qualcomm, Nvidia or Apple that give computers and smartphones their intelligence. But these “fabless” companies don’t operate their own fabrication plants; they just design the semiconductors. Manufacturing happens at advanced factories called foundries that produce the designs of those big-name electronics companies.

This is another key bottleneck. Just three or four foundries now account for the majority of global chip fabrication—TSMC and Samsung and their more distant rivals, California-based Globalfoundries Inc., controlled by Abu Dhabi’s investment arm, and United Microelectronics Corp. Looking at it another way, an estimated 91% of the contract chipmaking business is housed within Asia, the lion’s share of which is divided between just two regions: Taiwan and South Korea, home to TSMC and Samsung, respectively.

An opportunity for the U.S. to regain chip independence might come from Intel Corp., which last week unveiled a \$20 billion plan to set up its own foundry business. Intel, the largest chipmaker by revenue, designs and manufactures its own chips, but this expansion would enable it to produce chips for other companies as well.

### Asia's Game

Companies from Taiwan and South Korea dominate the foundry business



Note: Estimates as of February. Figures for Samsung include its System LSI unit; for Globalfoundries include the manufacturing unit acquired from IBM; for PSMC its foundry business only.

Source: TrendForce

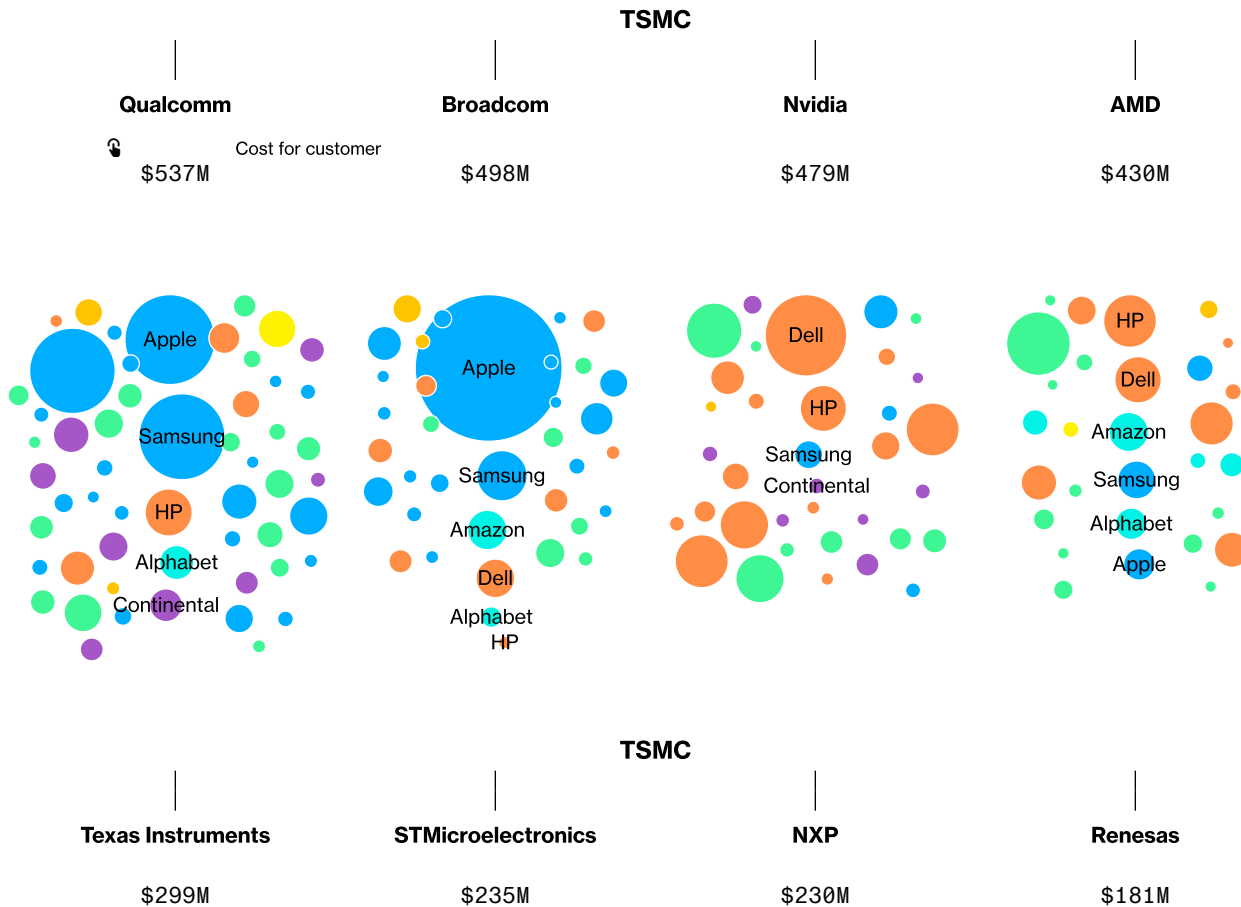
TSMC is the undisputed leader of that triumvirate, in terms of sheer scale, sophistication and reach, cranking out millions of wafers every year for marquee clients in just about every industry imaginable. TSMC's total wafer shipments were 12.4 million 12-inch equivalent wafers in 2020, up from 10.1 million in 2019. Taiwan's largest company has spent more than three decades to perfect its chipmaking craft and billions in past years to ensure it remains at the forefront of technology.

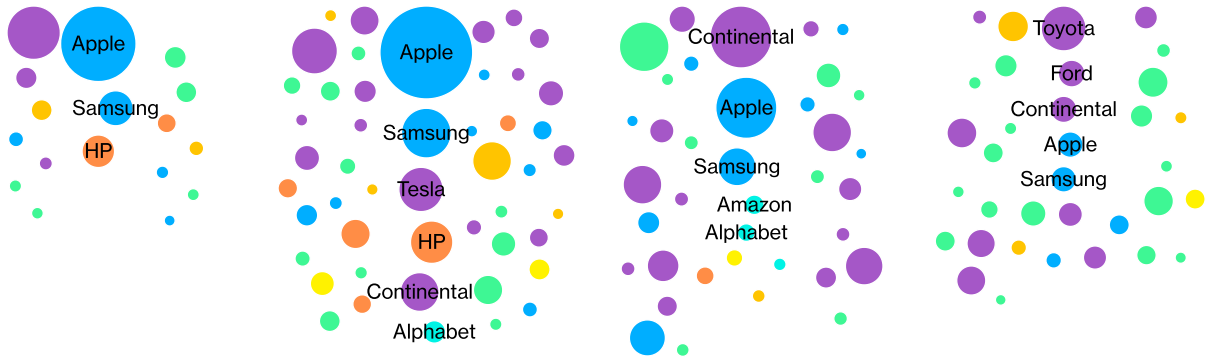
According to Bloomberg supply-chain estimates, 25% of all TSMC's business comes from Apple, the highest-profile client it directly manufactures chips for. However, TSMC's importance lies in the critical role it plays in the entire semiconductor supply chain; it also manufactures chips for other chipmakers or for fabless chip designers, such as Broadcom, Qualcomm, Nvidia, AMD or Texas Instruments. They are in turn supplying the world's biggest consumer electronics, communications equipment and auto parts companies.

**Supply Chain Bottleneck**

TSMC manufactures chips for chip designers and semiconductor firms, which in turn supply major makers of consumer electronics and cars

- Autos
- Communications
- Consumer electronics
- Hardware
- Household appliances
- Online Services





Note: The graphic captures only a subset of publicly-disclosed customers for TSMC and for its direct partners. Cost values are on a quarterly basis.  
 Source: Supply-chain data compiled by Bloomberg, based on company disclosures or other publicly available sources

Bottlenecks can appear in other parts of the supply chain, too. The Netherlands-based ASML Holding NV has a virtual monopoly on advanced photolithography equipment required to print patterns of cutting-edge chips onto the wafer. Companies from Japan, such as Shin-Etsu Chemical Co., dominate the market for chemicals used in semiconductor manufacturing. And manufacturing cannot start in the first place without access to electronic design automation software, a segment led by the U.S.'s Cadence Design Systems Inc. and Synopsys Inc.

Officials from the U.S. and Europe have beseeched Taiwan's officials for help in resolving the global chip crunch, and are pushing for the creation of domestic chipmaking capabilities. Yet research from Sanford C. Bernstein shows there isn't much that governments can do to address the current shortages. It takes years to build a new fabrication facility and get it operating smoothly—regardless of where it is located.

With assistance from: [Tom Lagerman](#) and [Ridho Reinanda](#)  
 Edited by: [Edwin Chan](#), [Peter Elstrom](#) and [Jeremy Diamond](#)

**Note on TSMC supply-chain data:** Data compiled by Bloomberg. Included are supplier-customer relationships, active as of March 24, for which the value, share of the supplier's total revenue and share of the customer's total expenditure, can be quantified either by figures disclosed by the company or by Bloomberg supply chain estimates. Company classifications based on the Bloomberg Industry Classification Standard. "Autos" includes auto parts manufacturers and car makers; "Communications" includes communications and wireless telecommunications equipment manufacturers; and "Hardware" includes computer hardware and storage manufacturers.

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