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The Uncertain Future of the Chip Shortage

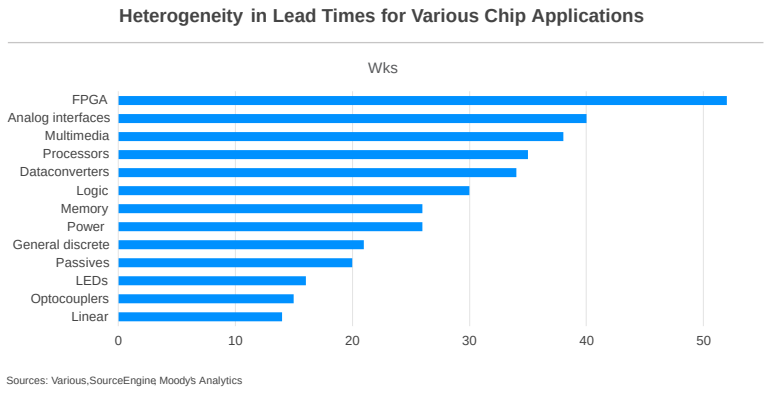
Lead times and prices for memory applications should stabilize, but prices and lead times could rise for discrete and analog applications if production pressures continue.

- For the first time since the start of the pandemic the aggregate semiconductor chip lead time fell last month, though ever so slightly.
- At the core of the chip shortage is the fact that most of the world's advanced chips are manufactured in Taiwan and South Korea, and there are significant entry costs to penetrate this market.
- While we see lead times remaining elevated through the end of the year, we expect the chip shortage to normalize sometime in 2023.

The semiconductor chip shortage captured the world's attention early on during the pandemic as the first clear sign that the measures undertaken during the pandemic were creating significant supply-chain disruptions. These disruptions have since expanded to include many other industries and have caused inflation to skyrocket in countries around the world. And while there are signs that supply-chain stresses are easing and the chip shortage is abating, in what follows we discuss the risks and uncertainties associated with the semiconductor chip industry and what to expect next.

The importance of lead times

One of the best metrics for assessing supply-chain stress has been semiconductor chip lead times—the time it takes for a microchip that is produced to reach the end consumer—as semiconductor chips are the oil of the digital economy. They power practically all electronic devices including cars, computers, sensors, gaming consoles, ovens and so on. For most of the past two years, the aggregate chip lead time has been increasing. Last month was the first time since the start of the pandemic that this key metric fell, though ever so slightly, from 27.1 weeks to 27 weeks. While the decline is notable given the upward trend in lead times in the past couple of years, 27 weeks is still far from the norm, and we expect lead times to remain elevated going into 2023.



Why are lead times so high, and what do they mean for the broader economy? Chip lead times are important because they are an indication of the degree to which new orders can be filled and therefore are a harbinger of future production capacity. Heretofore unseen lead times reflect demand for chips that has far outpaced supply. The shift toward goods during the pandemic coupled with the challenges in creating new supply

capacity meant that lead times would inevitably rise as existing capacity was maximized to meet unrelenting demand. Meanwhile, creating new supply for chips is a multiyear process. It takes significant time and resources to build a new foundry, but there is also significant lead time in obtaining the lithographic machines needed to make the chips themselves.

However, given how severe the chip shortage was earlier in the pandemic most corporate consumers resorted to ordering more than they need, resulting in excess inventory to be cleared. When excess inventory levels are high, lead times become less informative, since inventory supply can be used in lieu of new orders to produce the electronic gadgets eventually purchased by end consumers. That said, we argue that aggregate chip lead times will continue to be elevated, and it will be some time before the chip shortage truly comes to an end.

Why the shortage is so persistent

At the core of the chip shortage is the fact that most of the world's advanced chips (size 7nm and less) are manufactured in Taiwan and South Korea, and there are significant entry costs to penetrate this market. To put this in perspective, China has spent more than $10 billion over the past decade investing in its semiconductor industry, and its largest manufacturer only recently announced that it is finally able to produce 7nm chips, though the frontier has already moved to much smaller chip sizes. Even for companies like the Taiwan Semiconductor Manufacturing Co. and Samsung it takes years before they are able to build a new foundry, or plant for making chips. The pandemic has accelerated the pace of digitization worldwide, and with this the demand for consumer electronics. Chips are the foundation of modern electronic devices, and as technology advances, so does the demand for chips. Electric cars can use 10 times the number of chips required for older cars and also require more advanced microchips. In addition to cars, gaming consoles, electronic appliances and existing applications, the increasing use of artificial intelligence and big data in all facets of life will drive demand for advanced chips.

If the growing demand for advanced chips is what makes the shortage for that part of the spectrum so pervasive, it is the constrained supply for older chips that makes the shortage for the opposite side of the spectrum challenging to solve. Older chips still make up more than half of all chips that are manufactured, largely because more chips are needed for the applications where they are used. A modern cellphone may only use a handful of chips, while a single car would require thousands of older chips. Despite this, hardly any new capacity is being created for older chips, the reason being that advanced chips have been a larger revenue driver for the biggest chipmakers, to wit: Apple makes up nearly half of TSMC sales while automotive applications make up less than 10% of sales. Limited supply thus makes accommodating strong demand challenging, particularly over very short time horizons.

The impact of geopolitical and climate events

Though we see lead times remaining elevated through the end of the year, we expect the chip shortage to normalize eventually. To understand the context, it is worth noting that the chip shortage came to the fore not only during a global pandemic, but also in a year with unprecedented climate events in regions critical to the semiconductor chip supply chain. Taiwan experienced its most serious drought in 56 years that summer, followed by a factory fire and multiple earthquakes in Japan, and subsequently a deadly ice storm in Texas. All of this contributed to exacerbating the chip shortage beyond what ensued following the pandemic-induced lockdowns. With these events largely behind us, it is no surprise that the resulting demand-supply imbalance is gradually easing.

While pandemic-related measures have mostly been lifted around the world, China's zero-COVID policy remains largely in place. The intermittent lockdowns associated with implementing this policy have constrained supply to some extent but have also suppressed demand for chips and chip applications, since China constitutes the largest market in the world for most modern electronics. Recent developments around the Taiwan Strait following the visit of the speaker of the U.S. House of Representatives are also worth noting: China has restricted sand exports to Taiwan and could restrict other exports critical to chip production if the situation escalates. The other geopolitical event that has significant ramifications for the chip shortage is the Russian invasion of Ukraine. Both countries are significant producers of neon, palladium, helium and other inputs important for chip manufacturing. The reason this has not disrupted the chip supply chain more radically is because some chipmaking companies have lithographic machines that recycle more than 80% of the neon and noble gases used in production. It remains to be seen whether this will have a more material impact if the military conflict persists.

What to expect of the chip shortage in the near term

The chip shortage is indicative of larger supply-chain disruptions that have roiled the global economy and caused inflation in many countries to spike to levels not seen in decades. The chip sector is not immune to these price pressures. Both Intel and TSMC have indicated that they are raising prices later in the year and in 2023 because of rising raw material and production costs. This comes at a time when demand for consumer electronics is softening, though demand for automotive and data center clients remains strong. Other than rising production costs, chipmakers are dealing with elevated lead times for lithographic machines and other production equipment.

As the situation normalizes, we will see some divergence in the demand and supply balance for various chip applications. At the time of writing, chips used for networking, optimal and telecommunications equipment are in short supply—field-programmable gate arrays have lead times in excess of 50 weeks. By contrast, microcontroller units as well as power and memory chips have seen some of the largest declines in lead times. We expect lead times and prices for memory applications to stabilize, but can see prices and lead times rising for discrete and analog applications if the aforementioned production pressures continue.