

Insights

Semiconductor

In Peter Lynch's book "One Up on Wall Street," he discusses six categories of stocks investors should look out for: slow growers, stalwarts, fast growers, cyclicals, turnarounds, and asset opportunities. He defines cyclicals as companies in which sales and profits tend to rise and fall in somewhat predictable patterns based on the economic cycle; examples include companies in the auto industry, airlines, and steel. One sector that is inherently cyclical that we tend to follow closely is the semiconductor industry. It is a unique industry because of its unique blended characteristics of displaying secular growth in the long term, interspersed with cyclical swings.

What is a semiconductor?

Taking a step back, a semiconductor is a material that has electrical conductivity between that of a conductor and an insulator. Silicon is one of the most commonly used semiconductors in the industry, while other materials used, include germanium and gallium arsenide. The term semiconductor is sometimes used interchangeably with "chips" or "integrated circuits." These components are integrated into almost every electronic device, playing a crucial role in the operation. They are known to be the "brain" for the electronic device, displaying capabilities ranging from storage to processing.

Global semiconductor revenues from 1980s till present

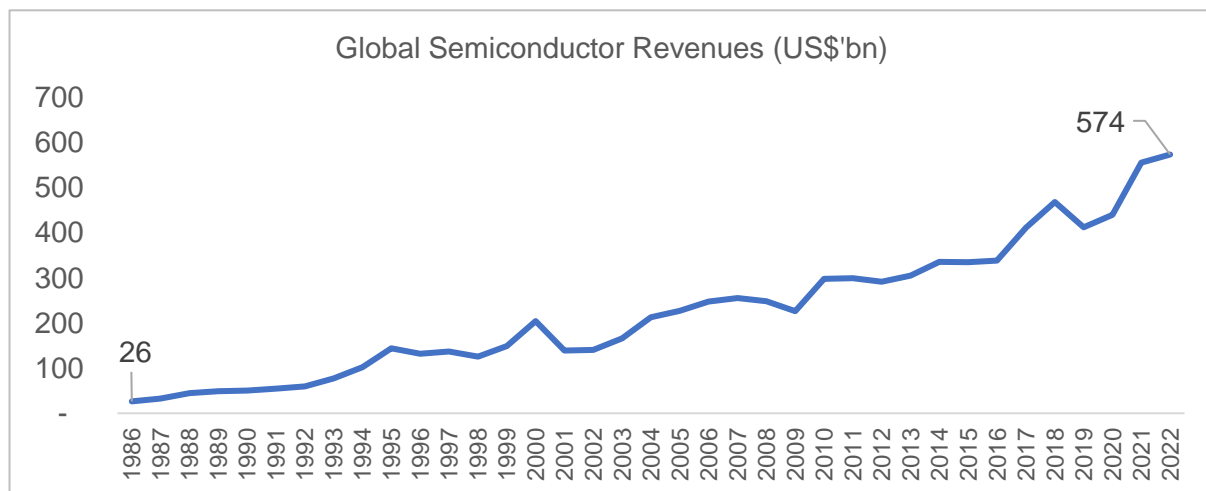


Figure 1: WSTS Blue Book Data- 1986-2022

Based on World Semiconductor Trade Statistics (WSTS) Blue Book Data, Global Semiconductor Revenue has risen from US\$26bn in 1986, to close to US\$600bn in 2022, representing close to an 8% CAGR over those years. They also forecasted that 2023 total global sales could be around US\$520bn, reflecting a 9.4% decrease Year-on-Year. In the longer-term, McKinsey's analysis further assumes that the industry CAGR could grow by another 6-8% leading up to 2030. There are many other semi-related sources estimating that global semiconductor revenue could reach US\$1tn by 2030. When will it happen? We do not know for sure, but in our opinion, we believe there is a high probability of reaching the US\$1tn mark given the secular trends of digitalisation.

End market segmentation

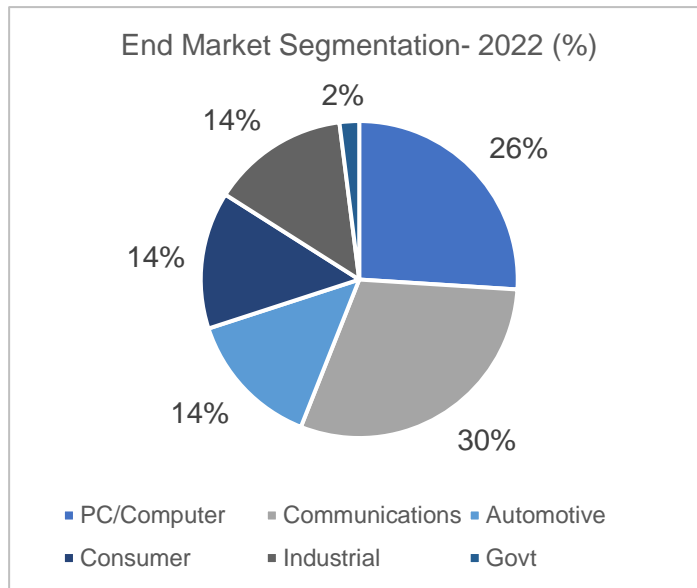


Figure 2: WSTS End Market Segmentation

As of 2022, consumer PC/Computer and mobile makes up majority of the semicon end-consumer demand, totalling more than half of the contributions. These segments are the two primary reasons for the semiconductor downturn that we have been experiencing since mid-2022, attributed to the weakening macroeconomy coupled with easing supply chain shortages. Going forward, there are a few key drivers that might help propel the semicon industry to new heights. McKinsey forecasts that automotive and industrial electronics will experience higher-than-average industry growth up to 2030.

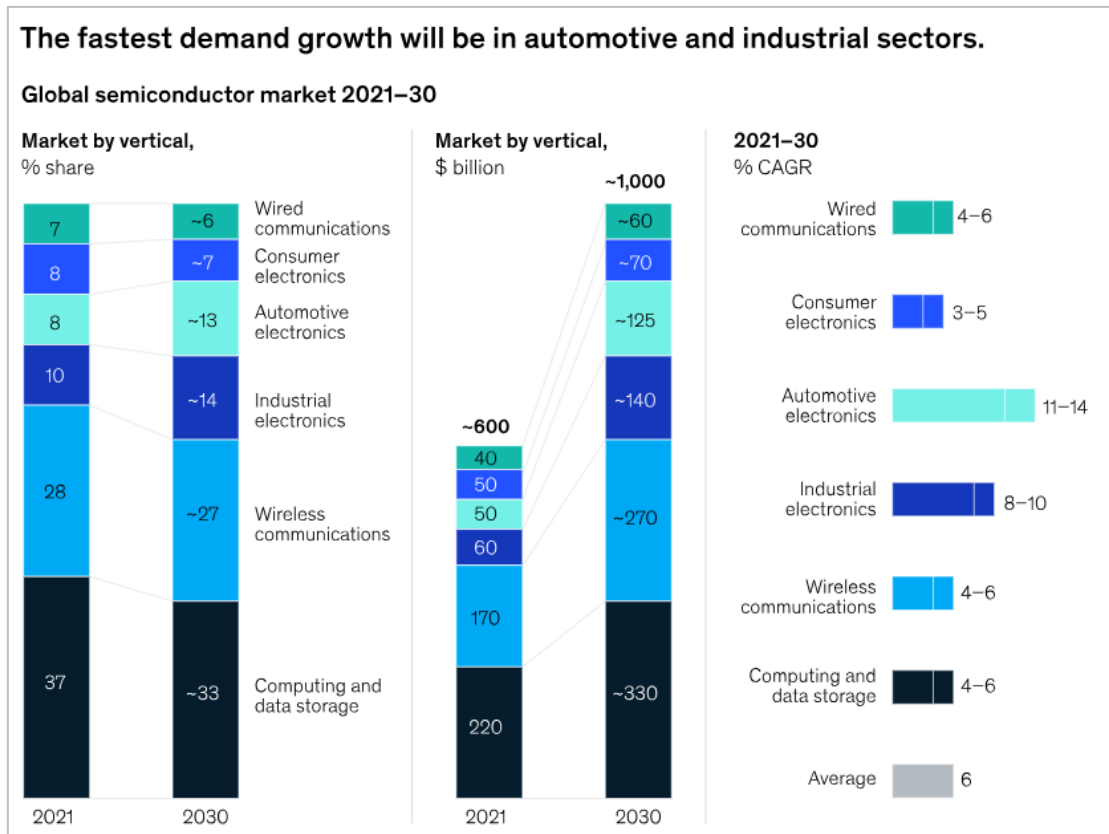


Figure 3: McKinsey & Company

Secular growth of the semiconductor industry

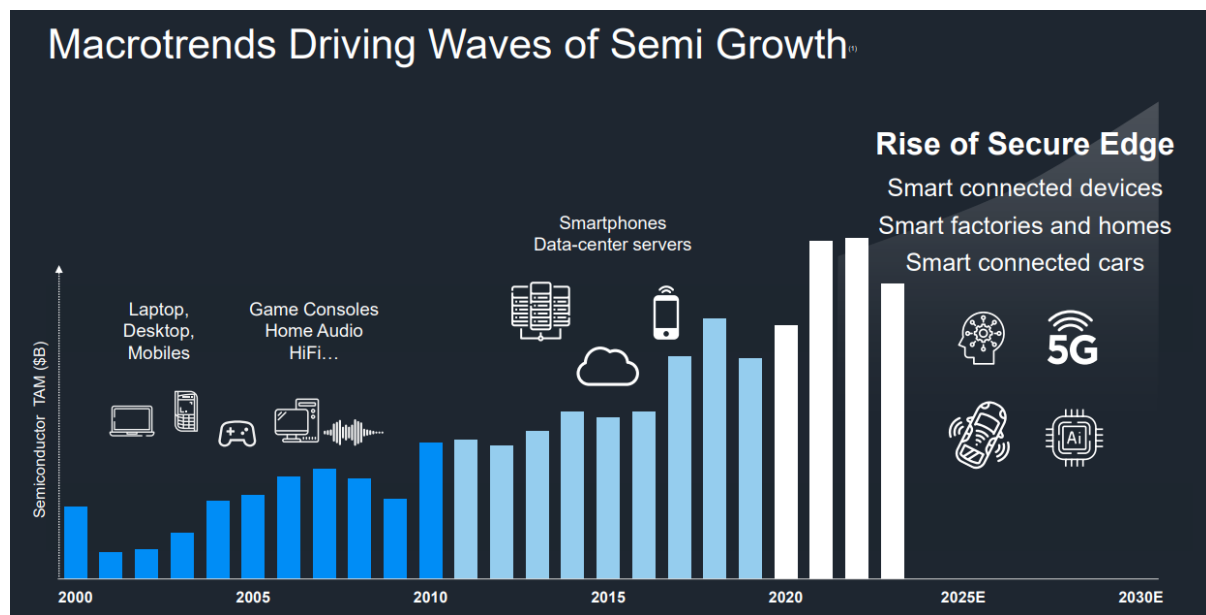


Figure 4: Omdia Application Market Forecast Tool Dec-23. NXP 4Q23 Results Presentation Slides

To delve deeper into what is driving the secular growth in global semiconductor sales, we can examine NXP's latest 4Q23 presentation slides where it clearly depicts the secular trends in different periods.

During 2000s to the 2010s, semiconductors were largely driven by mobile, desktop and laptop devices. The proliferation of smartphones, particularly Apple's first iPhone, led to increased demand for mobile computing devices, with Android makers entering the market. This increased demand for smartphones attracted developers to the growing market size, creating a positive feedback loop in the ecosystem. Consequently, there was a transition in usage from desktop sites to smartphone apps, due to its ease of use and convenience.

From 2011 to the present, popular smartphone apps such as Facebook, Instagram, and Snapchat, and e-commerce platforms including Amazon, Taobao, and Shopee, started to emerge. This ties in nicely with the next phase of growth from 2010, towards the cloud and data centre segments. The explosion in usage of these applications, in turn, drove the need for more storage and better processing power.

Finally, from 2020 onwards, Covid lockdowns around the world further accelerated the need for digitalization. Excluding the Covid-induced demand during 2020-2022, secular growth trends started to emerge, such as the electrification of cars, automated factories, and Internet of Things (IoT) products. There is also a race towards Artificial Intelligence (AI) after the emergence of ChatGPT. All these key segments, coupled with the steady usage of the mature segments, would likely drive semiconductor usage to new highs, which is why we believe the probability of the semiconductor industry reaching US\$1tn is feasible

Cyclical nature of the semiconductor industry

Next, let's examine the cyclical nature of the semiconductor industry. Breaking down its cyclicity, between 2000 and 2022, on average, the downcycle typically lasts around 14 months while the upcycle is double (28-30 months) that of the downcycle. Demand for semiconductors has been closely linked to macroeconomic factors, geopolitical trends, and technological breakthroughs. One way to explain the peaks and troughs is through the concept of the "bullwhip effect".

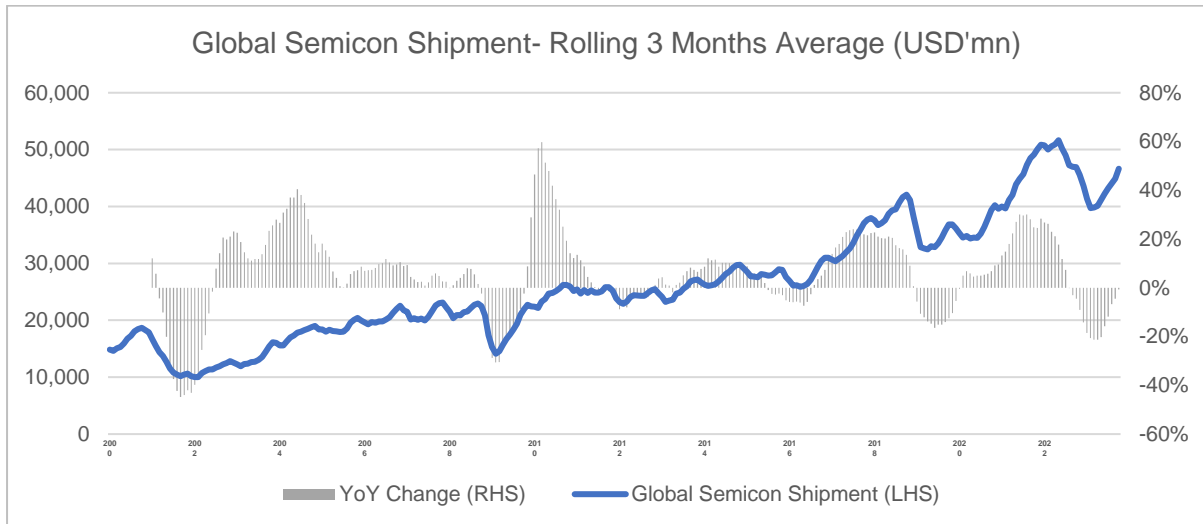
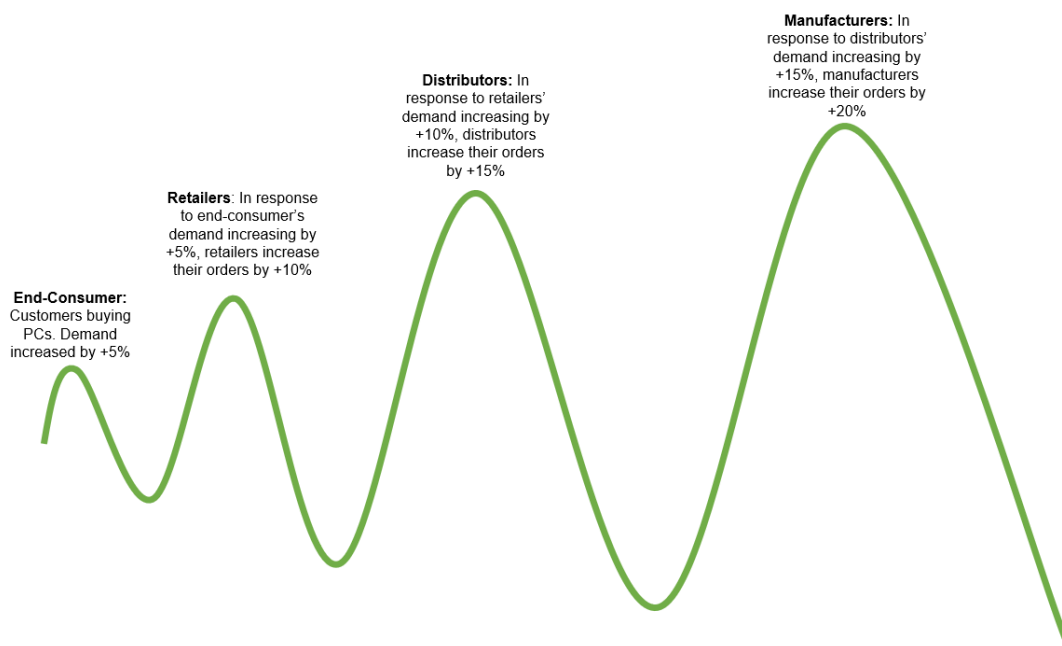


Figure 5: WSTS Global Semi Shipment- Rolling 3mths avg

The "bullwhip effect" is a phenomenon in the supply chain management where small fluctuations in demand for a product at the end consumer level can lead to large amplification in demand/orders further up the supply chain. The illustration resembles that of a lash of a whip, with small oscillations at the handle (end consumer demand), amplifying into larger oscillations at the tip (manufacturer's production schedule). The example below shows end consumer demand increasing by +5%, leading to manufacturers increasing their production by +20%.



We can observe an amplified version of this phenomenon during 2020-2022 in the semicon industry, where Covid lockdowns caused significant disruptions to the supply chain, resulting in massive pockets of shortages in different segments. Based on some of the manufacturers we follow closely, due to these shortages, their customers (OEMs/ODMs) are providing them with concrete order forecasts for up to 1 year, whereas the typical order forecast is usually between 3-6 months in advance. They could lead to pulling in orders in advance, resulting in double or even triple orders.

The pitfall of this practice is that it amplifies inefficiencies along the supply chain, as every step within the supply chain estimates demand incorrectly at a higher level, evident during 2022 when demand began to slow due to post-pandemic normalization, coupled with higher interest rates aimed at combating higher inflation. These factors exposed the cracks of oversupply within the semicon industry, leading to an industry downturn we are experiencing since mid-2022.

Why does the semiconductor industry exhibit the bullwhip effect?

There are a couple of reasons why the semicon industry is cyclical in nature:

- **Complex supply chain dynamics:** Producing a chip involves multiple stages. Simplistically, it begins with procurement of raw materials, followed by wafer fabrication, assembly and testing, and finally distribution to end users. Each step in the supply chain requires multiple layers of collaboration. Adding to its complexity, the supply chain is dispersed globally, further exacerbating the challenges. Any delays in communication or discrepancies in information between the manufacturers and their customers would result in a greater amplification of the bullwhip effect.
- **Capacity constraints:** Building a semiconductor fabrication plant requires significant capital investment and lead times for construction. According to Intel, a fab takes about 3-4 years, US\$10bn and 6000 construction workers to complete. Hence, when there is a sudden spike in demand, due to the lag in fab construction, there may be a shortage in supply, leading to delays in fulfilling orders and potentially exacerbating the bullwhip effect.
- **Technological node transition:** The continuous drive for smaller, more powerful, and energy-efficient chips has led to yearly transitions between generations of products. The short product life cycle of these advance nodes can lead to volatility in demand, resulting in forecasting inaccuracies and contributing further to the bullwhip effect.

Why do we like the semiconductor industry

- **Secular growth in the long term.** As aforementioned, the semiconductor industry exhibits secular long-term growth characteristics, characterized by short-term cyclical peaks and troughs. The proliferation of electronics devices mainly from the consumer electronics space like smartphones, laptops and tablets has contributed to growth in demand for semiconductors. Beyond these mature markets, other nascent/growing markets like automotive and AI where semicon content are growing at a fast pace would support the growth in the semicon industry in years to come.
- **High barriers to entry.** Given the high CAPEX and/or R&D requirements for players in the semiconductor value chain, it provides a high barrier to entry for potential new entrants. Some OEM players have a long-standing relationship with their key suppliers, where they would communicate long-term product roadmaps. This relationship is evident with the world's largest foundry TSMC alongside some of the largest semicon producers of the world like Nvidia and Apple. There are times when cookie cutter solutions do not make the cut, requiring customization unique to the OEMs.
- **Verge of recovery.** Using history as a precedence, we think the industry is on the verge of recovery where inventories across the board has been depleting. Since Aug-22, semicon shipments have been on a decline YoY and as of the latest data by WSTS in Oct-23, we are starting to see a narrowing of the YoY decline, from the peak decline of -22% YoY to -0.7%. As at Oct-23, we are 15 months into the downcycle.

Key risks:

- **Technological obsolescence.** In the area of advance node, the latest consumer electronics products require the latest chip to operate smoothly and run the latest program. If there are no breakthroughs in functionality of these products, replacement cycles might be extended, leading to a decline in demand. This could result in an oversupply of inventory levels.
- **Cyclical nature:** The cyclical nature of the semiconductor industry is influenced by macroeconomic factors, geopolitical trends, and technological breakthroughs. During downturns, semiconductor companies may experience steeper declines in revenue and profits, compared to other sectors such as consumer or healthcare due to the bullwhip effect on production.

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