Mizuho Economic Outlook & Analysis

July 10, 2023

The silicon cycle will soon bottom out

The "recovery" to positive y-o-y growth will probably take place from next spring

< Summary >

◆ The semiconductor market is facing a period of pronounced adjustment, with Taiwanese and South Korean semiconductor output and exports down particularly sharply on a y-o-y basis. However, there is robust demand for advanced and power semiconductors.

◆ A cycle analysis and a leading indicator both suggest the silicon cycle will bottom out mid-2023. However, more time will be needed before global semiconductor sales enter a "recovery" phase of positive y-o-y growth, with this likely to take place around spring 2024.

◆ The silicon cycle runs slightly ahead of the global manufacturing cycle, with the silicon cycle useful as a leading indicator of global manufacturing. As the silicon cycle recovers, global manufacturing will also follow suit to recover from spring 2024.

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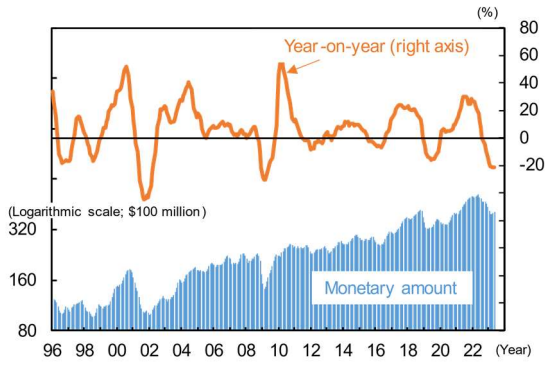
1. The global semiconductor market faces a mix of positive and negative factors

Global demand for semiconductors remains in the doldrums, with global semiconductor sales falling by over 20% year-on-year for four straight months from February 2023 (**Chart 1**). There is no shortage of factors behind this slump in demand either, with special pandemic-related demand coming to an end and the global economy slowing, for example.

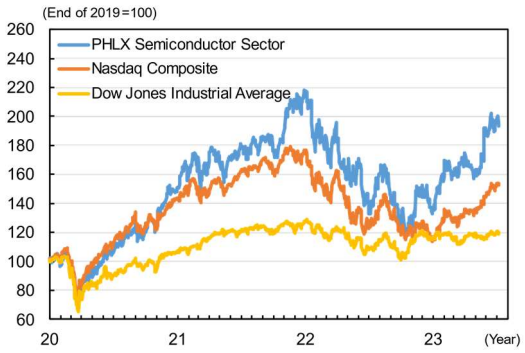
However, there are also reasons to be optimistic about the future of the semiconductor market, with US stock markets being buoyed by stocks connected to generative AI, a sector that requires a lot of semiconductors, for instance (**Chart 2**). This report explores the outlook for international semiconductor demand based on an examination of industrial and economic trends in Taiwan and South Korea, the two hubs of the global semiconductor industry.

Chart 1: Global semiconductor sales



Note: Three-month moving average. Most recent figure: April 2023
Source: Made by MHRT based upon releases by the US Semiconductor Industry Association (SIA)

Chart 2: US stock markets



Note: Most recent figures: Close of trade on July 4, 2023
Source: Made by MHRT based upon releases by Refinitiv

2. Market conditions in Taiwan and South Korea point to ongoing sluggishness, though there are signs of a recovery in some segments

Taiwan and South Korea account for around 80% of all global semiconductor production (foundries). Recent trends in these two countries suggests conditions remain tough in the semiconductor market. Taiwanese and South Korean semiconductor output and exports were up sharply on the previous year from late 2021 to the start of 2022, but then they slowed as special pandemic-related demand came to an end, for example (**Chart 3**). At present, output and exports remain sharply down on a y-o-y basis and there are no signs of things improving. In April, Taiwan Semiconductor Manufacturing Company (TSMC), a major global foundry business, announced it expected sales for 2023 to contract by around 1–6% y-o-y. This marked a downgrade on the firm's January outlook for a slight

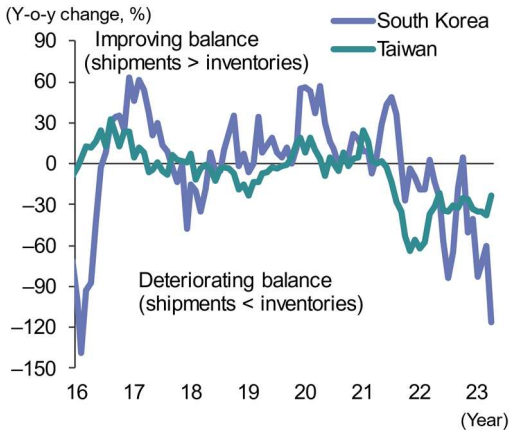
rise in income.

The supply and demand adjustment is particularly pronounced when it comes to semiconductor memory (such as DRAM and NAND flash). South Korea is the leading power in this sector, with conditions even tougher there than in Taiwan. The shipment/inventory balance (calculated by subtracting the semiconductor inventory growth rate from the shipments growth rate) is down sharply on the previous year in both Taiwan and South Korea, but the contraction particularly steep with it comes to the latter, with surplus stock becoming a pressing issue (**Chart 4**). In April, Samsung Electronics, South Korea's largest semiconductor firm, announced it had cut production for the first time in 25 years, with the company urgently adjusting its inventory on sluggish market conditions. Nonetheless, the firm's (preliminary) consolidated financial statement for 2Q 2023 showed operating profits hitting 600 billion won, a decrease of −95.7% on the same period last year, with conditions still tough.

Chart 3: Taiwanese and South Korean semiconductor output and exports

Note: The South Korean output data goes up to April 2023 and the Taiwan data up to May.
Source: Made by MHRT based upon releases by the Ministry of Economic Affairs of Taiwan and Statistics Korea, etc.

Chart 4: The shipment/inventory balance in Taiwan and South Korea



Note: Shipment/inventory balance= y-o-y shipments growth minus y-o-y inventory growth
Source: Made by MHRT based upon releases by the Ministry of Economic Affairs of Taiwan and Statistics Korea

Smartphones and PCs account for a large share of semiconductor final demand. Sales of these goods have stagnated now that special pandemic-related demand has come to an end, so it will probably take some time before semiconductor market conditions improve. According to the US research company IDC, global smartphone shipments stood at 268.6 million in 1Q 2023, down by a huge −14.6% on the same period last year. IDC also forecasts that the market will not recover until later 2023 onwards.

This situation is also reflected in the *Semiconductor Market Forecast Spring 2023*, a report prepared by World Semiconductor Trade Statistics (WSTS) based on forecasts

released by semiconductor firms, with WSTS also offering a bleak assessment about the future. Furthermore, *Semiconductor Market Forecast Spring 2023* predicts that the global semiconductor market will experience a downturn of −10.3% y-o-y in 2023, with the market undergoing a sharp contraction led by the memory segment (WSTS 2023 Forecast: −35.2% y-o-y).

It is not all bad news, though, and there are some bright signs regarding state-of-the-art semiconductors. The same report also predicts that the logic semiconductor market will contract by a relatively-modest −1.8% y-o-y, with the discrete semiconductor segment (including the power segment) set to grow by +5.6% y-o-y.

In fact, demand seems to be rising for products like the advanced semiconductors used for high-performance computing (HPC) and so on. In May, news emerged that Apple had placed an order with TSMC to manufacture the dual processers used in Apple's mixed reality (MR) headsets, with the US firms NVIDIA, Qualcomm also among the companies placing orders with TSMC for state-of-the-art semiconductors. This growing demand for advanced semiconductors is also driven by demand for generative AI, a closely-watched sector. According to recent reports, TSMC is achieving yields as high as 80% with regards to the production of its most advanced 3-nanometer chips (as of June). This is up on initial forecasts for yields between 50–60% and it points to robust demand for cutting-edge semiconductors.

There is also likely to be firm demand for the power semiconductors used in electric vehicle (EV) controllers, for instance. EV production and exports continue to grow at a very healthy pace, even in recession-threatened China. 3.005 million new energy vehicles (NEV) were sold over January–May 2023, with the sector growing by an impressive +45.1% on the same period last year. January–May also saw EV exports rising by a huge +153.7% on the same period last year to hit $16.56 billion.

Given this hearty demand, it seems the advanced and power semiconductor segments will play a key role in determining when market conditions bottom out and begin recovering.

3. The silicon cycle "trough" is expected to occur mid-2023; the manufacturing cycle is also expected to hit a turning point a little later

As the above shows, though semiconductor market conditions are moving sluggishly on the whole, some sectors are seeing a rise in demand. Next, we will explore the question of when the silicon cycle is likely to bottom out. This section will try to infer when the next turning point will be based on a cycle analysis and the leading-indicator approach.

(1) An analysis of the silicon cycle suggests the next "trough" could occur around

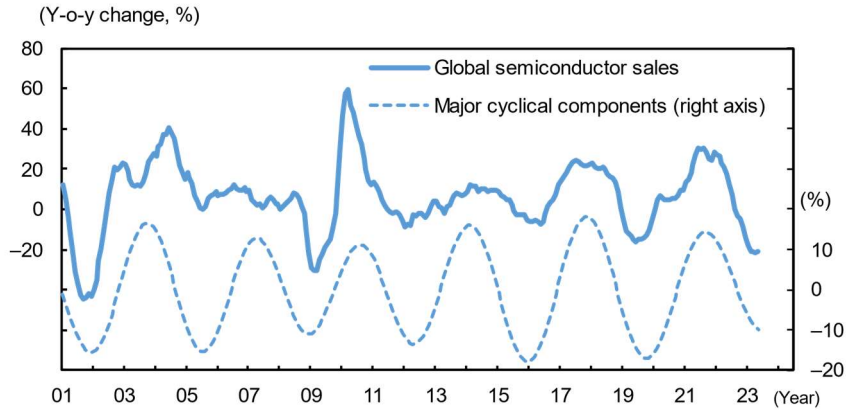
May–August 2023.

Let's begin by identifying the characteristics of the silicon cycle. The silicon cycle refers to the cyclical peaks and troughs of the semiconductor market. A glance at actual year-on-year semiconductor sales shows a repeated cyclical shift between "peaks" (when the market is shifting from expansion to contraction) and "troughs" (when the market is shifting from contraction to expansion). However, the duration of the cycle from peak to peak (or trough to trough) is not always the same.

One way of analyzing these fluctuation patterns is through a spectral analysis. This technique has long been used to analyze economic cycles and it involves extracting multiple waves from the data and uncovering cyclical characteristics. By applying a spectral analysis to data about cyclical fluctuations, we can find the period of the amplitude that appears most strongly. An actual spectral analysis of the y-o-y data for semiconductor sales suggested that the fluctuation period that appears most strongly is 42.7 months. From here on, this report refers to this cyclical fluctuation period of around 43 months as "the silicon cycle."

Chart 5 uses the band pass filter to extract the major cyclical components of this period of around 43 months (namely the silicon cycle) from the y-o-y fluctuations of semiconductor sales. This reveals that the last trough occurred in October 2019, with May 2023 marking the point when 43 months had passed since entering the current cycle. Based on this period of around 43 months, the next trough should occur around May 2023, so the market could now be entering a period of expansion. However, identified silicon cycles in the past did not always last exactly 43 months, with the periods of these cycles varying by around three months. Given this, the next trough could also occur around August, some three months or so later.

Chart 5: Major cyclical components of global semiconductor sales



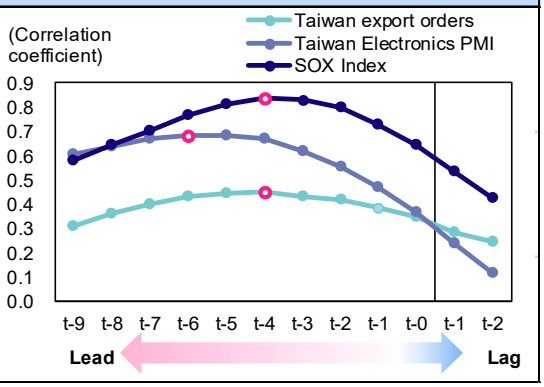
Note: The major cyclical components of global semiconductor sales (y-o-y) were extracted using the Christiano and Fitzgerald (2003) band pass filter.
Source: Made by MHRT based upon releases by the US Semiconductor Industry Association

(2) A leading US semiconductor indicator also suggests the silicon cycle will reach a turning point around April–July

Next, we will infer the timing of the next silicon cycle turning point based on leading indicator movements. There are several leading indicators of semiconductor sales, such as export orders for Taiwanese electronic products, the Electronics PMI released by Taiwan's Chung-Hua Institution for Economic Research, and the Philadelphia Stock Exchange Semiconductor Sector (SOX) Index, an index composed of 30 US semiconductor companies (**Chart 6**). This report used the SOX Index owing to its desirable characteristics, namely "a strong correlation," "a sufficiently-long timeframe to extract data from," and "the fact it does not yield erroneous signs of a turning point." From here on, mentions about semiconductor sales or the SOX Index will be on a y-o-y basis unless otherwise indicated.

Chart 6: Leading indicator candidates

Indicator	Country or region	Process	Start date	Lead or lag compared to global semiconductor sales
Philadelphia Stock Exchange Semiconductor Sector (SOX Index),	US	Y-o-y	Aug. 1994	
Taiwan Electronics PMI (order/inventory balance)	Taiwan	-	Jun. 2012	
Taiwan export orders (electronic products)	Taiwan	Y-o-y	Jan. 1984	



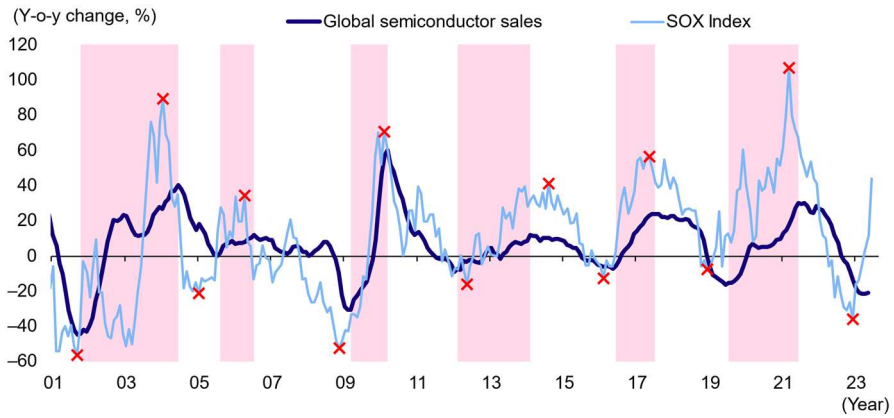
Note: The lead or lag compared to global semiconductor sales shows the correlation coefficients (2013–2021) for global semiconductor sales (y-o-y) and each indicator, as calculated for each time difference. The pink markers denote the times when the correlation coefficients were at their greatest for each indicator.
Source: Made by MHRT based upon releases by CEIC Data, Chung-Hua Institution for Economic Research, and the Ministry of Economic Affairs of Taiwan

The first step was to determine which phases (expansion or contraction) the SOX Index and semiconductor sales were in for each time period from 2000 onwards. This was done in order to quantitatively confirm the suitability of the SOX Index as a leading indicator of semiconductor sales. This step utilized the Bry and Boschan routine[1] developed by the US National Bureau of Economic Research (NBER). Semiconductor sales and Sox Index phases were determined using this routine, with **Chart 7** marking out when SOX Index

[1] Method of determining peaks and troughs by applying a moving average to the target series and by removing outliers based on empirical rules such as "there is a certain interval between the peaks (or troughs) and the time of the latest observation" and "the cycle and each phase are longer than a certain period"

peaks and troughs occurred. This reveals that the SOX Index tends to approach a turning point several months earlier than semiconductor sales. For example, semiconductor sales moved from a phase of contraction to a phase of expansion in July 2019, but the SOX Index had already entered a phase of expansion in January 2019, six months earlier. Based on past trends, the time difference between these two indicators is usually kept to within 3–6 months.

Chart 7: Semiconductor sales and the Philadelphia Stock Exchange Semiconductor Sector Index



Note: The pink shadows denote phases when global semiconductor sales (y-o-y) were expanding. The red markers on the Philadelphia Stock Exchange Semiconductor Sector Index line denote the index's peaks and troughs. These were calculated by MHRT using the Bry and Boschan routine.
Source: Made by MHRT based upon releases by the US Semiconductor Industry Association and CEIC Data

A glance at current indicator movements shows the SOX Index entering a phase of expansion in January 2023. Based on the time differences revealed by the aforementioned analysis, it seems likely that semiconductor sales reached (or approached) a trough sometime between April and July. In other words, the "around May–August" prediction arrived at through the cycle analysis is also supported by the movements of the SOX Index, a leading indicator.

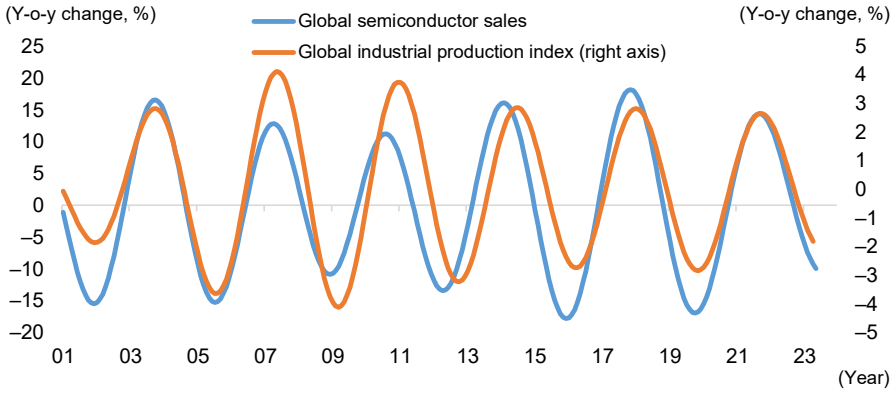
The SOX Index is already up sharply on a y-o-y basis, but it would be premature to expect semiconductor sales to also undergo a V-shaped recovery based on this. The cycle analysis suggests it usually takes around eight months from the time the silicon cycle hits a trough to the time it enters a recovery phase. With regards to the outlook for the global economy, the US and Europe (both major centers of semiconductor demand) are both expected to undergo an economic slowdown from late 2023 onwards. Under these circumstances, there is unlikely to be a sharp recovery in demand for final goods like PCs, smartphones and industrial machinery. It will take time before global semiconductor sales return to positive territories on a y-o-y basis, with this likely to occur sometime around spring 2024.

(3) The global manufacturing cycle could hit a turning point in the latter half of 2023 as the silicon cycle enters an expansionary phase

The silicon cycle runs slightly ahead of the global manufacturing cycle (**Chart 8**), with the silicon cycle useful as a leading indicator of the global economy. Both cycles have moved in unison since 2020 as the pandemic led to special demand and supply-chain turmoil, for example, but the silicon cycle still remains an important barometer when it comes to predicting global manufacturing trends.

With the silicon valley trough set to occur around sometime around mid-2023, the global manufacturing cycle will probably emerge from its worst period in the latter half of the year, with green shoots of recovery likely to grow more prominent from spring 2024.

Chart 8: The silicon cycle and the global manufacturing cycle



Note: Extracted from the y-o-y data using the Christiano and Fitzgerald (2003) band pass filter
Source: Made by MHRT based upon releases by the US Semiconductor Industry Association and the Netherlands Bureau for Economic Policy Analysis

4. Excess pessimism about semiconductor market conditions should be avoided

Semiconductors are an "industry staple product" and they are in demand across a wide range of sectors, from electronic equipment like computers and mobile phones to automobiles, industrial machinery, medical equipment and even modern weaponry. In recent times, the silicon cycle has consistently moved over a period lasting 3–4 years. There is no clear reason for this consistency, but the fact the cycle has peaks and troughs should discourage any excessive pessimism or optimism about semiconductor demand. During the current phase in particular, demand for advanced and power semiconductors is surging, with these segments likely to play a key role in helping market conditions to bottom out and recover from here on. Excess pessimism about global semiconductor demand should thus be avoided.

Reference

Refer to the original Japanese report by clicking the URL below for the reference material.
https://www.mizuho-rt.co.jp/publication/report/2023/pdf/insight-as230710.pdf