Mizuho Economic Outlook & Analysis

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Semiconductor market "before the dawn"

Semiconductor demand in 2020 is expected to pick up

< Summary >

- The silicon cycle has been in a recovery phase since May 2019. We believe the primary factors behind this recovery are the improvement in inventory adjustment and the bottoming-out of smartphone and laptop computer sales.

- Our study including a quantitative analysis suggests that real global semiconductor sales will start picking up in 2020. The main driver of this upturn will be the revival of datacenter investment. The push-up effect of 5G-related demand will likely remain limited for the time being.

- Nonetheless, the growth rate is expected to remain a single-digit figure, falling short of the double-digit growth rate registered during the boom period, because datacenters are still in an overcapacity situation and semiconductor demand for vehicles and industrial machinery continues to lack strength.

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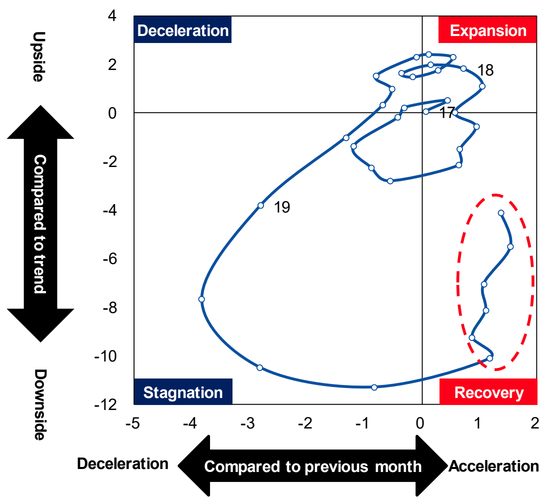
1. Semiconductor market has finally bottomed out

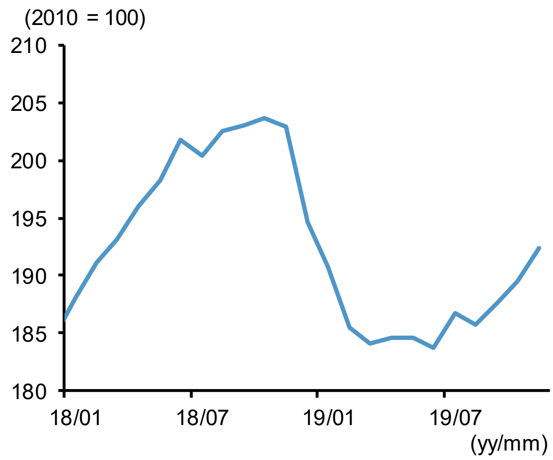
The semiconductor market clearly bottomed out in the middle of 2019. According to the silicon cycle movement (up until October) created by MHRI (**Chart 1**), the silicon cycle index, after entering a recovery phase in May 2019, continued moving upward toward the trend line until October. Although the index continues to move below the trend line, we can see that it has left the worst period behind. Real global semiconductor sales (**Chart 2**) have also shown improvement since July after flattening out in the March to June period.

Chart 1: Business cycle clock of the silicon cycle index



Note: Recent value is as of October 2019 (tentative figure). For details of the index, including the calculation method, refer to Yazawa and Miyajima (2018).
Source: Made by MHRI.

Chart 2: Global semiconductor sales



Note: Real-term figures are estimated by MHRI.
Source: Made by MHRI based upon CEIC Data.

Miyajima et al. (2019) and Yazawa et al. (2019) pointed out in early 2019 that “although the semiconductor market is expected to bottom out in the latter half of 2019, a judgment based on the track record of the silicon cycle, there is a risk that the timing of bottoming-out will be delayed or that semiconductor demand will start declining from the beginning of 2020 due to the rise in uncertainty over the intensification of US-China trade friction and the imposition of a fourth round of tariff increases by the United States.” However, amid the temporary stabilization of the US-China trade war and rising speculation that the tariff increase for the second part of the fourth list of goods (List 4B) will be postponed, with the subsequent cancellation of the tariff increase, the risk did not materialize. And later on, we were able to confirm that semiconductor demand actually began to pick up in the July to September period of 2019, as was suggested by the past silicon cycle.

We believe the future focus will be whether the semiconductor market shows a smooth recovery. In this latest report, we want to draw up a future outlook on the semiconductor market after confirming the present market situation.

2. Semiconductor demand is assessed to have bottomed out in mid-2019 in line with actual demand

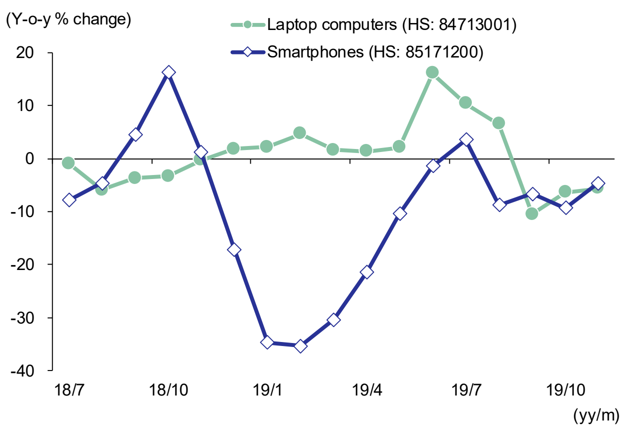
(1) Last-minute demand due to the US tariff increase against China for the second part of the fourth list of goods (List 4B) did not emerge

Yazawa et al. (2019) pointed out that, as of September 2019, last-minute demand would emerge for List 4B goods, such as smartphones and laptop computers, as the United States planned to increase their tariffs in December 2019. This would most probably lead to a surge in the export of these items from China to the United States and boost the special demand for semiconductors.

Nevertheless, last-minute demand did not materialize during the July to September and October to November periods. **Chart 3** shows Chinese exports of smartphones and laptop computers bound for the United States. If last-minute demand had occurred, China's exports of these goods to the US would have accelerated gradually after July. On the contrary, if we look at the year-on-year change, the growth rate rather declined, and our assessment holds that last-minute demand did not emerge. The main reasons why last-minute demand did not emerge are believed to be (1) replacement of laptop computers had already occurred as the period corresponded with the update of the new Windows version, and (2) last-minute demand had already materialized to some extent during the April to June period of 2019 when the US-China trade war was intensifying.

In light of these factors, we believe the recovery of semiconductor demand after the July to September period was triggered not by special demand ahead of the List 4B tariff increase but based on actual demand.

Chart 3: China's export of smartphone and laptop computers to the United States



Note: Data are 3-month moving averages.
Source: Made by MHRI based upon USA Trade Online.

(2) Progress in inventory adjustment and improvement in iPhone functionality contributed to stopping the decline in semiconductor demand

The biggest driver behind the recovery of semiconductor actual demand seems to be the progress made in inventory adjustment. Although it is difficult to grasp the entire market situation given the constraints of statistical data, in this section we use the statistics of Taiwan as one of the world's largest semiconductor producers. **Chart 4** depicts the balance of shipments and inventory by dividing semiconductors into memory and non-memory. The chart shows that the deterioration in the balance of both memory and non-memory from the latter half of 2018 generated adjustment pressure, and we can see that the adjustment pressure was particularly strong for memory. In the first half of 2019, the shipment and inventory balance of non-memory gradually improved, but the balance of memory continued to be deep in negative territory. And in the July to September period of 2019, the shipment and inventory balance of memory finally stopped deteriorating, and it seems that inventory adjustment is finally making some progress.

It should be noted that for non-memory, the shipment and inventory balance collapsed in September because inventory increased to a greater extent than shipments, but this increase should be assessed as positive inventory growth that does not warrant excessive concern. Thus, we can conclude that semiconductor demand has bottomed out, thanks to the progress made in inventory adjustment mainly in non-memory.

Furthermore, improvement in the new iPhone's functions also seems to have worked favorably for semiconductor demand. The new iPhone launched in September 2019 featured mainly camera function enhancements, as seen with the introduction of a triple-lens camera, new night mode for better low-light images, and improved image pixels for high-end models such as iPhone 11 Pro and Pro Max. In addition, as the prices of these new products were unchanged from the previous year's series and offered better value, sales seem to have made a better start compared with the previous year, which pushed up semiconductor demand centering on image censors.

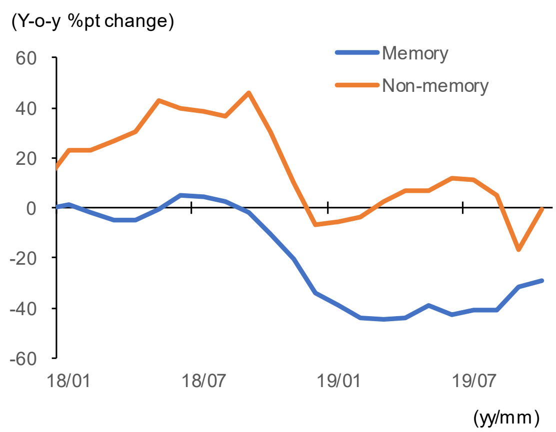
If we confirm the trend with statistics in Japan, which supplies many materials and parts used in the iPhone, for semiconductor shipments during the July to September period of 2019, CCD that includes image censors grew substantially (**Chart 5**).

The revival of the iPhone put the brakes on the decline in smartphone handsets demand. Global smartphone unit sales (based on an IDC press release) grew +0.8% year on year in the July to September period of 2019, marking the first positive growth in the past eight quarters. By manufacturer, while Huawei showed particularly strong growth mainly in the Chinese market (April to June period: +8.3% year on year → July to

September period: +28.2%), Samsung Electronics also registered better sales (April to June period: +5.5% year on year → July to September period: +8.3%), with Apple improving on its sales decline (April to June period: -18.2% year on year → July to September period: -0.6%). With smartphone handsets sales picking up and emerging from the worst period, we presume that semiconductor demand for smartphones has also been stimulated.

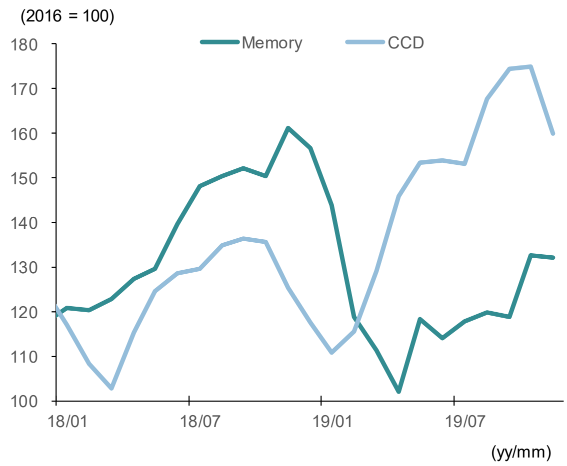
Moreover, global unit sales of laptop computers (based on an IDC press release) also grew +4.7% year on year in the April to June period of 2019 and +3.0% in the following July to September period, and maintained positive momentum. It seems that repurchase demand for new computers with Windows 10 surged before the termination of Window 7's extended support period in January 2020.

Chart 4: Semiconductor shipment and inventory balance in Taiwan



Note: Data are on a volume basis and are 3-month backward moving averages estimated by MHRI.
Source: Made by MHRI based upon CEIC Data.

Chart 5: CCD and memory shipments in Japan



Source: Made by MHRI based upon the Ministry of Economy, Trade and Industry, *Indices of Industrial Production*.

As explained in the earlier sections, thanks to the improvement in inventory adjustment and the uplift of semiconductor demand for smartphones and laptop computers, which account for about 40% of the total semiconductor market,[1] semiconductor demand has bottomed out. But we still cannot describe this positive trend as a full-fledged recovery because the demand for datacenters, vehicles, and industrial equipment continues to be weak. We will describe this more fully in later sections. In short, investment in datacenters lacks impetus compared with the period from 2017 to

[1] According to the industry association WSTS (World Semiconductor Trade Statistics), the share of semiconductors for communication is said to be 32%, the majority of which are for smartphones, and 31% for computers, of which half are for laptop computers. The total share of semiconductors for smartphones and laptop computers is thought to be about 40%.

early 2018 when GAFA (Google, Amazon, Facebook and Apple) was investing aggressively. Global automobile unit sales also remain sluggish centering on China. Also, various concerns including US-China trade friction are impeding the rise in global investment appetite, culminating in weak shipments of machine tools mainly to the Chinese market.

3. Quantitative analysis suggests a gradual recovery of semiconductor demand in 2020

After having assessed that the semiconductor cycle bottomed out in the latter half of 2019, along with actual demand, semiconductor demand is highly expected to improve in 2020. But what is the probability of this scenario? And if this scenario becomes a reality, how fast will the improvement pace be?

(1) Past silicon cycle empirically suggests the recovery to expansion period will last for 11 months

We make our future projection based on past empirical rules. First, we confirm how long the improvement phase ("recovery" to "expansion" phase) lasted in the past silicon cycle. In the silicon cycle index compiled by MHRI, the "recovery" phase lasted about six months and the "expansion" phase around five months on average in the past, meaning that the improvement phase continued for around 11 months (**Chart 6**). The length of the improvement phase, however, is quite volatile, ranging from three months at the shortest to 23 months at the longest, so the degree of deviation from the trend would be the key to forecasting the future. If we simply apply past average figures, it may suggest that the cycle had already entered an expansion phase in November 2019. But given that this time's adjustment range (downward deviation from the trend: -7.2%Pt) was greater than the one recorded during the China Shock from 2015 to 2017 (-5.1%Pt), we hold that the recovery phase will be slightly extended, delaying the start of the expansion phase to early 2020. Afterward, the empirical rules suggest that the expansion phase will continue at least until mid-2020. It must be added, however, that measuring the past cycle period is insufficient for making a good projection. So if we consider other analyses, such as frequency analysis and time series analysis, and also datacenter investment perspectives, the expansion phase is expected to continue until the end of 2020. The upward deviation from the trend is predicted to fall short of the 1.6%Pt registered during the cycle period starting from August 2018 based on our discussions in the later sections.

Chart 6: Improvement phase of the silicon cycle index

(Unit: month) (%Pt)

Period				Deceleration phase	Stagnation phase	Recovery phase	Expansion phase	Improvement period	Upside from trend	Downside from trend
1996/01	~	1997/10		6	4	7	5	12	5.7	-6.6
1997/11	~	2000/10		3	11	10	12	22	21.5	-10.0
2000/11	~	2004/02	(IT Bubble)	7	14	14	5	19	21.1	-16.5
2004/03	~	2006/03		6	9	8	2	10	5.9	-7.0
2006/04	~	2006/12		2	3	2	2	4	0.7	-1.4
2007/01	~	2008/03		1	2	1	11	12	15.0	-0.4
2008/04	~	2011/04	(Lehman Shock)	10	4	12	11	23	14.6	-27.6
2011/05	~	2012/04		7	2	0	3	3	7.8	-0.3
2012/05	~	2013/02		1	4	4	1	5	0.8	-3.6
2013/03	~	2014/10		0	9	7	4	11	3.2	-1.3
2014/11	~	2015/06		4	0	0	4	4	2.7	0.1
2015/07	~	2017/02	(China Shock)	5	6	6	3	9	2.7	-5.1
2017/03	~	2018/07		3	4	3	7	10	1.6	-2.0
2018/08	~			4	5	5?				-7.2
(Reference) Average of period from January 1996 to July 2018				4.2	5.5	5.7	5.4	11.1	7.9	-6.3

Notes: 1. The starting point is the time when the index first entered a deceleration phase, and the closing point is when the expansion phase ended.
2. The improvement period is the total period covering recovery to expansion phase.
3. Upside and downside from the trend mean the maximum and minimum value of deviation of the silicon cycle index from the trend.
4. For details of how the table was created, refer to Yazawa and Miyajima (2018).

Source: Made by MHRI based upon CEIC Data, among others.

(2) Wavelet analysis suggests a gradual recovery in the future

Our analysis in the previous section suggests that the semiconductor market will continue on an improvement track until the end of 2020. Next we studied its momentum using a wavelet analysis, a kind of frequency analysis. Wavelet analysis is a mathematical technique that breaks down fluctuations in different cycles and visualizes them, such as fluctuations in economic data broken down into short-, mid- and long-term cycles. The bottom line is our breakdown of semiconductor demand fluctuations into a short-term fluctuation component (economic cycle, etc.) and mid- to long-term component (launching of innovative products such as smartphones, etc.).

Chart 7 shows the frequency resolution by wavelet analysis of real global semiconductor sales. The chart reveals that after the latter half of 2018, the push-up effect by the short-term component suddenly disappeared and even dropped to a level well below the trend after 2019. The decline in semiconductor demand after the latter half of 2018 can be assessed as a downward shift due to this short-term component. But as the downward pressure of the short-term component was alleviated in mid-2019, the negative effect on real global semiconductor sales came to an end. As explained earlier, progress made in inventory adjustment and a certain increase in repurchase demand for smartphones and laptop computers seem to be factors that put the brakes on the decline in the short-term component.

On the other hand, the mid- to long-term component registered a significant upward shift from the trend due to the surge in real demand driven by advancements in the data economy such as IoT, proving there has been no change since the study conducted by Miyajima (2017). But its pace of growth decelerated compared with the level registered during the period from 2017 to the first half of 2018 and was not strong enough to offset the expanding downward shift of the short-term component. This may be because growth in semiconductor demand for new markets such as datacenters, vehicles and industrial equipment lost momentum in 2019, as mentioned earlier.

Then, how can we forecast the trend going forward based on the present cycle? First, for the mid- to long-term component, the upward shift from the trend has continued for 35 months as of now. As will be described later, the upward shift of the mid- to long-term component from the trend is not expected to change for a certain period of time, given that the revival in datacenter investment is expected to boost semiconductor demand in 2020. In the light of this, we should focus on the movement of the short-term component when forecasting the trend in 2020.

The downward shift of the short-term component is already heading toward contraction. Looking at past short-term component cycles, the period of downward shift from the trend was about 13 months on average, and as 11 months have passed as of November 2019 since the outset of the downward shift period, it is highly likely that the downward shift will end in the January to March period of 2020.

(3) VAR suggests the growth rate in 2020 will be about +9%

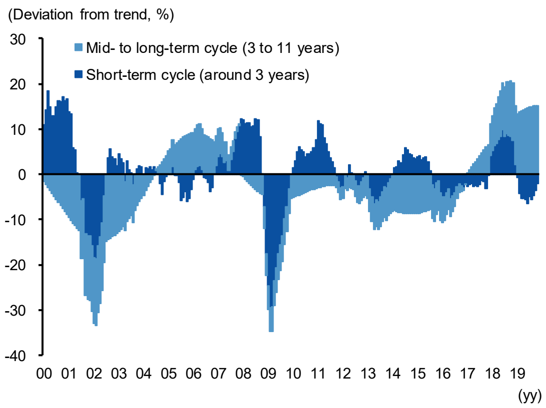
Our next question is how much will real global semiconductor sales grow in 2020? Here, we estimate the VAR model using the monthly data of four variables, including real global semiconductor sales, the US PMI, China PMI, and the Philadelphia Semiconductor Index (SOX), to forecast global semiconductor sales in the future. The framework of analysis is the same one used by Yazawa et al. (2019), which interprets the US and China PMIs as proxy variables expressing the business conditions of the manufacturing industry of the two countries as well as the entire world[2] and assumes that the US and China PMIs and SOX will lead the movement of global semiconductor sales.[3] Both the US and China are important nations in terms of semiconductor demand, and if manufacturing activities in these two nations become sluggish, it goes without saying that semiconductor demand for automobiles, industrial robots, and smartphones will drop

[2] Although it is difficult to obtain long-term time series data in Chinese statistics, PMI monthly data have been available since 2005. One reason why we focused on PMI is that we needed to obtain enough samples to conduct a time series analysis.

[3] The estimate period is from January 2010 to November 2019. Each variable is made steady by removing differences after being transferred to a logarithm, and we employ a lag length of three months based on the SC standard.

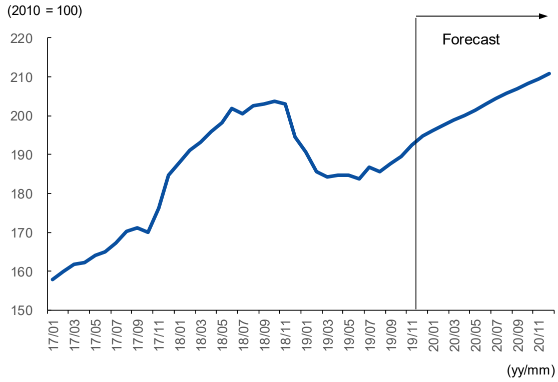
significantly. Meanwhile, SOX is expected to move reflecting the forecast trend of the semiconductor market based on such information as business plans released by semiconductor-related companies. **Chart 8** depicts the development of forecast values based on the VAR model. We can see from the chart that real global semiconductor sales will maintain their recovery trend even after 2020 fueled by a rise in SOX, among other factors. Nonetheless, the pace of recovery is anticipated to be slower compared with the recovery seen during the period from 2017 to the first half of 2018 on the back of slumping US and China PMIs in the latter half of 2019. The full-year real global semiconductor sales in 2020 are projected to grow by around +9%. Given that the year-on-year growth rate of real global semiconductor sales was +14% in 2017, +18% in 2018, and -5% in 2019 (based on actual results for January to November and forecast for December), the expected pace of recovery in 2020 will be rather slow.

Chart 7: Frequency resolution of real global semiconductor sales by wavelet analysis



Note: We broke down the real value, which is seasonally adjusted by MHRI.
Source: Made by MHRI based upon CEIC Data, among others.

Chart 8: Forecast of global semiconductor sales based on the VAR model (real basis)



Note: The estimate period is from January 2010 to October 2019. We selected the lag length of 3 months in accordance with the SC standard.
Source: Made by MHRI based upon CEIC Data.

4. Semiconductor demand is expected to recover primarily driven by datacenter investment

In the previous section, we projected the semiconductor market based on a quantitative analysis. The analysis revealed that the semiconductor market is expected to show only a modest recovery with a single-digit growth rate, and it is less likely that the semiconductor market will expand strongly with the same momentum as seen during the semiconductor boom from 2017 to 2018. According to the forecast provided by the industry association World Semiconductor Trade Statistics (WSTS) in November 2019, nominal global semiconductor sales in 2020 are anticipated to grow by only +5.9% year on year, a rate much lower than the double-digit growth rates of +25% registered in 2017 and +15% in 2018. The following section explains the background of this forecast.

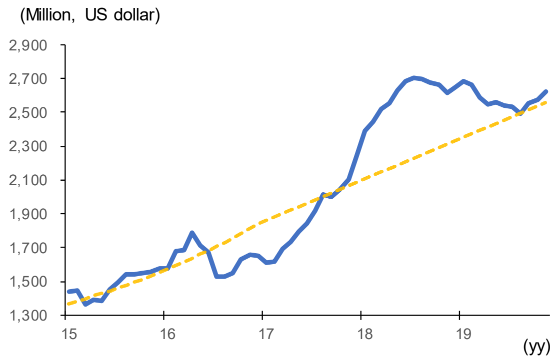
(1) In 2020, datacenter investment is expected to pick up

In 2020, we hold that investment in datacenters will bounce back gradually. As pointed out by Yazawa and Miyajima (2018), from 2017 to the first half of 2018, demand for memory for datacenters was given a significant boost by aggressive investment made by large IT corporations such as GAFA and real estate companies. Although we cannot grasp the precise situation of datacenter investment due to statistical constraints, we have tried to capture US datacenter investment by looking at the US server import value as a proxy indicator as presented in **Chart 9**. The chart shows that US server imports substantially increased from 2017 through the first half of 2018, implying that datacenter investment was being stimulated. However, datacenter investment reversed to a declining trend after the latter half of 2018, partly due to a rise in the sense of overcapacity following the sharp increase in investment until early 2018. Also, there were many cases where the specifications of the materials to be employed in the next datacenter facility model were undetermined in 2019, making firms postpone the installment of servers even though the datacenter buildings were completed. As a result, downward pressure was placed on semiconductor demand centering on memory.

But after the beginning of 2020, Amazon and Google are expected to resume datacenter investment, and with the final determination of material specifications, datacenter investment is expected to gradually rise again. As the prices of NAND flash memory used in servers significantly fell in 2019 (**Chart 10**), the procurement cost of memory subsequently declined, and we hold this will be a factor stimulating datacenter investment in 2020. As datacenter investment begins to recover, semiconductor demand centering on memory is expected to make a stronger comeback.

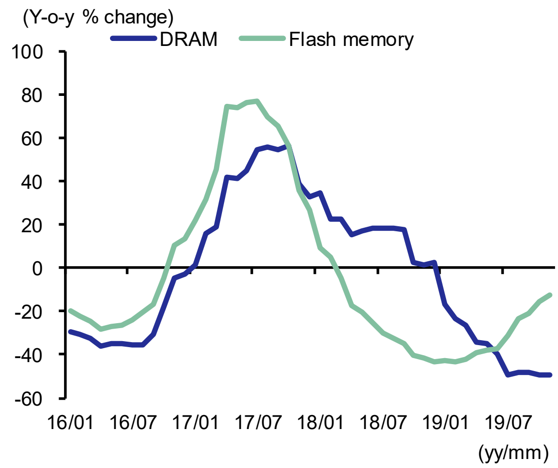
However, given that there is no change in the expected volume increase of data traffic and that the sense of overcapacity still exists, the pace of recovery in datacenter investment is foreseen to remain weaker than during the period from 2017 to the first half of 2018. The main entities investing in datacenters going forward are expected to be manufacturing companies and hospitals for the purpose of preserving their own data, hence investment will likely increase along with the actual demand for data preservation and utilization. Hence, datacenter investment in 2020 is not anticipated to gain momentum as it did in the period from 2017 through the first half of 2018, and its impact on boosting semiconductor demand will not be as strong as it was during this period. In fact, as shown in **Chart 9**, after the latter half of 2017, US server imports grew at a pace significantly stronger than the trend,[4] but began to decline in the latter half of 2018, and the latest November 2019 data suggests it is hovering at a level near the trend line. In the future, US server imports are projected to pick up along with the trend growth rate, which represents a normalized pace of growth.

Chart 9: Server imports by the United States



Note: HS847150. Data above are 3-month backward moving averages, seasonally adjusted by MHRI. The dotted line is the trend line.
Source: Made by MHRI based upon USA Trade Online.

Chart 10: Memory prices in South Korea



Source: Made by MHRI based upon CEIC Data.

(2) While 5G demand is positive, a full-fledged increase in demand will be from 2021

There is no question that the 5G trend is an important factor in predicting the outlook for the semiconductor market in 2020. Generally speaking, the expectation that the advancement of 5G will invite greater demand for semiconductors is rising strongly. **Chart 11** shows the total count of 5G-related articles in various newspapers. The number of articles rises sharply toward the end of 2019, displaying mounting expectation.

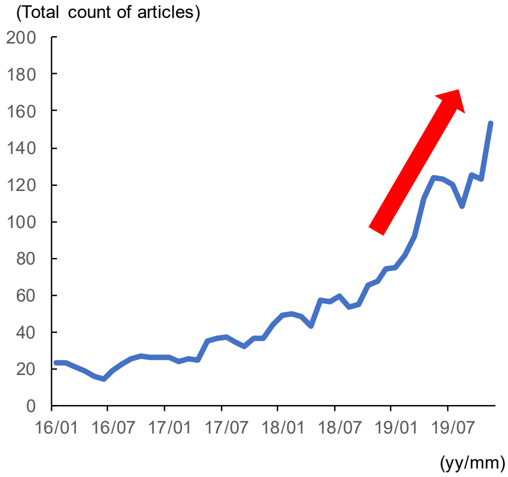
The development of the 5G telecommunication network, however, is proceeding at a slow pace, and there is a little possibility that 5G-related demand will suddenly surge in 2020. **Chart 12** presents the export of base station communications equipment from China, a country boasting the largest base station firm, Huawei. The chart reveals that China's export of base station communications equipment is not growing so strongly, and that installment of base stations required when developing a 5G communication network is not increasing sharply. We should consider that the 5G environment will be

[4] To draw the trend line we first created a new series by applying an HP filter to US imports of servers and extended the growth rate of this series during the period from 2015 to 2016, a period before datacenter investment grew significantly, assuming that this growth rate is equivalent to the trend growth.

developed step by step, after many trials and errors as well as judgments on whether the installment areas are appropriate for base stations.

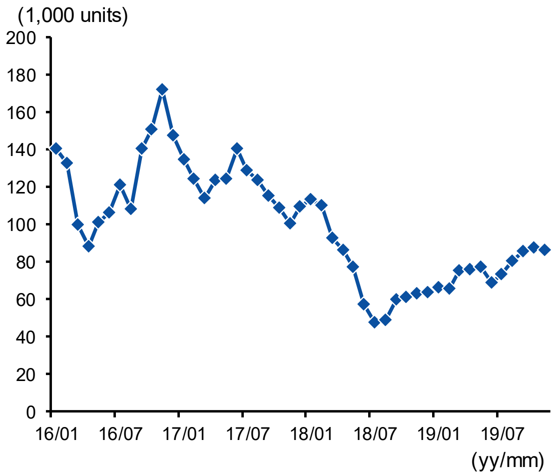
It should be noted that while some expect semiconductor demand (such as semiconductors for wireless communication) for base stations to expand fueled by the development of 5G base stations, its impact will likely remain limited as the share of 5G-related demand is viewed as substantially small relative to overall semiconductor demand.

Chart 11: Total count of 5G-related articles



Note: The graph above represents the total count of articles covered by the Nikkei, Asahi, Mainichi, Yomiuri, and Sankei newspapers. Data are 3-month backward moving averages of the total count of articles containing such words as "5G," "the fifth generation," or "the 5th generation," but does not contain "Huawei," "HUAWEI" or "base station."
Source: Made by MHRI based upon Nikkei Telecom.

Chart 12: China's export of base station communications equipment



Note: Data above are 3-month backward moving averages, seasonally adjusted by MHRI.
Source: Made by MHRI based upon CEIC Data.

The 5G-related item expected to have a big impact on semiconductor demand is the 5G smartphone. As the communication environment will gradually improve in 2020, 5G smartphones are expected to spread to some extent. In fact, according to the forecast provided by IDC, 5G smartphones are projected to account for 14% of total smartphone shipments in 2020, an optimistic view since this is a much larger share compared with the share of 4G smartphones registered when first launched in 2010 (1.3%).[5]

However, the pace of recovery of overall smartphone unit sales is sluggish. IDC forecasts smartphone shipments in 2020 to grow by +1.5% year on year, the first positive

[5] There is strong speculation in the market that smartphone makers will substantially expand their 5G smartphone production plans in order to strengthen their differentiation strategy after model changes, among other reasons. However, the expansion of smartphone production is believed to face challenges as the supply of parts becomes a bottleneck.

growth in the past three years, but this is much smaller compared with the +74.4% growth achieved in 2010 when 4G smartphones were becoming widespread. If we look at the outlook for mobile phone users by communication technology compiled by the *Ericsson Mobility Report* (June 2019), it projects that 5G smartphones will undergo full-scale expansion after 2021. Hence we should assume that it will be after 2021 when the spread of 5G smartphones buoys the overall semiconductor demand.

(3) Momentum will not strengthen in the semiconductor demand for laptop computers, vehicles and industrial equipment

While the recovery in semiconductor demand for datacenters and the bottoming out of smartphone sales will serve as positive factors in 2020, semiconductor demand for other applications should be estimated conservatively. With regard to semiconductors for laptop computers, the sales push-up effect thanks to the Windows upgrade is expected to diminish. Global automobile sales that affect semiconductor demand for vehicles plummeted in 2019 as a result of the strengthening of environmental regulations in some countries, including China. With the absence of such special factors, automobile demand is anticipated to stop falling further in 2020, but we cannot expect a full recovery, and semiconductor demand for vehicles is expected to demonstrate sluggish growth. A full-fledged recovery of industrial machinery centering on machine tools also seems unlikely without a full recovery in automobile sales and the global economy. We forecast that there is little prospect that semiconductor demand for vehicles and industrial machinery will lead the overall semiconductor demand.

5. Conclusion

In conclusion, the situation of the silicon cycle index suggests that current semiconductor demand has hit the bottom in line with actual demand. The main reasons include progress made in inventory adjustment and bottoming out of smartphone and laptop computer sales. Going forward, semiconductor demand is expected to pick up driven by semiconductors for servers and storage as well as smartphones that are said to account for about 40% to 50% of total semiconductor demand, thanks to the recovery in datacenter investment and increasing smartphone sales. Nonetheless, given that (1) datacenter investment will not accelerate as it did in the period from 2017 to 2018, (2) full-scale generation of 5G demand is expected to be realized from 2021, and (3) revival of semiconductor demand for laptop computers, vehicles and industrial machinery (accounting for around 30% of the total semiconductor demand) is unlikely, the momentum of recovery is expected to remain gradual. The growth rate estimated by VAR was around +9%, relatively small compared with the annual average growth rate

(+10%) registered between 2010 and 2018 after the Lehman Shock. The semiconductor market frequently records double-digit growth during an economic boom,[6] but in 2020 the growth rate is projected to be a single-digit figure and lack strength.

Supplementary discussion: Impact on Japan's GDP and confirmation of the current situation of risk factors

In the last section, we discuss the impact of the semiconductor market recovery on Japan's exports and production, as well as the current status of risk factors pointed out by Yazawa et al. (2019), including domestic production of semiconductors in China and Japan-South Korea friction.

(1) Recovery of the semiconductor market expected to boost Japan's electronic parts production and exports

To what extent will the recovery of the semiconductor market affect Japan's exports and production? Here, we estimate VAR using the three variables (quarterly data) of global semiconductor sales (real value seasonally adjusted by MHRI), export volume of electronic machinery, and production of electronic parts and devices to find the impulse response (**Chart 13 and 14**) and see how fluctuations in global semiconductor sales affect the export volume of electronic machinery and production of the electronic parts and device industry. We can confirm from the charts that improvement in the semiconductor market has a significantly positive impact on the export of electronic machinery and production of the electronic parts and device industry. If we make a mechanical calculation using the +9% expected growth rate of global semiconductor sales in 2020 computed in Section 3, recovery of the semiconductor market is expected to increase Japan's exports and GDP by approximately +1.2% and +0.2%, respectively (assuming the share of electronic machinery in total exports is about 18%). The revival of the semiconductor market[7] is expected to underpin the Japanese economy to a certain extent in the coming years.[8]

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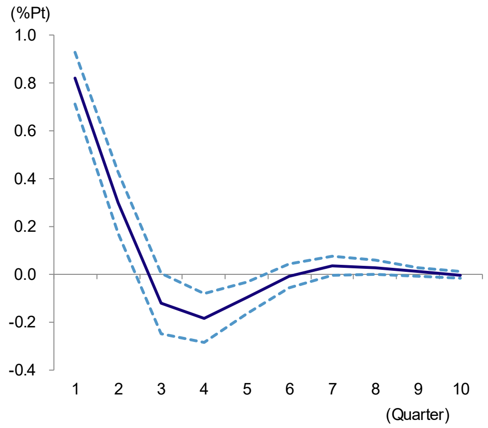
[6] Since 2010, double-digit growth has been recorded five times: +44.2% in 2010, +12.8% in 2011, +13.2% in 2014, +13.7% in 2017 and +17.9% in 2018.

[7] We also estimate how an increase in semiconductor manufacturing equipment exports driven by an increase in global semiconductor sales will affect the Japanese economy. We estimate that it will raise Japan's exports and GDP by around 0.9% and 0.1%, respectively. However, semiconductor manufacturing equipment may be greatly affected by other factors outside the semiconductor market (for example, global capital investment trends), so our estimates must be interpreted with sufficient latitude.

[8] In fact, production of the electronic parts and device industry in the July to September period rose by +3.5% from the previous quarter; if production proceeds according to plan, it is projected to grow by +3.7% in the October to December period.

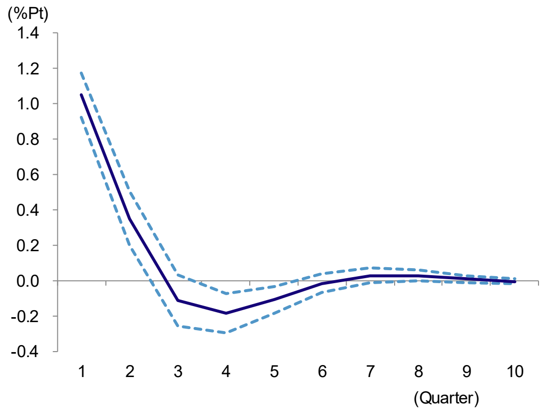
Chart 13: Impulse response of electric equipment exports against global semiconductor sales shock



Note: The graph shows the changes in export volume (quarter-on-quarter growth rate) of electronic equipment when 1%PT of global semiconductor sales shock is given. The dotted line represents a confidence interval of ±1 standard error. Lag length is two quarters in accordance with the AIC information standard.

Source: Made by MHRI based upon CEIC Data, among others.

Chart 14: Impulse response of electronic parts and device industry production against global semiconductor sales shock



Note: The graph shows the changes in export volume (quarter-on-quarter growth rate) of the electronic parts and device industry when 1%PT of global semiconductor sales shock is given. The dotted line represents a confidence interval of ±1 standard error. Lag length is two quarters in accordance with the AIC information standard.

Source: Made by MHRI based upon CEIC Data, among others.

(2) Risk of oversupply due to China's domestic semiconductor production plan has receded

Yazawa and Miyajima (2018) pointed out the possibility that China's plan to manufacture semiconductors domestically may trigger an overcapacity problem after 2020, warning that it may become a risk factor in the semiconductor market. Amid the ongoing US-China conflict, the Chinese government is apparently strengthening its intention to produce semiconductors domestically, and this move deserves close attention as it runs the risk of negatively impacting Japan and surrounding countries in Asia as a mid-term overcapacity factor (refer to Yazawa et al. [2019]).

But if we focus on 2020 only, the possibility of this risk factor becoming a reality seems low. China's import value of semiconductor manufacturing equipment declined in 2019 from 2018 (**Chart 15**), and the pace of increase in semiconductor production capacity has slowed down.[9] With the expectation that the semiconductor market will rally in 2020, investment in semiconductor manufacturing equipment is expected to pick up, but since yield enhancement of production requires a certain period of time, there is little possibility of the semiconductor production capacity in China skyrocketing by the end of 2020 to the extent that it would immediately deal a heavy blow to the global

[9] The suspension of manufacturing activity of JHICC (memory maker), a government-owned enterprise in China, due to the imposition of sanctions by the United States, apparently caused a delay in the semiconductor function upgrade, among other factors.

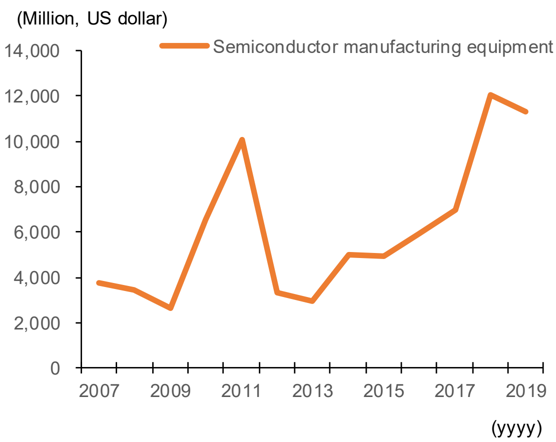
market. At present, the risk of overcapacity stemming from China's domestic production of semiconductors should be interpreted as a mid-term risk after 2020.

(3) Risk of semiconductor production decline in South Korea requires our ongoing attention, albeit the probability is low

Yazawa et al. (2019) concluded the probability was low that South Korean semiconductor production would be adversely impacted by Japan revising its export control of semiconductor manufacturing materials bound for South Korea, and semiconductor production in South Korea after July 2019 has not fallen so seriously, implying that the impact of Japan's revision of its export control has been minimal.

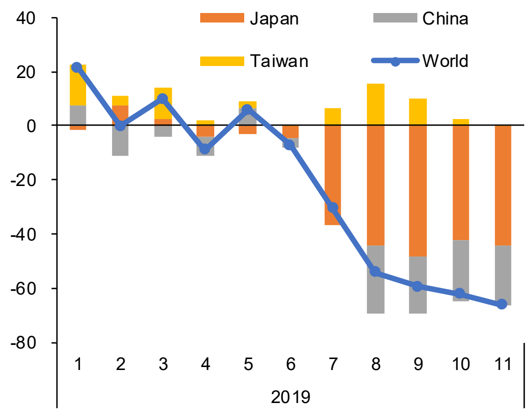
However, hydrogen fluoride used in semiconductor manufacturing and imported from Japan to South Korea continued to dip significantly even after November (**Chart 16**). Yazawa et al. (2019) predicted it would head toward recovery after August, but signs of a pick-up have yet to emerge. While statistics show that imports from Taiwan are rising, the lift is not strong enough to offset the decrease in imports from Japan. Since the inventory stock of hydrogen fluoride is said to be worth two-to-three months' consumption, we cannot deny the possibility that a decline in imports after July will place downward pressure on the production level with a certain time lag around the end of 2019. We expect Japan's export of hydrogen fluoride to rebound as administrative procedures become smoother, but we need to continue closely monitoring future developments in trade and production.

Chart 15: China's import value of semiconductor manufacturing equipment



Note: Data of 2019 are from January to November.
Source: Made by MHRI based upon World exports and imports statistics database.

Chart 16: South Korea's import of hydrogen fluoride (for semiconductor manufacturing)



Note: Data are volume basis. HS code is 2811111000.
Source: Made by MHRI based upon Korea International Trade Association.

Reference

Refer to the original Japanese report by clicking the URL below for the reference material

https://www.mizuho-ri.co.jp/publication/research/pdf/insight/gl200115.pdf