Asia in Focus

Asian chip exports—potentially vulnerable to the Fed hike cycle

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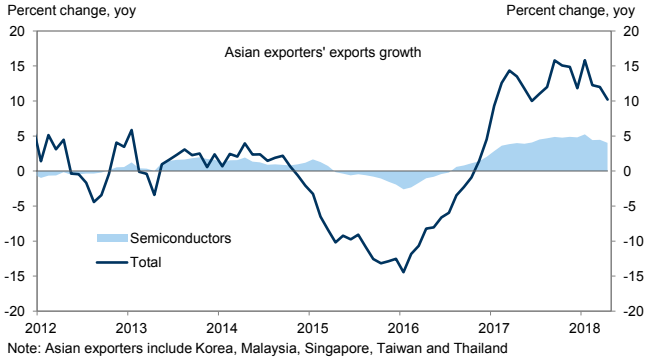
- **Strong chip demand in a new tech era:** Much of the recent robust performance of Asian exports is due to the extraordinary strength of global chip demand, boosted by a new technology revolution (based on cloud computing, smart devices, etc.). Given the large contributions made by chip exports to export growth in small open economies in Asia (nearly 40% in 2017), we assess the potential vulnerability of Asian chip exports to sustained Fed rate hikes (150bp by end-2019 in our US team's view) by studying patterns of chip cycles during past Fed hiking periods.
- **Fragility of Asian chip exports to Fed hike cycles:** Over the last four Fed hike cycles, chip exports from major chip producers (Korea and Taiwan) had moderated before or when the Fed fund rate reached its peak, and did not recover until the start of easing cycles. Moreover, the Asian chip cycles have been highly volatile with occasional deep corrections, second only to oil prices among major cyclical indicators. Our findings point to the potential fragility of the current Asian chip cycle in the face of Fed tightening, with its downturn possibly accelerating along with rising costs of capital from decade low levels.
- **Could this time really be different?** While we recognize the structural strength of chip demand this time, further Fed hikes would still be likely to weigh on Asian chip exports by slowing down incremental demand from corporates and consumers. A major counterargument against our top-down view could be rising structural demand from a host of new technologies such as hyper-scale data centers, autonomous vehicles, and internet of things. That said, we expect structural headwinds as well, including an entry of large Chinese firms into the chip industry (potentially depressing prices), rising trade barriers, and intensifying competition for new technologies. Equity markets already discount the sustainability of the current chip cycle, with a relatively low forward P/E ratio of around 5X given unusually high profit margins in excess of 40%.
- **Investment implications:** Should the ongoing moderation of the chip cycle worsen significantly, Korea would be most vulnerable to a chip cycle correction, with the effects broadly felt on the external, fiscal and growth fronts. Other chip exporters like Taiwan and Malaysia could keep policy rates on hold longer than we currently envisage.

Strong chip demand in a new tech era

With further Fed hikes ahead (150bp hikes by the end of 2019, in our US team's view), we study the relationship between Fed hike cycles and semiconductor cycles given the importance of the chip industry in Asia. Much of the recent robust performance of Asian exports is due to the strength of semiconductor exports (see "Asian exporters—New capex tailwinds," *Asia Economics Analyst*, Nov 26, 2017). Chip exports' contributions to headline exports growth ranged in 2017 from 23% in Singapore and Malaysia to as much as 40% in Taiwan and 50% in Korea, and chip exports are likely to exceed $230bn for Korea and Taiwan alone in 2018 (Exhibit 1). The strong performance of chip exports, after a lull in late 2015 and early 2016, stands in stark contrast to sustained declines in other tech exports, reflecting partly import substitution by China in the tech industry (notably displays and TVs), and partly offshoring by export-oriented economies to low-cost locations (Exhibit 2).

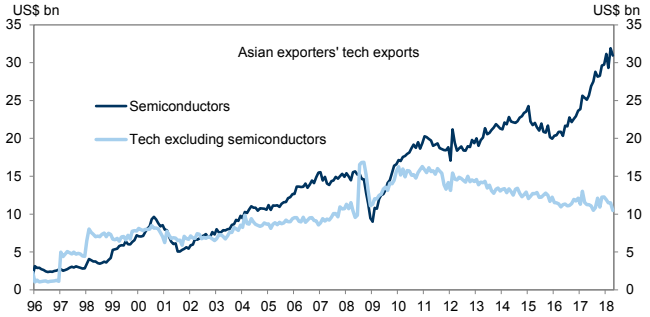
Exhibit 1: Chip exports from Asian exporters represent about 40% of headline exports growth in recent months



Note: Asian exporters include Korea, Malaysia, Singapore, Taiwan and Thailand

Source: Haver, Goldman Sachs Global Investment Research

Exhibit 2: Within tech exports, chip exports trends have long diverged from anemic non-chip exports



Note: Tech exports include office machines, telecom devices, and electrical and electronical parts (mostly SITC 75, 76, 77)

Source: Haver, Goldman Sachs Global Investment Research

Historical relations between Fed hike cycles and Asia chip cycles

For the study, we focus on three previous Fed hike cycles, starting in February 1994, June 1999 and June 2004. Given a mid-cycle reversal in early 1997, we map four episodes of Fed hike periods to various indicators of semiconductor cycles. The choice of Fed cycles was constrained by the relatively short lifetime of the semiconductor industry in Asia, which did not begin to kick off until the late 1980s along with the arrival of personal computers (Exhibit 3).[1] For chip cycle indicators, we select semiconductor production and exports in Korea and Taiwan, two major Asian economies with large production bases and sufficiently long series of exports data. We also include global sales of semiconductors (compiled by the Semiconductor Industry Association) and US chip production, given extensive cross-border supply chains in the industry. For comparison, we add oil prices, global exports in USD terms, US non-farm payrolls, and our Global Leading Indicator. We present percentage changes of these indicators during each cycle as a comparable reference to intra-period changes but, as discussed below,

[1] While our mapping has been done for the four episodes of Fed hikes, the main results of our event analysis does not change signficantly even if we apply the three main Fed hike cycles since 1994.

these two end-point comparisons mask much higher intra-cycle volatility, especially for semiconductor indicators. Below are our key findings.

Exhibit 3: Selected indicators of Fed hike cycles since 1994

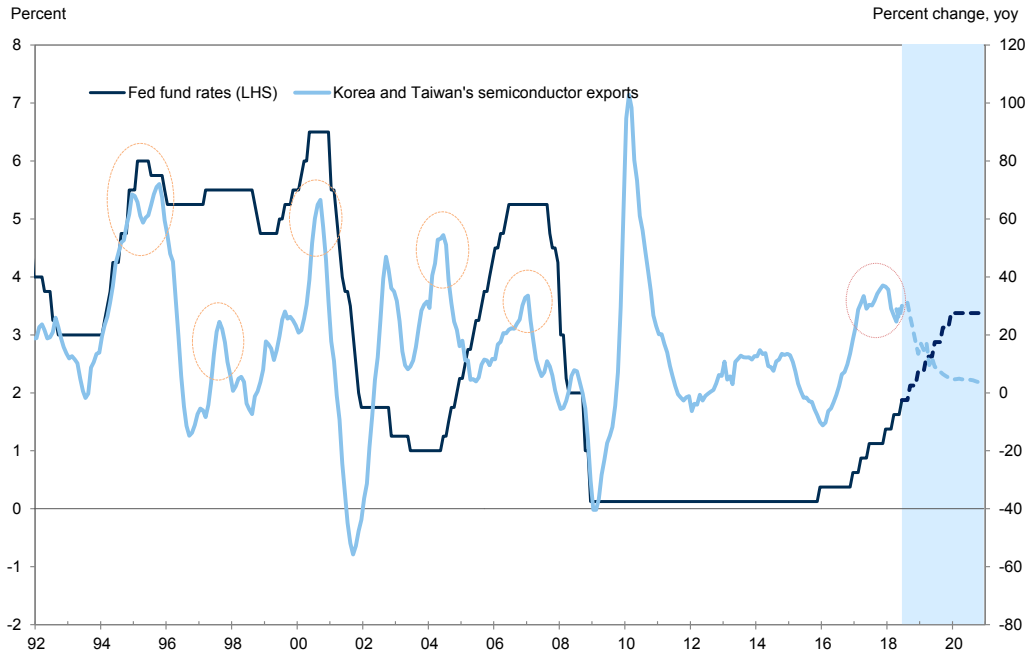
	Cycle I		Cycle II	Cycle III	Average
	(I-a) 1994	(I-b) 1997	1999	2004	(I)-(III)
Start month	Feb-94	Mar-97	Jun-99	Jun-04	
Peak month	Feb-95	Mar-97	May-00	Jun-06	
End month*	Jun-95	Aug-98	Dec-00	Aug-07	
Duration (m)	**16**	**17**	**18**	**38**	**22**
Fed fund rate (start)	3.00	5.25	4.75	1.00	3.67
Fed fund rate (end)	6.00	5.50	6.50	5.25	5.75
Total hikes (ppt)	3.00	0.25	1.75	4.25	2.08
Percentage changes during hike cycles (annualized)					
Global chip sale (USD)	50%	-7%	36%	6%	12%
Brent oil	70%	2%	34%	16%	17%
Korea chip output (volume)	80%	63%	30%	34%	42%
Taiwan chip output (volume)	26%	0%	48%	20%	23%
Memorandum item:					
Global goods exports (USD)	36%	-10%	10%	13%	4%
Global industrial output	5.0%	2.3%	5.3%	4.2%	4%
Asia chip exports (USD)	19%	-29%	36%	25%	11%
Global Leading Indicator	4.9%	0.8%	3.3%	4.4%	3%
US non-farm payroll	3.0%	2.6%	1.9%	1.5%	2%

*One month before the start of an easing cycle.

Source: Haver, Goldman Sachs Global Investment Research

First, Asia chip cycles, represented as chip exports from Korea and Taiwan, tend to fade before the peaks of Fed hike cycles. The peak of their chip exports in year-on-year growth terms preceded the peaking of Fed fund rates in the 1994 cycle, coincided in the following two cycles in 1997 and 1999, and preceded rates peaking in the 2004 cycle before spiking again later in the hiking cycle (Exhibit 4). In all four cases, Asian chip exports did not rebound meaningfully until the ensuing easing cycles, suggesting that the Fed hike cycle was an important factor weighing on Asian chip cycles. Similarly, the peak momentum of a global chip cycle, represented by global semi-conductor billings, coincided with the peaking of Fed rates in three out of four cycles while it preceded in the 2004 cycle.

Exhibit 4: Asian chip exports peaked during Fed tightening, either before or when the Fed rate peaked



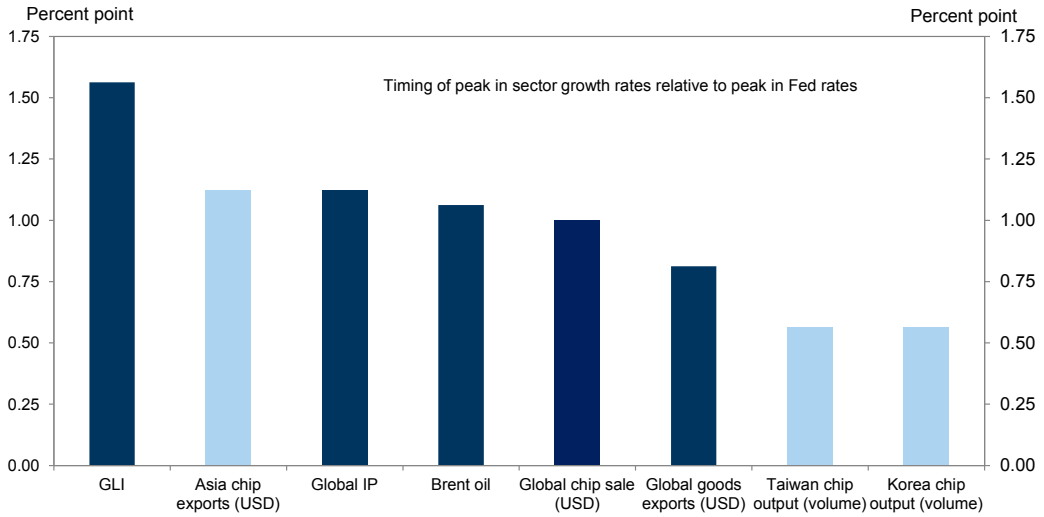
Note: Shaded area denotes GS forecast

Source: Haver, Goldman Sachs Global Investment Research

Second, Asia chip cycles tended to peak out relatively early in Fed hike cycles[2] compared with other activity indicators. Over the last four Fed hike cycles, Asian chip exports, represented by Korea and Taiwan chip exports, reached a peak on a year-on-year growth basis, on average, 15 months before the Fed hike cycle ended (or when the Fed fund rate was on average about 100-125bp below its peak level) (Exhibit 5). By comparison, chip production in Korea and Taiwan peaked out a bit later although still before the end of the Fed hike cycles, on average by 11 months, which reflects the tendency of continued expansion of production at a late stage of chip cycles in the face of declining chip prices (we have found a 60% correlation between chip production growth and price declines) (Exhibit 6). In the current Fed hike cycle that started in December 2015, the pattern of a late chip cycle has recently emerged, with production volume growth (the largest since late 2015) exceeding sales revenue growth, in a reversal from an up-cycle driven by pricing expansion that had continued until late 2017 (Exhibit 7). Other indicators including global chip sales and global good exports peaked between the two timings. Our proprietary Global Leading Indicator peaked out, on average, 19 months before the end of the Fed hike cycles.

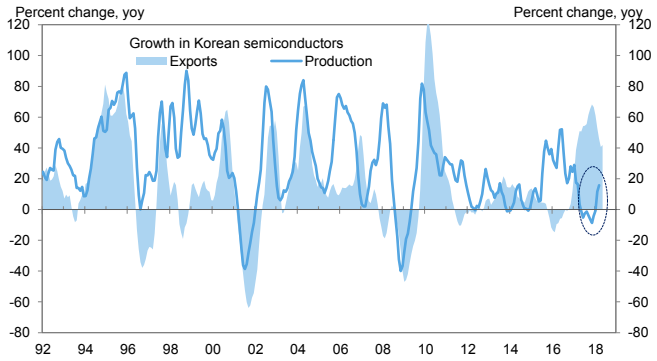
[2] We have also looked at how chip cycles moved after the start of Fed tightening. In the case of Korean chip exports, Fed fund rates rose 120bp on average over the last four cycles, before their export momentum on a year-on-year basis peaked. The size differ across cycles, with 250bps in the first 1994 cycle, 25bps in the 1997 cycle and 175bp in the 1999 cycle and 100bp in the 2004 cycle.

Exhibit 5: The Asian chip cycle topped at 100-125 basis points, on average, below peak levels of Fed fund rates, ahead of most other cycles
(Timing of peak in y-o-y sector growth rates relative to peak in Fed rates, in % points of Fed rates)



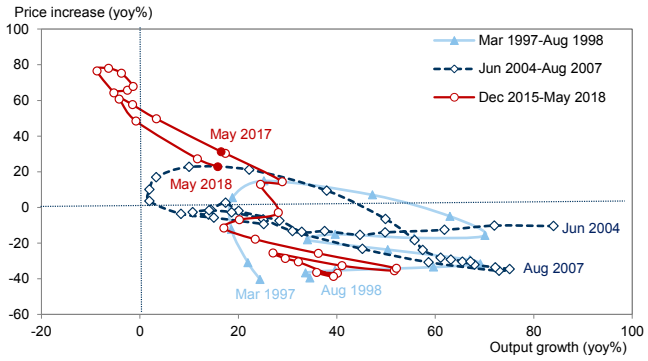
Source: Haver, Goldman Sachs Global Investment Research

Exhibit 6: A recent expansion of chip production has exceeded export revenue growth, implying weakening prices and a late-cycle phase



Source: Haver, Goldman Sachs Global Investment Research

Exhibit 7: In most chip cycles, production expansion tended to come with weaker chip prices



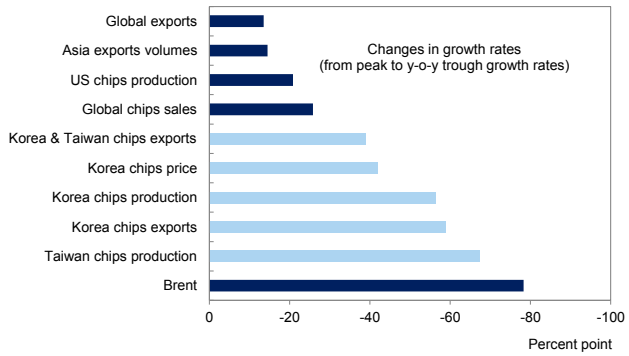
Source: Haver, Goldman Sachs Global Investment Research

Third, Asian chip cycles have been highly volatile, occasionally with deep corrections**.** A gap between the growth of chip indicators at peak versus post-peak trough levels in each hike cycle was among the largest in our cyclical indicators, with the gap ranging from 40 ppt to 60 ppt, second only to oil prices with 80 ppt (Exhibit 8).[3] The high volatility of Asian chip cycles during Fed tightening is not surprising in our view as the semiconductor industry, especially the memory chip business, is highly capital-intensive, requiring large capex and constant revamps and characterized by high earnings volatility.

[3] Our metric is the difference between a maximum growth rate of an indicator from a year ago and its minimum growth rate following the peak growth within each Fed hike cycle. An alternative could be to measure the difference between the highest level within each Fed hike cycle and the lowest level following the peak level. We did not choose the latter as the extent of the decline, if normalized for comparison, is highly sensitive to the duration of the decline within each hike cycle.

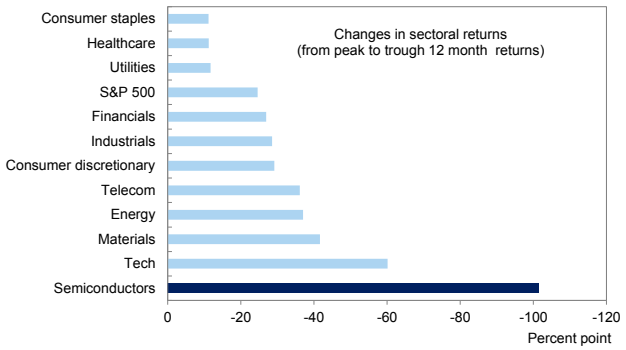
While major Asian chip companies do not appear particularly vulnerable to rising US interest rates, given their capex funding mostly through retained earnings, overall demand for chips could be affected by borrowing costs. It is also notable that stock prices of chip companies tend to be highly vulnerable to Fed tightening, with the chip sector of the S&P down by 80 percentage points on average from a peak to trough 12-month returns (Exhibit 9). Perhaps because of the large downside risks, the semiconductor index tended to peak out well ahead of other sectoral indexes of the S&P including Industrial, Energy, and Consumer Discretionary, and is second only to Materials.

Exhibit 8: Asian chip indicators are among the most vulnerable during the hike cycles
(Average year-on-year growth rates at the peak vs the trough in each Fed hike cycle)



Source: Haver, Goldman Sachs Global Investment Research

Exhibit 9: Tech stocks are among the most vulnerable during the hike cycles
(Average year-on-year stock index returns at the peak vs the trough in each Fed hike cycle)



Source: Haver, Goldman Sachs Global Investment Research

Could this time really be different?

Overall, we are cautious on the near-term outlook for the Asian chip cycle. Our study of past Fed hike cycles points to the potential fragility of the current Asian chip cycle in the face of Fed tightening. A cycle downturn could possibly accelerate as the cost of capital continues to rise from its decade-low levels to 3.25%-3.5% by the end of 2019, as our US team currently expects. Our top-down view is consistent with our sector analysts' view that undersupply of overall memory chips will likely continue this year but the extent of the undersupply will likely moderate, with flash memory (NAND) to be incrementally more oversupplied on acceleration of supply growth and recent inventory rising. For 2019, our sector analysts expect NAND oversupply to persist and the market for direct random access memory (DRAM) to be only marginally undersupplied from a relatively large undersupply in 2018.

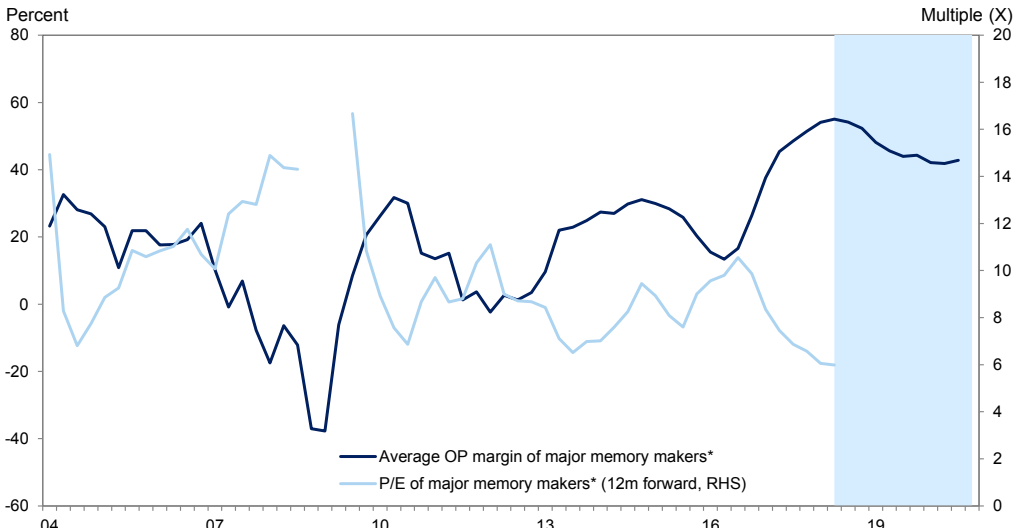
While we recognize the structural strength of chip demand this time, further Fed hikes would still likely weigh on the Asian chip cycle by slowing down incremental corporate demand for hyper-scale data centers and solidifying consumers' resistance to higher chip prices. A major counterargument against our top-down view could be rising structural demand from a wide range of new technologies such as hyper-scale data centers, autonomous vehicles, high-end mobile phones and internet of things. A return to synchronized global growth, as seen in late 2017, combined with rapid progress in

harnessing a new technology revolution, could help re-ignite an unprecedented upturn in the Asian chip cycle in the face of sustained Fed hikes.

While these structural factors, possibly fully in force several years from now, sound convincing, this does not necessary mean that the semiconductor industry will avoid cyclical downturns in the short term, given the historical record of the fragility of the Asian chip cycles to Fed tightening. Moreover, we expect structural headwinds as well, including the upcoming entry of Chinese firms with soft budget constraints into the chip industry, rising global trade barriers amid increasing trade protectionism, and intensifying competition for new technologies. While our tech analysts are of a view that China is likely to focus initially on processors and foundries, rather than memory chips, recent industrial reports suggest that China appears to move rapidly on the buildup of memory capacity as well with acceleration in memory capex, although the products are likely to be low-end products initially, not competing directly with those of Korean and Taiwanese chip companies.

Nonetheless, a new entry of Chinese companies with sizeable financing supports from the government and easy access to large local markets could pose challenges to incumbent chip producers that have been shielded by significant technological and capex barriers. The drive for developing a national chip industry could be further accelerated in China given a recent elevation in trade tensions and intensifying competition for high-tech industries between the United States and China. Perhaps most importantly, equity markets already discount the sustainability of a strong chip cycle, with a relatively low forward P/E ratio of around 6X despite unusually high operating profit margins above 40% that have been for sustained more than a year (Exhibit 10).

Exhibit 10: Strong margins and very low valuation suggest that equity investors do not believe in the sustainability of the currently high earnings



Note: Shaded area denotes GS forecasts; the dotted line excludes periods of volatile P/E due to negative or negligible earnings
*Including Hynix, Micron Technology and the memory segment of Samsung Electronics.

Source: Quantiwise, Goldman Sachs Global Investment Research

Investment implications

Should an ongoing moderation of the chip cycle accelerate, Korea, a globally dominant producer of memory chips, would be most vulnerable to the chip cycle correction, with the effects broadly felt on the country's external, fiscal and growth fronts. Korea's balance of payments would deteriorate rapidly from falling export receipts and slowing or even reversing inflows to local equity markets, where two large chip producers account for 43% of MSCI Korea earnings in 2017 and about 70% of the earnings growth expected in 2018. National incomes, where exports of chips contributed nearly 5% of GDP in 2014 and possibly 7% of GDP in 2018, would be affected by both the direct impact on the chip industry and the indirect impact on other sectors, including construction, machinery, retail and wholesale trade, and financials. There would be substantial fiscal implications as well, given the large contributions to the government budget from the semiconductor sector and related sectors. Other countries such as Taiwan and Malaysia, which have substantial exposure to a broad semiconductor industry including production of non-memory chips and testing and packaging, would not be adversely affected as much as Korea but might not raise policy rates as early as we currently envisage.

Disclosure Appendix

Reg AC

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