Americas Technology: Semiconductors - Memory

Updating our DRAM and NAND industry views; lower our WDC & STX price targets

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We are updating our DRAM and NAND industry models and outlook. For DRAM we now expect slight oversupply in 2019 (driven by 1H19), and for NAND we continue to expect oversupply in 2018 and 2019 but to a greater extent than our prior view. We assume improvement in 2H19 for both DRAM and NAND.

The changes we are making to our industry outlook are consistent with the industry note we wrote in August post Flash Memory Summit suggesting that both DRAM and NAND fundamentals were incrementally weaker (link), due to both increased bit output as well as decelerating demand (in part on inventory in the channel given tepid 1H smartphone sell through). Our industry discussions in September suggest that these weaker memory trends have continued.

We continue to believe that the DRAM industry has improved cycle to cycle, with more of a profit focus (we believe that Samsung Electronics started to delay capex much sooner than it did in prior cycles) and challenges shrinking at the leading edge. To that end, after a record long 9 quarter upturn (through 3QCY18E), we are assuming a benign downturn, and we assume the magnitude of price declines in DRAM during the downturn will be more modest than past downturns.

However, even with this relatively benign downturn assumption, our estimates are below FactSet consensus. Moreover, we believe that investors need to remain cognizant of the fact that memory downturns have historically often been worse than initially expected by companies or analysts. We attribute this in part to the compounding effect of customers delaying purchases once pricing starts to fall, exacerbating the supply imbalance. The maximum ASP drop on an absolute basis in a downturn has historically occurred three quarters or more after pricing first started to decline.

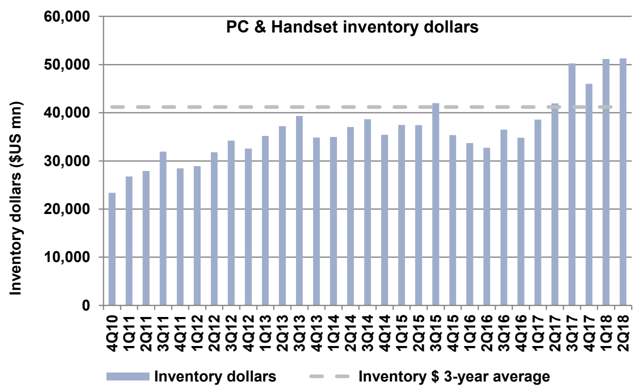
DRAM: We expect modest oversupply in 2019, driven by 1H19

Supply/Demand model update

We are revising our DRAM industry model, and we now expect slight oversupply for 2019 in total (driven in particular by 1H19), weaker than our prior forecast showing slight undersupply for the year in total (with oversupply in 1H19 more than offset by undersupply in 2H).

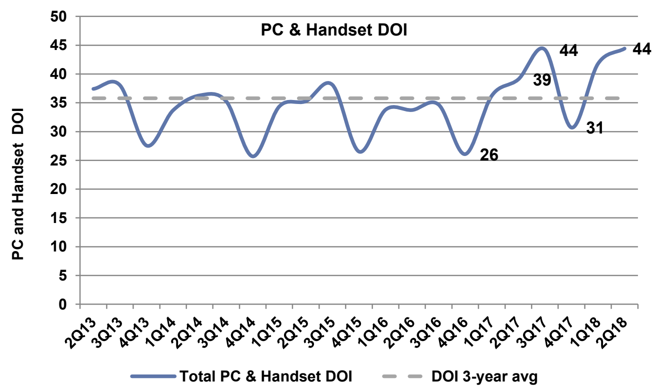
We are adjusting our S/D model to better reflect our industry discussions suggesting that some DRAM shipments recently have gone into inventory, rather than true end consumption, implying actual content per box growth has been somewhat lower than we previously expected. As we discuss in more depth in our Micron downgrade note also out today, and as we wrote in August in our Flash Memory Summit takeaways note (link), we believe that some of the PC and handset companies have inventory on hand (as they chased bits during the shortage, and in part on weak smartphone sell through). Our bottom-up aggregation of PC and handset company results showed that inventory remained high exiting 2Q18 (Exhibits 1-2).

Exhibit 1: PC and Handset company inventory is elevated on a dollars basis
PC and Handset inventory dollars



Source: Company data, Goldman Sachs Global Investment Research

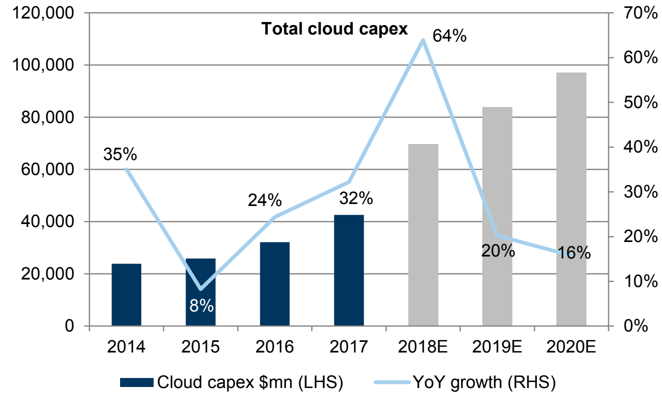
Exhibit 2: PC and Handset DOI is elevated relative to history
PC and Handset DOI



Source: Company data, Goldman Sachs Global Investment Research

In addition, as we wrote in August, our industry discussions suggest that as certain datacenter projects and longer-term DRAM procurement contracts wind down in 2H18, several hyperscale companies plan to moderate DRAM procurement in 1H19 (and are looking for lower pricing). This is directionally consistent with the bottom-up aggregation of GS forecasts for capex for the leading hyperscale companies, which shows a deceleration from 64% yoy growth in 2018E to 20% in 2019E (Exhibit 3).

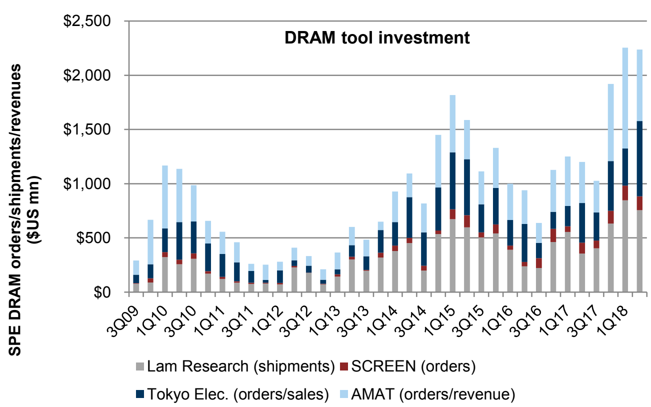
Exhibit 3: We expect the rate of US hyperscale capex growth to slow
Hyperscale capex dollars and YoY growth



Source: Company data, Goldman Sachs Global Investment Research

At the same time that some customers have reduced procurement plans, we expect bit production growth to accelerate. This is based on industry WSPM (wafer starts per month) increasing on a yoy basis in 2H18/1H19 from investment decisions made earlier this year (such as Pyeongtaek and M14), as DRAM tool shipments have been running at record highs in 1H18 (Exhibit 4). Even holding WSPM flat from current levels, 2019 WSPM would be up yoy vs. 2018. We estimate that theoretical bit supply growth could be in the 20-25% yoy range in the late 2018/1H19 time frame (assuming typical bit/wafer growth in the +10-15% yoy range, compounding with the increased WSPM).

Exhibit 4: DRAM tool procurement was at a record high in 1H18
DRAM tool investment per AMAT, SCREEN, LRCX, Tokyo Electron



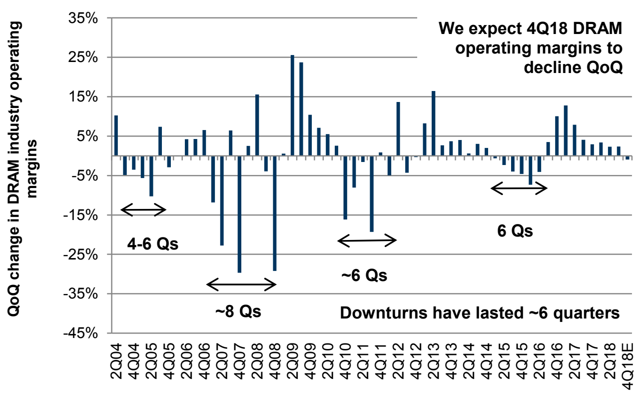
Source: Company data, Goldman Sachs Global Investment Research

Overall, we model a deceleration to about 19.6% supply growth in 2019E from 22.7% in 2018E. For demand, we model a deceleration to up 18% yoy in 2019E from up 20.2% yoy in 2018. This implies 0.2% oversupply for 2019E in total, which is driven by oversupply in 1H.

We do appreciate that there have been some delays in DRAM tool procurement plans already, demonstrating improved profit focus from the memory companies. This reduction, coupled with the challenges at the more advanced nodes and new demand drivers (such as AI) imply that this downturn could be relatively benign. We are reflecting this relatively gradual downturn in our DRAM models (for example we assume a 37% ASP decline peak to trough this downturn for Micron compared to the 50% peak to trough decline that was realized last downturn; note we assume a 25% yoy ASP decline in CY19).

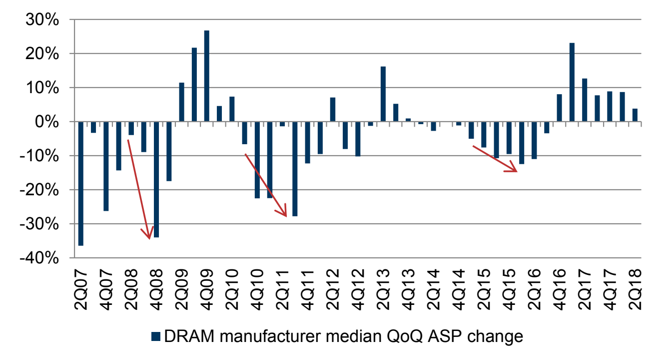
That said, we believe investors should also be cognizant that memory downturns have historically been much worse than investors and companies initially had expected. This is in part from the snowballing or compounding effect that sentiment has on the market, with customers pushing out purchases as long as possible to get lower prices which exacerbates near-term oversupply. Moreover, there is typically a delay of a few quarters from when new tool orders are cut until it leads to slower output. The net effect of these factors can be illustrated by the fact that DRAM downturns often last about 6 quarters (including last downturn in a market that had already consolidated), and the fact that the peak qoq ASP decline is usually seen 3-5 quarters after prices first begins to fall (Exhibits 5-6).

Exhibit 5: DRAM industry downturns have lasted about 6 quarters
QoQ change in industry average operating margins



Source: Company data, Goldman Sachs Global Investment Research

Exhibit 6: It can take 3-5 quarters for DRAM ASP declines to hit their max
Median QoQ ASP decline for DRAM manufacturers

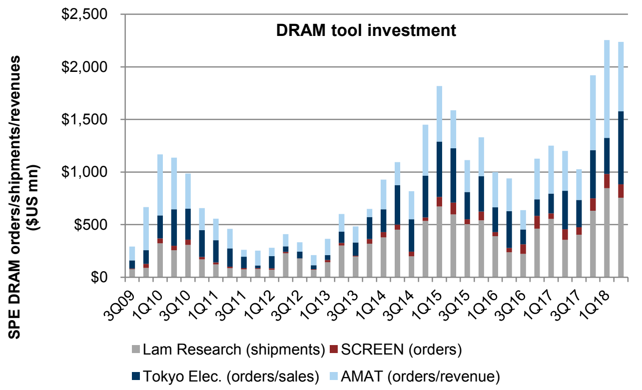


Source: Company data, Goldman Sachs Global Investment Research

Capex update - We expect capex to decline 26% yoy in 2019E

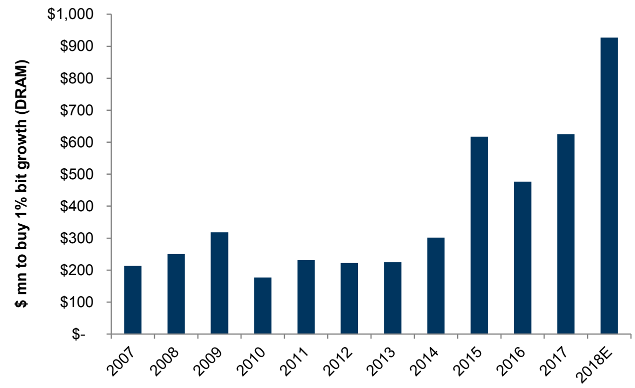
DRAM tool investment as measured by data from the semi equipment companies was up 95% YoY in 2Q18 and is up 88% YoY over the past two quarters in total (Exhibit 7). We attribute the higher levels of tool investment to the combination of higher capital intensity (Exhibit 8) and to support incremental DRAM wafer capacity coming online in 2H18 (i.e. tools required to fill clean room space for 2H18 wafer starts).

Exhibit 7: DRAM tool investment hit a record high in 1H18
DRAM tool investment



Source: Company data, Goldman Sachs Global Investment Research

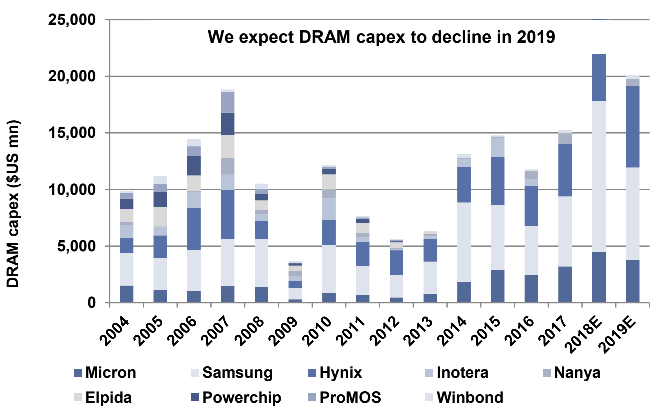
Exhibit 8: DRAM capital intensity has increased
DRAM capital intensity



Source: Company data, Goldman Sachs Global Investment Research

We expect total DRAM industry capex to increase 76% YoY in 2018E and to be down 26% YoY in 2019E (Exhibit 9). Interestingly, Tokyo Electron expects DRAM industry WFE spend to decline about 30% yoy in 2019 (albeit from a high base). We believe that this would be a positive for DRAM supply/demand if it occurs, and more material capex/order reductions is one of the things we will look for to make us more positive on the space (we also will be looking for lower inventory in the supply chain).

Exhibit 9: We expect DRAM capex to fall in 2019 from a high 2018 base
DRAM industry capex



Source: Company data, Goldman Sachs Global Investment Research, FactSet

NAND: We continue to expect oversupply in 2018 and 2019

Supply/Demand model update - We now expect more oversupply in 2018 and 2019

We are revising our 2018 and 2019 supply/demand estimates for the NAND market.

We now expect more oversupply in 2018E (3.15% from 0.62% prior) and incrementally more oversupply in 2019E (we now expect oversupply of 0.46% compared to 0.32% prior).

We believe that oversupply is being driven by faster bit growth in 2018E vs. 2017 (due to improved 3D NAND yields and post several years of record capex), as well as inventory at customers in mobile (following weak 1H18 sell through).

On 2018, our view of more oversupply is consistent with our industry discussions (which we discuss in depth in our August note (link) post Flash Memory Summit, as well as in our Micron downgrade note published today), which suggest that NAND pricing has become incrementally weaker since early summer, and we expect NAND ASPs could be down by as much as a mid to high teens percent qoq in 3Q and again in 4Q led by client SSD price pressure and inventory in mobile. Additionally, SSD exabytes in 2Q18 came in lower than we had forecast per IDC but we are still modeling SSD bit demand higher than IDC for the full year.

On the supply side, we are now modeling 44.5% NAND bit supply growth for 2018E from 43.1% prior, even though there have seen some tool order delays recently, due to increased yields.

For 2019, we now expect bit supply growth to decelerate to about 37% yoy from 40% yoy growth prior. Our assumption of decelerating industry bit supply growth is driven in part by slowing growth of industry 3D wafers on an absolute basis (66% yoy growth in 2018E on average vs. 35% in 2019E). By company, we expect Samsung bit growth of 35%, Hynix at 42%, Toshiba/WD at 36%, and Micron/Intel at 40%.

We believe that new technologies (such as QLC and 96L) will help keep bit growth at a relatively high level next year, even with somewhat lower capex (our bottom-up NAND capex model shows a roughly 10% yoy decline in 2019E).

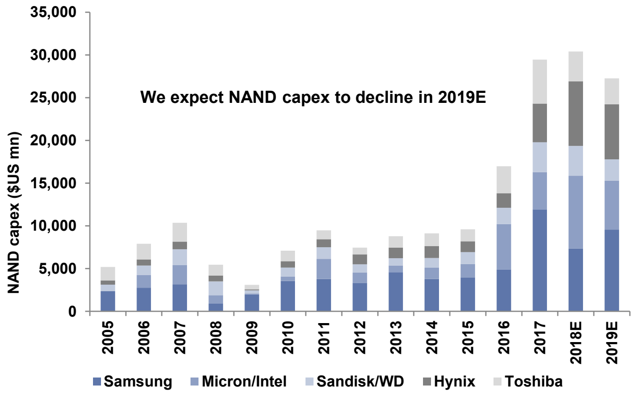
Our supply growth forecast for 2019 is consistent with forecasts from companies including Micron and Western Digital for industry bit growth to generally be in the 35-45% range.

On the demand side, we expect 38.4% YoY growth in 2018 and 40.5% growth in 2019, driven primarily by increasing SSD unit and content growth. Key assumptions behind this: 1) Enterprise SSDs – we expect about 70% YoY growth in enterprise SSD GB shipments in 2018 and 58% YoY growth in 2019 driven by the combination of strong datacenter demand in 2018 and continued market share gains vs. HDDs in 2018/2019. 2) Client SSDs – we expect the SSD attach rate to PCs (combined for desktops and notebooks) to increase from about 47% in 2018 to about 54.5% in 2019. 3) Smartphones – we assume embedded content per box growth of 25-30% yoy, and low single digit unit growth, in both 2018 and 2019.

Capex update

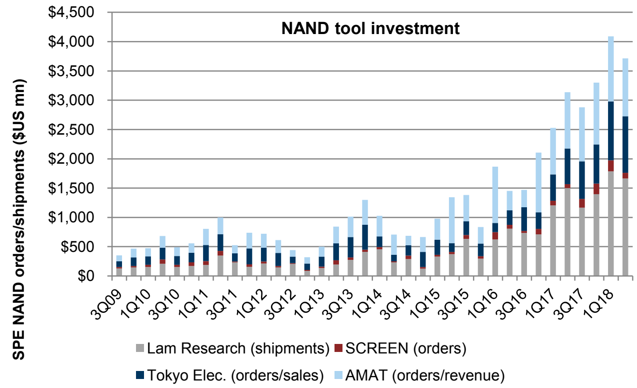
NAND tool order investment has more than doubled from historical levels and hit a new record in 2018 (Exhibit 10-11). 1H18 NAND volumes hit an all time high based on sales/shipment/order data from several of the leading semi equipment companies, and we believe this is materializing in higher NAND bit growth this year.

Exhibit 10: NAND capex hit an all time high in 2018E...
NAND industry capex



Source: Company data, Goldman Sachs Global Investment Research

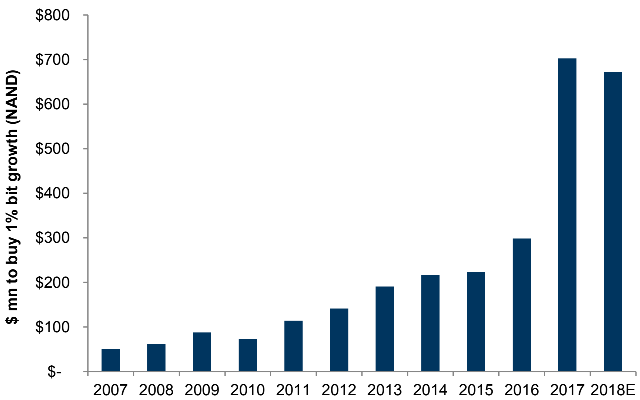
Exhibit 11: ...NAND tool orders were at a record level in 1H18
NAND tool investment



Source: Company data, Goldman Sachs Global Investment Research

Part of this increase has been due to increased capital intensity (Exhibit 12). For example, mainstream 64L 3D NAND technology takes about double the cleanroom space as leading edge 2D NAND did.

Exhibit 12: NAND capital intensity has increased
NAND industry capital intensity



Source: Company data, Goldman Sachs Global Investment Research

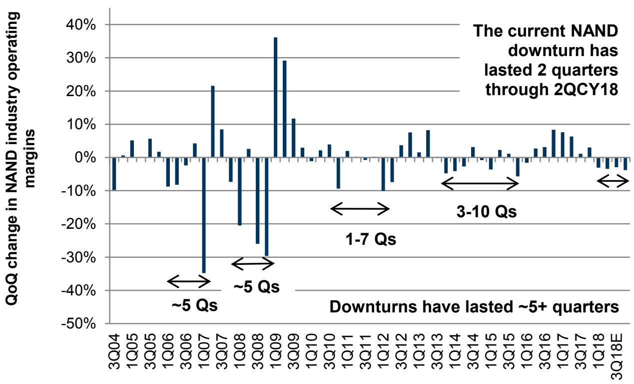
We expect NAND capex to decline in 2019E by about 10% yoy, as we expect some moderation due to oversupply. WD said it is evaluating reducing capex on its last EPS call, and we lowered our capex assumption for WD and Toshiba by about 20% vs. our prior view for 2019E. We also reduced our assumption for Micron's capex by about 15% for CY19 vs. our prior forecast, although we expect Micron's capex to remain at a higher level than history as it needs to add clean-room space, and as Micron is trying to gain market share in NAND. We believe the share gain focus that some NAND companies have, especially in SSDs, is contributing to the oversupply situation that we believe will last into 2019.

NAND downturns can last for 5 or more quarters

We believe that NAND oversupply will continue in 2019. NAND downturns in the past have typically lasted for 5 or more quarters (Exhibit 13). While NAND industry margins contracted very slightly in 1QCY18, margins began to decline more materially in 2Q18, and we expect more material declines in 2H18/1H19.

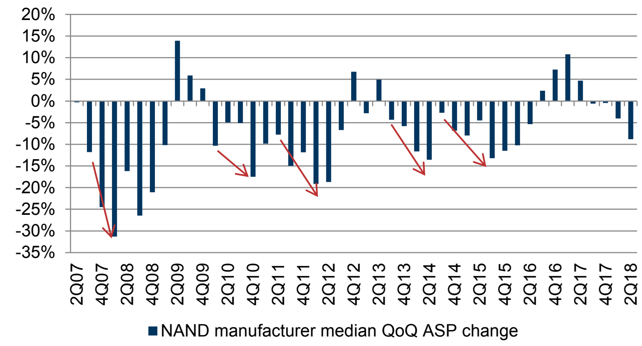
The acceleration in price declines is consistent with historical downturns as the peak absolute ASP decline for the cycle is historically realized about 3-5 quarters after the downturn starts (Exhibit 14).

Exhibit 13: NAND downturns have typically lasted 5 or more quarters
QoQ change in NAND industry average operating margins



Source: Company data, Goldman Sachs Global Investment Research

Exhibit 14: ASP declines can take 3-5 quarters to hit their max
Median QoQ change in NAND manufacturer ASP



Source: Company data, Goldman Sachs Global Investment Research

Drives: Making minor updates to our industry model for IDC 2Q actuals

We are updating our drive industry model for 2Q18 actuals from IDC, and to reflect recent company commentary and datapoints.

Overall, we now forecast a CY18 HDD TAM of 385 mn from 382 mn prior driven primarily by 2Q18 actuals being about 2 mn drives ahead of our estimate (upside vs. our forecast was mostly in the desktop and mobile compute segment). This compares to IDC's forecast at 384 mn in 2018 and TSR at 383 mn. For 3Q18/4Q18, we continue to model an HDD unit TAM of 100/95 mn. This compares to IDC at 100/94 mn, Nidec at 97/96 mn, and TSR at 97/97 mn.

We continue to expect HDD industry units to decline at a 6% CAGR from 2017-2022E and we now expect HDD industry revenue to decline at a 3% CAGR from 4% prior given higher nearline HDD mix.

We continue to forecast the capacity HDD enterprise market will grow bits at about 70% yoy in 2018E, consistent with comments from both Seagate and Western Digital on robust datacenter spending and strong nearline demand. Recall that WD noted its 1HCY18 exabyte growth was over 90% YoY and the company maintained its view of CY18 bit growth of 65%+ (note WD also maintained its long-term CAGR for bit growth in this market at about 40%). We assume a normalization in 2019 for bit growth to 25% in the capacity enterprise HDD market.

Exhibit 15: We expect HDD industry revenue to decline at a 3% CAGR
Drive industry forecast

	2015	2016	2017	2018E	2019E	2020E	2021E	2022E	2023E
Total Drive Market									
HDD Petabytes	538,349	623,464	689,490	873,388	981,866	1,125,737	1,284,510	1,492,379	1,706,070
YoY	2%	16%	11%	27%	12%	15%	14%	16%	14%
HDD Units ('000)	**469,120**	**424,360**	**404,022**	**385,404**	**357,084**	**334,707**	**309,973**	**291,488**	**275,348**
YoY	-17%	-10%	-5%	-5%	-7%	-6%	-7%	-6%	-6%
HDD Revenue ($US mn)	**27,497**	**25,108**	**24,283**	**25,585**	**24,003**	**22,849**	**21,424**	**20,735**	**19,879**
YoY	-16%	-9%	-3%	5%	-6%	-5%	-6%	-3%	-4%
HDD ASP per GB	$0.051	$0.040	$0.035	$0.029	$0.024	$0.020	$0.017	$0.014	$0.012
YoY	-18%	-21%	-13%	-17%	-17%	-17%	-18%	-17%	-16%
HDD ASP per Drive	$58.61	$59.17	$60.10	$66.39	$67.22	$68.26	$69.12	$71.14	$72.20
YoY	0%	1%	2%	10%	1%	2%	1%	3%	1%
SSD Petabytes	25,532	45,833	63,339	97,659	150,783	221,915	326,954	444,124	618,145
YoY	53%	80%	38%	54%	54%	47%	47%	36%	39%
SSD Units ('000)	**110,426**	**157,390**	**179,851**	**219,980**	**251,921**	**285,847**	**320,786**	**347,637**	**372,942**
YoY	24%	43%	14%	22%	15%	13%	12%	8%	7%
SSD Revenue ($US mn)	**13,420**	**16,881**	**25,085**	**28,635**	**32,739**	**37,145**	**43,117**	**46,669**	**51,824**
YoY	8%	26%	49%	14%	14%	13%	16%	8%	11%
SSD ASP per GB	$0.526	$0.368	$0.396	$0.293	$0.217	$0.167	$0.132	$0.105	$0.084
YoY	-29%	-30%	8%	-26%	-26%	-23%	-21%	-20%	-20%
Total Petabytes	**563,881**	**669,296**	**752,829**	**971,046**	**1,132,649**	**1,347,652**	**1,611,464**	**1,936,503**	**2,324,215**
YoY	3%	19%	12%	29%	17%	19%	20%	20%	20%
Total Revenue	**40,917**	**41,989**	**49,368**	**54,221**	**56,743**	**59,994**	**64,541**	**67,404**	**71,703**
YoY	-10%	3%	18%	10%	5%	6%	8%	4%	6%

Source: IDC, Goldman Sachs Global Investment Research

Lower our estimates and price target for WDC; lower our STX price target

WDC (Neutral)

We update our WDC estimates and price target to incorporate the changes that we make to our industry forecasts.

We lower our estimate of CY18/19/20E EPS with SBC to $11.71/$6.85/$9.70 including SBC from $12.06/$8.10/$10.55 on lower revenue and margins. The biggest driver of this is taking our view of 2HCY18 NAND ASPs to be down in the mid teens range qoq, compared to the low double digits prior. Excluding SBC (to compare to FactSet consensus), we model EPS of $9.06/$9.23/$12.00 in FY19/20/21E.

We lower our 12-month price target to $63 (from $80) based on 7X (from 8X given lower peer multiples) applied to our normalized EPS estimate of $9.00 (including SBC; from $9.95 prior on our lower forward EPS estimates).

Key risks relate to NAND supply/demand, HDD demand, margins (which are tied to HDD mix and NAND S/D), and leverage.

STX (Sell)

We lower our 12-month price target to $39 (from $44) using 7X (from 8X on lower peer multiples) normalized EPS of $5.40 (unchanged), and a $1 component for Seagate's share of Ripple XRP holding (unchanged). We lower our target multiple to 7X which is in line with our target multiples for WDC and MU.

Key risks to our Sell thesis relate to better than expected HDD fundamentals (potentially from tighter NAND supply/demand than we expect, or from better overall HDD pricing or volume from faster data creation), better than expected trends in gross margins, a longer nearline demand growth cycle relative to history, M&A, the dividend, and XRP price volatility.

Rating and pricing information: Western Digital Corp. (N/N, $54.98); Seagate Technology (S/N, $48.98)

Disclosure Appendix

Reg AC

We, Mark Delaney, CFA, Timothy Sweetnam and Bruno Dossena, hereby certify that all of the views expressed in this report accurately reflect our personal views about the subject company or companies and its or their securities. We also certify that no part of our compensation was, is or will be, directly or indirectly, related to the specific recommendations or views expressed in this report.

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	Buy	Hold	Sell	Buy	Hold	Sell
Global	35%	53%	12%	63%	56%	51%

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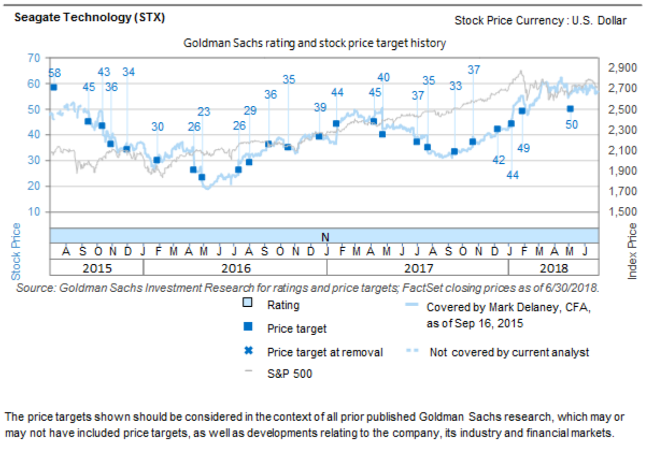
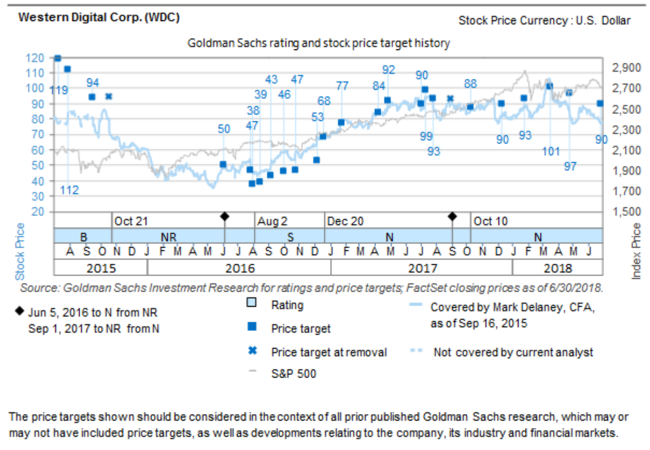
Price target and rating history chart(s)





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