SEMICON Taiwan: DRAM Industry Outlook

Rational Competition, not a Cartel

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Part 1: Structural vs. Cyclical up-cycle
The cyclical nature hasn’t changed

- Investors were excited that consolidation in the DRAM industry had finally come to an end.
- However, it is not a “cartel” oligopoly, competition remains.
- The industry will continue to be cyclical because:
  1. players decide their production plan individually (not collectively);
  2. long lead-time is required to expand capacity, while demand becomes less transparent.

Oversupply can still occur in the memory sector

Source: WSTS, Morgan Stanley Research, e= Morgan Stanley Research estimates
So what has changed? Moving to a more rational level of competition

- In the past,
  - Sovereigns backed-up DRAM companies in Japan, Korea, and Taiwan.
  - Weaker players existed, thus industry leader, Samsung, could lower prices to crowd out competitors.
  - Theoretically, players make less profit in an oligopoly with more players
- Today, there are no sovereigns, no weak players, and fewer competitors → more rational competition
Production decisions are based on shareholders’ benefit

- DRAM makers’ margins have returned to their historical high, adding output could maximize profits
- Margins may roll over, but overall profits (EPS) may improve

Source: DRAMeXchange, Morgan Stanley Research, e = Morgan Stanley Research estimates
How much can DRAM’s structural margin improve?

- NAND reached rational competition in 2006. Through the cycle operating margin was ~15%
- DRAM structural operating margin could be slightly higher given fewer players than NAND
- Conclusion: DRAM remains cyclical, but structurally better due to more rational competition

Source: DRAMeXchange, Morgan Stanley Research
Part 2: Memory Capex Trend
Summary of recent capex trends

- Capex efficiency is at an all-time high
- Memory capex is accelerating
- DRAM orders are slightly higher than NAND
- Very etch-centric for NAND spending this time

KLA memory orders back to highs since 2010

DRAM industry capex by company

Source: WSTS, DRAMeXchange, Morgan Stanley Research, e= Morgan Stanley Research estimates
Why are we concerned about supply increases?

- According to investors, we are hitting the technology limit of memory...again.
- Every US$1 of capex can generate 1.3 gigabits equivalent of DRAM shipments, doubling shipments 3 years ago, based on our estimates.
- There is still room for technology migration

Source: DRAMeXchange, Morgan Stanley Research, e= Morgan Stanley Research and DRAMeXchange estimates
Orders are accelerating

- The NAND transition in planar (1x 1ynm) and 3D NAND are very Etch-centric
- DRAM spending is slightly higher than NAND

LAM memory shipments surging... ....Similar trend in AMAT

Source: WSTS, Morgan Stanley Research
Part 3: Supply, Demand, and Price Forecasts
Our forecast for supply increase

- We believe supply is more important than demand
- We forecast DRAM bit shipments to grow 33% in 2014:
  - Samsung converting Logic to DRAM
  - Taiwan DRAM is resuming production
  - Faster-than-expected technology migration

### MS forecast vs. 3rd party forecasts

<table>
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<th>Supply Bit Growth YoY (1Gb Eq., mn)</th>
<th>2013e</th>
<th>2014e</th>
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<td><strong>DRAM</strong></td>
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<tr>
<td>Morgan Stanley estimates</td>
<td>27%</td>
<td>33%</td>
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<tr>
<td>DRAMeXchange estimates</td>
<td>26%</td>
<td>17%</td>
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<td><strong>NAND Flash</strong></td>
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<td>Morgan Stanley estimates</td>
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<tr>
<td>DRAMeXchange estimates</td>
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<td>36%</td>
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Source: DRAMeXchange, Morgan Stanley Research, e= Morgan Stanley Research and DRAMeXchange estimates
Our big picture view of demand

- Mobile (smartphone+tablet) units are 4x PCs now, and still growing
- Content per box in mobile has upside

Source: DRAMeXchange, Morgan Stanley Research, e= Morgan Stanley Research and DRAMeXchange estimates
Our forecast for demand growth

- We forecast DRAM demand to grow 28% in 2014
- Mobile is key demand driver. CAGR to sustain above 25% through 2015

MS forecast vs. 3rd party forecast

<table>
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<th>Demand Bit Growth YoY (1Gb Eq., mn)</th>
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<th>2014e</th>
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Demand by end market

Source: DRAMeXchange, Morgan Stanley Research, e= Morgan Stanley Research and DRAMeXchange estimates
Our forecast on prices

- DRAM price to decline 22% in 2014 to US$0.72 per gb.

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<tr>
<th>Industry Blended ASP (1Gb Eq., mn)</th>
<th>2013e</th>
<th>2014e</th>
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<td>Morgan Stanley estimates</td>
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<td>DRAMeXchange estimates</td>
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<td>Y/Y Growth</td>
<td>-17%</td>
<td>-17%</td>
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Source: DRAMeXchange, Morgan Stanley Research, e= Morgan Stanley Research and DRAMeXchange estimates
Part 4: Future of Taiwan DRAM
Taiwan DRAM Before and After Consolidation

Source: Company Data, Morgan Stanley Research
Opportunities and Challenges for Taiwan DRAM industry

- Wafer foundry: viable business model to be Micron’s foundry
- Brand players: still not competitive in technology and channel. Cycle determines profitability
- Backend: benefit from unit growth
- Module player and Flash controller IC vendors: headwinds of embedded storage (eMMC/SSD)

Taiwan DRAM Industry Business Model

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<tr>
<th>IDM</th>
<th>Backend</th>
<th>Controller</th>
<th>Module</th>
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