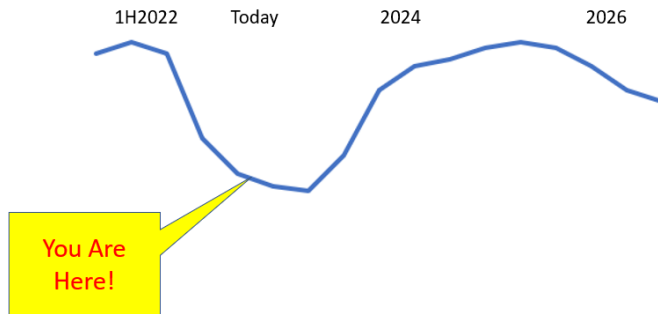


Memory Market Cycles



We have an Excel model predicts pricing and bit shipment effects and recovery. In our base case Excel model of memory cycles, we have simple assumptions and change from there based on actuals

BASE CASE

- 1) Suppliers keep 4 weeks inventory. Customers keep 4 weeks inventory.
- 3) When there is a perceive shortage or above average bit growth, customers increase inventory or double order to get to 8 weeks inventory
 - a. They don't tell suppliers, but the suppliers should know its happening
 - b. Price is going up, so it make sense to buy ahead
 - c. This accelerates the upturn and shortage
- 4) Then the perceived shortage (real or fake doesn't matter) goes away
 - a. Even if it goes back to normal, the customer needs to cut 4 weeks of inventory.
 - b. Which creates more of a surplus, price drops

- c. Since price is going down and there is a surplus, a customer should cut inventory to 2 week (working inventory/JIT). Not doing this is financially wrong
 - d. This leads to an excess inventory of 6 weeks.
 - e. In some cases the supplier was building up inventory due to orders and cancellation of double orders. So there is 8+ weeks too much total inventory.
- 5) Requirements from suppliers for next 6 months is now 30% less than it was during boom until it corrects.
- a. Prices are adjusted to incentivize people to buy bits they might not want. Price drops
- 6) The graph of revenue and margins for last 15 years shows this very clearly

NOTE: in the above scenario, the economy is fine, Wars don't matter, COVID doesn't matter, it is simple perceived DEMAND and INVENTORY that caused the bullwhip effect. This is why memory is always cyclical.

TODAYS CRASH

This time was different: Due to supply concerns, and Taiwan concerns and hype about memory growth, Some MAJOR customers went from 4 weeks to 12 weeks inventory, instead of 8 weeks. When the shortage was relieved or didn't materialize the result was shared with suppliers. That is why Micron and others very quickly cut production, which is a inefficient thing to do. They realized that this was far worse than typical and would take 1 year plus to solve if they kept bit growth moving. This is why it is taking longer to work off the inventory (should be 6months), why the price crash is so severe. Every memory company is losing money. It was caused simply by customer inventory.

When the smoke clears, I predict we will find that bit growth from 2021-2023 was DRAM 15%, NAND 25% just like everyone predicted beginning of 2021. No breakthrough apps, no black swan events, no impact of wars or invasions. Same as it ever was. The supply chain perceptions created a nightmare shortage and nightmare oversupply.

The issue is the next part of the story: how do we react??:

- 1) Suppliers should go back to growing at long term rates. 15% DRAM, 25% NAND
- 2) Suppliers should not add capacity or believe any demand increase, they are getting played by customers. AI will not change this. A slight permanent undersupply. Monitor end customers shipments
- 3) When the oversupply ends, we often see 6-12 months of balance, then a future shortage. This time will be different, We will see <1qtr of normal this time. AND we need price to increase 20-30% just to make reasonable margins to cover development. Flattening of price will require 2 years to get back to profit.
- 4) CAVEAT: this requires oligopoly where one company is not trying to gain market share

SUMMARY

- + Oversupply is unprecedented in the last 10 years but will be corrected in ~Q3.
- + Due to severe losses, and minimal inventory when oversupply is corrected, A shortage will appear quickly. Prices must go up to survive, supply growth needs to be constrained
- + Question 1: will the prices peak at 5% OM or 30% OM or something in between?
- + Question 2: will memory suppliers keep getting trapped into oversupplying or just grow at long term rates?

We can monitor this for clients

Homework quiz: Which current memory end market is responsible for **90%** of the Memory hype and <2% of the memory bit shipments. It is projected to be maybe <5% of bits by 2028. Hint: Ask ChatGPT whether DRAM Bit growth rate will suddenly increase in the next 5 years.

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