

Micron Technologies (Nasdaq: MU)

The Babson College Fund is initiating coverage on Micron Technologies (Nasdaq: MU) with a BUY rating with a price target of \$116, which represents a 24% upside from the current price of \$94. Micron is the industry leader in innovative memory and storage solutions offering high performance DRAM, NAND, and NOR products.

Investment Summary:

Thesis 1: The recovery of dynamic random access memory (DRAM) and Not-and (NAND) memory chip demand and pricing will drive both top and bottom-line growth for MU

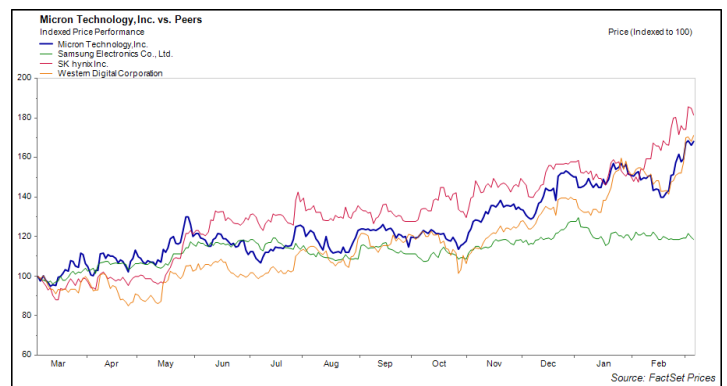
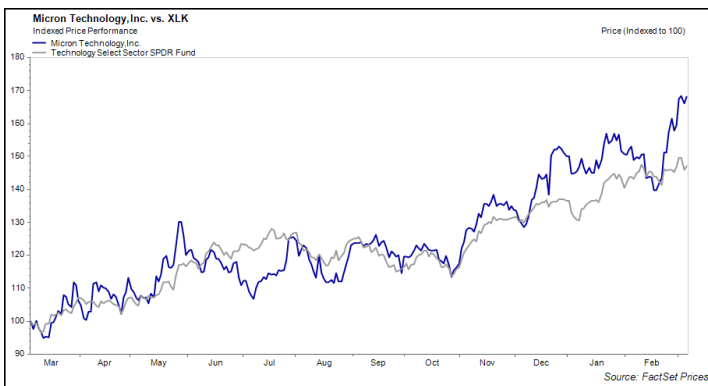
Thesis 2: Micron is well positioned to gain market share due to the release of the industry's first High Bandwidth Memory (HBM) 3E

Stock Rating | BUY

Price Target	\$116.1
Recommended Weight	5%
Current Price	\$93.8
Upside	23.8%
Consensus	\$108.7
Ratings	Buy: 28 Hold: 8 Sell: 3

Key Statistics

52 Week Range	\$53-99
Avg Daily Volume (3 Month)	15,071,967
Market Value (B)	\$105.5
Enterprise Value (B)	\$110.2
Shares Outstanding	1,146
Dividend Yield	0.5%
Float	99.3%
Short Interest	1.63



Company Overview:

Micron Technology is the 5th largest semiconductor company in the world, generating over \$15B in revenue in FY23. They design, develop, and manufacture industry-leading memory and storage products globally. Micron's advanced product portfolio includes DRAM, NAND, NOR, solid-state drives, graphics and high bandwidth memory, and managed NAND and multichip packages. The products are critical to the advancements in emerging technologies such as AI, ML and 5G across data centers and consumer devices and data and information needs to be processed and stored efficiently. Micron's main customers include other semiconductor companies who produce GPUs or CPUs, electronic manufactures, data center and server providers, AI tool developers and automotive companies. Some of their largest customers include Apple, Dell, Lenovo, Intel, AMD, Nvidia, Qualcomm, Microsoft, IBM, and Cisco.

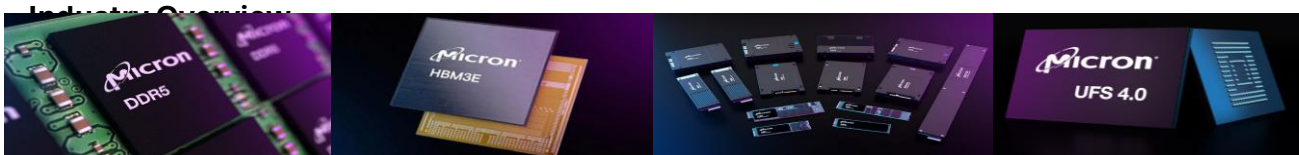
Business Units:

Compute and Networking Business Unit (CNBU): CNBU includes memory products and solutions sold into client, cloud server, enterprise, graphics and networking markets. In FY 2023, CNBU accounted for 37% of total revenue, producing \$5.7 billion in revenue. Sales in this business unit mainly consist of DRAM products including DDR4, DDR5, LPDDR5, and LPDDR4. The main drivers behind this segment include the shift of infrastructure and workloads from on-premises to the cloud, commercial and consumer PC growth, 5G infrastructure deployments and increasing data transfer requirements.

Mobile Business Unit (MBU): MBU includes memory and storage products sold into the mobile market including discrete NAND, DRAM, and managed NAND products. In FY 2023, MBU accounted for 23% of total revenue, generating \$3.6 billion in sales. The growth of 5G deployments is driving growth in this segment as 5G devices require higher DRAM and NAND content per device.

Embedded Business Unit (EBU): EBU includes memory and storage products and solutions sold into automotive, industrial, and consumer markets and includes discrete and module DRAM, discrete NAND, managed NAND, SSDs and NOR. In FY 2023, EBU accounted for 23% of total revenue, generating \$3.6 billion in sales. Strong trends of digitalization, connectivity, and intelligence in every device are driving increasing demand in embedded markets for memory and storage products.

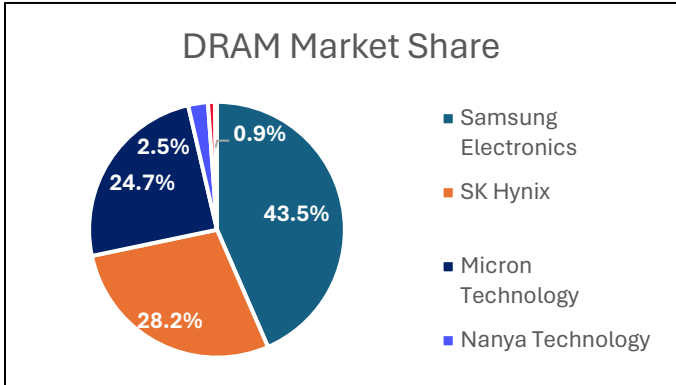
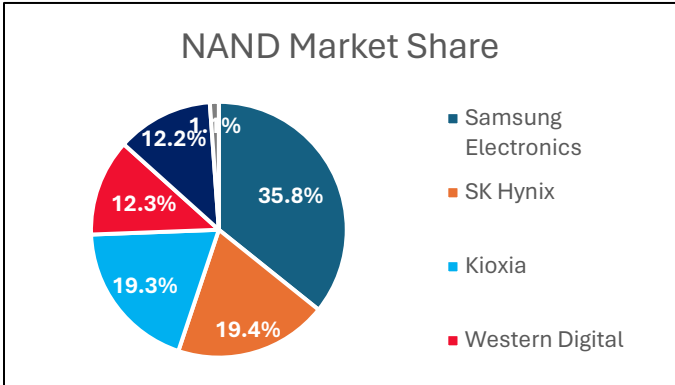
Storage Business Unit (SBU): SBU includes SSDs and component-level solutions sold into enterprise and cloud, client, and consumer storage markets. In FY 2023, SBU generating 16% of total revenue, generating \$2.6 billion in sales.



The global memory chip market was valued at \$149B in 2023 and is expected to grow at a CAGR of 8% from 2024 to 2030. Memory chips are used for storing data or information in personal computers (PCs), smartphones, data centers, servers and other electronics. Memory chips can hold memory either temporarily through random access memory (RAM), or permanently through read only memory (ROM). Read only memory contains permanently stored data that a processor can read but cannot modify. Memory chips comes in different sizes and shapes. Some can be connected directly while some need special drives. Memory chips are essential components in computer and electronic devices in which memory storage plays a key role. The subsector generates a significant amount of revenue within the semiconductor sector, accounting for around 35% of sales. While it is a cyclical sector highly influenced by supply and demand dynamics that expand and contract chip prices, the memory market is experiencing strong growth driven by increasing demand for memory-intensive applications. The continued technological advancements in artificial intelligence (AI), machine learning (ML), 5G, and the implementation of data centers is increasing the need and demand for more advanced memory chips that transfer data at faster rates.

The memory market is highly competitive due to the changing prices of the chips and the strong demand for the highest-performing products. Therefore, companies in the memory sector are constantly investing in developing chips that reduce power needed and increase data transfer speeds. The major players in the market include Micron, SK Hynix, Samsung, Western Digital and Kioxia. The graphs below show the overall market share based on the type of chip, DRAM and NAND.

The different types of memory chips address the various needs of the devices they are implemented into. Two types of memory chips include volatile and nonvolatile memory. Volatile memory, also known as temporary memory, is a type of memory that needs power to retain its stored data and information. Once the power is shut off the data is no longer stored. The most common type of volatile memory is dynamic random-access memory (DRAM). DRAM’s popularity among manufacturers is due to its ability to efficiently store



data as a smaller chip as compared to other volatile chips. It is used as storage in personal computers because it has faster performance as compared to nonvolatile memory.

Nonvolatile memory can retrieve stored information even after being turned off, making it better suited for devices that need long-term data storage. Types of nonvolatile chips include NAND and NOR. NAND is used for random access capabilities, meaning it can access data in any order and does not need to follow a sequence of storage locations. It is typically used in long-term storage devices like USBs and memory cards. In contrast, NOR accesses individual memory cells and is typically used for code storage.

Investment Summary

Thesis 1: The recovery of DRAM and NAND demand and pricing will drive both top and bottom-line growth for MU

Historical Trends:

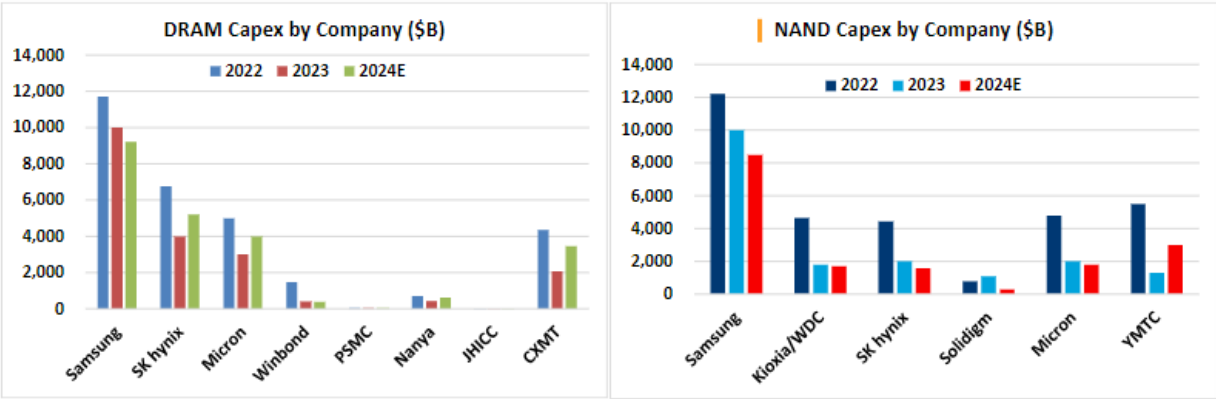
During 2020, the market for NAND flash memory and DRAM experienced a sharp increase in demand. The pandemic accelerated digital transformation initiatives across industries, driving demand for data center infrastructure and cloud computing. In addition, it triggered a shift in consumer behavior, with increased demand for laptops, tablets, and other home electronics as remote work and online learning became more prevalent. However, manufacturers and suppliers faced many production delays as they had to adhere to lockdowns, social distancing measures, and workforce shortages, disrupting the NAND and DRAM supply chains. During this period, demand for DRAM and NAND outpaced the amount manufacturers were able to produce, driving up the prices for the chips.

However, demand quickly fell off in the last two quarters of 2022 over inflation and recession concerns, and an overall unfavorable macroeconomy that reduced consumer spending. As a result, original equipment manufacturers (OEMs) reduced building excess electronic component inventory and cancelled orders for chips. This left component manufacturers, like Micron, with an excess supply of chips and a lack of demand. As a result, prices for DRAM and NAND dropped significantly for eight consecutive quarters over 2022 and 2023.

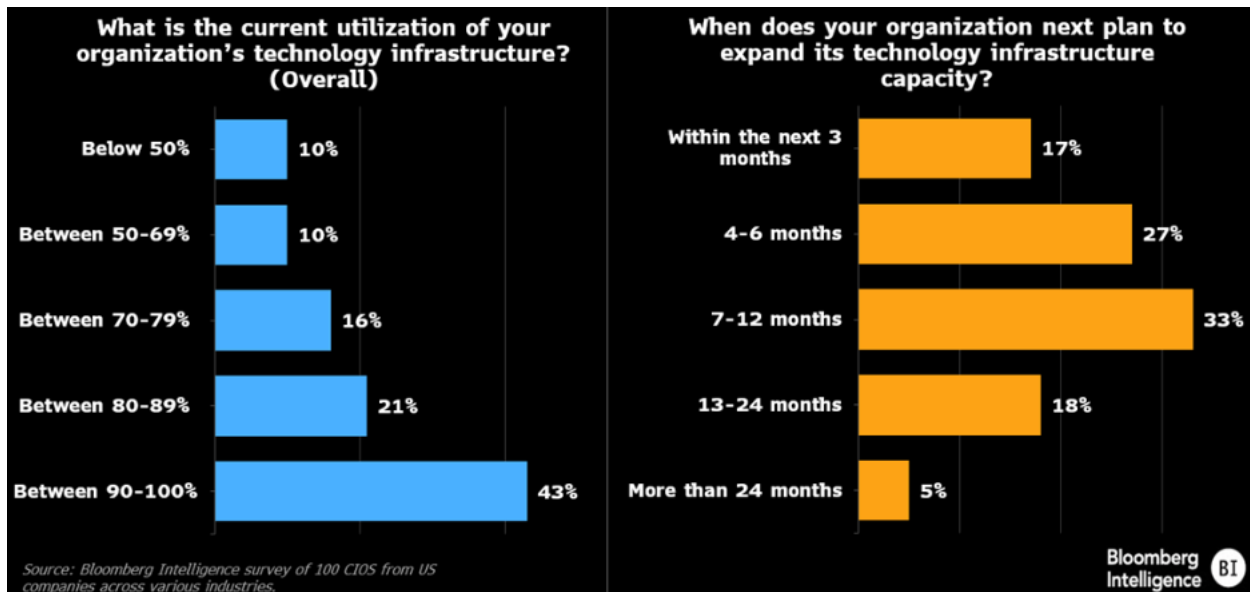
Current Trends / Outlook:

The DRAM and NAND markets are believed to have bottomed in 2023 showing signs of recovery in the first quarter of 2024, with contract prices increasing 13-18% Q/Q for DRAM and 18-23% for NAND. In the near term, the increase in prices is driven by the continued higher demand for AI processors and more stabilized supply of DRAM and NAND. The major competitors in the market are only expected to increase their capex modestly in

2024 to prevent the supply of chips outpacing the demand and keep prices from dropping again soon. The additional capex is expected to be invested in developing higher capacity DRAM products, specifically high bandwidth memory (HBM) chips, to address the growing demand for AI accelerators and processors. By keeping Capex relatively stable, Micron is able to balance the supply and demand trends within the memory market to avoid overproduction of these chips. In turn, inventory day-on-hand decreases driving higher pricing power for Micron and other memory chip suppliers. According to the Former Chief Strategy Officer at Micron, “normal inventory level would be about 100 days. When [he] sees the 200-day level start to meaningfully decrease that would be a strong signal” for reduced inventory risks and growing demand. Last quarter, Micron reported days inventory outstanding of 159, down from FY23 of 180. Management believes that days inventory outstanding is going to continue to decrease days inventory outstanding throughout the year to reach 120 days by the end of 2024. This is a strong signal of growing demand for memory chips.



High demand is being driven by the development of AI tools and implementation of data centers, which has been a main focus for many companies over the past year. According to a Bloomberg Intelligence survey of CIOs, over 60% of corporations in the United States have an IT infrastructure utilization rate exceeding 80%, of which 43% operate at 90% or more. This implies nearly half of companies in the US are running at almost full capacity and need to update their infrastructure. Among the CIOs surveyed, 44% say they plan to expand IT infrastructure capacity within the next six months and 77% aim to do so within one year. The rebound in enterprise IT investment could boost demand across the semiconductor industry for CPUs and GPUs. DRAM and NAND are key components to the performance and capabilities of GPUs and CPUs as they need to process increasingly large amounts of data. The demand for technology with high processing speed continues to grow and in turn driving the demand for high-bandwidth memory (HBM), a type of DRAM chip, that has very high data-transmission speeds.



This trend is starting to be reflected from Micron's customers as management has noted that demand for AI has been strong as data center infrastructure operators are shifting from traditional servers to servers that can support more advanced AI. As a response, several of their customers have announced aggressive roadmaps for new GPUs and AI accelerator ASIC product introductions with increasing requirements for HBM capacity, performance and power. This is expected to drive high growth in Micron's DRAM segment as they have a strong portfolio of products in the segment including DDR5, several types of high-capacity server memory modules, low power DRAM (LPDRAM), data center SSDs, and HBM3E, which will be further discussion in Thesis 2.

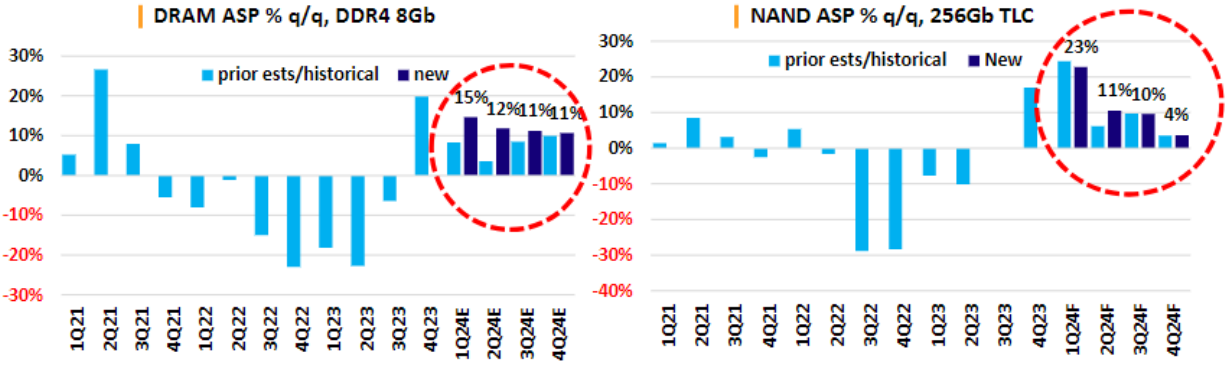
In addition, according to the survey, 73% of CIOs plan to increase spending on server storage devices in 2024, with 46% planning a 20% boost or more. This will help drive growth for solid state drives (SSDs) and NAND chips, which are both an essential part of server storage devices.

End market customers in data centers and AI continue to highlight high growth and high demand for their products. For example, Microsoft, who is a customer of AMD and Nvidia, reported in their last earnings that Azure¹ continue to drive strong revenue growth for the company delivering 30% year over year growth.

DRAM and NAND suppliers faced significant issues regarding profitability and are expected to raise prices. It is anticipated that prices will need to increase by over 40% once again for major manufacturers to break even. To achieve profitability, future price hikes are expected to be at least 50% or even higher according to Economic Daily. Therefore, the

¹ Cloud computing platform that offers cloud data centers with AI tools embedded into the platform

ASP for DRAM and NAND are expected to increase by over 10% throughout 2024. This is expected to drive higher revenue and improve gross margins, helping Micron to reach profitability in 1H of 2024. Micron has already seen improvements in gross profit and net income over the past four quarters, nearing profitability.



Source: Bloomberg, Trendforce, DRAMeXchange, Mizuho Securities USA research.

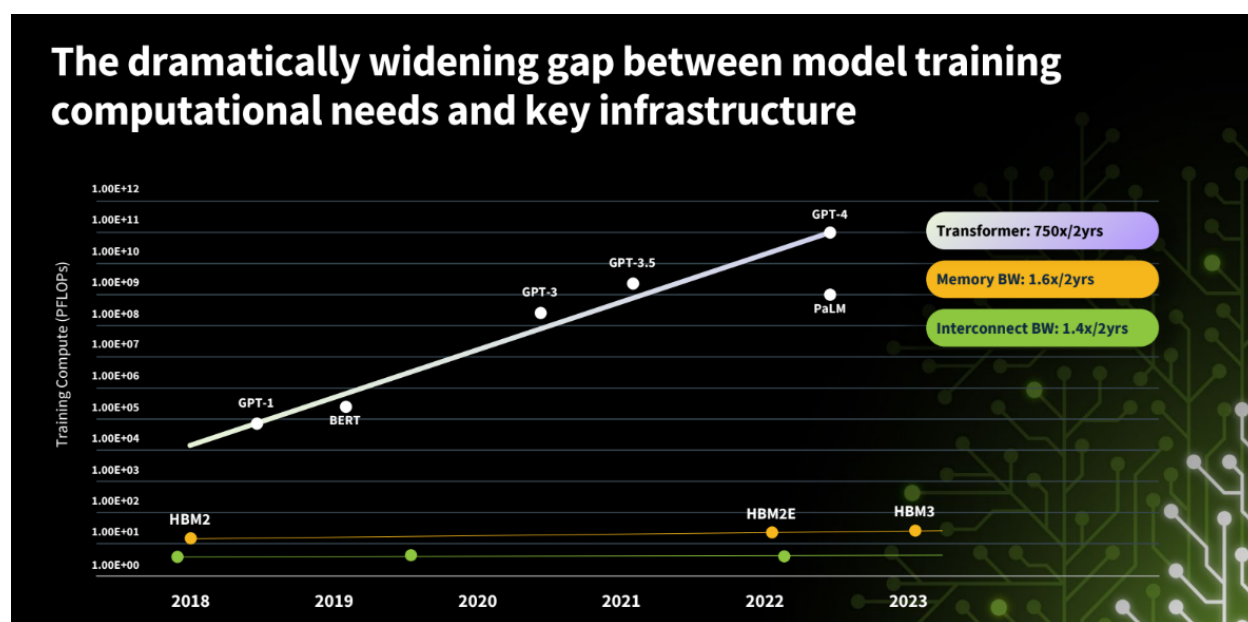
Reflection in Model:

The combination of improving DRAM and NAND pricings and the continued high demand to develop advanced AI tools is expected to drive strong growth for Micron throughout 2024 and 2025. This is reflected in the model with 50% revenue growth in DRAM and a 40% revenue growth for NAND for the next two years. For the remaining projection period, the growth rates are the historical averages experiences throughout Micron’s cyclical periods. The recovery in prices will also drastically improve Micron’s gross margin and overall profitability. This is reflected in the model with COGS reducing from over 100% to 80% in 2024 and the falling to 65%, Micron’s historical COGS, by the end of the projection period. In addition, Micron is successful in reducing inventories with Q1 inventory falling to \$8.3B or 159 days, down from 170 days in the prior quarter. Management is expected to reduce days of inventory throughout 2024 to improve costs and reduce risks with a target of reaching 120 days of inventory by fiscal 2024 end.

Thesis 2: MU is well positioned to gain market share due to the release of the industry’s first High Bandwidth Memory 3E (HBM3E) memory chip

The production of AI and machine learning (ML) models continues to be the focus of tech companies. Training these models with new information is a very memory and storage

intensive process. As model parameters continue to grow at around 10x a year, AI performance is limited by the ability to store and retrieve training and inference data from memory. The disconnect in the improvement of performance between CPUs and memory products continues to widen, as the computing power of processors has historically grown at an exponential rate, while the performance of memory chips has improved in a more linear way. According to Microsoft's presentation at the Open Compute Project Summit, the computational demand of transformer models has grown around 750x over the past two years, while memory bandwidth has only grown 1.6x over the same time period. The growing processor-memory performance gap increases the need for new, higher performing memory solutions.



To combat the growing gap between performance of processing chips (CPUs and GPUs) and memory chips (DRAM, HBM, NAND) chip manufacturers need to increase the memory capacity by using more high-performing memory chips in their processing chips. According to the former Chief Strategy Officer at Micron, “it’s actually very early in the terms of artificial intelligence being a significant driver for semiconductor demand. But the AI workloads in the data center environment are probably resulting in a five to ten times increase in terms of memory workload per system relative to non-AI applications. So that is a direct driver of more DRAM content per system than would otherwise be the case, pre-AI.” The growth of data centers and AI are a significant driver of growth for DRAM as the computational capabilities of the technologies are growing exponential and more memory bandwidth is needed to process the data and information. Therefore, more memory chips are needed per CPUs and GPUs used in the production of these data centers and AI.

Micron is well positioned to address the challenges of its customers by releasing the industry's first HBM3E chip that is aimed to help advance AI innovation with a memory solution that can keep pace with expanding workloads. Micron's HBM3E helps reduce data center operating costs by consuming about 30% less power than competing offerings. In addition, its superior performance delivers more than 1.2 terabytes per second of memory bandwidth enabling fast data access for AI accelerators, supercomputers, and data centers.

Micron holds a competitive advantage over its competitors, Samsung and SK Hynix, by being first to market with a better performing memory chip. The data rate (speed at which data is transferred from one device to another or between a peripheral device and the computer) and the bandwidth of the HBM3E are both 1.5x higher than the next best performing HBM, the HBM3, currently on the market. In addition, it also increases the maximum capacity from 32GB to 36GB. These characteristics allowed Micron to become a supplier to Nvidia's new H200 GPU chips, making Nvidia break its exclusivity with SK Hynix who as the previous sole supplier of Nvidia's H100 GPU chips. Nvidia is expecting to bring this new chip to market and beginning shipments in the next quarter. Collette Kress, Nvidia's CFO, expects strong demand for the H200 chip as it nearly doubles the inference performance of their previous H100 chip. The H200 will help drive growth for Micron as each chip requires 6 HBM3E chips.

Even though Samsung and SK Hynix are planning to release their own HBM3E products over the next few quarters, Micron will still hold a competitive advantage due to the superior quality of their product. The expected data rate of SK Hynix's HBM3E is around 8 GB/second, (15% slower than Micron's data rate of at least 9.2), and the bandwidth per device is expected to be 1150 GB / second as compared to Micron's at least 1200 GB / second. While Samsung's HBM3E performance is expected to be fairly in line with Micron's, the earlier release of Micron's product positions the company well to capture market share from the current market leader, SK Hynix.

Nvidia is not the only chip manufacturer expecting to bring a new, higher-power AI chip that requires more processing power and an advanced HBM chip to market this year. AMD and Intel both plan to launch their next gen GPUs by the end of the year. Micron is well positioned to capture part of the production demand for both companies with HBM3E. Micron already has strong relationships and partnerships with Intel and AMD in regards to the production and supply of their DDR5 chips. By leveraging the partnerships they already have, Micron is well positioned to be a supplier for the new chips Intel and AMD plan to release this year. Management is very optimistic about HBM3E making Micron more competitive in the industry, expecting it to contribute several hundreds of millions in

revenue in 2024 and continued high growth into 2025. In addition, they are expecting Micron to gain HBM market share, which is currently around 5%, to match overall DRAM bit market share of 25%, in 2025.

The production of HBM3E will not only drive top-line growth for Micron, but due to its higher ASP / content, it will also help improve Micron's bottom line. Micron's prior HBM2 had an ASP / content of around \$0.80 / GB, while the HBM3E has an ASP / content of around \$1.85 / GB. The increase in ASP from the HBM2 to the HBM3E is almost 120% which will help improve margins

Reflection in Model:

The projections for fiscal year 2024 are in line with management guidance for Q2 2024. For revenue, management expects \$5.3B which is reflected in the model with a total FY24 revenue of \$23B or roughly \$5.3B per quarter. Gross margin and operating expenses for FY24 are projected similarly to revenue. For gross margin, management projects 12% +/- 1.5%, this was reflected in the model as the high end of the guidance, 13.5%, since Micron has beat top and bottom line expectations over the past two quarters and are well positioned to do so again due to increased prices and demand. Finally for operating expenses, guidance is \$1.07B +/- \$15M. this is reflected in the model using a slightly more conservative approach by taking the high end of guidance for expenses and projecting them to equal around \$1.2B per quarter or \$4.7B annual for FY24.

The remainder of the projection period for expenses estimates them slowly returning to historical averages over the next five years. This is due to the expected recovery from 2023 driven by the new HBM3E chip that is essential to new products released this year and has a higher ASP compared to Micron's previous products.

As for revenue, coupled with the higher demand and prices explained in thesis 1, HBM3E enables Micron to gain market share within the HBM market. Management is expected Micron to gain 20% in market share within HBM, going from 5% to 25% by 2025. This is reflected in the model by high growth for the next two years then growth returning to the historical average over the past five years in DRAM.

Catalysts and Risks

Catalysts

- Upcoming earnings: March 20th after market
 - o Q2 earnings will drive the stock price as new Nvidia partnership and increasing memory chip prices will help Micron beat expectations
- Release of new products from Intel and AMD in 1H 2024
 - o Intel and AMD are both planning to start manufacturing new products in the first half of 2024. Micron is well positioned to gain new customer contracts for DRAM as they have already proven the high caliber of their chips by becoming a new supplier for Nvidia's new chip. This will help drive revenue growth for Micron throughout the 2024 and 2025.
- International expansion
 - o Improving relationships with China after the previous ban of some Micron chips was lifted will help drive growth international growth

Risks

- Volatility in NAND and DRAM prices
 - o The volatility in memory chip prices always poses a risk to Micron's bottom line and their ability to return profits. A sudden drop in prices can significantly reduce the ASP of their products and decrease net income
- High competition in the industry
 - o Micron's ability to continue to produce high quality chips that can transfer data at high speeds is critical to them retaining market share
- If there is a sudden reduction in demand for products
 - o Lower than expected demand is also a risk to Micron and the memory chip industry if supply outpaces demand

Valuation Summary

The valuation of Micron is based on a 50/50 split between DCF and CompCo, with a price target of \$116 representing a 24% upside. For the DCF, the price target of \$116 is based on a 5-year PGR valuation. This is derived by using a 2.5% PGR given the high growth of the

semiconductor industry due to increasing demand for high-speed devices and advanced AI tools as well as Micron’s leading market position. It also considers a 9.1% WACC that was hand-calculated.

The CompCo price target is based on an EV/EBITDA multiple. The multiples were chosen due to the fact Micron and other peers are currently unprofitable due to the recent downturn in memory chip prices. The comparable companies were chosen since they also produce a large portion of the memory chips globally. An EV/EBITDA multiple of 18x was selected using the 45% percentile from benchmarking against their peers. This resulting in a price target of \$116 representing a 24% upside.



Appendix

Management Team



Sanjay Mehrotra
CEO
Compensation: \$33M

Mehrotra joined in May 2017 as our President, CEO, and Director. Mehrotra cofounded and led SanDisk Corporation as a start-up in 1988 until its eventual sale in May 2016, serving as its President and CEO from January 2011 to May 2016, and as a member of its Board of Directors from July 2010 to May 2016. Mehrotra served as a member of the Board of Directors for Cavium, Inc. from July 2009 until July 2018 and for Western Digital Corp. from May 2016 to February 2017 and has served since March 2021 as a member of the Board of Directors of CDW Corporation.



Mark Murphy
CFO
Compensation: \$8M

Murphy joined in April 2022 as Executive Vice President and CFO. From June 2016 to April 2022, Murphy served as the CFO of Qorvo, Inc. Prior to Qorvo, Murphy served as Executive Vice President and CFO of Delphi Automotive PLC, and prior to Delphi, held executive roles at Praxair, Inc. and MEMC Electronic Materials, Inc. Murphy currently serves on the Board of Directors of Albany International Corp. Murphy is a veteran of the U.S. Marine Corps and holds an MBA from Harvard University and BS in Business from Marquette University



Sumit Sadana
Exec. VP & Chief
Business Officer
Compensation: \$9M

Sadana joined in June 2017 as Executive Vice President and Chief Business Officer. From April 2010 to May 2016, Sadana served in various roles at SanDisk Corporation, including Executive Vice President, Chief Strategy Officer, and General Manager, Enterprise Solutions until it was acquired by Western Digital in May 2016. Sadana currently serves on the Board of Directors of Silicon Laboratories, Inc. Sadana holds a B.Tech. in Electrical Engineering from the Indian Institute of Technology, Kharagpur, India and an MS in Electrical Engineering from Stanford University.



Manish Bhatia
Exec. VP Global
Operations
Compensation: \$7M

Bhatia joined in October 2017 as Executive Vice President, Global Operations. From May 2016 to October 2017, Bhatia served as the Executive Vice President of Silicon Operations at Western Digital Corporation. From March 2010 to May 2016, Bhatia held several executive roles at SanDisk Corporation including Executive Vice President of Worldwide Operations until it was acquired by Western Digital in May 2016. Bhatia holds a BS and MS in Mechanical Engineering and an MBA, each from the Massachusetts Institute of Technology.



Scott DeBoer
Exec. VP Technology &
Products
Compensation: \$7M

DeBoer joined in February 1995 and has served in various leadership positions since that time. DeBoer was named Executive Vice President, Technology Development in June 2017 and named Executive Vice President, Technology & Products in September 2019. DeBoer holds a PhD in Electrical Engineering and an MS in Physics from Iowa State University. He completed his undergraduate degree at Hastings College.

Management Compensation

	Compensation Component	Characteristics	Purpose	Determining Factors
FIXED	Base Salary	Fixed Compensation	Compensates executives for performing day-to-day job responsibilities Attracts, develops, and retains highly-qualified executive talent Maintains stable management team	Market Data median sets baseline Adjusted for executive's contributions, experience, and performance
CASH COMPENSATION	Short Term Incentive Pay (suspended for 2023)	Variable, performance-based cash compensation	Provides performance-based, incentive cash awards for outstanding performance at the individual, business-unit, and/or company-wide level Encourages accountability by rewarding achievement of specific performance goals Focuses executives on achievement of near-term financial and operational objectives	Market Data median forms baseline Annual, pre-determined goals set by the Compensation Committee <ul style="list-style-type: none"> Profitability targets Achievement of certain technology, product, business, and cost aims Other goals including customer, sustainability, and diversity, equality, and inclusion
		Target payout is tied to a percentage of executive's base salary	Promotes long-term company success and drives shareholder value	
VARIABLE	Performance RSUs	Variable, performance-based equity compensation Three-year performance period	Creates direct, specific alignment with shareholders' interests by focusing executives on long-term value creation through the achievement of key operational milestones and stock price performance	Primary goals set by the Compensation Committee <ul style="list-style-type: none"> DRAM revenue or percentage of revenue from high-growth, stable segments NAND bits shipped or percentage of bits shipped into the data center segment Relative TSR growth of the Company's stock price versus the median of the PHLX Semiconductor Sector Index
		Measured at the end of the second and third year for the operational goals and each day beginning on the first day of the second year for the financial goal 50% of total banked PRSU vests at end of second year, remaining and any incremental vests at end of third year		
LONG-TERM INCENTIVE PAY	Time-Based RSAs	Variable, performance-based equity compensation	Provides alignment with shareholders' interests by focusing executives on long-term value creation	Value based on stock price
		Vests over three years	Provides retention value	