

Technology

Observer

October 2025

Microscopic Technology Powers Macroscopic Opportunities: AI Is Etching an Attractive Growth Cycle for Chip Equipment

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Executive Summary

Consider the complexity and labor intensity of building the most technologically advanced skyscraper today, with hundreds of floors. Shrink it to a microscopic level. Make the floors one atom high and shrink the hallways to the width of a single strand of DNA. Then mass produce millions of exact copies every single month. This is the mind-bending wonder of semiconductor manufacturing, which is the foundation of all modern technology.

Wafer fabrication equipment, or WFE, is the set of machines that do just this and cumulatively generate over \$100 billion in annual revenue. WFE vendors drive the cutting edge of electronics, making the aforementioned skyscrapers smaller, more complex, and more efficient. These firms hold immense technological depth in enabling chipmakers like Nvidia, Apple, and TSMC to power better generative AI models and electronic devices.

We forecast 8% annualized growth over the next five years for the WFE market and see artificial intelligence infrastructure investments driving this strong growth cycle. We see ASML, Applied Materials, Lam Research, Tokyo Electron, KLA, and ASM International as the biggest beneficiaries of this investment cycle, as technology leaders in each of their respective sections of the market, which also underpins our wide moat ratings on this group. This group has outperformed the broader stock market historically, which we credit to structural demand growth in semiconductors. We see AI enabling the next chapter of this structural outperformance.

Disclosure

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ASM is our top pick in WFE, while we see fair valuations for ASML, Applied Materials, and Tokyo Electron. ASM has an attractive secular opportunity to gain share via its position in atomic-layer deposition that isn't being fully priced in. ASML and Applied are closer to our valuations but trade below Lam and KLA. We view these stocks as AI winners, and investors looking to play into WFE should see better opportunities in these well-positioned vendors at fair prices today.

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Companies Mentioned

Name/Ticker	Economic Moat	Currency	Fair Value Estimate	Current Price	Uncertainty Rating	Morningstar Rating	Market Cap (Bil)
ASM International (ASM)	Wide	EUR	635.00	547.00	High	★★★★★	27.00
ASML (ASML)	Wide	EUR	820.00	850.00	High	★★★★	339.00
Applied Materials (AMAT)	Wide	USD	200.00	219.00	High	★★★★	174.00
Lam Research (LRCX)	Wide	USD	100.00	141.00	High	★★★	179.00
KLA (KLAC)	Wide	USD	800.00	1040.00	High	★★★	140.00
Tokyo Electron (8035)	Wide	JPY	27000.00	29700.00	High	★★★★	13606.0

Key Takeaways

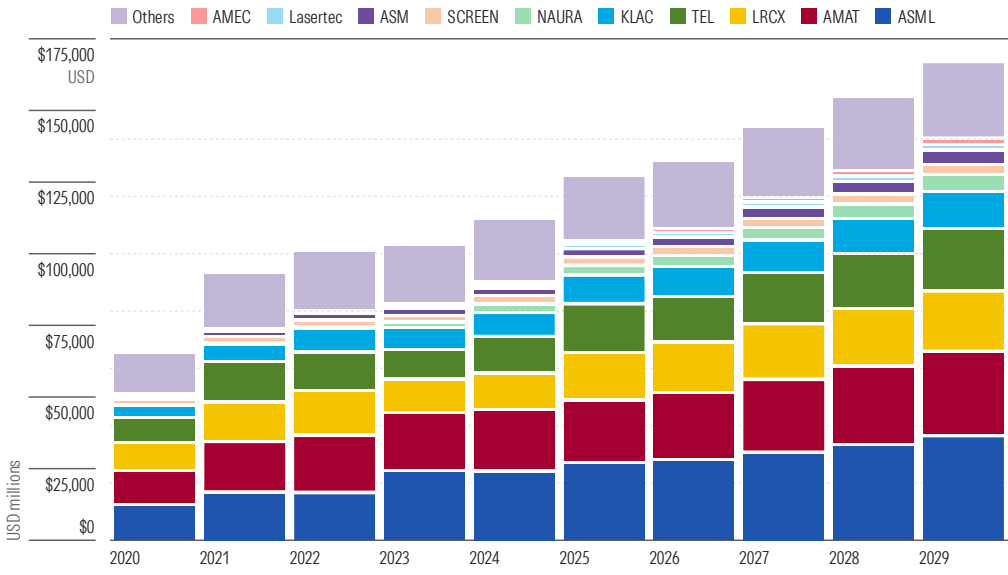
AI infrastructure investments are driving a structural, five-year growth cycle for WFE, leading to our forecast for 8% annualized growth through 2029. Third-party forecasts from Gartner appear to underestimate AI investment's ability to drive durable WFE growth.

- ▶ We believe WFE in isolation underestimates the total AI revenue opportunity for WFE vendors, with attractive growth in advanced packaging equipment and services increasing the total addressable market size by about 25%.
- ▶ ASML, Applied Materials, Lam Research, Tokyo Electron, KLA, and ASM International are the biggest AI winners in WFE. These firms hold the most exposure to the cutting edge of chip technology, including leading-edge logic and advanced packaging like TSMC's CoWoS and HBM processes that support AI chips. We expect these six to grow above the rest of the market and take share from smaller peers.
- ▶ This group of six WFE technology leaders has outperformed the stock market historically due to structural growth in chip demand. We see AI as the next structural driver of share price outperformance.
- ▶ ASM is our top pick in WFE. ASM is the technology leader in atomic-layer deposition, or ALD, which should see higher penetration in advanced chips for AI. This is an attractive secular story that should drive market share gains and isn't being fully recognized in the market.
- ▶ ASML, Applied Materials, and Tokyo Electron have underperformed Lam and KLA in 2025, even though we view all five as AI winners. As technology leaders across lithography, advanced packaging, and etch and deposition, we expect these firms to see a similar growth opportunity to their peers. Investors looking to buy into WFE's AI opportunity should find a better opportunity in these stocks at fair prices.
- ▶ ASML has a practical monopoly on lithography, and we expect it to benefit from greater penetration in AI chipmaking and a technology transition to high-NA at the end of the decade.
- ▶ Applied Materials is the most exposed to advanced packaging among WFE firms, which positions it well to capitalize on AI demand in the medium term. Applied appears to be valued as an underperformer relative to peers, which doesn't match our expectations.
- ▶ Lam Research and KLA are being valued as the biggest net beneficiaries of AI in WFE. We agree that these two are AI winners, but they are being valued at a premium to peers that share a similar opportunity.
- ▶ We expect elevated spending out of China on WFE to be another driver of WFE growth. To us, third-party forecasts from Gartner look overly pessimistic on China's ability to maintain these investment levels.
- ▶ We see low risk to our wide-moat WFE coverage from geopolitical China risk. We assign a low probability to future trade restrictions from the US and believe domestic Chinese vendors are more than one decade behind these technology leaders in their ability to drive strong yields at customers.

AI Drives Our Above-Consensus WFE Growth Forecast

We forecast 8% growth through 2029 for the global wafer fabrication equipment, or WFE, market, with AI infrastructure investments as the largest driver of growth. AI is driving a rapid increase in global supply for advanced chips like GPUs and putting the chip industry on a rapid pace of complexity growth. Both of these dynamics are constructive to WFE spending and inform our bullish forecast.

Exhibit 1 AI Investments Drive Our Forecast for WFE Spending To Rise Past \$160 Billion in 2029

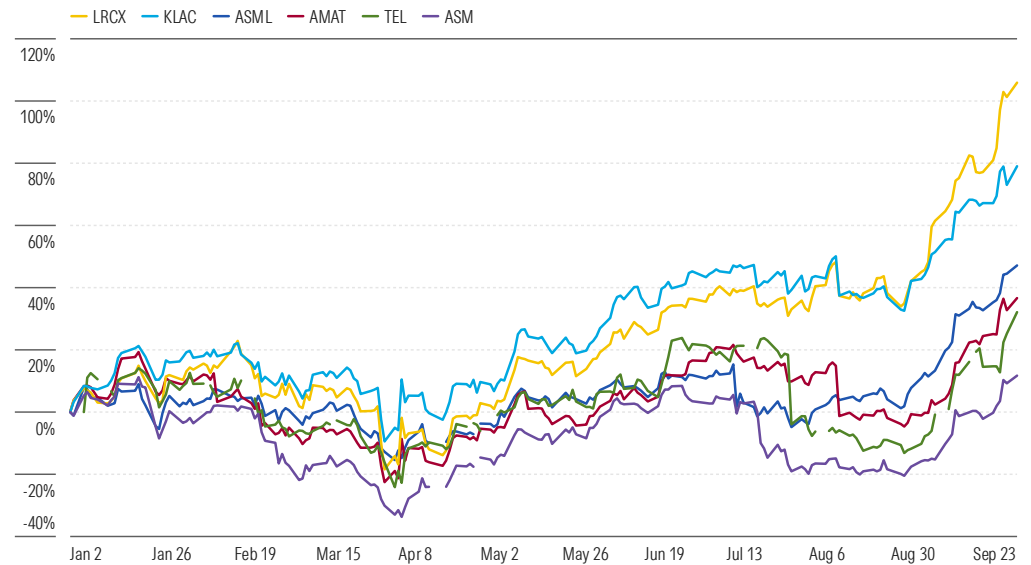


Source: Morningstar analyst estimates, Gartner.

We believe our six covered WFE companies are the best-of-breed on the cutting edge of chip manufacturing with technology-driven wide moats. This group stands to be the primary beneficiaries of increased AI investment in chipmaking. We see this investment driving higher WFE spending, as well as higher advanced packaging spending. Advanced packaging occurs after WFE but is a new and growing market for WFE vendors to serve.

Our top pick in WFE is ASM International. ASM is close to a pure-play on advanced deposition (atomic-layer, which we will describe in detail in this report) and stands to see higher penetration in AI chips. We expect it to gain market share and don't see the market pricing this in.

ASML, Applied Materials, and Tokyo Electron look fairly valued to us but have underperformed peers like Lam Research and KLA year to date. While Lam and KLA have appreciated more than 80% year to date, ASML, Applied, and Tokyo have appreciated in the 10% to 45% range (Exhibit 2). To us, this is a disconnect, as we see all four as AI winners over the next five years. Investors making a play on AI growth in WFE should see fairer prices to these two than their overvalued counterparts.

Exhibit 2 ASM Is Our Top Pick in WFE, While AMAT and ASML Trade at Fair Prices After 2025 Underperformance

Source: Morningstar, PitchBook.

Our five-year forecast comes above Gartner's WFE forecast, which we believe underestimates the level of AI investment over an enduring five-year period. Gartner's forecast appears especially low against our high growth estimates for chipmakers' capital spending. Our 17% annualized growth forecast for leading-edge chip investment matches our growth estimates for TSMC's capital expenditures, which are above sell-side consensus.

We also see Gartner as overly bearish in its expectations for a steep correction in China demand, where we see it remaining at elevated levels. Our chief differentiation comes in 2027 and beyond, as we consider both AI investments and China's domestic buildout as durable over a longer-term period. In addition to expecting higher WFE growth than Gartner, we see advanced packaging as an incremental and attractive growth opportunity for these well-positioned wide-moat vendors.

For ASML, we believe the market is valuing it as if lithography's outperformance versus the rest of WFE is over. This has become a common narrative in the market: that lithography "intensity" has peaked. We agree with part of this narrative, as we don't believe lithography intensity will grow meaningfully in coming years, but we don't expect any sizable decline, either. We model lithography intensity holding steady in the 23%-25% band in the next five years. Short term, chipmakers are seeking performance gains via vertical scaling and advanced packaging, both of which rely more heavily on etch and deposition than lithography. We expect a higher mix of AI chips that use more of ASML's lithography equipment to maintain its share in the market, however. Longer term, we see upside to lithography intensity from the release of new, advanced lithography (dubbed high-NA) at the end of the decade.

Exhibit 3 We're More Bullish Than Gartner and the Market on AI Investment, China Investment, Lithography Performance, and ASM's Valuation

Topic	 What the Market/Third Parties Say	 Morningstar's Take
AI Investment 	AI investment will drive moderate, high-single digit growth in the short-term, followed by a downturn in 2027, per Gartner's forecast.	AI investments will drive 17% annualized growth over five years for leading-edge WFE in a strong upcycle. AI will also drive 17% growth in incremental advanced packaging equipment for WFE vendors.
China 	After significant overorders in 2023 and 2024, Chinese spending on WFE will decrease for four straight years in Gartner's forecast.	We expect a correction in Chinese WFE spending in 2025, followed by mid-single digit growth as China continues to build up domestic chip capacity.
Lithography Intensity 	Lithography intensity has peaked. ASML may underperform the rest of WFE as chipmakers pursue advanced packaging and vertical integration.	Lithography benefits from a higher mix of AI chips. We forecast it to rise in line with other WFE in the short-term, but outperform in 2028 and 2029 with the introduction of high-NA EUV from ASML.
Vendor Positioning 	Lam Research and KLA are net AI winners. Short-term orders and guidance disappointments for ASML, Applied Materials, and ASM portend continued underperformance.	ASM, ASML, Applied, and Tokyo Electron share an attractive longer-term AI growth opportunity with Lam and KLA. These stocks are better ways for investors to play the AI opportunity in WFE.

Source: Morningstar, Gartner.

Complementary Technologies Build Chips Up, Layer by Layer

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Key Takeaways

- ▶ Chipmaking is an iterative process involving thousands of individual process steps and numerous complementary technologies. Chief among these are lithography, etch, deposition, and process control.
- ▶ WFE growth is a function of global chip supply and complexity. We observe a long runway for increasing complexity with new transistor architectures and advanced packaging, particularly for AI chips.

Semiconductors Enable the Modern World

Semiconductors are the backbone of every piece of modern electronics and are one of the most impressive and complex pieces of technology hardware ever created. Simply put, we would not have the cars, personal devices, or software we have today without these chips. Designing a cutting-edge chip is a complex feat on its own, but the manufacturing of these chips is where engineers truly push the limits of physics.

This report will focus on the manufacturing of these chips, and the key vendors that enable continuing evolution and technological breakthroughs. In this section, we will give investors a brief primer on chip manufacturing, inclusive of the different process steps, critical technologies to understand, and the focus of each leading firm. Investors with a good understanding of chip manufacturing technology and its market participants can skip our first two sections to dive immediately into our forecast and primary takeaways but should refer to these sections for the basics that underpin our analysis.

Semiconductors 101

Basically, a semiconductor is a switch: electrical current running through an individual circuit is a signal that can be turned on or off as a binary output. Modern cutting-edge chips comprise billions of these individual circuits (also called transistors) to create a complex line of binary code that undergirds modern software and applications.

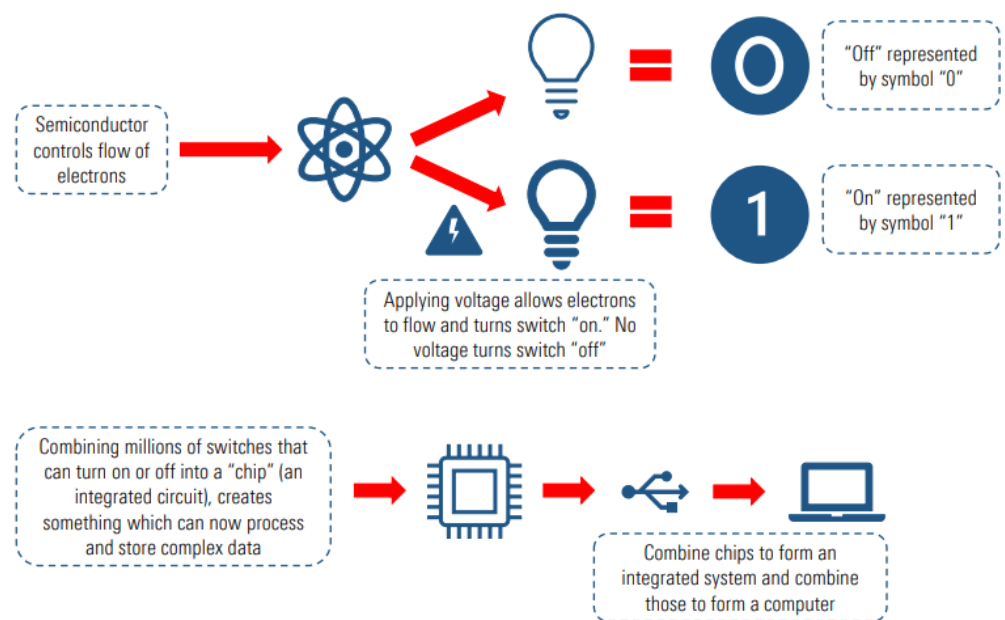
The words “semiconductor” “chip” and “integrated circuit” are often used interchangeably to refer to the end product that sells into a computer, phone, car, or other application. Technically, “semiconductor” refers to the material of which a chip is made, and “chip” and “integrated circuit” refer to the final product. The word “semiconductor” refers to the material (often silicon) that can be either a conductor or an insulator—when a conductor, a circuit is “on,” and when an insulator, a circuit is “off.”

Chips enable the encoding and processing of complex information. As humans have tried to accomplish these tasks, they run into many issues. Machines break down. The speed of information processing is

limited by the physics of the medium by which you are processing it. Machines can quickly become impractically large. The first computers were made of light bulbs and took up whole rooms.

Semiconductors allow the expression of logic without any mechanical moving parts (less breakdown) at a microscopic scale (makes size practical) by controlling the flow of electrons (enables very fast speeds). This is not easy to accomplish, and the semiconductor industry pushes the limits of physics to enable the modern world.

Exhibit 4 Semiconductors Control the Flow of Electrons, Enabling the Modern World



Source: Morningstar.

Logic Chips

Logic chips often come to mind when people envision a chip—the "Intel inside" a PC, Apple's smartphone processor, or Nvidia's AI chips. Logic semiconductors use transistors and gates to build digital circuits that process the 0s and 1s needed for computation. Toward the low end, a simple microcontroller might be used to activate the circuit board on an electric toothbrush. At the higher end, a leading-edge processor may have tens of billions of transistors to conduct the most complex processing needs—computing engines, graphic processing units, and neural processing units to offload AI workloads on a device. Logic devices might be programmable (such as field programmable gate arrays) or built for specific applications (application-specific integrated circuits). Because logic is such a broad category, it can be hard to fully summarize with so many end markets and products.

Logic semiconductors are everywhere—being the largest semiconductor product category. They are most concentrated in the PC, server/IT infrastructure, and communication end markets. Intel and AMD

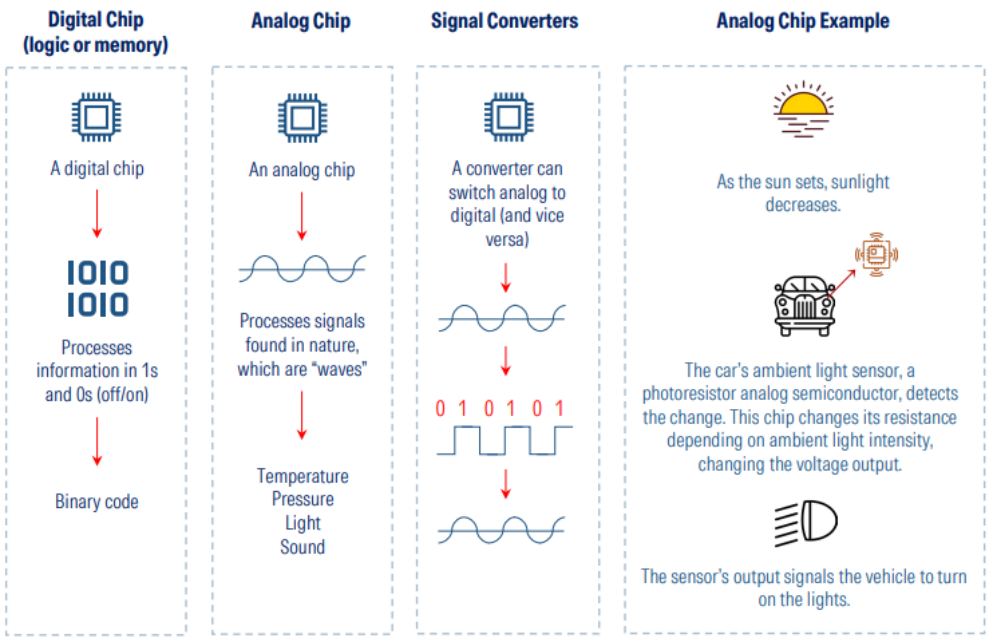
dominate the PC CPU market, Nvidia now dominates the server market with Intel and AMD in second place, and Qualcomm and Apple are key suppliers in mobile. Broadcom dominates in networking and connectivity, and increasingly custom processors. Because of their importance, the geopolitical race to build the most advanced semiconductors in the US, Taiwan, China, and elsewhere is centered on logic chips, which help run the digital and physical world.

Analog Chips

Analog chips deal with real-world parameters like pressure, temperature, or light. Real-world signals are continuous (not discrete), can be expressed as wave functions with frequencies and amplitudes, and can take an infinite number of different values (there are infinite possible values between 0 degrees Celsius and 5 degrees Celsius). Chips that include analog and digital circuitry are known as mixed-signal.

Although digital chips are more expensive and demanding technologically, their design can be more straightforward. Binary signals have just two states, and signals are immune to noise or degradation. On the contrary, analog chips deal with noise or interference, and engineers might need many trial-and-error cycles to get the optimal performance for an application.

Exhibit 5 Analog Chips Convert Real-World Signals to Digital; Digital Chips Operate With Binary Code



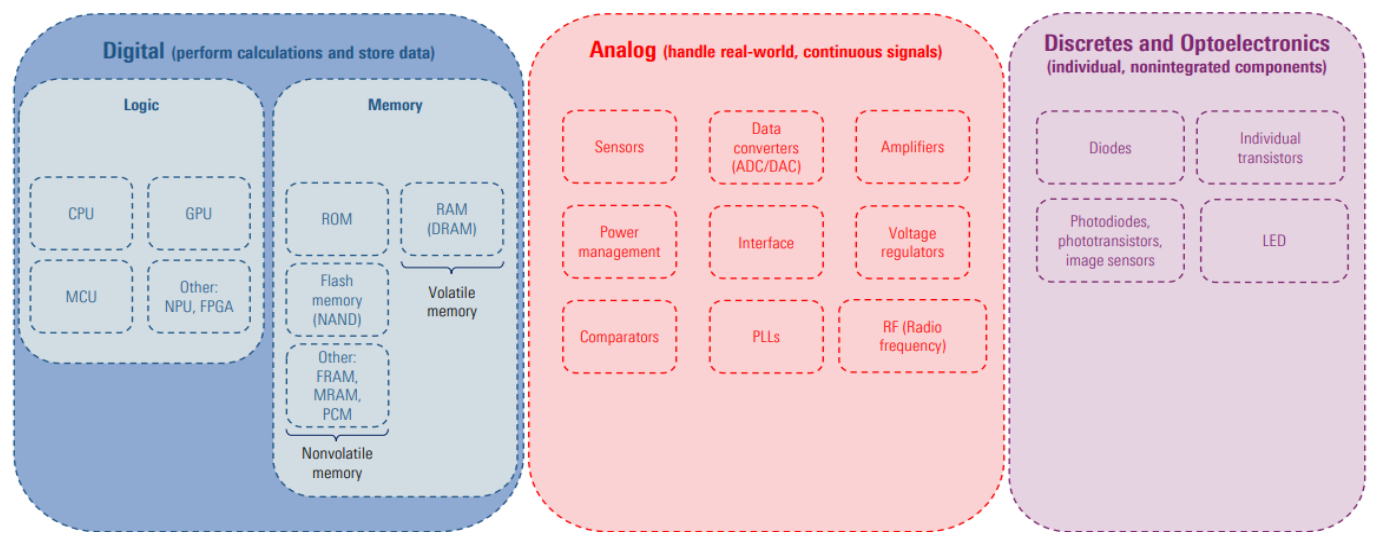
Source: Morningstar.

Memory Chips

Memory chips focus on storing and delivering information, rather than processing inputs into outputs like logic and analog chips. The two primary types of semiconductor memory are DRAM and NAND. DRAM is short-term memory used for application processing across servers, PCs, and smartphones. NAND is used for long-term storage of files and applications—this is what enables solid-state drives in PCs and servers.

Exhibit 6 Myriad Semiconductor Types Support Every Individual Electronics Application

Different Applications Require Different Types of Semiconductors and Many Times a Combination of Them
We will dive into logic and memory, the largest combined categories, and the smaller, but still important analog category. We will not cover discretes/other in-depth.



Source: Morningstar.

Chipmaking 101

The manufacturing of any of these types of chips involves an iterative process with myriad complementary technologies. Investors should think of chips being built from the ground up, layer by layer, to create a totally unique end product. This all starts with a wafer of a material, often silicon (but many others exist for specific purposes: silicon carbide, gallium nitride, gallium arsenide, silicon geranium, and more.)

Raw material, like lumps of silicon, will be cooked in a furnace to produce a cylindrical ingot--a helpful mental image is a large, metallic sausage. That ingot then gets sliced into thin wafers, less than one millimeter thick. These wafers then get polished to a zero defect surface, becoming fully reflective like a mirror. Once a manufacturer has a polished wafer, it can begin modifying its properties and adding circuitry on top of it. Wafer fabrication equipment, or WFE, refers to all the following steps that build up a complex chip on a wafer and is the primary revenue source for the firms we cover in this report.

Chipmaking is analogous to building a microscopic high-rise building, with circuits at the bottom floor, additional floors on top, and pipes running vertically through the building. In this case, the floors are

layers of various materials, and the pipes are intricate mazes of wires that interconnect the transistors in the basement. These microscopic connections have to be perfectly aligned for a chip to work, leading to immense complexity and precision throughout the manufacturing process.

The majority of the fabrication process occurs in a clean room, which is a controlled environment almost completely devoid of pollutants. A chip manufacturing clean room can be 10,000 times cleaner than a hospital operating room, as even a single speck of dust can ruin the circuitry of a chip. Each step in the chip manufacturing process occurs within a vacuum chamber of a machine, given the extreme precision with which chemicals and atoms need to be added or removed.

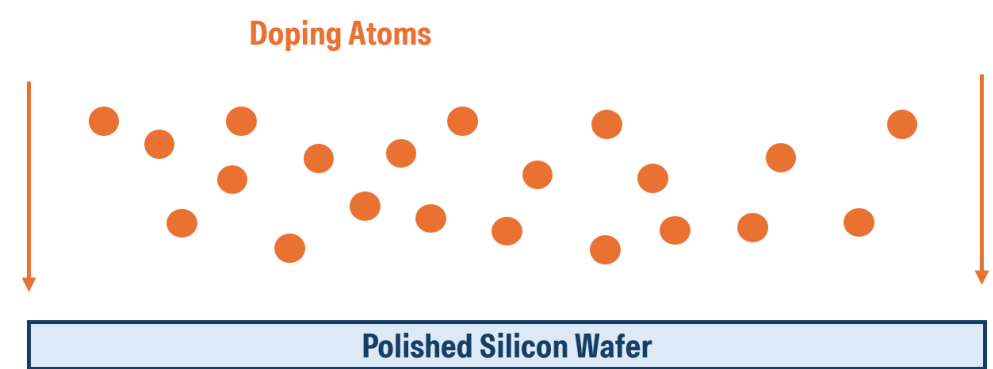
We emphasize here that all of what we describe below is complementary—none of these steps are substitutes for each other and, in fact, rely on each other to create a final chip.

Step One: Modification

Chipmakers can first use heat or chemicals to alter the chemistry of the wafer itself. These technologies are predominantly called doping, rapid thermal processing (RTP), oxidation, or diffusion. RTP uses heat, while oxidation and diffusion use chemicals. Oxidation adds a layer of chemical to the wafer. Doping and diffusion add individual atoms to the wafer. Thermal processing can activate the individual “doping” atoms.

Together, these allow chipmakers to tailor the specific properties of a wafer for a desired chip's design. This adjusts the conductivity of pieces of the wafer, allowing for the creation of circuits later on in the manufacturing process. We think of doping as laying the chemical foundation for the circuitry that comes later in chipmaking.

Exhibit 7 Modification Uses Heat and Chemicals To Alter the Properties of a Wafer



Source: Morningstar.

Step Two: Deposition

Deposition broadly refers to the application of new layers to a base wafer. An individual chip can have up to or more than 100 individual layers. These layers are generally either a conductor (usually a metal) or an insulator (also called a dielectric.)

Chemical vapor deposition, or CVD, is one of the most common methods, which uses vapor to apply a chemical layer to the wafer. CVD is most useful for insulators like gases.

Sputtering uses radio-frequency waves or electricity to remove atoms from a physical substance that then travel onto a wafer to create a layer. Sputtering is most useful for conductors and metals.

Atomic layer deposition, or ALD, is an advanced, precise version of CVD, which applies a thin, one-atom-thick, layer to a wafer. Unlike CVD, where several materials are thrown into a chamber at the same time, ALD deposit films one-atom thick, allowing for better smoothness and conformality. ALD is suitable for structures with very high aspect ratios, where more mature technologies could create an uneven surface.

Exhibit 8 Deposition Adds a New Chemical Layer to a Wafer



Source: Morningstar.

Step Three: Lithography

Lithography uses light to apply a pattern on a wafer layer, after deposition. Investors can think of these patterns as the blueprint for the actual circuitry in a chip. The chemicals applied during deposition have a reaction to light, which prints the pattern on the deposited layer when light is selectively applied through a lens.

Photomasks are the lenses where a pattern is drawn. Light is then shown through these photomasks to apply the pattern onto the wafer itself.

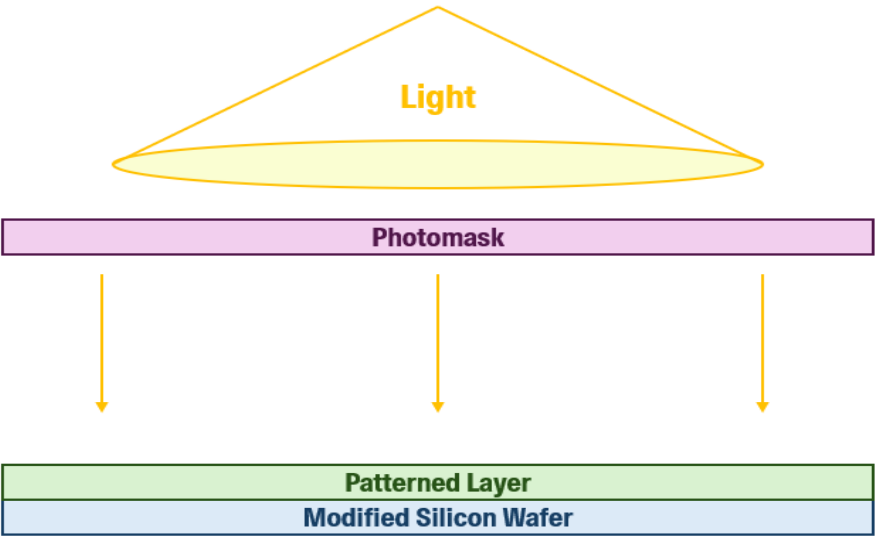
Deep ultraviolet, or DUV, lithography refers to the wavelength of light applied. DUV has been the workhorse of the chip industry for decades, with a 193-nanometer wavelength of light being a common specification. The size of the wavelength of light directly translates to how small of a circuit can be printed on a wafer.

Extreme ultraviolet, or EUV, lithography is more advanced than DUV, using smaller wavelengths of light for more precise pattern design. The smaller wavelength allows for the printing of smaller circuitry. It's more expensive but more precise. These typically use 13.5-nanometer wavelengths.

High-NA EUV lithography is an even more precise and complex application of EUV, using a smaller numerical aperture (or in simpler terms, larger mirrors to reflect the light) to emit the light to create even smaller and more precise patterns. This is a nascent technology, and we don't expect adoption in high-volume manufacturing until the end of the decade.

The type of lithography used will depend on the chip layer, with these lithography technologies being complementary. The more critical and complex layers will normally use EUV, while for more basic layers DUV will be enough. Depending on the layer of the chip, a chipmaker could opt to use either DUV or EUV, or even (in the future) high-NA. Adopting EUV is a gradual process. It doesn't happen at the whole-chip level but one layer at a time (out of hundreds.) So, a given chip could use EUV for 10% of its layers but use the lower-cost DUV for the rest.

Exhibit 9 Lithography Applies a Pattern to a Semiconductor Layer With Light



Source: Morningstar.

Step Four: Material Removal (Etch)

After the pattern of a circuit layer is applied into the deposited layer with lithography, chipmakers selectively remove the material to physically etch the pattern into the layer. After lithography, the pieces of the layer that were patterned are chemically altered. Etching removes the pieces of the layer that didn't react with the light, leaving the etched-in pattern.

Dry etch is the most common form of material removal, typically using plasma to carve out the circuit pattern.

Conductor etch and dielectric etch refer to removal of either conductive or insulating materials. Both are required, with the selection depending on the layer at hand.

Exhibit 10 Material Removal Etches the Lithographed Pattern Into a Layer



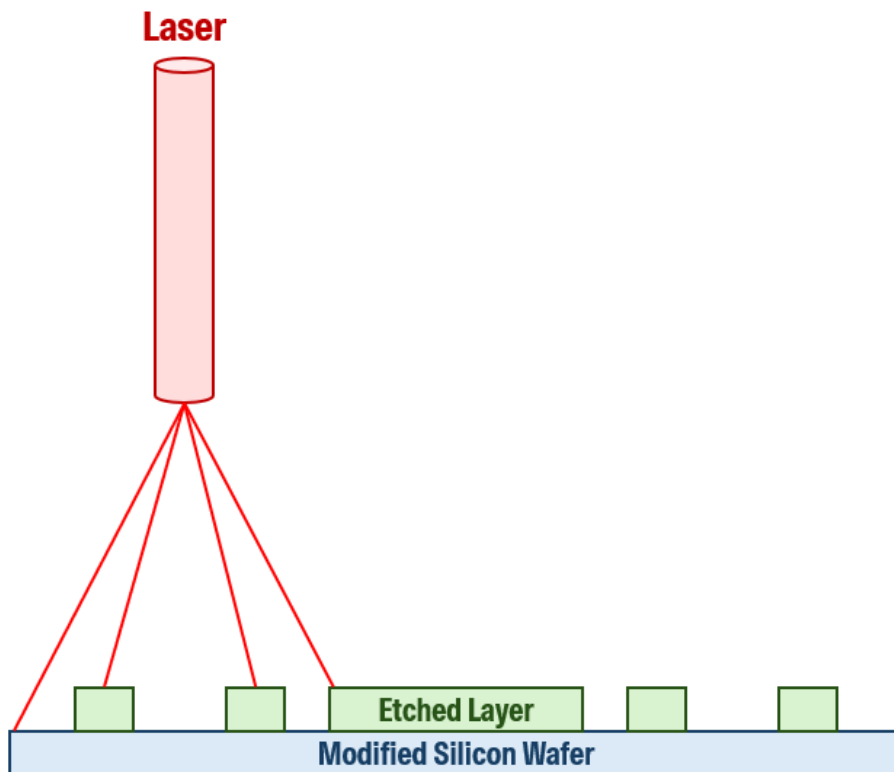
Source: Morningstar.

Step Five: Process Control

Process control is the process of inspecting wafers and measuring patterns throughout the steps of chip manufacturing. With such microscopic and precise specifications, process control ensures that each step is accomplished successfully before continuing to add layers to the wafer.

Wafer inspection involves assessing a whole wafer and detecting any defects that might have occurred during the process. This can happen with a bare wafer before layering begins or in between any steps described above (like after patterning). When dealing with measurements in nanometers and single atoms of chemicals, inspection is crucial in ensuring successful manufacturing and also helps improve efficiency on future wafers.

Metrology is the measurement of patterns and circuits. This can be double-checking the pattern accuracy on a photomask for lithography or the actual pattern on the wafer after etching. Metrology is used to enable mass production of high quality standards throughout manufacturing.

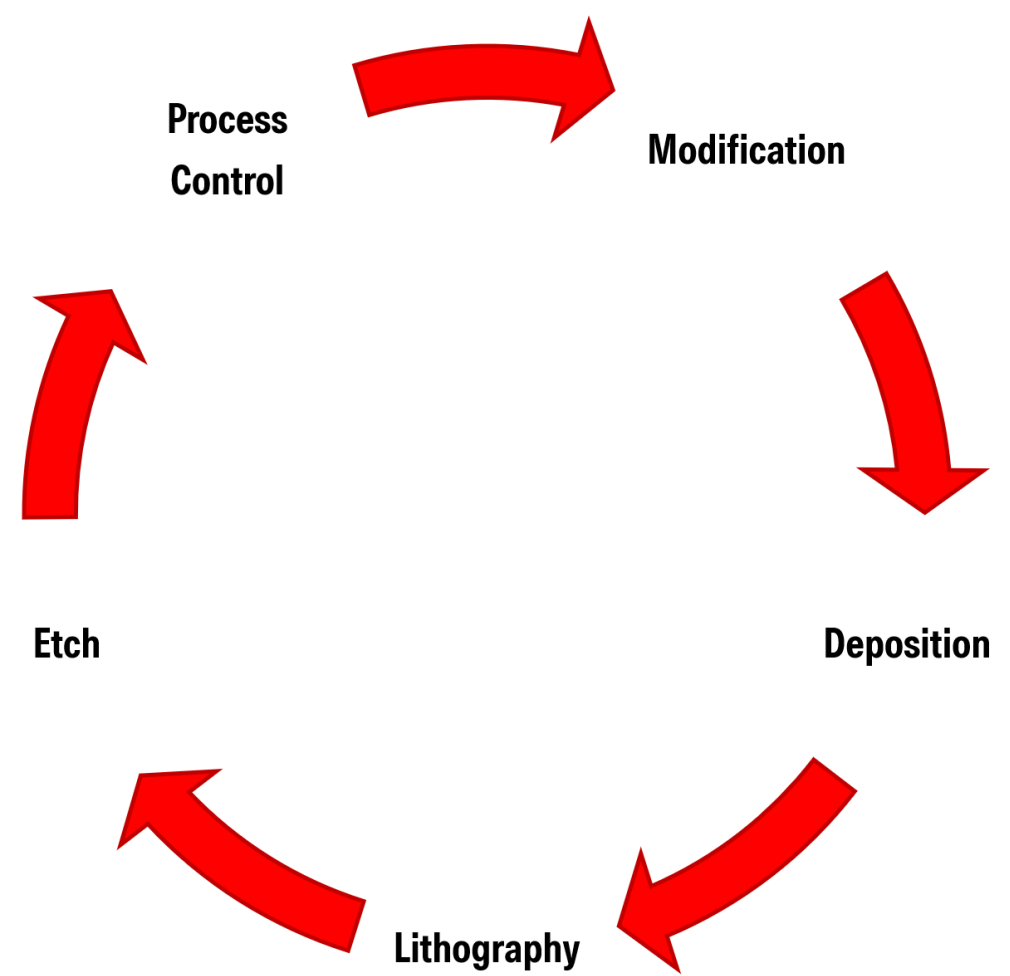
Exhibit 11 Process Control Measures Patterns and Inspects for Defects

Source: Morningstar.

Rinse and Repeat

Advanced chips can use thousands of the process steps described above, and in varying orders. Different layers require different materials for deposition, different wavelengths for lithography, and different etch tools. Process control can occur between any two steps. Doping and modification can happen in between steps, as well. We emphasize that each individual step is critical, and all of them work together to create a finished, usable product. The intricacies of which technologies get used where, and in which order, are some of the many difficult complexities of advanced chip design.

Exhibit 12 Chips Are Built Up Layer by Layer, With Hundreds to Thousands of Individual Steps



Source: Morningstar.

Complexity Is Rising

In WFE, we see sales and growth as a function of global chip supply and complexity. Higher levels of supply require new equipment sales, and more complex chips require more advanced, higher-priced equipment. We see AI driving the next era of growth for both supply and complexity. We expect AI to drive a significant increase in chip demand and these chips are advancing at a rapid cadence of complexity growth. Advanced logic chips for AI require thinner layers and smaller patterns, leading to higher use of etch, deposition, lithography, and process control.

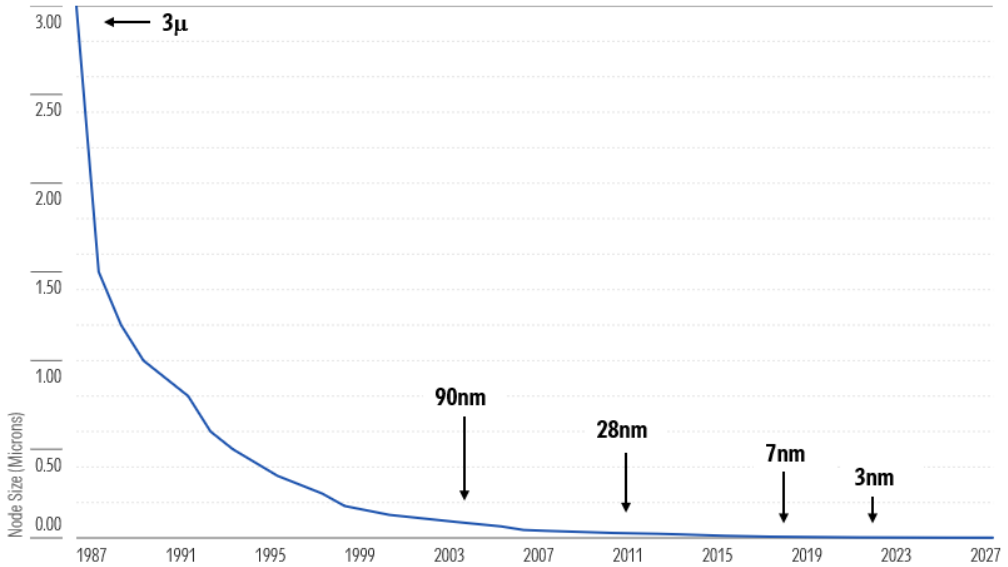
Scaling refers to the trend toward greater circuit density in chips over time, which is the predominant driver of complexity. For most of the history of semiconductors, lateral scaling has been pursued. Lateral scaling refers to packing more individual circuits, or transistors, into the same surface area of a chip. This allows for more complex signal processing and greater computing power. Alternatively, it allows

chipmakers to fit the same amount of compute into a smaller surface area, saving cost and improving power efficiency.

Scaling is the key driver of WFE growth. Advancing denser, more powerful, and more efficient chips requires both more advanced chip designs and more advanced equipment to physically implement those designs. Advances in chip complexity are never-ending and require consistent purchases of new, cutting-edge equipment to enable them.

Lateral scaling is often communicated via the process node of a chip, which roughly refers to the size of a transistor on a chip. These used to be measured in microns (one millionth of a meter, or one thousandth of a millimeter) but are now measured in nanometers (which are one thousandth of a micron, or one billionth of a meter). Cutting-edge chips today are measured on a two-nanometer process at the likes of TSMC. Current nodes of two or three nanometers refer mostly to marketing terminology, and no longer directly translate to the exact sizes of circuits on a wafer. However, the shrinking of transistors, and increasing density on integrated circuits, continues to progress at each successive node.

Exhibit 13 Ever-Shrinking Transistor Sizes Generate More Performance per Chip



Source: Morningstar, TSMC.

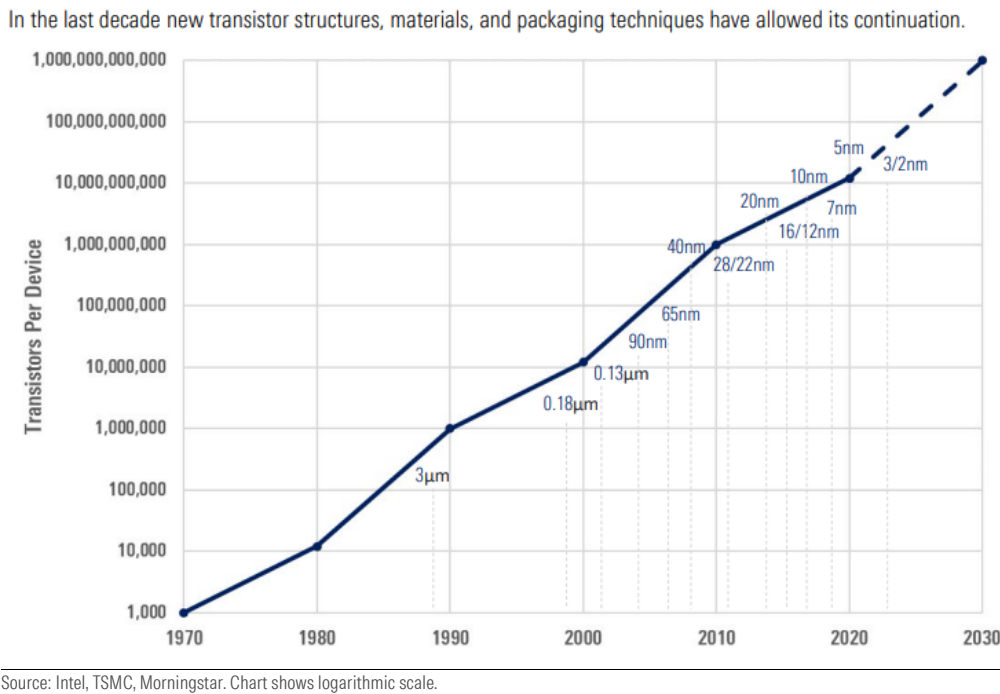
The pursuit of lateral scaling leads to higher intensity for lithography, etch, deposition, and process control. Smaller feature sizes have led to the transition from DUV lithography to EUV lithography in advanced logic and memory chips, for example. As more layers and steps utilize EUV, it generates higher pricing power and unit sales of new EUV equipment for ASML. These smaller transistor designs also require more precise deposition, with more layers transitioning to atomic-layer deposition and driving new equipment sales for ASM. It also requires more precise etching equipment. All of the above

entail more process steps and smaller designs, which require greater quantities of more advanced process control equipment.

Another method to pursue lateral scaling is using double-patterning lithography. This involves two passes of the lithography step to print a smaller, more precise transistor without a more advanced lithography machine. This requires double the etch and deposition steps to make up for less advanced lithography, which can drive sales of more advanced etch and deposition equipment. Generally, we see double-patterning increasing the intensity of etch and deposition versus lithography, while moving past double-patterning to single-patterning on more advanced lithography, like EUV, drives relatively higher lithography intensity.

Lateral scaling has been the key component of the relentless pursuit of Moore's Law over the past 60 years of chip technology. Championed by Gordon Moore, one of the fathers of semiconductors, the eponymous law states an expectation for the amount of transistors on a chip to double every two years. This vision has largely borne out accurately since its coining.

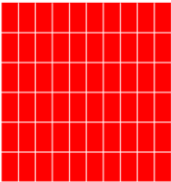
Exhibit 14 According to Moore's Law, the Number of Transistors per Device Doubles Every Two Years



More recently, chip design has added vertical scaling as a new vector to enable denser, more powerful chips. Lateral scaling continues at each generation with shrinking circuits on successive nodes of chips. Vertical scaling refers to adding layers on top of each other on a chip—rather than increasing density on a two-dimensional plane, now chipmakers can add circuitry in three-dimensional formats on chips.

This was a significant inflection with the advent of 3D NAND flash memory in the 2010s. Stacking layers on top of each other requires significantly more advanced etch equipment, as chipmakers need to drill holes between potentially hundreds of layers. This drove extremely strong etch performance during the 3D NAND transition between 2015 and 2022. Now, vertical scaling is making its way into logic and DRAM chips as well, allowing for a new vector to raise chip performance and increase etch intensity.

Exhibit 15 3D Structures Focus on Stacking Features on Top of Each Other, Like With 3D NAND Memory

2D NAND Chip	3D NAND Chip
 Billions of NAND cells together combine to write code that stores information. Adding more cells = lateral scaling	 Hundreds of layers of NAND planes stack on top of each other to increase the density of a flash chip. Adding more layers = vertical scaling

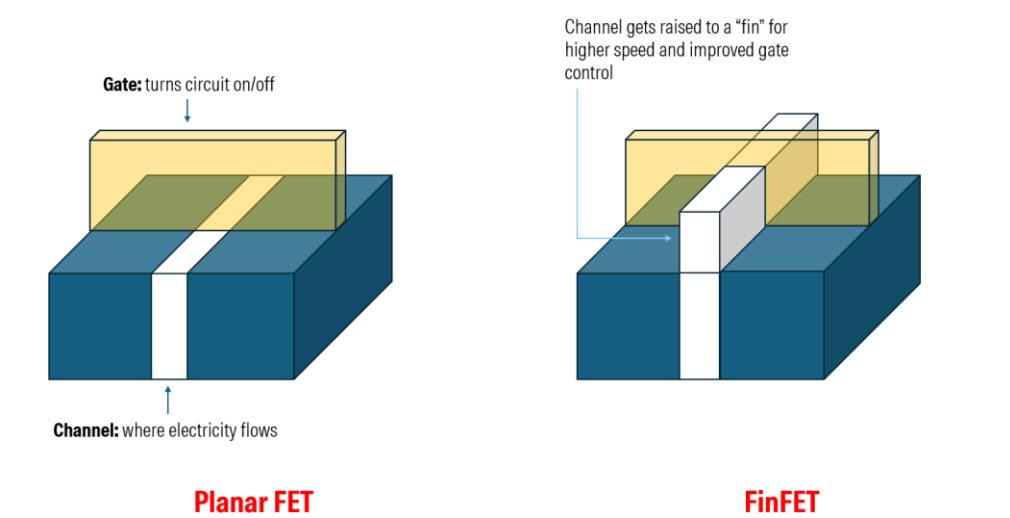
Source: Morningstar.

Beyond Increasing Circuit Density, Circuits Themselves Are Evolving

Another way of increasing chip performance is via new circuit architectures. Semiconductors started with a planar field-effect transistor, or FET. Investors should think of this as a 2D circuit switch across a uniform plane. Current flows through a channel from point A to point B, controlled by a gate that turns the flow on or off.

This architecture lasted for roughly 50 years until the early 2010s, when Intel introduced the FinFET. FinFET transistors are three-dimensional. Rather than current traveling in a line, it now travels in a vertical “fin.” This allows for more precise control of current, due to having three physical sides to the channel, as well as faster current flow, which enables faster speeds on chips. This required significantly more WFE intensity, given the need to etch 3D shapes onto a wafer and deposit materials uniformly over a 3D structure.

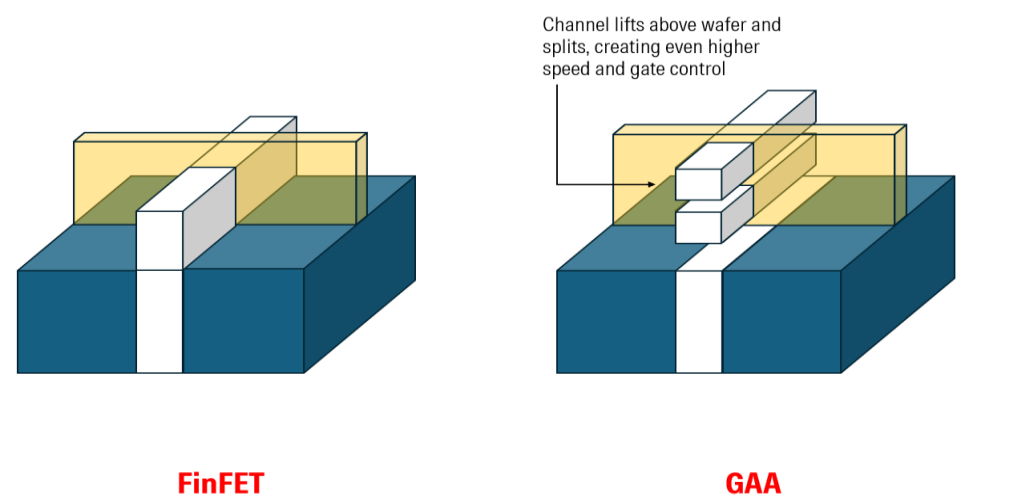
Exhibit 16 FinFETs Added 3D Circuit Characteristics to Improve Performance



Source: Morningstar.

Cutting-edge chips are now progressing to a new architecture, dubbed gate all-around, or GAA. GAA adds a fourth side to the channel, lifting it above the wafer itself to be surrounded on all four sides by the gate. Similar to the advantages of FinFET over a planar transistor, this adds control and speed to semiconductors, enabling better performance. It also adds significant manufacturing complexity for WFE firms to precisely build more complex, untethered 3D structures.

Exhibit 17 GAA Transistors Add More 3D Complexity for Even Better Performance



Source: Morningstar.

Beyond GAA, the industry is looking ahead to CFET (complementary FET) transistors toward the end of the decade. Without delving too deeply into atomic physics, we'll simply tell investors that CFET transistors further shrink the lateral width of the circuit by adding to the vertical height. This effectively halves the lateral size of individual circuits and creates opportunities for both vertical and lateral scaling.

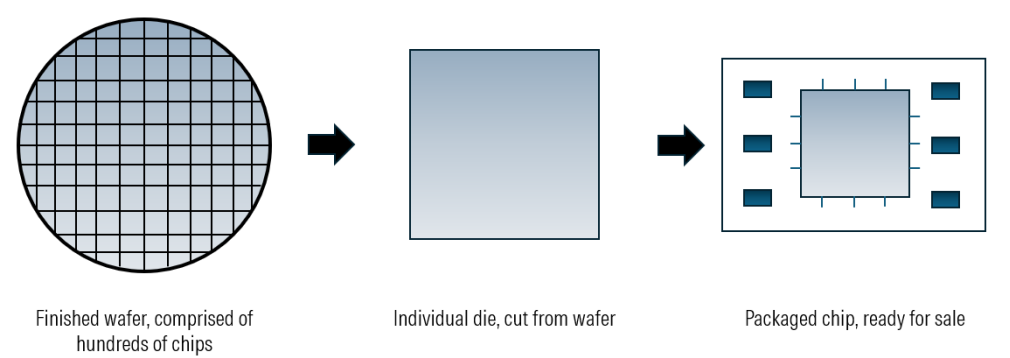
The advancement to new transistor architectures, particularly across three dimensions, requires more layers using atomic-layer deposition and EUV lithography, and more precise etching. We generally see the move to GAA transistors boding well for all WFE technologies across deposition, etch, lithography, and process control. We expect the eventual move to CFET transistors to require layers with high-NA EUV, which could drive higher lithography intensity at the end of the decade.

Advanced Packaging Brings Scaling Outside the Wafer Itself

Finally, we'll address a key piece of vertical scaling: advanced packaging and heterogeneous integration. These two technologies work in tandem to increase end chip complexity without relying on increasing lateral transistor density on a wafer. These technically don't count as WFE, as they occur after the chips on the wafer are fully built up. However, WFE vendors serve this market, and we see it as a key growth vector across lithography, deposition, etch, and process control.

To start, packaging is the final process of chip manufacturing, where a finished wafer gets cut into multiple individual dies. A single wafer could comprise dozens or hundreds of dies, depending on the complexity of the chips in question. After these finished dies are cut, they get placed into a sturdy metal package that both protects the fragile circuitry and enables connectivity with broader electronic systems for which the chip is destined.

Exhibit 18 Chips Get Manufactured Together on a Wafer Before Being Cut and Packaged Individually



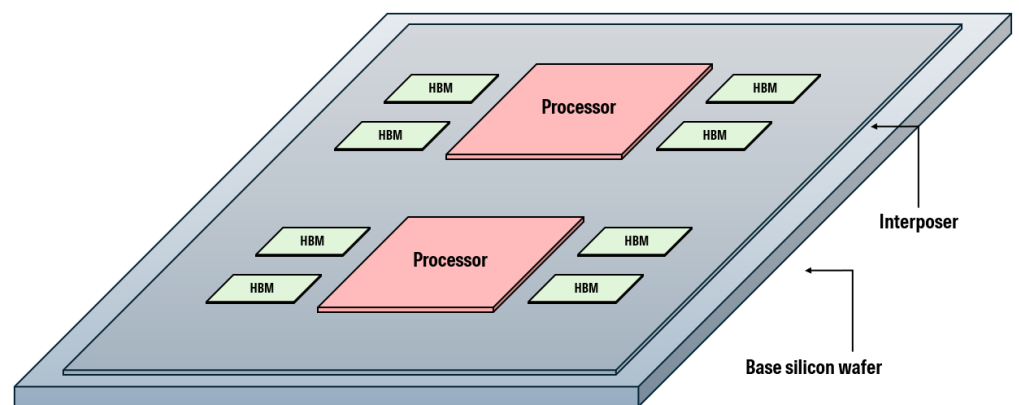
Source: Morningstar.

Heterogeneous integration is commonly referred to as the use of chiplets. Chiplets are small chip modules that can combine together on a wafer to form a unified chip. These allow chipmakers to include logic, memory, and analog technologies together on one package, rather than having discrete chips for each. Generally, manufacturing a chiplet is less complex than a monolithic chip and allows for greater customization in the final packaging process.

While the design and manufacture of chiplets may be less complex on their own, combining these into a final product requires significant advanced packaging technology. Advanced packaging is popular in AI compute chips like Nvidia's GPUs and highlighted by TSMC's proprietary chip-on-wafer-on-substrate, or CoWoS process. At a high level, this involves putting chiplets together on top of a base silicon wafer, connecting them into a unified chip. This requires significant interconnects between chiplets and additional wiring, all of which require incremental WFE intensity across etch, deposition, and process control.

As Lam Research puts it: "By bringing memory and processing closer together to optimize electrical pathways, chiplet designs can improve processing speed, and pack more power into smaller form factors. However, as chiplets scale taller and become more complex, they present a range of new manufacturing hurdles."

Exhibit 19 TSMC's CoWoS Advanced Packaging Process Brings Multiple Chips Together on a Unifying Package

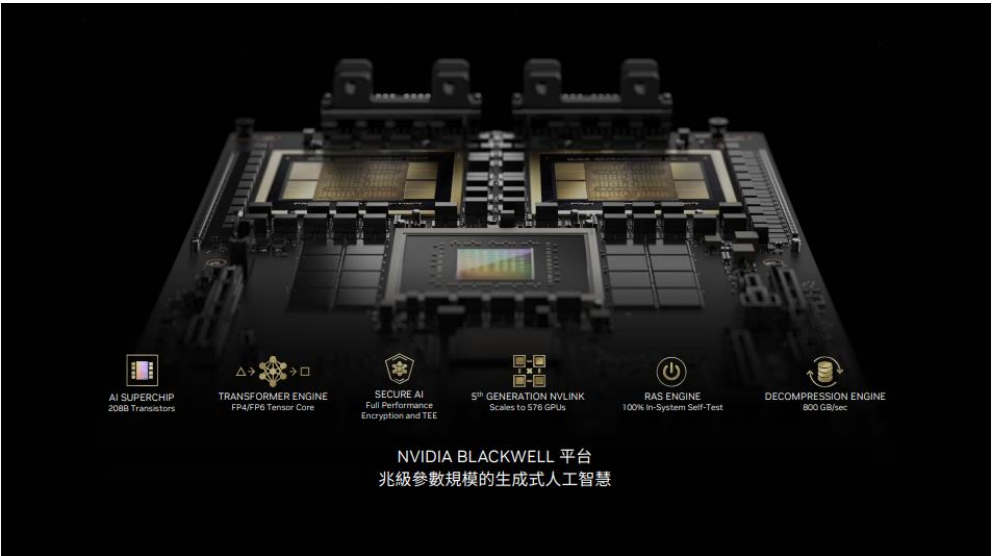


Source: Morningstar.

Technologies like CoWoS rely heavily on deposition and etch to connect these disparate chiplets. This is commonly referred to as "drill and fill" where chipmakers etch holes between two chiplets and fill them with copper to electrically connect chiplets together.

Advanced packaging allows the likes of Nvidia to combine two compute chips together to form a superchip, like its GB200. This can achieve significant gains in performance, with better power efficiency than a monolithic chip would achieve for the same performance. TSMC and other industry participants will sometimes refer to this as 2.5D technology, but we view it as an example of vertical scaling and 3D architectures.

Exhibit 20 Nvidia's GB200 Is a Prime Example of Using Chiplet-Based Designs To Advance Total Performance



Source: Nvidia Computex Keynote 2024.

Exhibit 21 Different Ways to Pursue Scaling Lead to Varying Outcomes for Intensity Across Different WFE Technologies

Design trend	Where it shows up	Lithography	Etching	Deposition	Why it moves spend this way
Multi-patterning	Logic/Memory	→	↑	↑	More deposition and etching steps are required in-between lithography steps.
DUV (Double Pattern) → Low-NA EUV (Single Pattern)	Advanced logic & DRAM	↑	↓	↓	When a chip layer transitions from double-exposure lithography to single-exposure, etch/deposition steps are reduced. Price rises because the Low-NA EUV scanner is more expensive than DUV scanner.
Low-NA EUV (Double Pattern) → High-NA EUV (Single Pattern)	Advanced logic/DRAM	↑	↓	↓	When a chip layer transitions from double-exposure lithography to single-exposure, etch/deposition steps are reduced. Price rises because the High-NA EUV scanner is more expensive than Low-NA EUV scanner.
Absolute higher number of EUV layers	Logic & DRAM	↑	↑	↑	More lithography needed and more advanced etch/deposition steps required
Gate-All-Around (nanosheets) & CFET	Advanced Logic	↑	↑↑	↑↑	High NA will be introduced for GAA and CFET, increasing lithography spending. GAA and CFET also require lateral etching, incremental dielectric deposition layers, and more epitaxy, among others.
2.5D/3D Packaging	Packaging	→	↑	↑	Advanced packaging requires more drill-and-fill to connect chiplets together.

Source: Morningstar.

A Concentrated Group of WFE Leaders Drive the Cutting Edge of Chip Manufacturing

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Key Takeaways

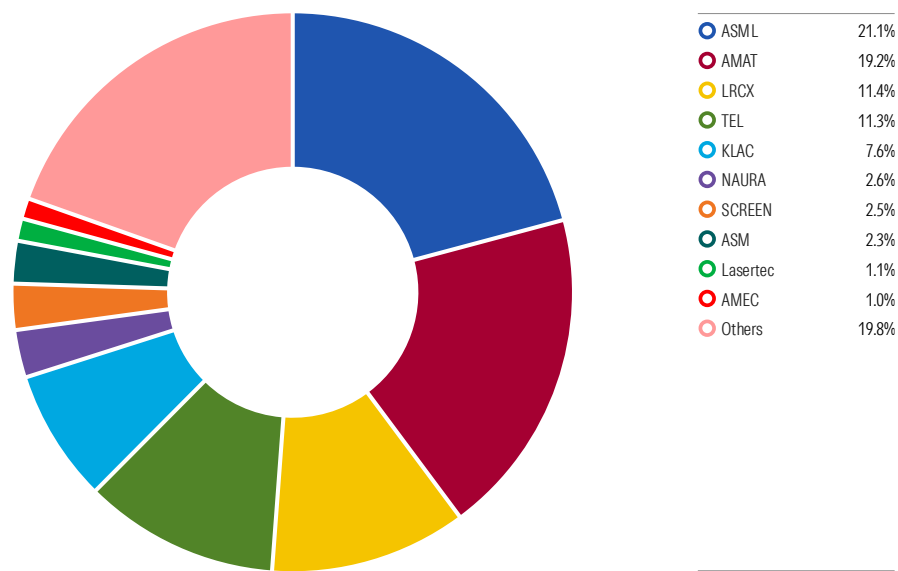
- ▶ The WFE market is a practical oligopoly, with the six firms under our coverage controlling three-quarters of the market: Applied Materials, Lam Research, ASML, KLA, ASM International, and Tokyo Electron. These firms are technology leaders in their sections of the market.
- ▶ Services offer a recurring revenue stream for WFE vendors that hedges against cyclicity.
- ▶ We assign wide moat ratings to all of our six covered WFE vendors. These moats are carved from immense technological depth built by heady research and development spending and switching costs for customers.

WFE Is an Oligopoly of Complementary Players

As we iterated previously, chipmaking technologies are wholly complementary. WFE is not a winner-take-all market. In any given fab, analysts would expect to see machines from ASML, Applied Materials, Lam Research, KLA, Tokyo Electron, ASM, and more. Multisourcing reigns supreme, even within a specific technology, like etch. At different layers and process steps for a given chip manufacturing line, there may be a Lam etch tool at some and a Tokyo Electron etch tool at others. This can stem from a firm's idiosyncratic prowess at a specific type of etch for a specific material at a specific step in the manufacturing process or a particular customer relationship. This dynamic is mirrored in deposition and, to a lesser extent, process control. The large exception to this rule is lithography, where ASML has a stranglehold monopoly on all but the lowest-value equipment.

There has been significant consolidation over the past few decades, resulting in a small group of leading firms that hold the majority of the wafer fabrication equipment market. Gartner sized the 2024 wafer fabrication equipment, or WFE, market at \$112 billion. The six firms under our coverage earn 75% of this spending and are followed by a long tail of smaller, niche firms (Exhibit 22).

Exhibit 22 Six Wide-Moat Technology Leaders Control 75% of WFE Spending

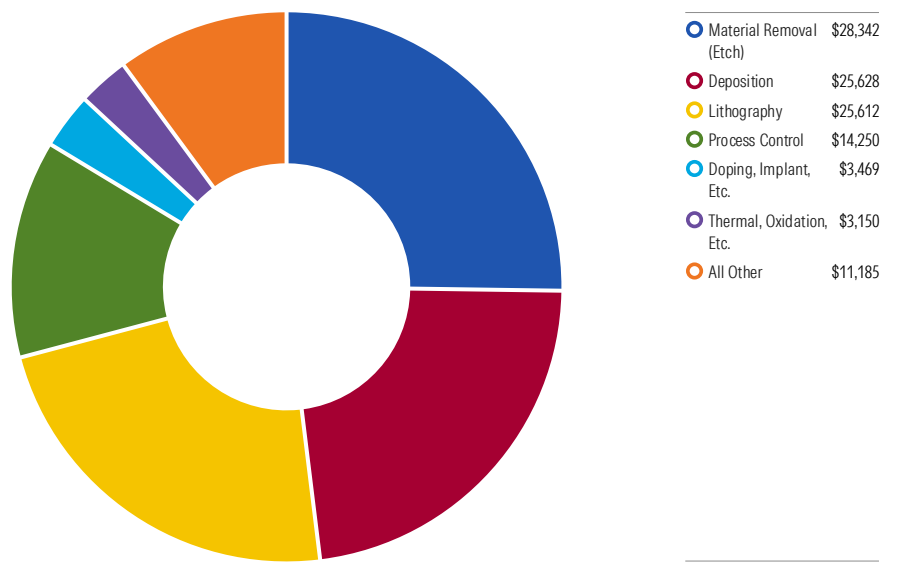


Source: Morningstar, Gartner. Based on 2024 market share data.

Chipmakers Invest in Four Primary Technologies

The largest three sections of this market, by far, are lithography, etch, and deposition, representing almost 75% of the market. These are WFE’s workhorse technologies. Process control is the clear fourth-place spot.

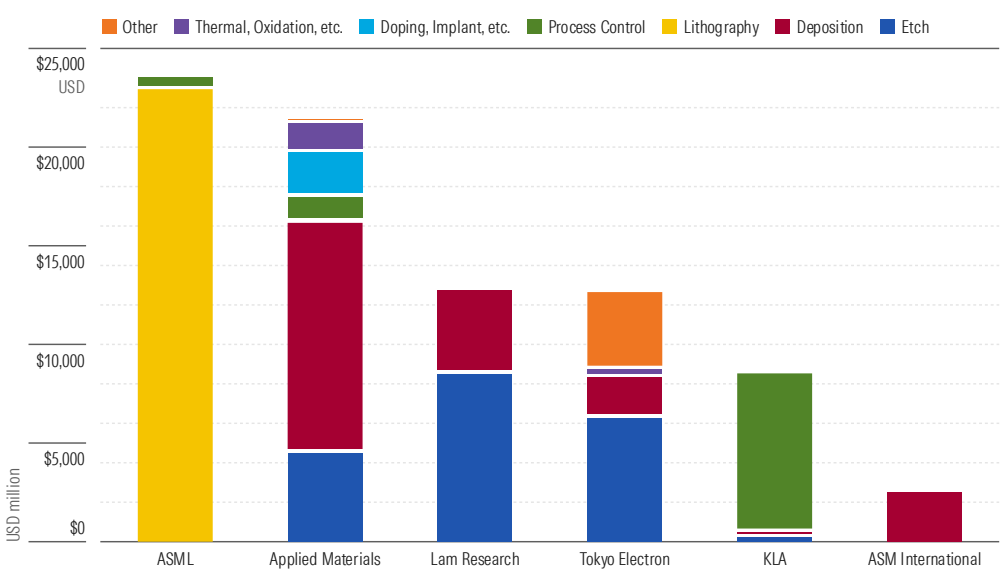
Exhibit 23 Lithography, Etch, Deposition, and Process Control Make Up the Majority of WFE Spending



Source: Morningstar, Gartner. Based on 2024 market share data.

WFE firms generally specialize in one or two of these technologies. Such complex manufacturing requires immense technical depth. We usually see moats carved for companies with the best technology depth, rather than breadth, in this market. Applied Materials stands out as the exception, participating materially at every major process step besides lithography.

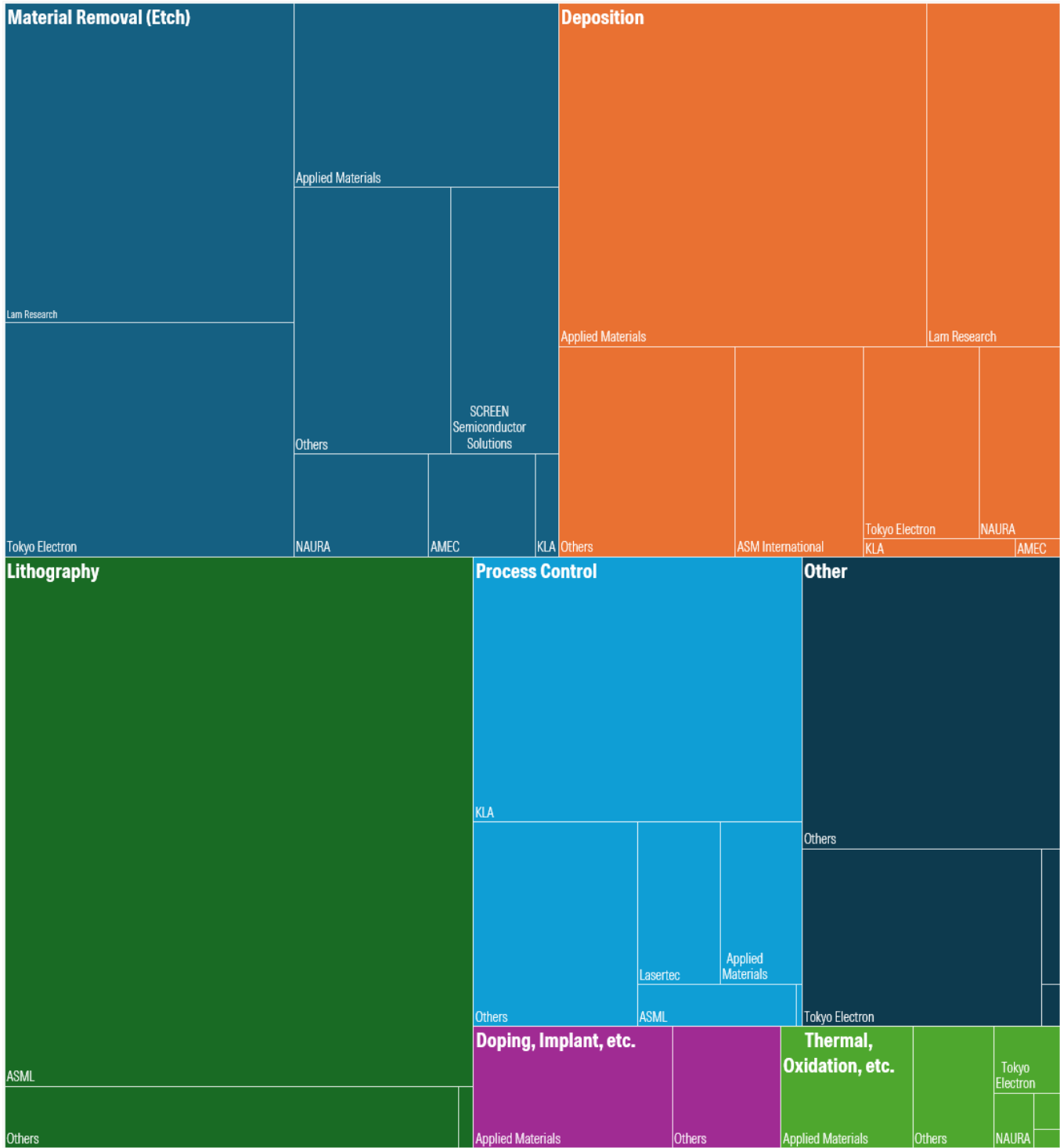
Exhibit 24 WFE Vendors Usually Specialize in One or Two Technologies



Source: Morningstar, Gartner. Based on 2024 market share data.

This technology concentration at vendors is the direct result of technological leadership and depth. No one can match ASML's abilities in lithography or KLA's in process control. When lithography and process control intensity rise, these directly benefit ASML and KLA. Similarly, we see Applied as the technology leader in deposition and Lam Research as the technology leader in etch. While both firms play in both markets, we see Applied benefiting more from higher deposition intensity and Lam benefiting the most from increases in etch intensity.

Exhibit 25 The WFE Market Is Composed of Many Complementary Technologies and Multisourcing Between Numerous Vendors



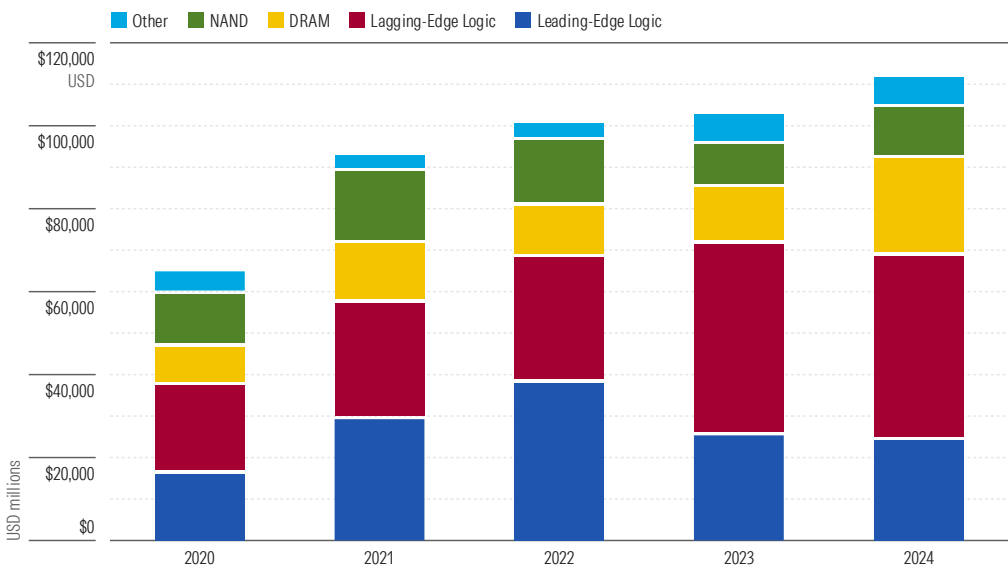
Source: Morningstar, Gartner. Based on 2024 market share data.

WFE Sales Broadly Sort Into Logic or Memory

We categorize WFE sales going to four distinct market verticals: leading-edge logic (the most advanced chips for compute), lagging-edge logic (less advanced, serving automotive and industrial markets), DRAM memory, and NAND memory. We've seen logic historically make up roughly 60% of the market, with DRAM and NAND taking up the rest. There is a small section of specialized memory spending on technologies that are neither DRAM nor NAND, but this is a small, niche section of the market.

We see generally similar market shares across these four markets between the leading WFE vendors under our coverage. Lam Research used to have a higher exposure to NAND memory but has gained share in logic chips over the past five years. Across the six technology leaders we cover, we view them all as broadly exposed across logic and memory today.

Exhibit 26 Logic Makes Up the Majority of WFE Spending, Split Between Leading- and Lagging-Edge

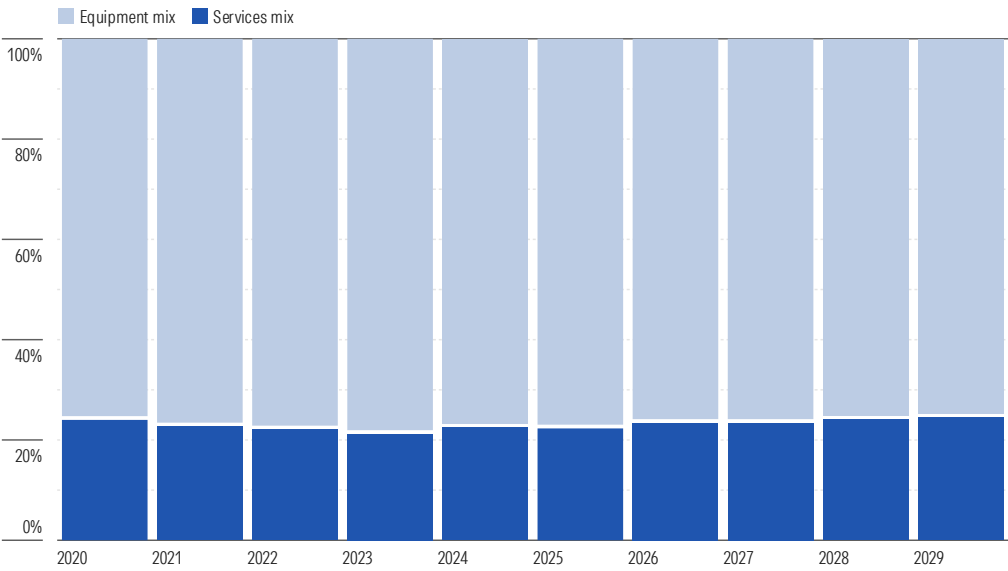


Source: Morningstar, Gartner.

Services Hedge Equipment Cyclical

Outside of the technology in which a firm specializes, the most important concept for investors to recognize is the scale of services for these WFE firms. Across our coverage, roughly 25% of overall revenue comes via services (Exhibit 27), with the balance coming from new equipment sales. This creates a good countercyclical, recurring revenue stream that we consider a terrific investment characteristic.

Exhibit 27 Across Our Covered WFE Firms, Services Make Up Roughly 25% of Revenue



Source: Morningstar analyst estimates, company documents. Represents combined revenue mix of ASML, Applied Materials, Lam Research, Tokyo Electron, KLA, and ASM International.

A single chipmaking machine can range from \$5 million-\$10 million for basic deposition to more than \$300 million for high-NA EUV lithography. A fully outfitted chip manufacturing facility, dubbed a fab, may have hundreds or up to 1,000 of these individual machines, leading to equipment spending on a single leading-edge fab surpassing \$10 billion.

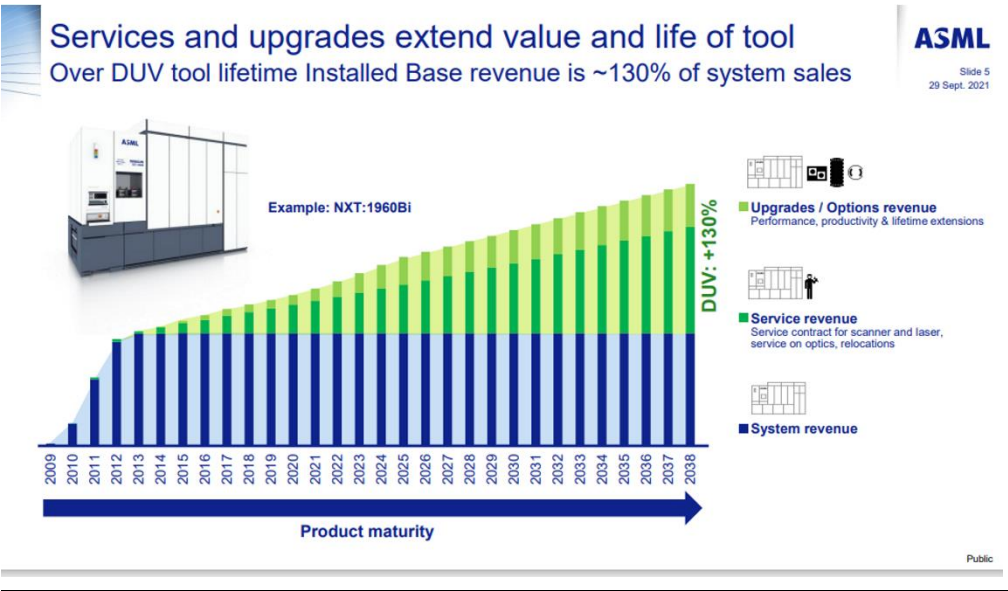
These manufacturing tools are so complex that they can't be operated without consistent, on-the-ground partnership with equipment services engineers. Service technicians from the likes of Applied Materials will work onsite at a fab, first training fab employees on operating the machines. Thereafter, they will remain for troubleshooting and general manufacturing optimization. Semiconductor manufacturers like TSMC, dubbed foundries, hold a massive fixed-cost base of equipment. These businesses' end-all-be-all is maximizing volumes and throughput (also known as yield) to earn profits on this fixed-cost base—making services technicians consistently optimizing production speeds critical to their success.

Attachment rates for service are high, especially for the most advanced equipment, as third-party vendors lack the know-how to repair and service these machines. Software updates are also proprietary, helping to lock in the customer. None of this equipment can run effectively at high yields without a services contract from the vendor.

KLA has cited that over the lifetime of a machine, which can be 20-30 years, it expects to recoup the equivalent to the initial sale price in services revenue. ASML goes even further and expects that, over their lifetimes, its DUV machines will generate 130% in service revenue compared with the initial sale

price (and EUV machines may earn 150% or more). These come primarily from spare parts, upgrades over a machine's life, and R&D work from building out new production lines.

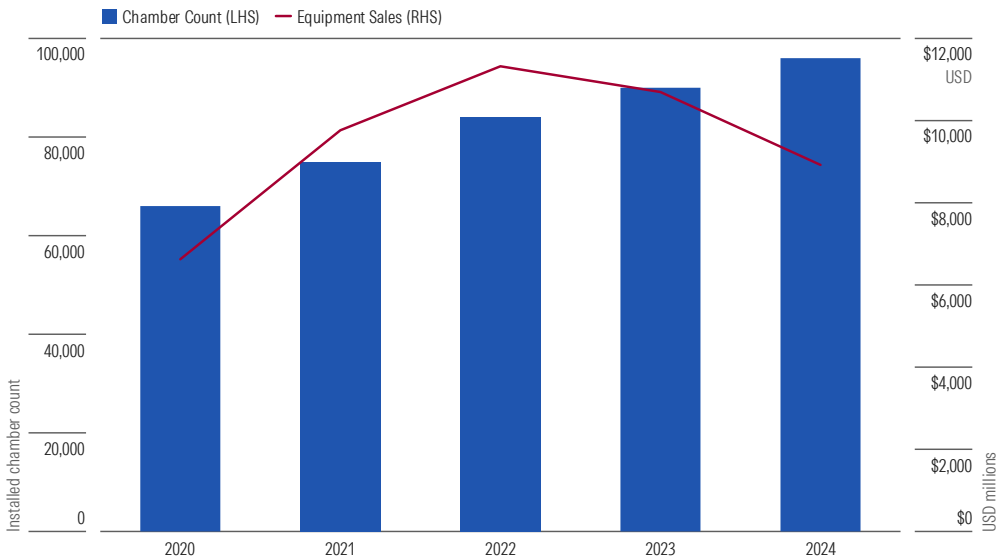
Exhibit 28 ASML Expects To Recoup More Than 100% of Equipment Prices Via a Lifetime of Services



Source: ASML.

Service revenue typically rises in a more linear fashion compared with equipment, given it is related to the existing installed base. As the installed base of equipment rises each year with new equipment sales, the services addressable market expands as there is an absolute higher number of machines installed. Even if equipment sales stalled or declined in a given year, we would expect services revenue to rise, as it is the result of the cumulative installed base of equipment, which grows with any new equipment sales. We show this in Exhibit 29 with Lam Research as a prime example.

Exhibit 29 While Equipment Sales Exhibit Cyclicalty, the Cumulative Installed Base Grows Consistently



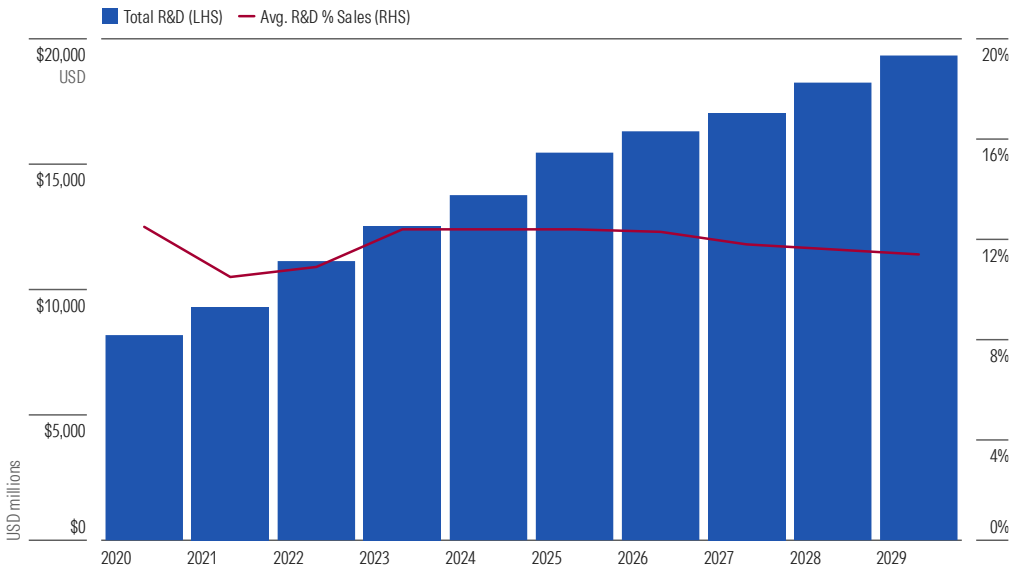
Source: Lam Research, Morningstar.

Leaders Etch Moats With R&D

Each of the six WFE vendors covered in this report holds a wide economic moat, and we would consider these the highest-quality WFE firms in the world. These firms have earned leading market shares via immense technological prowess and the ability to drive the cutting edge of chipmaking. For the most part, these firms are specialists in one to two technologies where they exceed peers in delivering complexity and high yields to customers.

Each of these peers well outspends any other WFE firm on research and development to stay at the front of the pack and enable the next evolution of chipmaking (whether it be a new transistor architecture, lateral scaling, vertical scaling, or advanced packaging). A company like Lam Research may spend less absolute R&D dollars than a larger peer like Applied Materials, but it will invest more in its core area, etch, giving it an edge. R&D investment is the single largest investment item for these firms and is critical to maintaining their wide moats. We expect these high investment rates into R&D to continue (Exhibit 30).

Exhibit 30 WFE Vendors Establish Technology Leadership With Heady Research and Development Spending

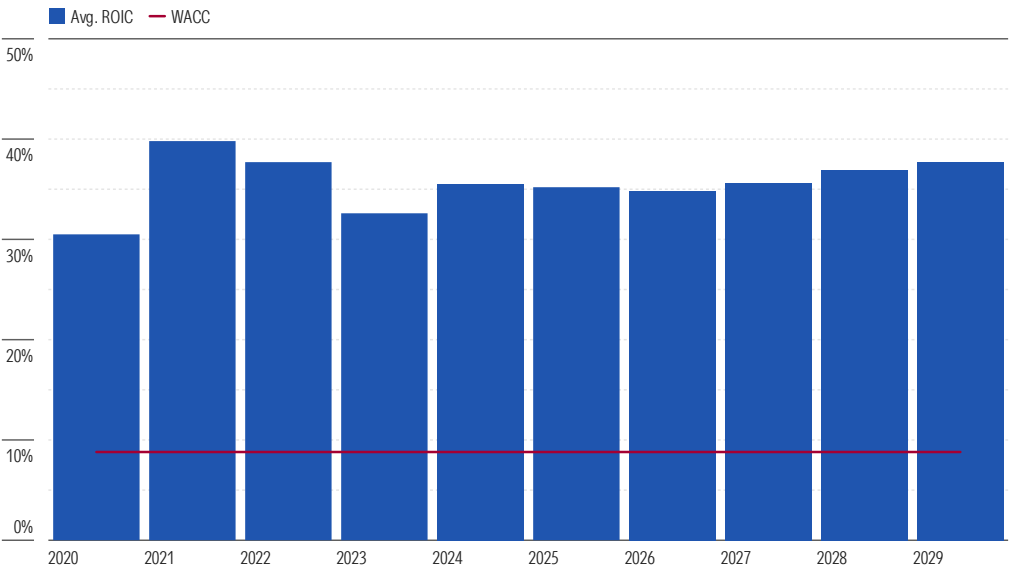


Source: Morningstar analyst estimates, company documents. Sum of annual R&D spending for Applied Materials, Lam Research, ASML, KLA, ASM, and Tokyo Electron.

Furthermore, we see switching costs contributing to wide moats for these best-of-breed WFE titans. Chipmakers will build out a production process for a new chip specifically tailored around their equipment selection at each process step. Services engineers will ensure that the machines deliver the quickest high-quality throughput to have the entire production line humming. Each machine is highly specialized, technical, and software-driven, leading to a steep learning curve for fab technicians. All these combine to make the machines very difficult to rip out and replace. Doing so would require months of testing and new training of employees, not to mention the cost of purchasing new machines. These switching costs drive the sticky services revenue streams for WFE vendors.

R&D-driven intangible assets combined with switching costs provide our covered group of WFE leaders with strong pricing power and immense returns on invested capital (Exhibit 31). We consider each of these leaders to be an extremely high-quality business, with strong profits, heady cash flow, and durable competitive advantages.

Exhibit 31 Our Covered Six WFE Leaders Exhibit Strong Returns on Invested Capital and Wide Moats



Source: Morningstar analyst estimates, company documents. Average ROIC and WACC across ASML, Applied Materials, Lam Research, Tokyo Electron, KLA, ASM International.

AI Should Drive a Strong Five-Year Upcycle for WFE Vendors

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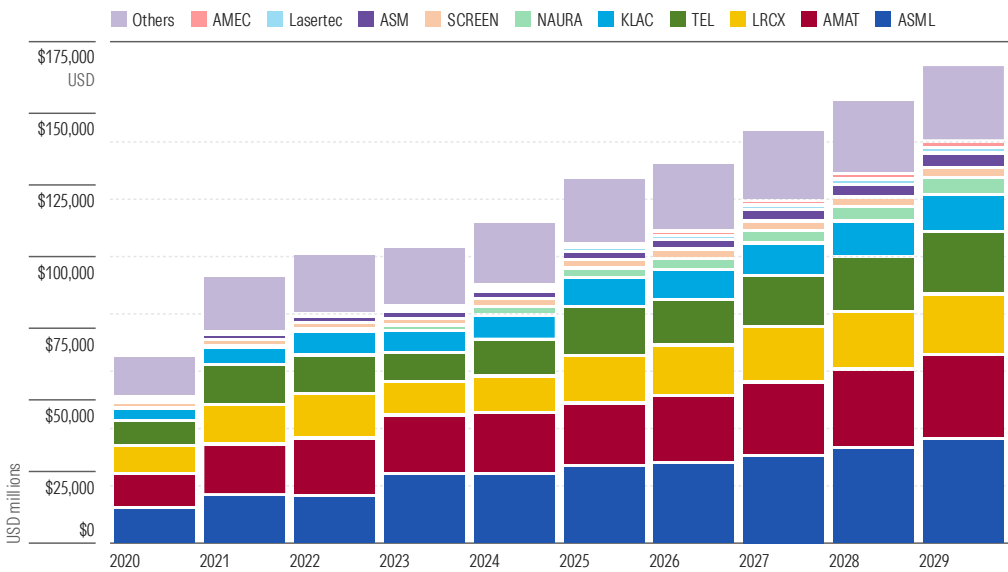
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Key Takeaways

- ▶ We forecast 8% annualized growth in WFE spending, rising to \$167 billion in 2029. Our expectations for strong AI infrastructure investments drive our forecast. We're more bullish than Gartner on the magnitude and duration of this growth but appear in line with sell-side consensus in the short term.
- ▶ WFE in isolation underestimates the total opportunity for vendors under our coverage. These firms also benefit from advanced packaging sales and services, increasing their total addressable market by 25%.
- ▶ ASML, Applied Materials, Lam Research, Tokyo Electron, KLA, and ASM International are the biggest AI winners in WFE. These firms hold the most exposure to the cutting edge of chip technology, including leading-edge logic and advanced packaging like TSMC's CoWoS and HBM processes that support AI chips. We expect these six to grow above the rest of the market and take share from smaller peers.
- ▶ We view Lam and Applied as the biggest beneficiaries of advanced packaging investment. Lam should see more etch intensity for chiplet-based designs, and Applied holds the broadest advanced packaging portfolio.
- ▶ ASML and ASM should benefit from a higher mix of advanced logic chips that require more use of ALD and EUV. ASML should also benefit from a transition to high-NA EUV at the end of the decade.
- ▶ We expect elevated spending out of China on WFE to be another driver of WFE growth. To us, Gartner looks overly pessimistic on China's ability to maintain these investment levels.

Exhibit 32 We Forecast AI Investments To Drive 8% Annualized Growth for WFE Over the Next Five Years



Source: Morningstar analyst estimates, Gartner.

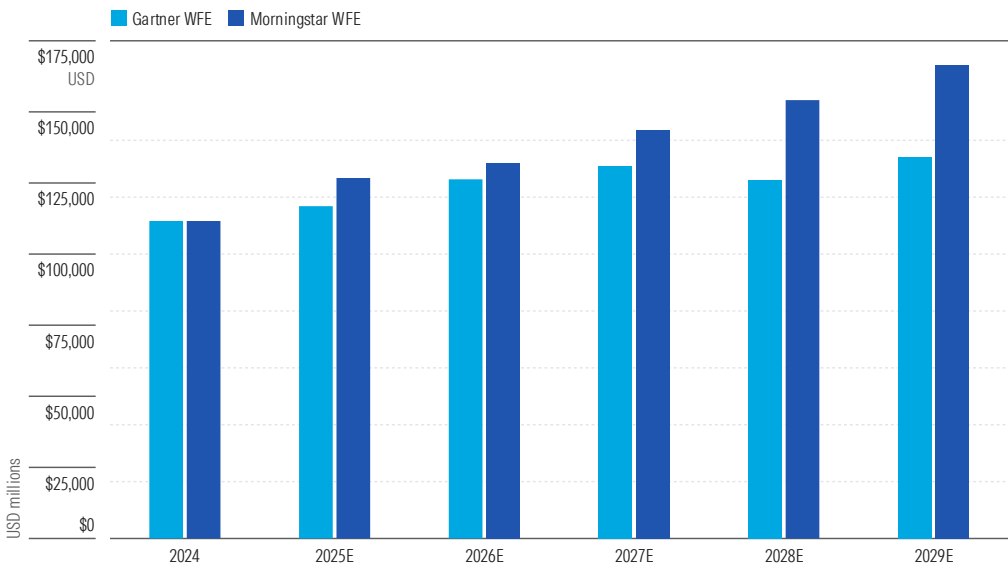
We Forecast a Strong, AI-Driven Upcycle for WFE

We forecast the WFE market bottom-up, led by our models for the six WFE technology leaders under our coverage: Applied Materials, ASML, Lam Research, Tokyo Electron, KLA, and ASM International. Our forecasts for WFE vendors are built up by equipment type (lithography, etching, deposition etc.), end market (logic and memory), geographic destination, and between services and equipment. These splits allow us a high level of granularity in our total market forecast, which we intend to break down for investors step by step throughout this section. We round out our forecast with simplified estimates for the rest of the WFE market, including a handful of the next-largest firms that we don't cover. Investors can find our detailed forecast assumptions in table form in our Appendix.

We're More Bullish Than Gartner and Consensus on Longer-Term WFE Growth

Our 8% annualized growth forecast looks bullish compared with Gartner's five-year global WFE forecast, which we attribute in large part to our bullishness on the level and durability of AI investment. Our delta against Gartner is relatively moderate through 2027, with a mid-single-digit percentage difference. By 2029, however, we estimate a 20% larger market than Gartner, and we see our primary differentiation arising in this longer-term forecast and our expectations for continuing AI infrastructure investments through the end of the decade.

Exhibit 33 Our Longer-Term AI Investment Confidence Drives Our Above-Gartner Forecast

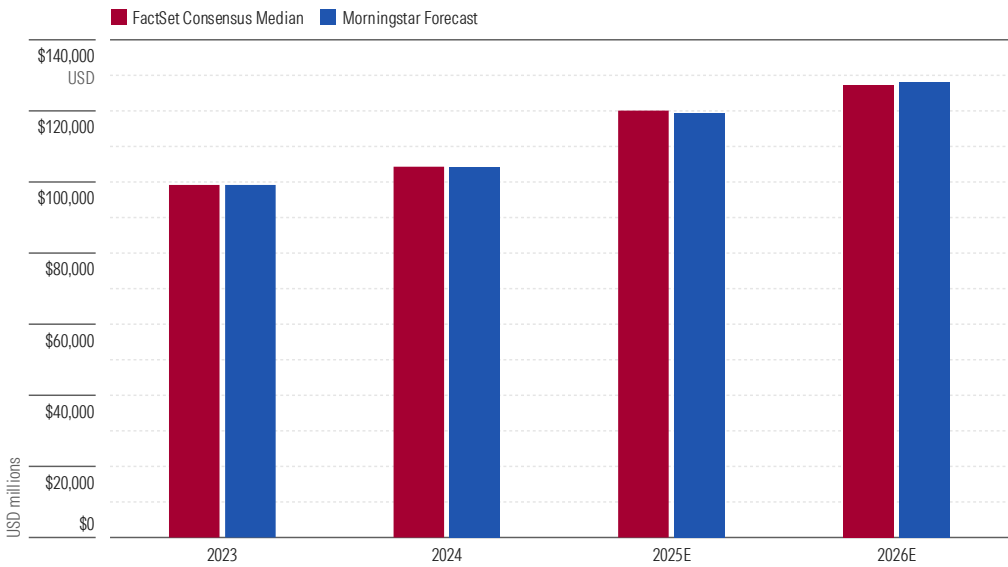


Source: Morningstar analyst estimates, Gartner.

While we're bullish against Gartner's forecast, our expectations are more in line with sell-side consensus estimates, at least in the short term. When we compare our aggregated forecasts for the six wide-moat WFE vendors under our coverage with FactSet consensus, we come in mostly in line through 2026. We model 10% growth in 2025 for this group's total revenue, followed by 7% growth in 2026 (Exhibit 34).

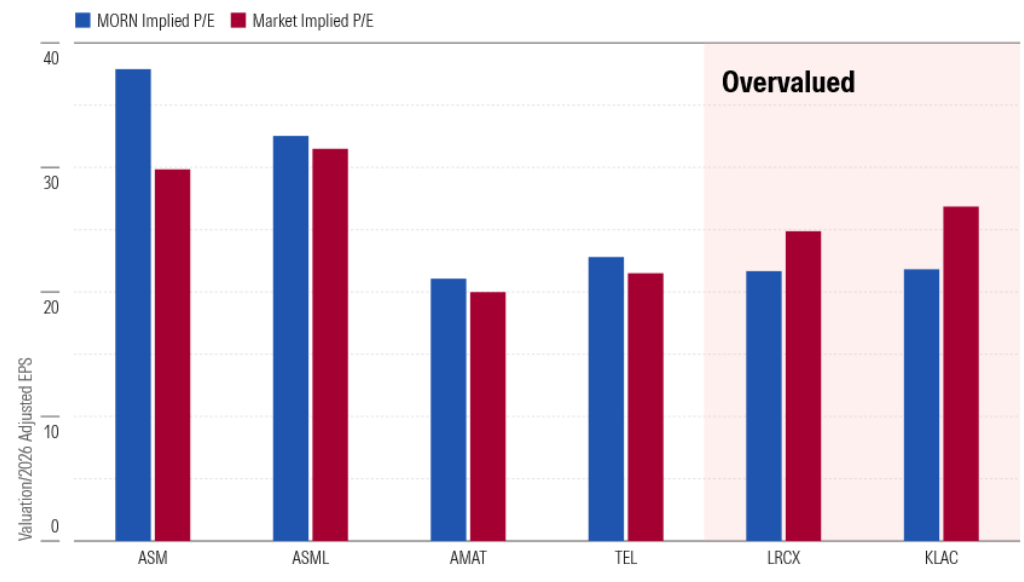
However, valuations in the market imply a greater divergence in our views versus consensus longer term (Exhibit 35). While we see an attractive growth opportunity being priced in for Lam Research and KLA, we see a stark difference in the valuations on ASML, Applied Materials, and ASM. To us, this implies weaker long-term growth being priced in for these three names, baked in to weaker valuation multiples off of 2026 earnings. We don't agree with this disconnect. To us, all six of our wide-moat names are strong beneficiaries of AI investment and should experience similar growth opportunities. This informs our belief in ASM as our top pick and fair valuations on ASML and Applied.

Exhibit 34 Our Aggregated Firm Revenue Forecasts Come in Line With Short-Term FactSet Consensus Estimates...



Source: Morningstar analyst estimates, PitchBook. Revenue summed for ASML, Applied Materials, Lam Research, Tokyo Electron, KLA, and ASM International.

Exhibit 35 ...But Diverging Valuations Show a Greater Disconnect in Longer-Term Growth Assumptions

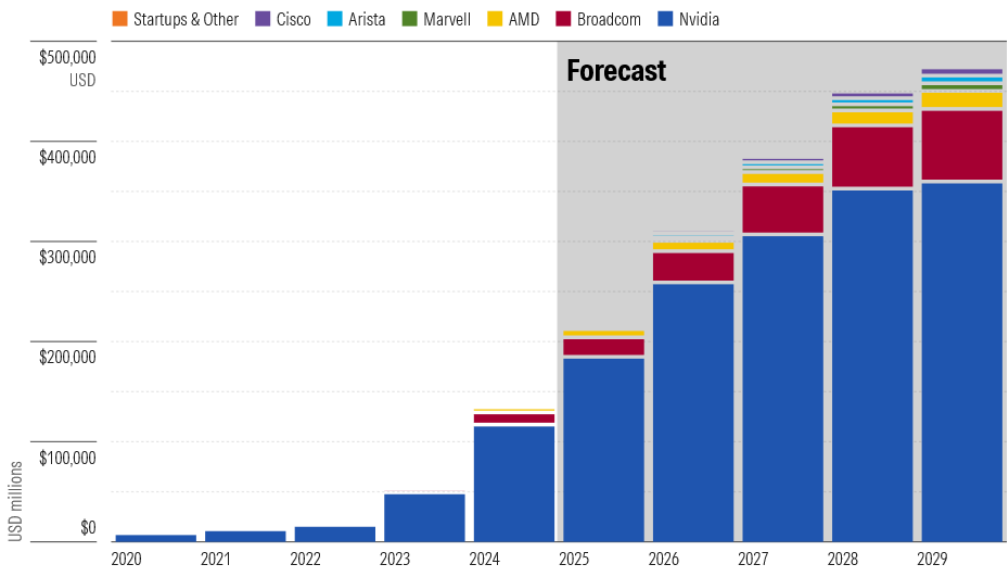


Source: Morningstar analyst estimates, PitchBook.

No Surprise Here—AI Is Driving WFE Growth

AI is the biggest driver of WFE growth over our forecast, the biggest driver of our valuations of ASML, Applied Materials, and ASM, and a primary point of our differentiation against Gartner. The surge in AI infrastructure investments has been well established at this point. We see AI infrastructure spending, primarily by leading hyperscale cloud providers like Microsoft, Meta, Google, and Amazon Web Services, driving immense growth for chip vendors like Nvidia and Broadcom (Exhibit 36). This growth, in turn, raises orders from their manufacturing partners like TSMC, which in turn raises orders from WFE vendors.

Exhibit 36 Insatiable AI Demand Is Driving Immense Growth for AI Accelerators and Networking



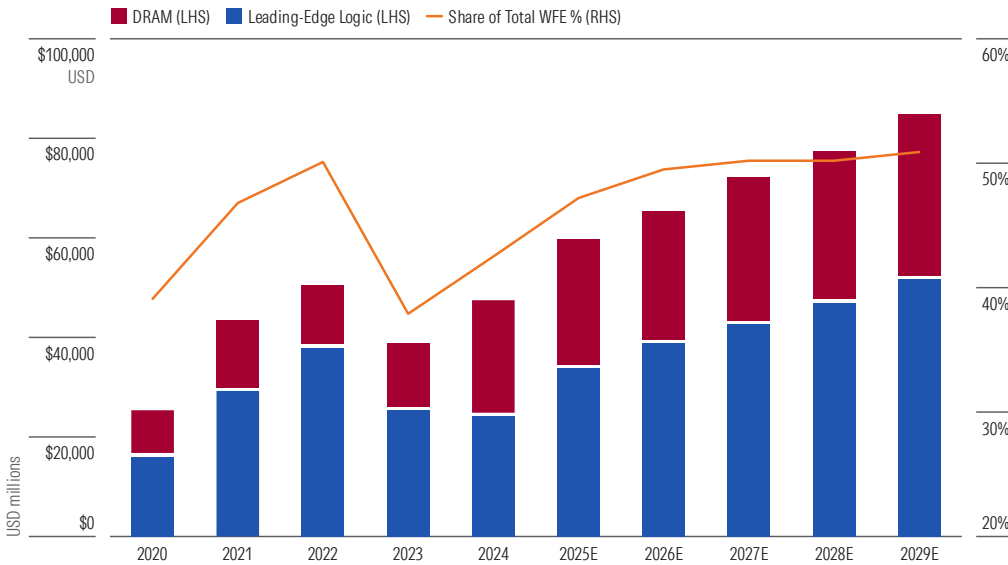
Source: Morningstar estimates, company documents. Data as of Aug. 28, 2025.
Note: Nvidia and Marvell=FY end-January, FY 2025 roughly equal to calendar 2024. Broadcom=FY end-October, FY 2024 roughly equal to calendar 2024.

AI investment drives sales of leading-edge logic WFE for GPUs and other accelerators as well as DRAM WFE for high-bandwidth memory to go into these accelerators. It also includes advanced packaging equipment that tilts heavily toward AI chips using chiplet-based designs and the likes of TSMC's CoWoS process. We define "leading-edge" logic chip investment as supporting chip nodes of 7 nanometers and below, which includes all AI processors.

We expect the strongest growth for leading-edge logic WFE over our forecast, rising by 17%, annualized, through 2029. This comes primarily via our expectations for investments in AI chip production. DRAM investment surged in 2024 to fuel the initial demand for HBM. We expect DRAM investment to remain elevated to support rising demand, but after such strong initial investment in 2024, we don't expect quite as much growth in our forecast (6% annualized) as we do for leading-edge logic. In Exhibit 37, we show our expectations for leading-edge logic and DRAM to make up more than half of total WFE in 2029, compared with a 42% mix of total WFE spending in 2024.

We note that our expectations for WFE growth from AI pale in comparison to our expectations for AI chip growth from the likes of Nvidia and Broadcom. This stems from WFE being a derivative of chip production, and that chipmakers like TSMC can pass higher volumes through newer equipment. So, while we don't expect WFE to grow commensurately with Nvidia's high-flying growth, we expect it to rise directionally in line with AI chip supply.

Exhibit 37 AI Should Drive Strong WFE Growth and a Rising Mix of Advanced Logic and DRAM Chips



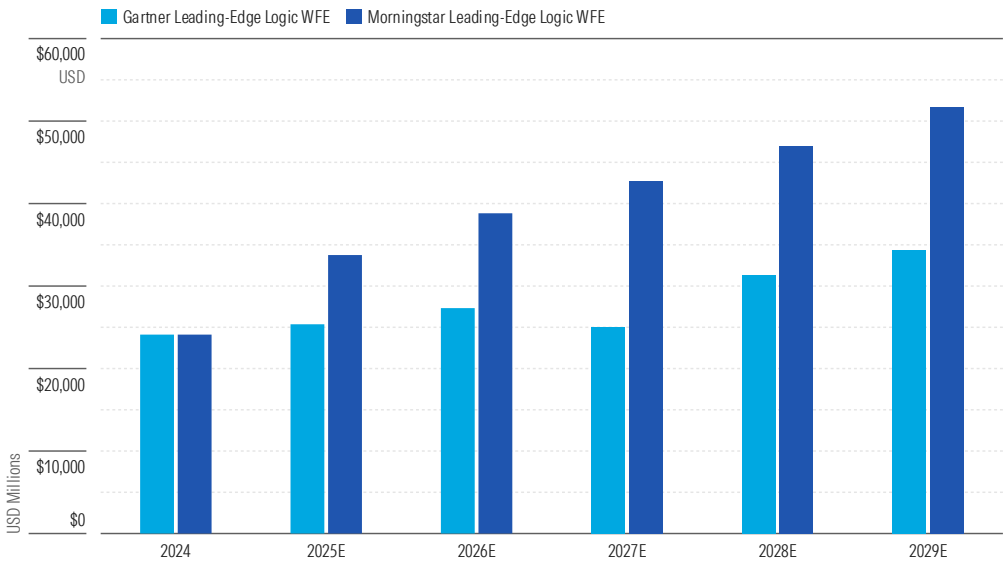
Source: Morningstar analyst estimates, Gartner.

Our AI Bullishness Puts Our Leading-Edge WFE Forecast Well Ahead of Gartner

We are more optimistic than third parties about the magnitude and durability of leading-edge logic WFE growth coming from AI investments, which informs our bullishness on ASM as our top pick and our valuations across the group.

Gartner’s forecast calls for 7% annualized growth through 2029 for leading-edge logic WFE, versus our own forecast at 17%. Our primary differentiation comes in 2025 and 2027, shown more clearly in Exhibit 38. Gartner’s forecast for 5% leading-edge growth in 2025 appears a significant underestimate to us, against strong reported growth for WFE firms through the first half of the year and our expectations for 40% capital spending growth from TSMC, which is the dominant leading-edge customer today. We also disagree with Gartner’s forecast for an 8% decline in 2027, as we expect AI investment to endure over the next five years and maintain more consistent medium-term growth. We model 40% leading-edge logic WFE growth in 2025, followed by low-double-digit growth over the next four years.

Exhibit 38 Our AI Expectations Drive Our Leading-Edge Logic WFE Forecast Higher Than Gartner's



Source: Morningstar analyst estimates, Gartner. Leading-edge defined as 7nm nodes and below.

We Align Our Leading-Edge WFE Forecast to Investment Growth at Advanced Chipmakers

Our forecast for leading-edge logic WFE growth and our valuations on our preferred picks in WFE are supported by our capital spending growth estimates for leading-edge chipmakers. Similar to dynamics we observe in WFE, we see a very small handful of firms succeeding at cutting-edge chip manufacturing and benefiting disproportionately from AI investment over our forecast. Namely, we expect TSMC, SK Hynix, and Micron to be the largest AI chipmaking customers over the next five years.

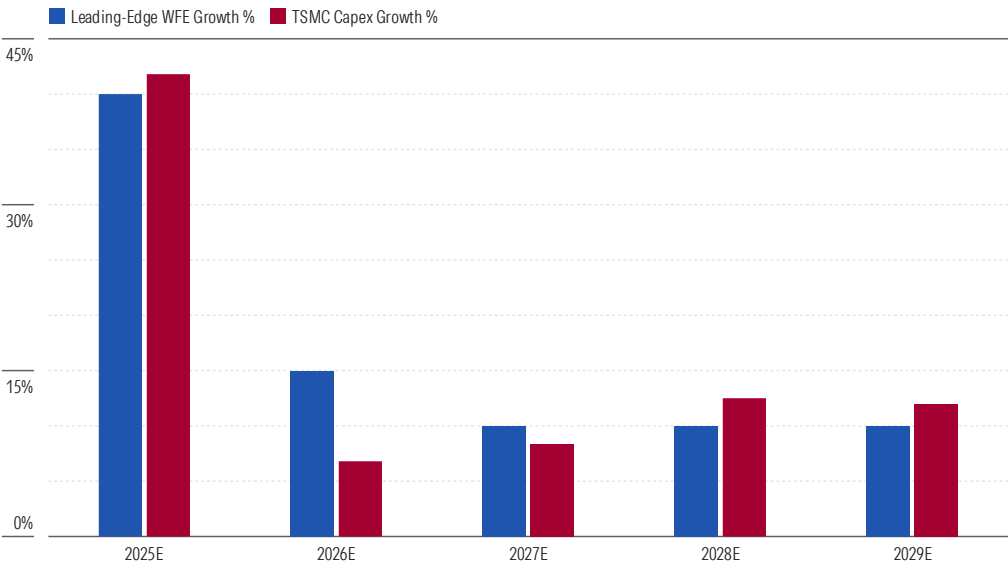
TSMC has a significant lead in leading-edge logic chip manufacturing, producing all the GPUs and accelerators for Nvidia, AMD, and Broadcom (not to mention processors for Apple, Qualcomm, and every other leading chip designer). We expect this lead to expand over the next five years given missteps across both of TSMC's major foundry competitors, Intel and Samsung, in progressing to more advanced chip nodes. Alongside logic, we see SK Hynix and Micron as the leading customers for high-bandwidth memory WFE given their early market leadership in HBM chips and capacity. We expect Samsung to eventually catch up to its two major peers in HBM but still see this as an overall concentrated base of customers leading AI chipmaking investments.

The largest beneficiary over our forecast is TSMC. Simply put, AI demand is immense and supply-constrained, leading to huge investment in new capacity from TSMC, especially as it consolidates share from underperforming competitors like Intel and Samsung. We forecast 42% growth in capital spending from TSMC in 2025, followed by double-digit annualized growth through 2029.

Our 17% annualized growth forecast for leading-edge logic WFE matches our capital expenditures forecast for TSMC, where we assume a 16% CAGR in the same period. TSMC is a good proxy for broader cutting-edge chip manufacturing investment as the sole manufacturer of AI accelerators and other

advanced processors for Nvidia, AMD, Broadcom, Qualcomm, and Apple. After a stronger surge of initial investment in 2025, we anticipate continued robust investment growth at TSMC in the high single digits to low double digits through 2029. We also note that our forward expectations for TSMC capital spending match its five-year historical growth rate of 16% annualized growth, from 2019 to 2024.

Exhibit 39 Our Leading-Edge Logic WFE Forecast Agrees With Our TSMC Spending Estimates

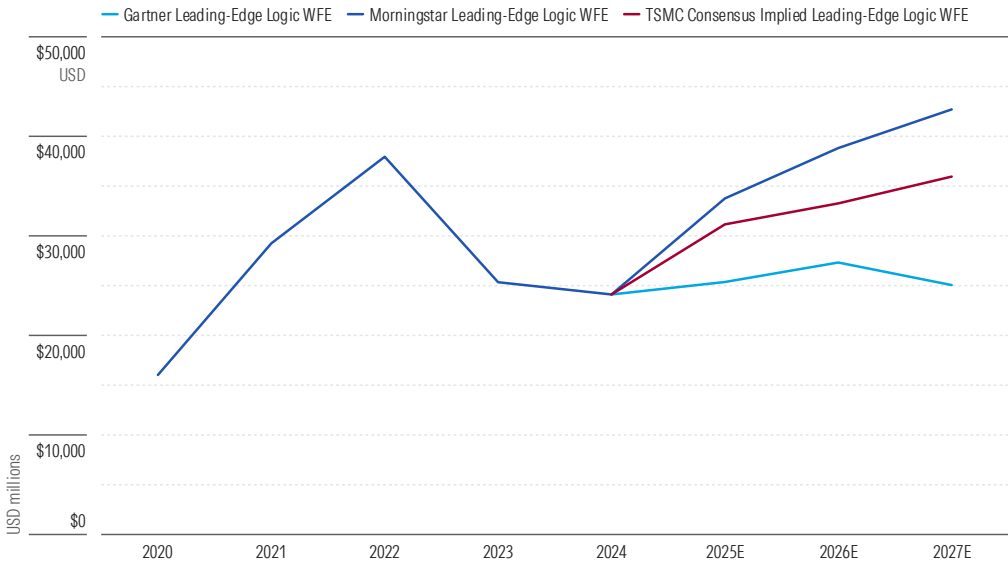


Source: Morningstar analyst estimates.

To us, Gartner's leading-edge WFE forecast makes a disconnect with our views on the investment growth outlook of leading AI chip manufacturers. We expect leading-edge logic WFE to closely follow the investment growth rate of TSMC, and Gartner's forecast falls short of our expectations for the latter.

Investors may well be skeptical of our lofty assumptions for AI investment. Our bullish WFE market forecast is heavily leveraged to strong assumptions for AI infrastructure spending, predominantly from the likes of TSMC. Any lower investment on TSMC's part could create downside to our WFE expectations. Our TSMC capital expenditure forecast is above consensus by about 10%, primarily due to higher expectations in 2025. If we aligned with consensus expectations for TSMC capital spending, we'd see downside to our current leading-edge WFE forecast and to our valuations on our wide-moat WFE coverage. We show this in Exhibit 40. Even in this more bearish scenario, we would still come in above Gartner's leading-edge logic WFE estimates. Skeptical investors can take a more conservative view and still see strong growth upside for WFE vendors at the leading edge, though potentially see less attractive valuations for the group, with the exception of undervalued ASM.

Exhibit 40 TSMC Consensus Implies Downside to Our Leading-Edge Logic WFE Forecast but Remains Bullish on AI



Source: Morningstar analyst estimates, PitchBook, Gartner.

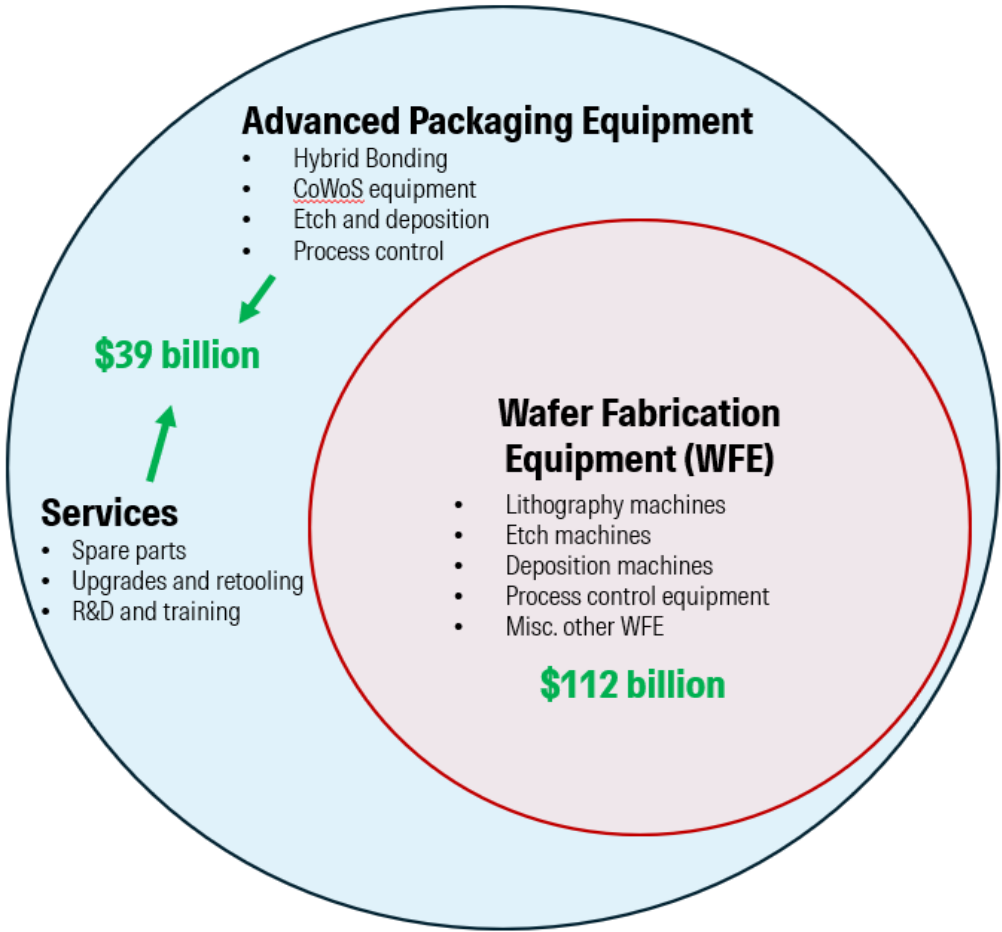
WFE Is Only One Piece of the Puzzle

We believe looking at WFE spending alone underestimates the total addressable market for our covered group of WFE technology leaders, which also benefit from growth in advanced packaging and services revenue that isn't included in the definition of WFE. We believe advanced packaging and services add roughly 25% to the base WFE opportunity for these well-positioned vendors. While the total WFE market came in at \$112 billion in 2024, we estimate the total opportunity for these vendors was \$150 billion, including services and advanced packaging revenue.

Investors should have a view on WFE—it is a number that each vendor discusses and a common denominator for discussing the industry. However, we believe that WFE in isolation is an increasingly dated metric. Advanced packaging is a nascent adjacency for leading chipmakers that is becoming more and more foundational to advanced chip manufacturing. Packaging used to be an afterthought—chip complexity was focused on wafer fabrication. Now, however, chipmakers like Nvidia are using advanced packaging techniques as a core way to improve chip performance and efficiency. Rather than fitting more features in the same silicon piece, designers are now turning to chiplets, where different chips are interconnected for optimal performance, energy consumption, and heat dissipation.

While it technically occurs after wafer fabrication, we view advanced packaging as a new piece of the total equipment opportunity for WFE vendors. Advanced packaging uses similar manufacturing techniques to wafer fabrication, including additional steps for lithography, etch, deposition, and process control. This drives an additional growth outlet for the likes of Applied, Lam, and KLA.

Exhibit 41 Looking at WFE in Isolation Underestimates the Total Opportunity for WFE Vendors



Source: Morningstar analyst estimates, Gartner. Figures represent 2024 global revenue.

Advanced Packaging Is Another Vector of AI Chip Investment

Advanced packaging specifically tilts heavily toward AI investments, which drives a material piece of our growth forecasts and valuations for the likes of Applied Materials, Lam Research, and KLA. Our advanced packaging market estimate and forecast is relatively narrow, focusing on CoWoS and similar technologies specifically serving cutting-edge AI and high-bandwidth memory chips. There are varying definitions of advanced packaging market sizing, and the broader total packaging market is significantly larger but is less exposed to WFE vendors. For our purposes, current advanced packaging capacity predominantly serves GPU and HBM chips.

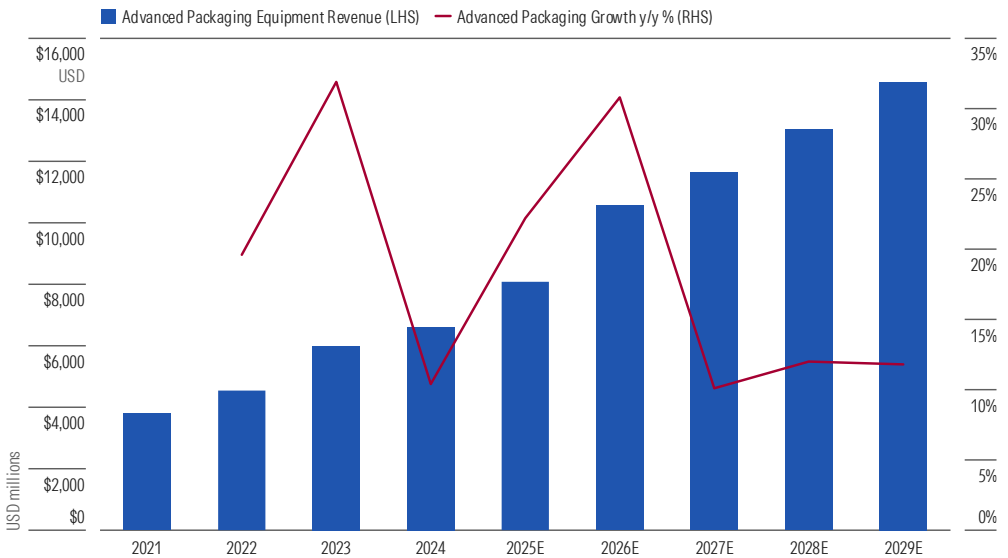
We won't cover packaging pure-plays, like Besi or ASMPT, in this report. These firms also stand to benefit from our advanced packaging forecast, but we focus here on the adjacent impact on WFE firms and won't discuss the pure-play packaging opportunities in-depth. In our view, there is a large and quickly growing pie for both WFE vendors and pure-play packaging vendors to serve in CoWoS, HBM, and related technologies. Investors looking at pure-plays on the advanced packaging opportunity in

isolation should refer to our reports on Besi and ASMPT. For this report, we'll focus on the combined opportunity in WFE and advanced packaging for our WFE coverage.

Advanced packaging expands the addressable AI revenue opportunity for WFE technology leaders over the next five years. AI chips are heavily supply-constrained, and firms like TSMC and Intel have significant plans to expand advanced packaging capacity. TSMC has cited a goal of 50% growth for its CoWoS capacity between 2022 and 2026, and Intel has previously iterated plans to quadruple its own advanced packaging capacity by 2025. TSMC is also ramping up its next-generation advanced packaging technology, 3D SOIC, the evolution to CoWoS.

All in, we size our narrow definition of the advanced packaging market at above \$6 billion in 2024, rising 17%, annualized, to more than \$14 billion in 2029. We forecast this market from the top down, using capital spending estimates for packaging vendors and leading foundries like TSMC. From these estimates, we assume varying spending mixes to advanced packaging equipment specifically. We estimate that between 5% and 15% of capital spending by leading-edge chipmakers will go toward advanced packaging going forward. Wafer fabrication remains the larger part of the advanced chipmaking process, with WFE taking up roughly 60% of total capital spending, but advanced packaging is an increasingly critical final step.

Exhibit 42 We Forecast 17% for Advanced Packaging Equipment Sales Over Five Years, Led by TSMC



Source: Morningstar analyst estimates.

We expect the mix of spending on advanced packaging to skew higher for TSMC, which is heavily investing in expanding its CoWoS capacity and represents a disproportionate amount of overall cutting-edge chip capacity. We estimate TSMC allocating more than 10% of its total capital spending to advanced packaging capacity, compared with a mid-single-digit percentage for Intel. We expect TSMC

to make up the lion’s share over the next five years with its CoWoS process used by Nvidia, Broadcom, and AMD for leading AI accelerator chips.

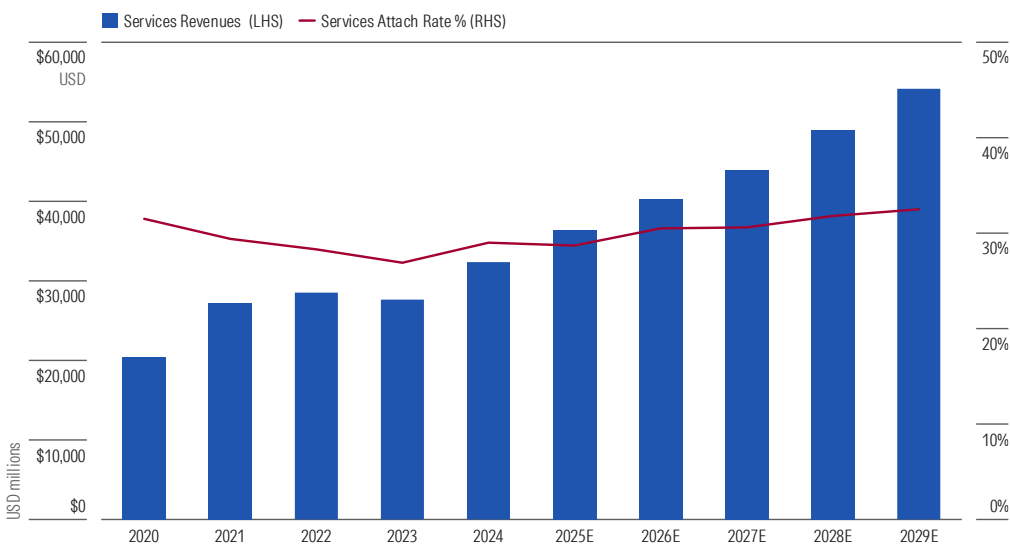
Our advanced packaging growth estimate matches our 17% growth estimate for leading-edge logic WFE spending, as well as our TSMC capital spending expectations. We assume a rising mix of advanced packaging spending for TSMC as it invests to expand its CoWoS capacity, which is more heavily supply-constrained than pure leading-edge logic WFE today.

Services Add Another Revenue Opportunity on Top of WFE and Advanced Packaging

Services provide yet another growth opportunity, and a hedge against cyclical­ity, for our wide-moat WFE vendors. Like advanced packaging, services aren’t included in the market definition of WFE but are intrinsically a piece of the total revenue opportunity for these vendors. Services also apply to advanced packaging equipment just as they do to WFE. At a roughly 25% mix of total firm revenue across our WFE coverage, services are a core piece of our growth thesis for ASML, Applied Materials, and peers.

We forecast global WFE and advanced packaging services revenue to rise at an 11% rate over our forecast, from \$32 billion in 2024 past \$50 billion in 2029, providing an additional growth vector for WFE vendors. Services have historically expanded at double-digit annual growth rates, driven by an expanded install base, upgrades for new chip designs, and standard repairs and troubleshooting. We forecast this trend continuing.

Exhibit 43 We Expect Steadily Rising Services Revenue, and a Rising Services Attach Rate, Over Our Forecast



Source: Morningstar analyst estimates, company documents.

Against our 8% WFE growth estimate, we imply a gently rising mix of services overall. We define a services attach rate as the proportion of services revenue to equipment revenue. This number can be lumpy due to the lumpiness of WFE sales—when equipment sales spike in a given year (like 43% growth

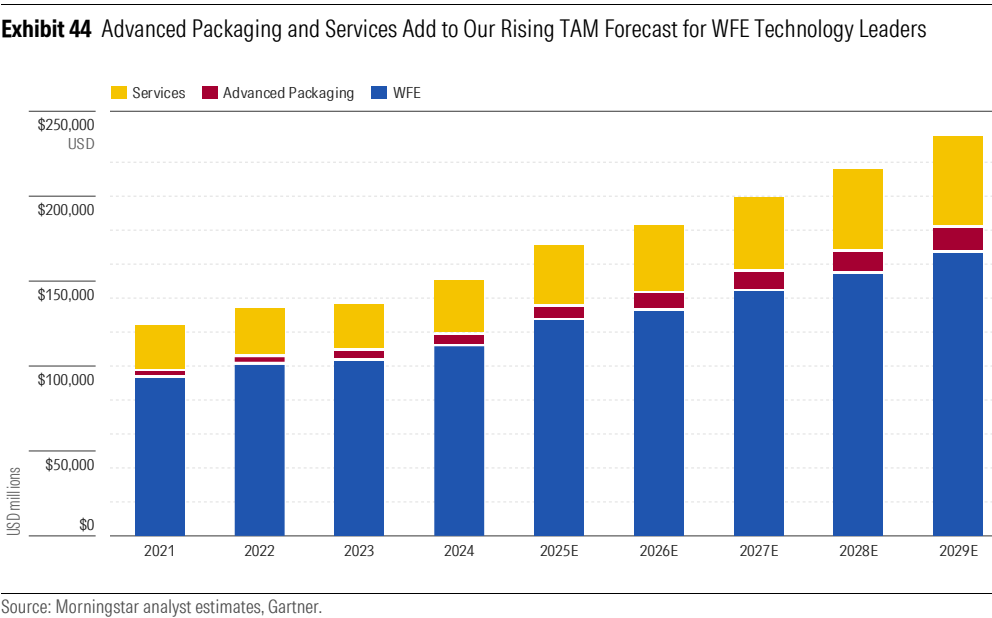
in 2021), this attach rate takes a short-term hit. Over time, however, we expect it to rise. We forecast the services attach rate to rise to the low-30% range in 2029, up from the high-20% range in 2024.

Higher machine complexity is another driver of higher service revenue. As we described earlier, while ASML estimates its DUV machines can generate 130% of the initial equipment sales in services revenue over their lifetime, the number grows to 150% or more for EUV. Thus, a higher mix of advanced equipment for AI chips provides additional upside to the services opportunity, and attach rate, for WFE vendors.

We note for investors that not all services businesses, as reported by WFE firms, are created equal. Many firms like Applied Materials and Lam Research count legacy equipment sales in their services segmentations. We correct for this in our forecast, sorting legacy equipment revenue into WFE and keeping our services mix exposed only to pure services (repairs, upgrades, R&D, and training).

Adding Advanced Packaging and Services Widens the Total Opportunity for WFE Leaders

Adding our views on advanced packaging and services to our total WFE forecast, we estimate 9% growth in the total addressable market for our wide-moat WFE coverage, rising from \$150 billion in 2024 to \$230 billion in 2029. This is a market driven by AI investments across WFE, advanced packaging, and services in the medium term. This total addressable market forecast implies about 100 basis points of higher growth than just looking at WFE in isolation.



While this combined forecast implies a higher delta to Gartner's WFE-only forecast, we remind investors that this comprehensive market is baked into sell-side consensus for the total revenue opportunity for these vendors. As such, we continue to see ourselves in line with the market through 2026, but with diverging growth expectations in 2027 and beyond. Just as with our WFE forecast, our bullishness on AI

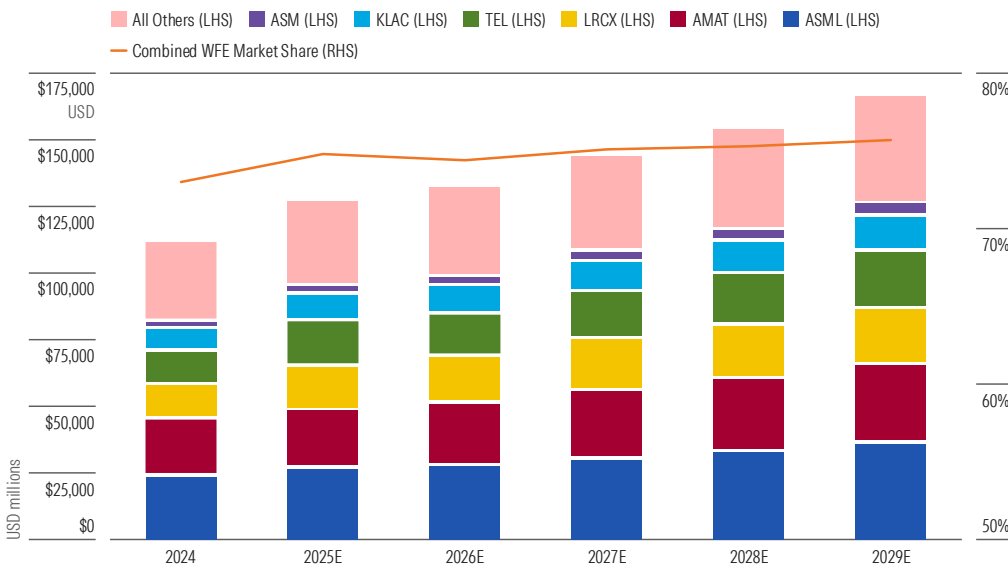
investments driving enduring growth over five years informs our total forecast, including for advanced packaging. We see growth enduring steadily over five years but believe that lower, diminishing growth is currently baked into valuations on ASML, Applied Materials, and ASM. Our bullish views make these look more attractive today.

Strong AI Investment Should Benefit Best-of-Breed Incumbents

We see ASML, Applied Materials, Lam Research, Tokyo Electron, KLA, and ASM International as the biggest beneficiaries of AI investment in WFE and advanced packaging. Each of these firms hold a wide economic moat, resulting from their immense proficiency at driving leading-edge chipmaking technology. We credit this technological leadership for this group's combined 75% share of the market today, and we see an even higher share at the leading-edge frontier of chipmaking.

These six are thus well positioned to benefit disproportionately from AI investment over our forecast. To us, these are the largest winners of AI investment in WFE and should all see attractive, durable growth over the next five years.

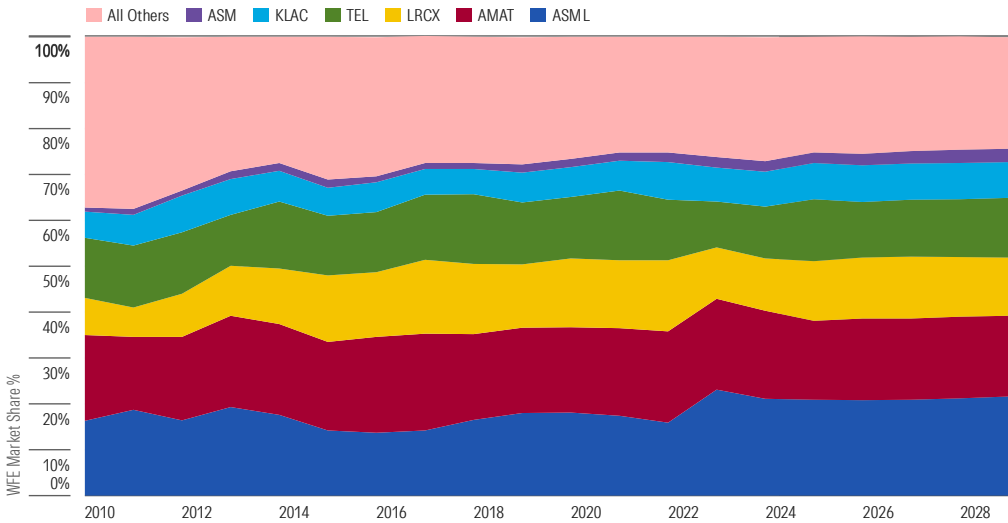
Exhibit 45 We See Our Covered Wide-Moat WFE Vendors Maintaining High Share During a Strong AI Growth Cycle



Source: Morningstar analyst estimates, Gartner.

Over the last 15 years, we've seen this group of six wide-moat technology leaders steadily gain share over smaller rivals—specifically gaining more than 1,000 basis points of share since 2010. To us, this shows a superior ability to innovate and drive the cutting edge of chipmaking, resulting in higher share at the most advanced customers like TSMC. We expect this trend to continue over our AI-driven forecast, which we show in Exhibit 46.

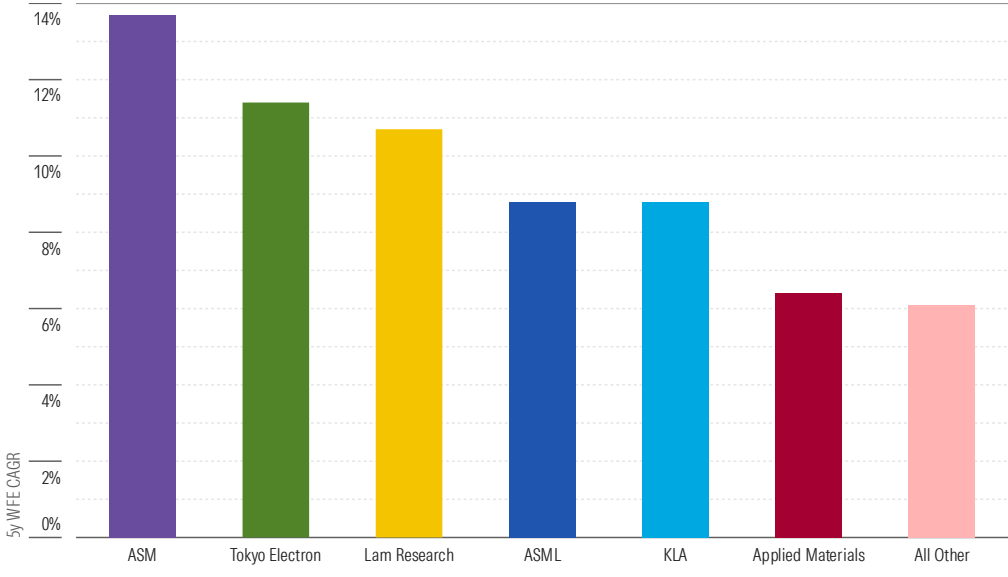
Exhibit 46 We Expect Market Share Gains for WFE Technology Leaders to Continue Over Our Forecast



Source: Morningstar, Gartner.

Our expectations for higher growth in leading-edge logic and DRAM WFE directly correlate with our high-growth expectations for this group of six technology leaders. These firms hold a higher share of spending on cutting-edge chips, and a rising mix of those chips to serve AI will drive above-market growth for these firms. We expect growth for the long tail of smaller firms as well, but we see these serving lower-value sections of the market and underperforming our wide-moat WFE coverage. In particular, we see the highest growth from ASM as our top pick, to the tune of 14%, annualized.

Exhibit 47 We Expect Our Wide-Moat WFE Coverage To Grow Above the Rest of the Market



Source: Morningstar analyst estimates.

ASM and ASML Should Grow Via a Higher Mix of Advanced Logic Chips

ASM and ASML excel at specific leading-edge process steps, which we expect to expand within WFE spending, which positions them well to capture an outsized portion of rising AI WFE demand. AI chips should utilize more layers with ALD and more layers with EUV. As leading-edge logic WFE rises in the mix of total WFE with AI investment, we expect a higher mix of ALD and EUV to follow and benefit these firms. This drives our high growth expectations for both and informs our bullishness on these as two of our preferred picks, particularly for ASM with the highest growth in our forecast.

ASM International is the leader in atomic-layer deposition, or ALD, and practically a pure-play to this technology. ASM's concentration in this most cutting-edge piece of the deposition market should drive share gains. We expect advanced chips to require more steps using ALD (compared with more traditional deposition like CVD that is dominated by Applied Materials), which allows ASM to serve more layers within a chip manufacturing process. This remains a niche process step, shown by ASM's 2% market share in 2024. ALD is critical despite lower share, and we see incrementally more use of this technology driving attractive growth for ASM. Put simply, ALD penetration should rise in AI chips, and ASM stands to benefit commensurately as the ALD technology leader.

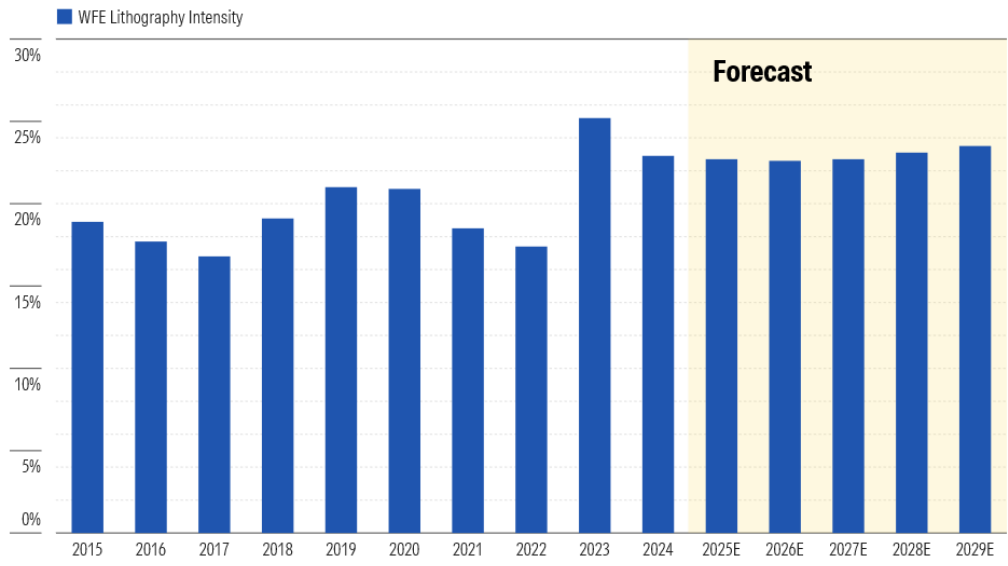
We Don't Think Lithography Intensity Has Peaked

For ASML, we see a rising mix of advanced logic chips raising demand for lithography, as these chips use more high-priced EUV lithography equipment than their less-advanced counterparts. We also see the introduction of new high-NA EUV equipment toward the end of the decade as an additional growth driver. We expect ASML to grow in line with WFE through 2027, with growth picking up around 2028 and 2029 with the adoption of high-NA EUV at customers enabling higher pricing.

There is a common thesis among investors that lithography intensity has "peaked." We see this as a short-term-oriented thesis. Since a trough in 2017, spending on lithography tools has gained 500 basis points of total WFE spending share, reaching 23% in 2024. We model lithography intensity plateauing during the next five years in the 23%-25% band, but not declining (Exhibit 48).

We see partial credence to the "lithography peak" thesis, as we do expect chipmakers to pursue vertical scaling and advanced packaging in the short term, which requires proportionally less lithography (and proportionally more etch and deposition). However, we see this dynamic offset by a higher mix of advanced logic chips for AI that use proportionally more lithography in WFE. These offsetting dynamics lead us to expect lithography to plateau at its current level. In the long term, we expect ASML to benefit from greater penetration in AI chipmaking and a technology transition to high-NA at the end of the decade, which provides some upside to lithography intensity at the end of our forecast. When these machines get adopted for high-volume manufacturing, they will carry higher prices for ASML to drive growth.

Exhibit 48 Our Forecast Assumes Modest Growth in Lithography Intensity From 2024



Source: Morningstar analyst estimates, Gartner.

Historically in chipmaking, we've seen alternating periods of horizontal and vertical scaling, with one usually being prioritized over the other in a given period. During horizontal scaling, chip designers aim to shrink the size of transistors and pack more into a given area. During vertical scaling, chip designers develop new transistor architectures or packaging designs. Horizontal scaling requires proportionally more lithography, and vertical scaling requires proportionally more etch and deposition.

ASML has enjoyed a period of horizontal scaling in logic chips over the last decade, creating strong stock outperformance. After the introduction of the FinFET around 2014, logic chipmakers shrunk these designs and increased the transistor density of their chips. Over the next three years, we see the pursuit of vertical scaling taking priority, with the transition to GAA transistors and more advanced packaging intensity. This would lead to more gains in etch and deposition intensity, and relatively lower gains in lithography intensity.

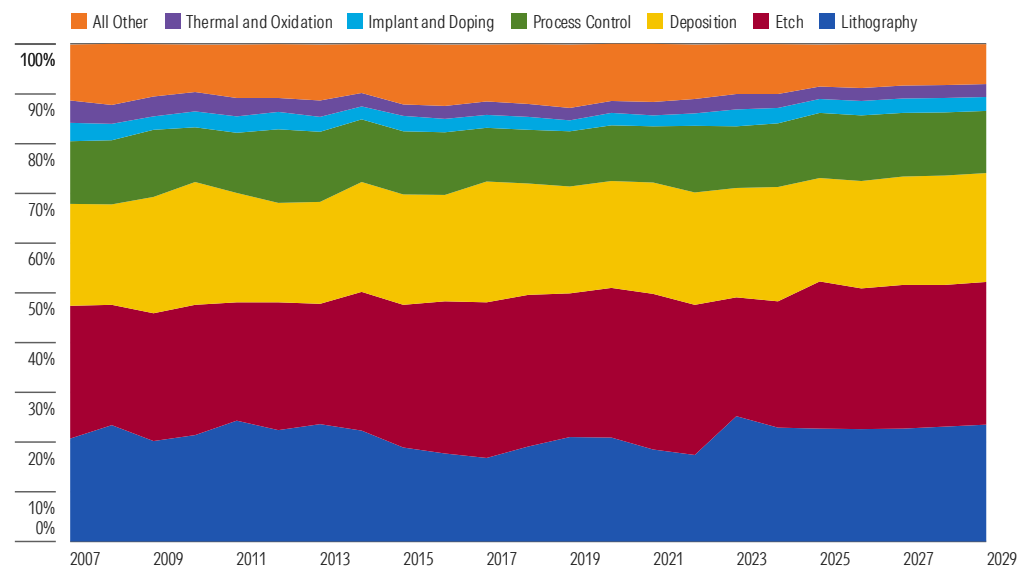
We posit a simple argument for lithography intensity to maintain even during a period of vertical scaling in the short term: a higher mix of advanced logic chips. Advanced logic chips, like for AI applications, require proportionally more lithography than lagging-edge logic or memory. As we expect the mix of leading-edge logic chips to rise over our forecast, this would directly lead to higher overall lithography intensity in the market via mix. This creates an offset to scaling via advanced packaging in our forecast, with a net neutral impact to lithography intensity through 2027.

Furthermore, when we take a long-term view, we expect a new period of horizontal scaling to follow the oncoming period of vertical scaling. This would entail increasing the density of GAA transistors on a chip and raising the circuit density of individual chiplets. One example we expect toward the end of the decade is more chip layers transitioning to single-patterning using high-NA EUV. Single-patterning is

simpler and improves yield but requires more expensive lithography tools. Chipmakers typically pursue double-patterning to advance complexity without more advanced lithography, but this reaches a ceiling at a certain point. Over long time periods, we see alternating eras of single- and double-patterning driving a tick-tock pattern in lithography intensity. In the short term, we see double-patterning over the period of vertical scaling but expect a period of single-patterning to follow, likely using ASML's high-NA tools.

We find historical credence to this view. Over a long time horizon across multiple technology transitions, we've seen relatively low changes in WFE intensity between technologies. Long-term investors should continue to see WFE leaders, like ASML, Applied Materials, and our other wide-moat coverage as attractive beneficiaries of broad gains in chip complexity. To us, changes in intensity of one technology in the short term are more noise than signal, with a high likelihood of mean reversion. Thus, we see the risk of long-term lithography underperformance as low.

Exhibit 49 We've Seen a Consistent Mix of WFE Technologies Since 2007, Which We Expect to Continue



Source: Morningstar, Gartner.

Another argument for the lithography peak thesis is cost. These machines are incredibly expensive, with EUV lithography equipment costing around \$250 million per machine, and high-NA EUV reaching \$350 million-\$400 million per machine. Some investors may expect high prices to lead chipmakers to pursue other means of improving chip complexity.

These numbers attract a lot of headlines, but we contend that what matters is not the cost of the machine but the cost per wafer or chip produced. Fabs are businesses with great operating leverage and produce very high volumes. Even if a machine is expensive, it will be accretive if it manages to reduce marginal cost per chip. From the foundry point of view, every business will try to optimize on its largest cost items (lithography), so if fabs can find a way to marginally reduce the dependence on

lithography while maintaining chip quality, they will. Hence, ASML must continue delivering on technology and productivity improvements to maintain customer satisfaction, which we expect it will do given its long-term technological and productivity roadmap.

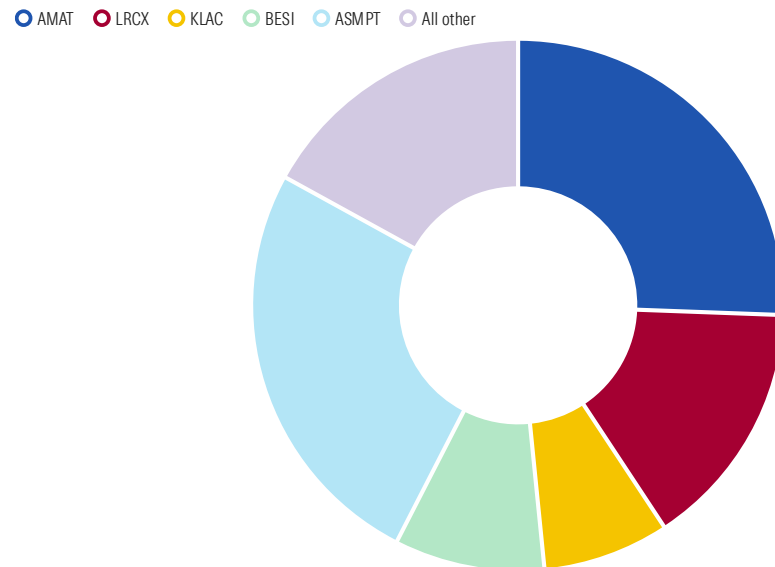
ASML enjoys healthy pricing power because price increases are always supported by increased output per machine (wafers-per-hour). This creates a win-win situation where ASML can raise its price while customers can lower their price per wafer produced. If a new machine offers a 40% output improvement but ASML just raises the price by 20%, ASML can get a good ROI on its R&D investments while customers can lower total cost of ownership.

Applied and Lam Are the Best Positioned for Advanced Packaging Like CoWoS

Applied Materials and Lam Research hold the strongest market shares among WFE vendors in advanced packaging, which should benefit their growth over the medium term. We expect investment in leading-edge AI chips to focus on chiplet-based architectures, like Nvidia's GB200. This should drive higher etch intensity for Lam and greater demand for Applied's broad portfolio of etch and deposition. We see this optimism being more heavily valued in Lam's stock today, which informs our view of Applied as a better pick for investors. We expect Applied to see less WFE-specific growth than Lam with a lower exposure to etch steps but for this to be made up by its advanced packaging growth for total revenue.

Applied holds the broadest WFE portfolio in the world, playing across deposition, etch, process control, and modification. This enables it to attack a larger total set of advanced packaging processes, which the company has made a priority. We believe Applied holds the largest advanced packaging market share among its peers (Exhibit 50). We expect it to maintain this over our forecast as it benefits from TSMC's CoWoS investments and its broad portfolio with which to serve them.

While this doesn't technically sort into WFE, it does contribute to the firm's overall growth opportunity, which we see as attractive. We believe looking at WFE in isolation in this era of AI investment undervalues the total addressable market for Applied. When adding in advanced packaging, we see it growing in line with its high-performing peers and maintaining a strong market share.

Exhibit 50 Applied Holds the Top Market Share Among WFE Vendors in Advanced Packaging, With Lam Second

Source: Morningstar analyst estimates.

We also expect strong growth from Lam, as a leader in etch for logic chips and with high exposure to NAND memory. Lam should benefit from etch intensity in cutting-edge chips, both during WFE and during advanced packaging. In essence, as chips get larger and more complex, the etching of precise holes through multiple layers becomes more complicated than depositing a film of materials precisely over a surface. This drives the need for more etch equipment at higher prices. We see this in WFE as transistor architectures become more complex in three dimensions—GAA and CFET transistors require more etch intensity than their FinFET predecessors.

Lam's etch proficiency positions it well in advanced packaging, where we see similar dynamics toward rising etch intensity to connect chiplets together. Lam holds the second-largest advanced packaging portfolio among WFE vendors, and its particular strength in etch should drive a high share of the "drill" step in drill-and-fill to enable processes like CoWoS. Lam should also benefit from a recovering NAND market to help reverse share losses in recent years caused by the NAND cyclical downturn, which incrementally inflates its share gains over our forecast.

KLA and Tokyo Electron Are the Agnostic Plays

We expect KLA to perform roughly in line with the WFE market. KLA is broadly exposed to all chip types with its dominant process control portfolio and benefits from rising chip complexity. We see KLA as agnostic to differences in intensity between etch, deposition, and lithography, with strong positioning in process control for each of these technologies. Higher chip complexity that requires more manufacturing steps overall commensurately requires more process control steps to ensure quality, high-volume yields. As such, we see KLA rising in line with the broader WFE market, supported by expanding chip supply and complexity.

KLA could see upside to WFE growth and potential share gains via a higher mix of logic in total WFE spending, as logic chips require higher process control intensity. In our view, the market is pricing in this bull case, leading to shares looking overvalued to us. We see a more consistent mix between logic and memory long term. While we have bullish expectations for AI investment driving a higher mix of leading-edge logic WFE, we see this offset by a declining mix for lagging-edge logic WFE, which we'll cover next in this section. We believe total logic WFE spending will settle around a 60% mix of overall WFE longer term, which is consistent with 2024 levels, and thus we expect market performance for KLA.

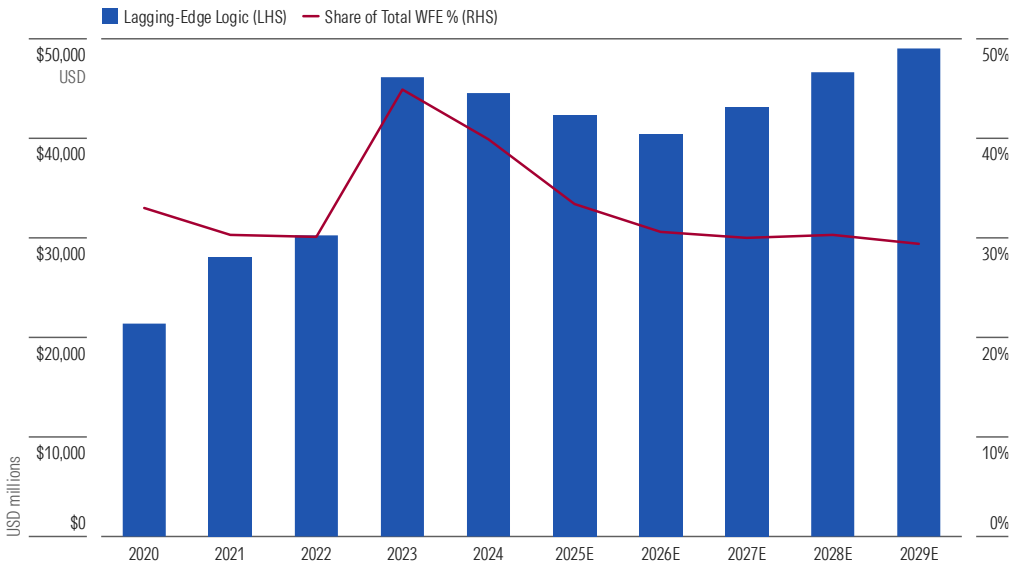
Tokyo Electron is more of a broad market play to us, without a specific specialization like Applied has in advanced packaging or Lam has in etch. We see Tokyo as a technology leader in line with these other wide-moat peers, but its portfolio is more broad and less specialized than a peer like Lam in etch. We see it as a strong secondary option across both etch (where Lam leads) and deposition (where we see Applied and ASM leading). This broad portfolio positions Tokyo well to benefit from AI infrastructure investments in WFE, and we anticipate share gains from smaller suppliers as chipmakers increasingly opt for the technology leaders to support the manufacturing of advanced chips.

China Demand Should Support Healthy Lagging-Edge Global WFE Spending

Outside of AI, we still see moderate growth for lagging-edge logic WFE, which primarily serves chips for cars and industrial equipment, as a secondary WFE growth driver. Lagging-edge logic was the largest end market for WFE in 2024 and represents a significant piece of our valuations on ASML, Applied Materials, and our other wide-moat WFE coverage. China is the most significant driver of this lagging-edge investment, in our view.

Auto and industrial chips have been in a downturn across 2024 and 2025, and lagging-edge logic equipment orders are set to decline across both years as a result. We see the cycle bottoming for WFE in 2026, with more material order growth to follow in 2027 and beyond (Exhibit 51). Equipment is usually a lagging indicator coming out of a cycle, as chipmakers first raise volumes across their existing equipment before ordering new machines. Still, we expect lower lagging-edge logic growth than AI will drive at the leading-edge, implying a shrinking mix over our forecast. All in, we forecast 2% annualized growth for lagging-edge logic WFE, inclusive of the downturn in 2025 and 2026 and a subsequent rebound.

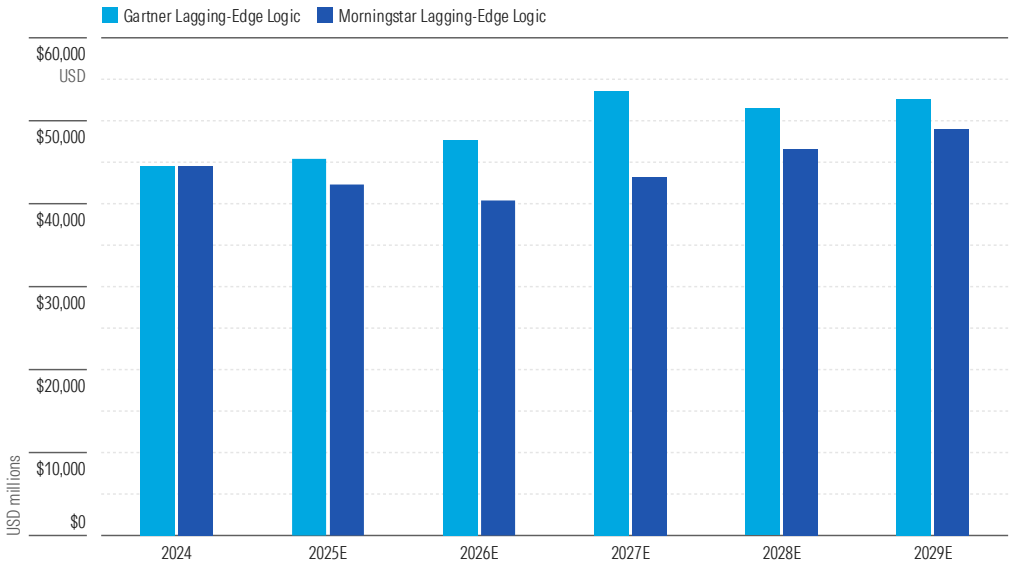
Exhibit 51 We Model a Cyclical Rebound for Lagging-Edge WFE in 2027 but Lower Growth Than Leading-Edge



Source: Morningstar analyst estimates, Gartner.

Our lagging-edge logic WFE forecast largely agrees with Gartner, though we are more conservative in the short term as we see the downcycle for auto and industrial chipmakers remaining a headwind into 2026. We anticipate higher growth from 2027 through 2029 to bring us closer in line with Gartner's forecast, which calls for 3% annualized growth through 2029.

Exhibit 52 Our Lagging-Edge WFE Forecast Is Softer Than Gartner's, Particularly in the Short Term



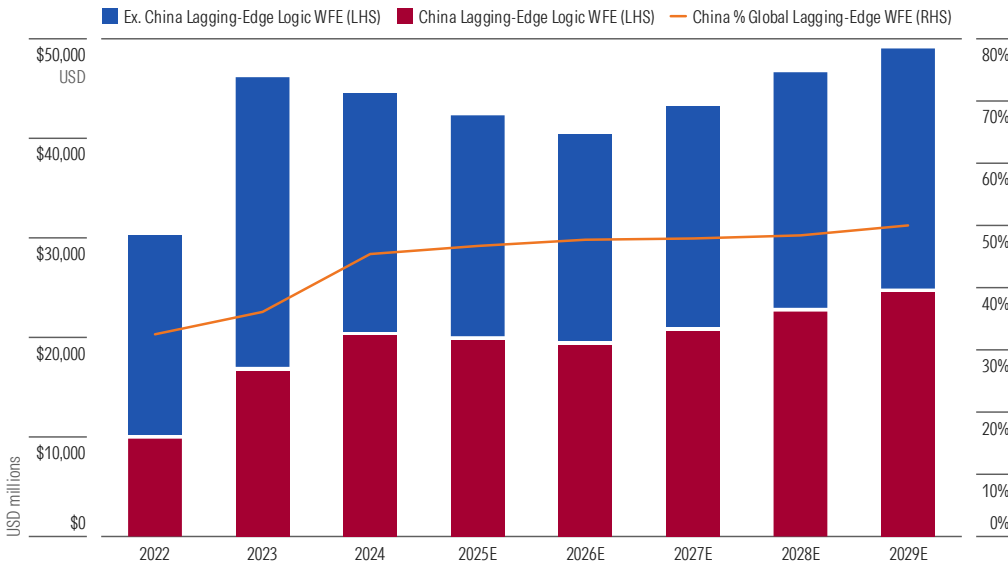
Source: Morningstar analyst estimates, Gartner.

We Expect China Demand To Stay Elevated After Correction in 2025 and 2026

Most of our lagging-edge WFE growth forecast comes from China, which is our other primary point of differentiation with Gartner. In short, we believe Gartner is underestimating the level of Chinese domestic capacity investment over the next five years and overestimating the growth from non-China lagging-edge WFE. In Exhibit 53, we show that China makes up for nearly half of global lagging-edge WFE demand, per our estimates. We expect China's portion of lagging-edge WFE demand to rise by 4%, annualized, above our total lagging-edge growth forecast of 2%.

The primary driver of our total WFE forecast is advanced logic chips for AI, but it's important to remember the criticality of lagging-edge logic chips, too. These are the chips that power cars, industrial machines, and simple appliances like washing machines. We don't expect immense growth from these end markets, but they command a significant portion of total chip production (and roughly 30% of WFE sales over our forecast). China's ambitions for domestic self-sufficiency in semiconductors generate immense domestic investment specifically in these lagging-edge chips. China is aiming to fill more of its domestic products with domestically produced chips, across cars, industrial equipment, appliances, and more.

Exhibit 53 China Is the Most Significant Driver of Global Lagging-Edge WFE Demand, per Our Estimates

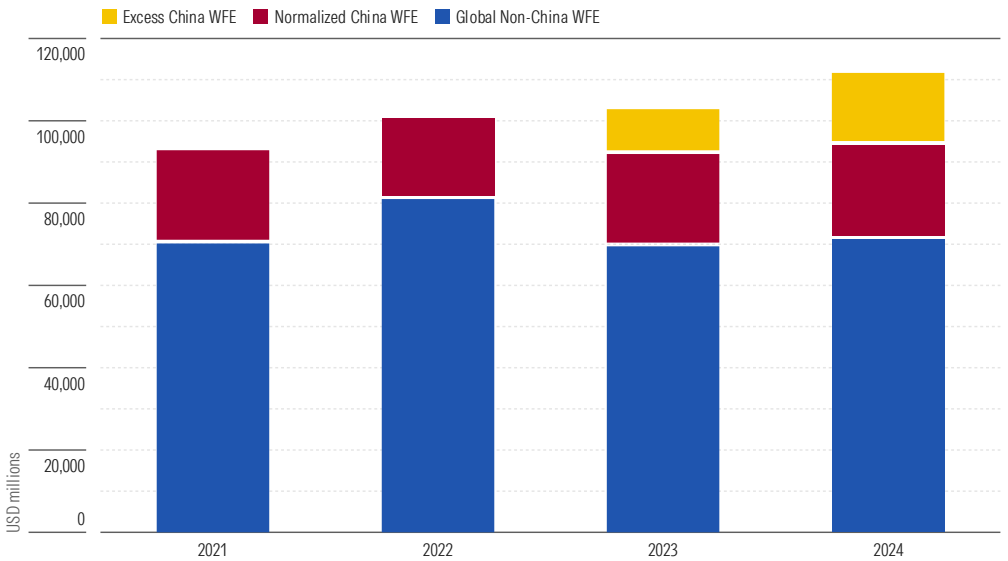


Source: Morningstar analyst estimates, Gartner.

China submitted immense WFE orders across 2023 and 2024, which included overordering to avoid future US trade restrictions (Exhibit 54). In total, we saw nearly \$30 billion in excess WFE equipment orders over two years from Chinese customers as they raced to order as much equipment as possible ahead of potential future restrictions. This led to supernormal growth in those years out of China, amid a cyclical decline in equipment sales across most other geographies. China is barred from any orders of leading-edge equipment from the US and its allies, which covers substantially all leading-edge

equipment suppliers. China's equipment orders are exclusively in lagging-edge logic or memory going forward.

Exhibit 54 We Estimate Nearly \$30 Billion in Excess WFE Orders From China Across 2023 and 2024

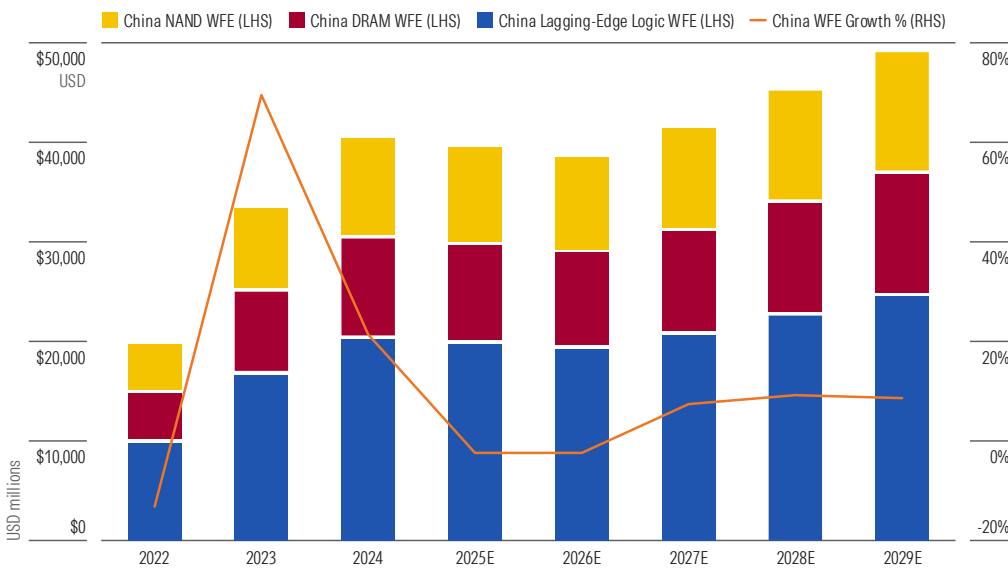


Source: Morningstar analyst estimates, Gartner.

We expect China's equipment orders to dip in 2025 and 2026 after this period from a combination of a normalization of overordering and incremental restrictions from the US installed in December 2024. Still, we forecast China's demand to remain elevated and grow past 2025 as it continues to build up domestic capacity (Exhibit 55).

When we compare our 2029 China WFE forecast with levels prior to overordering (2022) we estimate meaningfully higher growth than other geographies. To us, overordering reflected a lumpy investment, but the long-term trend of China building up its domestic supply and ramping manufacturing investments is durable. After a correction from overordering that we project for 2025, we model mid-single-digit China equipment revenue growth, coming predominantly from a buildup of lagging-edge chip supply. We see 2% annualized declines for WFE sales into China through 2026, followed by 8% annualized growth between 2027 and 2029 after the digestion of these excess orders.

Exhibit 55 After a Correction From Excess Orders, Our China Forecast Supports Our Lagging-Edge WFE Expectations

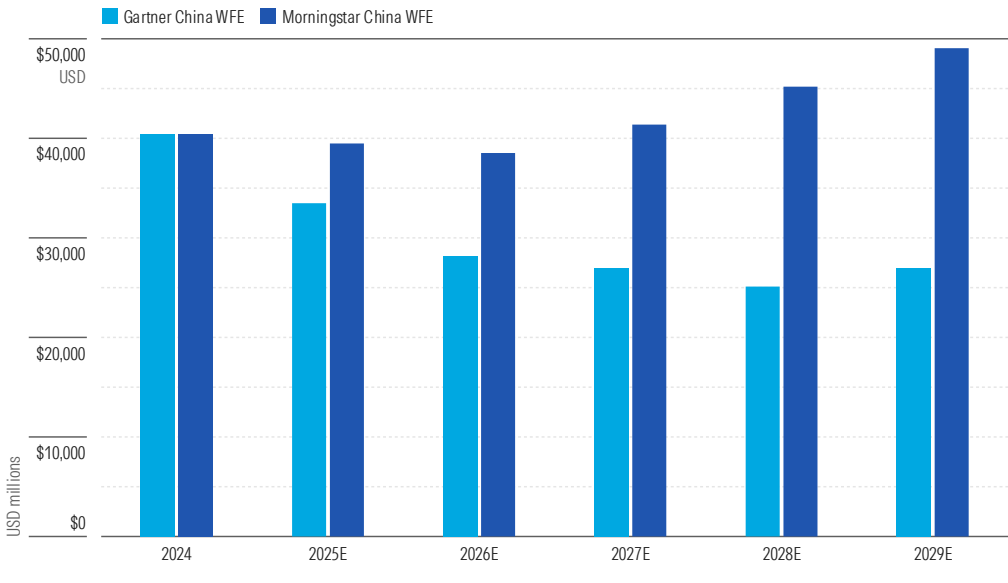


Source: Morningstar analyst estimates, Gartner.

Gartner's China Forecast Looks Low

Our China WFE forecast comes in well above Gartner's, which appears overly pessimistic to us. Gartner forecasts four years of WFE spending declines to Chinese customers, with growth not coming back until 2029. Gartner estimates China's 2029 WFE as flat compared with 2022 levels. In our view, this assumes that the overorders cover all incremental demand over a seven-year period, which we see as conservative. In Exhibit 56 we show our 4% annualized growth forecast for WFE into China through 2029, while Gartner implies a 5% annualized decline over the same period.

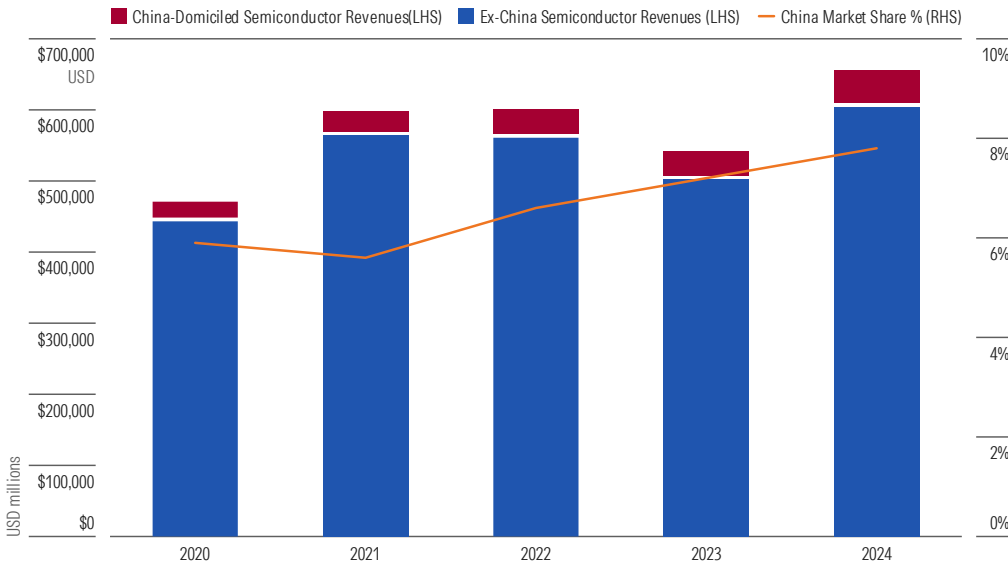
Exhibit 56 We See Gartner's Forecast for an 8% Annualized Decline in China WFE Through 2029 as Pessimistic



Source: Morningstar analyst estimates, Gartner.

We agree that there will be a correction off the supernormal levels of 2024, but we expect the normalized level of China demand to remain quite high. A combination of national security concerns and immense domestic demand are driving a continued ramp of onshore Chinese chip manufacturing capacity over our forecast. China is gaining share in analog and power chips for autos and industrial equipment, both from improving domestic technology and incentives for Chinese customers to prioritize domestic chips. This share reached 8% of global semiconductor revenue in 2024 (Exhibit 57). These share gains inform our forecast for high WFE orders into China to fulfill rising demand for domestic chips. To us, Gartner's forecast declines for WFE sales into China would have to imply weakening growth and even potential share losses for Chinese chipmakers, which we don't see as likely.

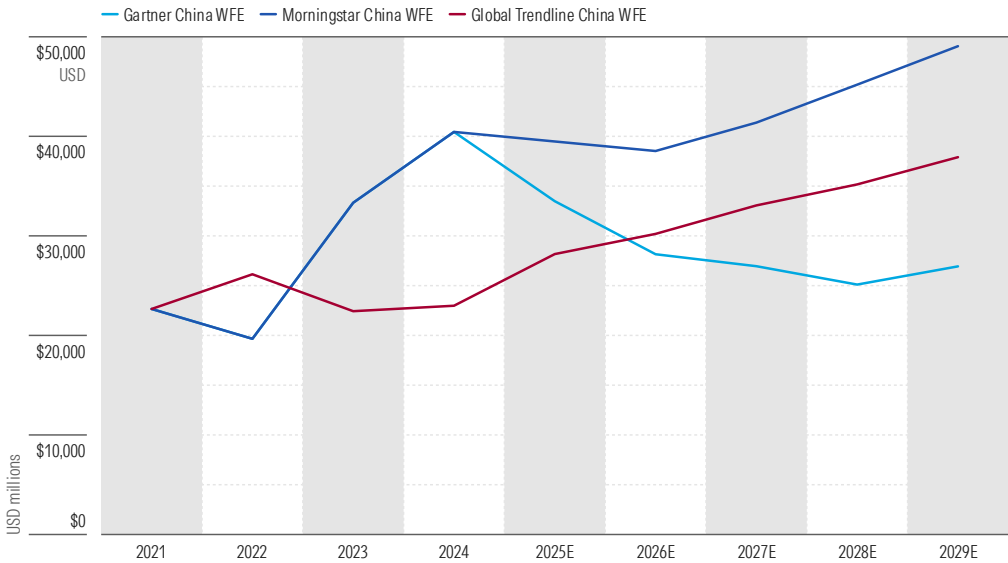
Exhibit 57 We Expect Rising Chinese Semiconductor Supply To Drive Continued Strong Lagging-Edge WFE Demand



Source: Morningstar, Gartner.

We could reasonably see our forecast being optimistic, with potential for a greater correction from excess orders continuing a decline of WFE sales into China into 2026. Even so, we would still expect growth to resume thereafter. We model a bear-case scenario in Exhibit 58, aligning China to the rest of the world's WFE growth since 2022. In this scenario, we would expect roughly \$10 billion less in annual WFE revenue into China over the next five years, and it would depress our total WFE growth estimate by a little over 1%, annualized. This would still bake in \$10 billion in higher WFE sales into China in 2029 than Gartner estimates, and our overall WFE forecast would still remain well above Gartner's. Investors taking this more bearish view on China's investment may see valuation across this group as more challenging but should still see good value in ASM.

Exhibit 58 Investors Could Take a More Conservative View on China and Still See Upside to Gartner's Forecast



Source: Morningstar analyst estimates, Gartner.

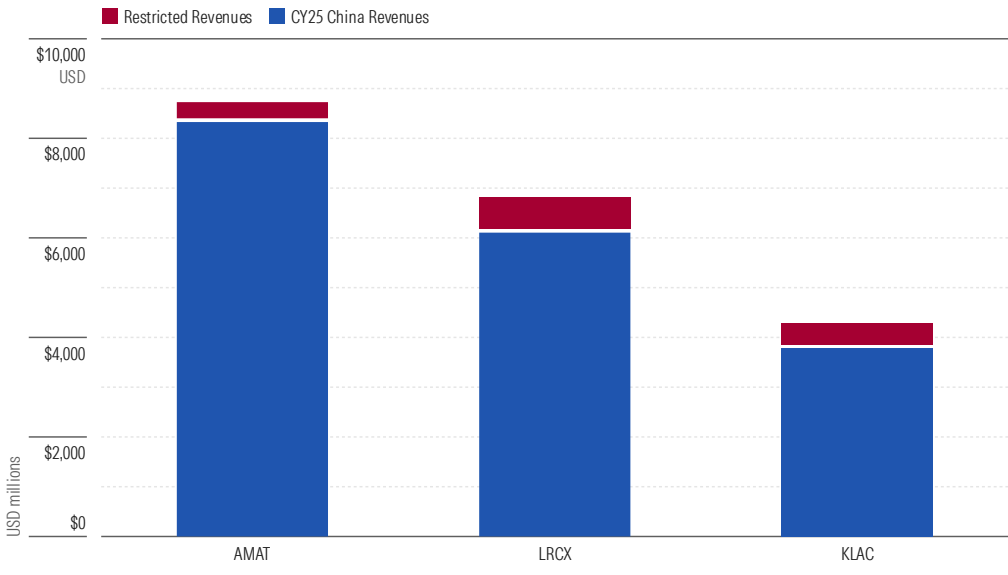
We See Low Risk of More Restrictions on Lagging-Edge Equipment Sales Into China

One reason investors may take a more bearish view on China WFE growth than we do is geopolitical risk. China represents roughly 25%-30% of sales for WFE firms under our coverage and has been already subject to trade restrictions from the US and its allies. These restrictions could heighten in the future, further compressing revenue and growth opportunities for firms under our coverage. Even if the US and its allies don't impose further restrictions, China could restrict the purchases of western equipment to incentivize its own domestic sector.

To level set, China exposure from WFE firms has already been restricted. As things currently stand, US and European firms are unable to sell any cutting-edge equipment into China. The most recent set of restrictions on WFE from the US came under the end of the Joe Biden administration in December 2024. In simple terms, western equipment companies are barred from shipping any equipment intended for cutting-edge chip manufacturing. This includes any nodes of 7 nanometers or smaller as well as advanced packaging equipment for advanced chips like high-bandwidth memory, or HBM.

The additional restrictions imposed at the end of 2024 are a headwind to WFE equipment sales and services revenue in 2025. Across our coverage, these new restrictions equated to a roughly \$500 million revenue loss per firm (5%-15% of annual sales), as shown in Exhibit 59. We model China WFE revenue to decline in the high single digits in calendar 2025, resulting from both these new restrictions and the normalization from overordering in 2024.

Exhibit 59 New Restrictions in 2024 Cut Off 5%-15% of China Revenue for US WFE Firms



Source: Morningstar analyst estimates, company documents.

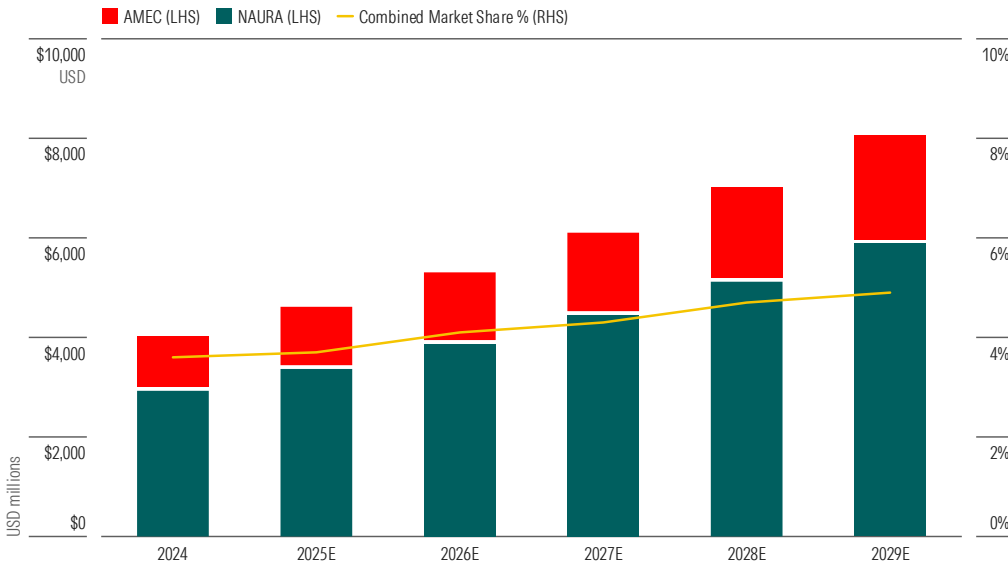
We don't see material risk from future restrictions on equipment sales into China beyond this latest batch. Again, the only sales from western firms today are for lagging-edge equipment. This equipment largely serves to manufacture chips for automotive and industrial applications, and we see neither as a high focus of national security risk.

We concede that China's domestic chip sector is a popular point of leverage in geopolitical negotiations, which would leave bears worried about this remaining, significant, lagging-edge exposure. We expect future restrictions to continue to focus on cutting-edge equipment, chips, and other AI infrastructure, rather than these machines for less sophisticated chips. We also believe the Donald Trump administration recognizes the risk of restrictions accelerating China's own domestic capabilities, which leaves the US with less leverage in the future. We see credence in this last point in the re-opening of AI chip sales into China, headlined by Nvidia's H20 chip. We see potential for Washington, D.C. to focus on winning competitively in AI models, rather than risking a swifter buildup of China's domestic hardware capabilities.

We See Low Competitive Risk From Nascent Chinese WFE

While we see low risk of future selling restrictions from the West, we could also see restrictions from the Chinese government on purchases of western equipment. Chinese WFE vendors NAURA and AMEC have gained share in recent years, with their combined share approaching 4% of global WFE market share in 2024 (Exhibit 60). We see this share expanding gradually up to 5% over the next five years.

Exhibit 60 Nationalization Drives Share Gains for Chinese WFE Firms That Remain a Minority of the Overall Market



Source: Morningstar analyst estimates, Gartner.

We believe leading western firms under our coverage hold significant performance advantages over Chinese domestic competitors, even in lagging-edge equipment. We believe these share gains for NAURA and AMEC come nearly exclusively from domestic incentives for Chinese chipmakers to help build up its equipment sector. If these incentives were to heighten, or if purchase restrictions get tacked onto these incentives, it could negatively impact the sales opportunity for western WFE firms under our coverage. A good example here on the chips side is that even with Nvidia’s H20 chip being allowed into China by the US, the Chinese government has become restrictive on allowing domestic firms to purchase these chips.

To us, China’s domestic chip supply is its top priority. We believe that attempting to pursue complete self-sufficiency in both chips and WFE at the same time would be detrimental to both aims. Yield is the end-all-be-all for the profitability, and thus longevity, of chipmakers. The wide-moat technology leaders under our coverage provide the best yield to customers, even at the lagging-edge. This is an area where we believe Chinese vendors are a decade behind, if not more. We believe that for China to truly invest in its domestic chipmaking, it requires the best equipment, which comes from these western WFE vendors. With yields still being the highest priority, we expect continued strong placement for Applied and Lam in etch and deposition steps for Chinese chipmakers.

We also see no evidence of NAURA and AMEC’s equipment serving any customer outside of China, which emphasizes our point that these firms don’t yet offer a competitive product but are benefiting from domestic incentives to grow their share within Chinese customers.

We still expect China to continue incentivizing purchases from NAURA and AMEC when they are good enough, but this is in a minority of cases (shown by rising, but low market share in Exhibit 60). As such, we expect orders to continue flowing to both western and Chinese domestic equipment firms in lagging-edge chips. In short, Chinese lagging-edge equipment demand will rise enough to float many boats. While this is a minor headwind to China growth in our forecasts for companies like Applied Materials and ASML, it falls short of an immense substitution effect that would have a larger impact on our valuations. Longer term, we could see closer technological parity in lagging-edge equipment from domestic Chinese vendors, but we see this happening over a 20-year horizon, not a five- or 10-year one.

We also see dominant companies operating in valuable niches of WFE being best positioned to defend against China risk, particularly KLA and ASML. China's leading domestic vendors, NAURA and AMEC, only operate in etch and deposition equipment. We see no viable competitors out of China for process control or lithography. Investors particularly concerned with China risk may seek higher exposure to these more fortified names, and ASML looks fairly valued today.

Our China WFE forecast (bullish relative to Gartner) is based on two key tenets: we don't anticipate future additional restrictions on lagging-edge equipment, and we expect continued growth in China's demand for automotive and industrial chips to drive demand for lagging-edge equipment out of western WFE firms.

We're Less Optimistic on Lagging-Edge WFE Outside of China

Our high differentiation on China WFE sales and our agreement with Gartner's broader lagging-edge logic forecast create a disconnect in our views on non-China lagging-edge WFE sales. Gartner's low China assumptions and relatively stable lagging-edge assumptions imply aggressive growth for non-China lagging-edge WFE. This would imply share gains for the rest of the world and share losses for China, where we see the opposite happening. We predominantly see China's chip sales serving domestic applications and displacing western competitors.

We see China as a significant piece of the global lagging-edge market, with increasing share in analog and power chips that go into cars and industrial equipment. China's domestic consumption is massive, and Chinese chipmakers displacing western competitors in their home market drives share gains. We see this as the predominant driver of growth for China WFE, and China as a meaningful driver of global lagging-edge equipment growth. Semiconductors are a matter of strategic import for the Chinese government, with aspirations to become more self-sufficient. This strategic importance is driving incentives to Chinese companies to buy Chinese semiconductors, and in turn driving WFE sales into Chinese chipmakers.

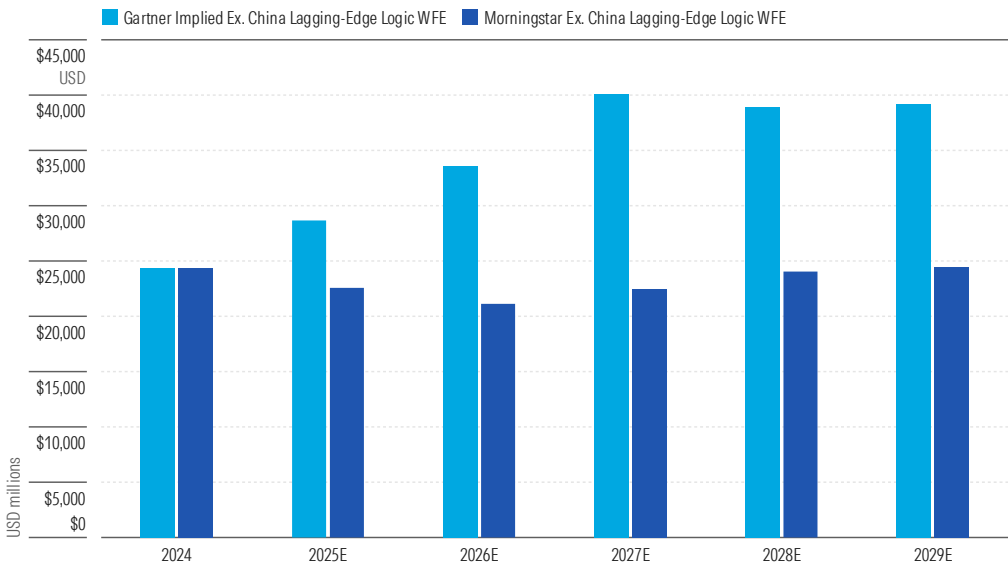
We believe our own forecasts for low-single-digit growth over five years, for both equipment sales into China and for global non-China lagging-edge logic equipment sales, are aligned. Gartner's estimate for a five-year 8% annualized decline in China equipment sales doesn't match its 7% annualized growth forecast for total lagging-edge equipment, given the size of the Chinese lagging-edge WFE market.

We assume a roughly 50% split of total China WFE sales going toward lagging-edge logic, with the remaining half split between DRAM and NAND memory WFE. Backing out China from Gartner's lagging-edge WFE forecast leads to significant implied growth through 2027 for non-China lagging-edge WFE, which looks too high to us.

We see midcycle longer-term growth in lagging-edge chips and WFE in the mid to high single digits. In the short term, we expect depressed sales through 2026 before an eventual rebound. Over 2026, we expect lagging-edge chip demand to improve globally but for WFE sales to lag this by about one year as chipmakers prioritize raising utilization of existing equipment before ordering more. Gartner's growth forecast through 2027 for lagging-edge WFE outside of China looks aggressive when considering the ongoing downturn and the rising share of Chinese lagging-edge chipmakers.

To us, China is gaining share in global lagging-edge chip supply, and we would expect China WFE and global lagging-edge WFE to move in tandem. Instead, Gartner's forecast implies a growing disconnect between the two, which adds to our conviction of its China WFE forecast being too low.

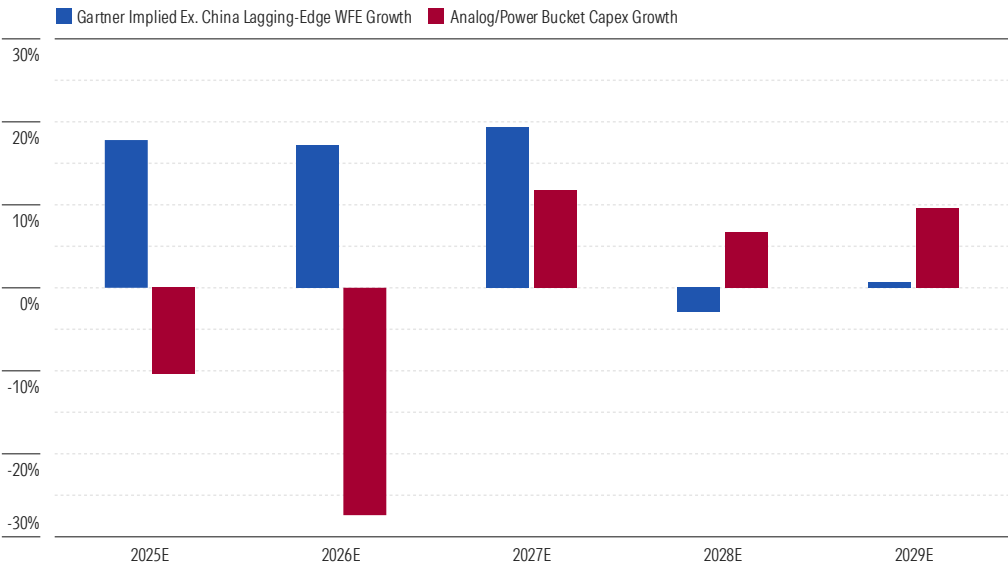
Exhibit 61 Gartner's Non-China Lagging-Edge WFE Forecast Looks Aggressive To Us



Source: Morningstar analyst estimates, Gartner.

As a final point of emphasis, we see Gartner's implied growth for non-China lagging-edge WFE to be in stark contrast with our own forecasts for capital spending from leading analog and power chipmakers (Exhibit 62). When we assess our capital spending growth forecast for a representative bucket of the five largest western analog and power vendors under our coverage (Texas Instruments, Analog Devices, On Semiconductor, Infineon, and ST Microelectronics), it appears far more conservative than Gartner and more in line with our own WFE forecast.

Exhibit 62 Gartner's Non-China Lagging-Edge WFE Forecast Doesn't Match Our Capital Spending Expectations



Source: Morningstar analyst estimates, Gartner. Bucket comprised of capital expenditure estimates for Texas Instruments, Analog Devices, Infineon Technologies, STMicroelectronics, and On Semiconductor.

We recognize that China is a point of significant debate among investors—both on the demand side and in relation to domestic WFE competition. We’ll dive more into our views on China’s overorders and our competitive analysis of new Chinese WFE entrants in our next section. Our view on demand is that China’s domestic buildout will continue and maintain high levels of revenue for WFE vendors.

AI Should Drive Higher Geographic Concentration for WFE in Taiwan, the US, and Korea

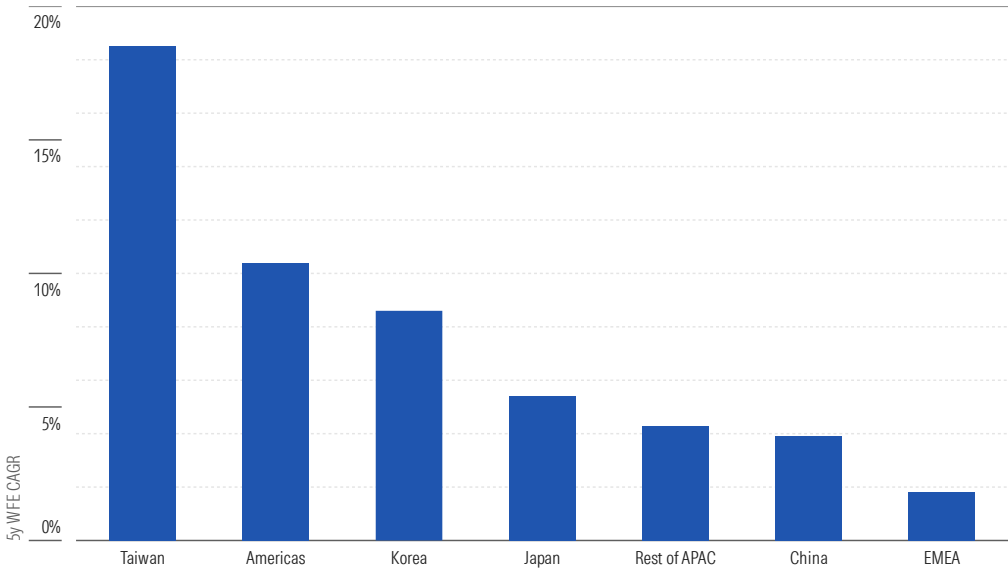
We anticipate a rising concentration among WFE customers in our forecast, which, in turn, increases geographic concentration for WFE vendors in the US, China, and Korea alongside continued strong exposure to China. We expect TSMC, Micron, and SK Hynix to be the net beneficiaries of AI investment, driving higher WFE order concentration to Taiwan, Korea, and the US.

For TSMC as the biggest driver of AI chip capacity investment over our forecast, this investment is largely concentrated across Taiwan and the US. Taiwan is the firm’s domicile, but it is aggressively building capacity in the US to defend against geopolitical risk and support US supply aspirations. US manufacturing placates leaders in Washington, hedges against tariff-related costs, and helps TSMC diversify.

We forecast a rising mix of customer exposure for Taiwan (TSMC), Korea (SK Hynix), and the US (TSMC and Micron). Taiwan is the most significant beneficiary, rising 18% annually through 2029—which roughly matches our 15% compound annual growth estimate for TSMC capital spending over the same period (both with supernormal growth in 2025).

The US and Korea see more modest gains. Korea has already ramped up capacity significantly for HBM, leading to less impressive—but still strong—growth in our forecast. We expect broad-based strong growth in the US from domestic buildouts to support nationalization of chip supply across TSMC, Micron, and analog chipmakers. China cedes the most geographic share over our forecast, which is a result of normalizing from excess orders in 2024 that we described earlier. Nevertheless, China remains the largest consumer of global WFE over our forecast, driven by immense domestic demand for lagging-edge chips serving automotive and industrial markets.

Exhibit 63 We Expect Taiwan, the US, and Korea To See the Highest WFE Growth Over Our Forecast



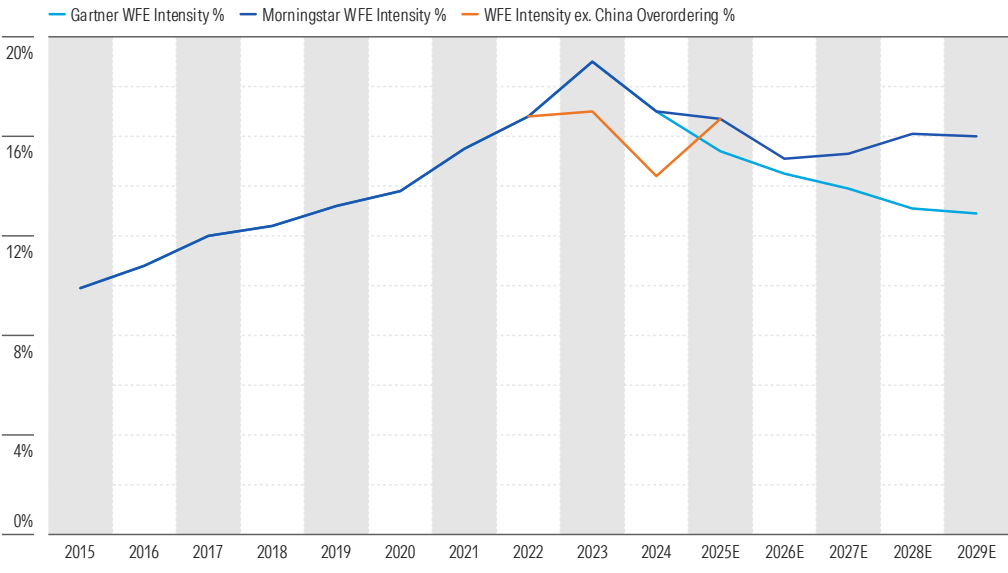
Source: Morningstar analyst estimates, Gartner.

We See Moderation in WFE Intensity After Chinese Overordering

Our forecast for total WFE market growth implies a structurally higher level of WFE intensity for chip manufacturing than historically, though less than the supernormal levels in 2024 resulting from excess orders from China. WFE intensity measures the revenue of WFE versus total industry semiconductor revenue. This metric has historically hovered in the low-double-digit percentage range but has seen an upward trend since 2015.

We expect current WFE intensity closer to the midteens to maintain over our forecast. Gartner's WFE forecast implies aggressive WFE intensity declines into the low teens. Higher complexity chips require greater levels of equipment investment to effectively design gate all-around transistors, smaller transistor sizes, and vertical structures. Intensity was supernormally high in 2023 and 2024, which reflected the impact of Chinese overordering. We see it coming down from these recent levels (Exhibit 64) but maintaining about a 15% to 16% intensity of total chip revenue. To us, Gartner's implied WFE intensity forecast assumes stagnant chip complexity versus levels in 2018, with which we disagree.

Exhibit 64 We Expect WFE Intensity To Moderate Into the Low Teens With the Conclusion of Chinese Overordering

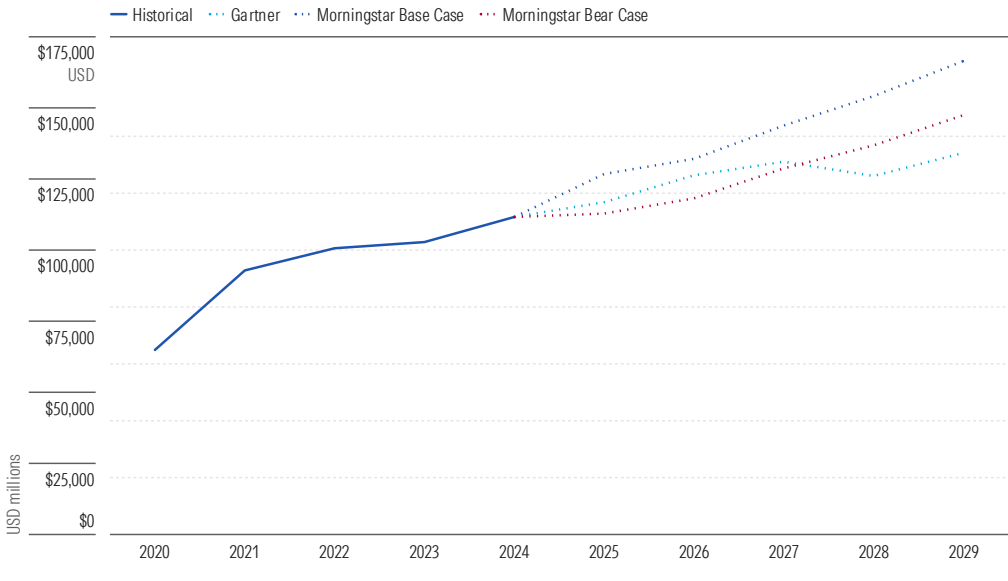


Source: Morningstar analyst estimates, Gartner.

We emphasize that our valuations on WFE firms like ASML, Applied Materials, and ASM don't rely on expanding WFE intensity and include our views for intensity to come down from 2024 levels. This contrasts with what many WFE management teams would contend—that intensity will continue to rise with complexity. We believe intensity can rise over a longer-term period, but that growth off of the peak in 2023 with Chinese overorders is ambitious.

More Bearish Views on AI Investment and China Growth Would Still Provide Upside to Gartner
Investors may reasonably take a more conservative position on future AI investment growth than our forecast and a more aggressive position on the correction for Chinese orders after 2024. We model a bear case for WFE that includes both of these views (Exhibit 65). In this scenario, we assume leading-edge logic chips rise in line with sell-side consensus estimates for TSMC capital spending, and we assume China revenue normalizes to the mix from 2021.

Exhibit 65 We Model a Bear Case for AI Investment and China Orders That Implies 5% Annualized WFE Growth



Source: Morningstar analyst estimates, Gartner.

In this bearish scenario, we model 5% annualized growth for WFE over the next five years, implying global revenue reaching \$144 billion in 2029. This represents nearly 300 basis points of lower annualized growth than our base case. Our bear-case scenario in 2029 is 11% below our base case forecast but remains 7% above Gartner's 2029 figure. Investors skeptical to the AI growth opportunity and that are more conservative on China's investment may align more to this bear case and still see upside against Gartner's views. In this scenario, we would see more challenging valuations across our WFE coverage, especially for Lam and KLA. However, we still like the value ASM provides to investors currently.

Buy the Dip on ASM, but ASML, Applied Materials, and Tokyo Electron Remain Solid Plays on WFE Growth

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Key Takeaways

- ▶ ASM International is our top pick in WFE. It is a pure-play on atomic-layer deposition, or ALD, which should see higher penetration in advanced chips for AI. We expect it to gain market share over our forecast due to its strong ALD positioning. Short-term market worries over order numbers in 2025 create a buying opportunity.
- ▶ ASML, Applied Materials, and Tokyo Electron are being valued as underperformers to Lam Research and KLA. In our view, these five stocks share an attractive AI growth opportunity. ASML, Applied, and Tokyo have been pressured by short-term market concerns that don't impact our long-term expectations for them to see structural growth with AI investment. These three are fairly valued, and offer better entry points currently than Lam and KLA.
- ▶ ASML has a monopoly on advanced lithography, which should benefit from a higher mix of leading-edge logic chips for AI. We believe the "lithography peak" thesis has been overestimated by the market. We believe a higher mix of AI chips will benefit ASML's growth. We also expect the introduction of high-NA EUV at the end of the decade to drive attractive share gains and growth for ASML.
- ▶ Applied Materials is the best play on the advanced packaging opportunity in AI, with the highest market share among WFE vendors. The stock trades below peers with similar AI opportunities, like Lam Research and KLA. We see it sharing a similar long-term growth opportunity to these peers and see it as the best play among this US-based group for investors to buy into WFE's AI growth prospects.
- ▶ Tokyo Electron is a broader play on the overall trend for AI to boost WFE growth. It holds a secondary market share in etch and deposition but remains well exposed to cutting-edge chip investment along with its other wide-moat peers. Currently, it presents a better entry point than Lam or KLA.

In a Group of Wide-Moat AI Winners, Only Two Are Trading Like It

ASML, Applied Materials, Lam Research, Tokyo Electron, KLA, and ASM are all AI winners, in our view. We expect these firms to grow above all lesser peers over the next five years as AI investment benefits WFE and advanced packaging spending. We see strong growth estimates baked into valuations for Lam Research and KLA, which are rightly valued as leaders in advanced etch and process control, respectively. We don't see this growth opportunity priced into ASM, ASML, Applied, or Tokyo to the same extent. In our view, these match the high-quality characteristics and strong growth opportunities of the rest of the group, and 2025 underperformance has been myopic and created better entry points.

ASM's ALD leadership should drive higher penetration in leading-edge AI chips. This is an attractive secular story that drives our expectations for ASM to gain market share. We don't believe the market is adequately pricing in this opportunity, making this our top pick in WFE.

ASML's command of advanced lithography should benefit from a higher mix of AI chips. Applied's breadth and particularly strong advanced packaging position should allow it to capture its fair share of AI growth. Tokyo's broad position enables it to benefit from rising AI chip supply investments. To us, these are better plays on WFE's AI growth story than Lam and KLA, which look overvalued to us.

ASM Is Attractively Valued for Strong ALD Growth and AI Investment

We see a compelling multiyear growth story in wide-moat ASM International as the technology and market share leader in atomic layer deposition, or ALD. ASM is strongly positioned to benefit from the industry's shift toward smaller geometries, new transistor architectures (GAA and CFET), as well as advanced packaging. All these trends require more ALD, where ASM is the market share leader. Beyond ALD, epitaxy has emerged as a second growth engine, where ASM is expanding share from the low-20% range to 30% in 2025. Combined, these drive our expectations for ASM to be a significant share taker in our WFE forecast and our top stock pick in WFE.

Myopic Worries Don't Alter Our Long-Term Conviction

An order miss in the second quarter has weighed on ASM's stock, but we see this as a buying opportunity and a temporary pause in its long-term growth trajectory. Shares sold off in July 2025 when orders of EUR 702 million disappointed the market and management guided for a book-to-bill ratio of less than 1 for the third and fourth quarter of 2025. While shares have since recovered from this initial sell-off, we still see value for investors in ASM at current levels roughly 15% below our EUR 635 fair value estimate.

Exhibit 66 We See a Short-Term Order Miss as a Buying Opportunity for ASM



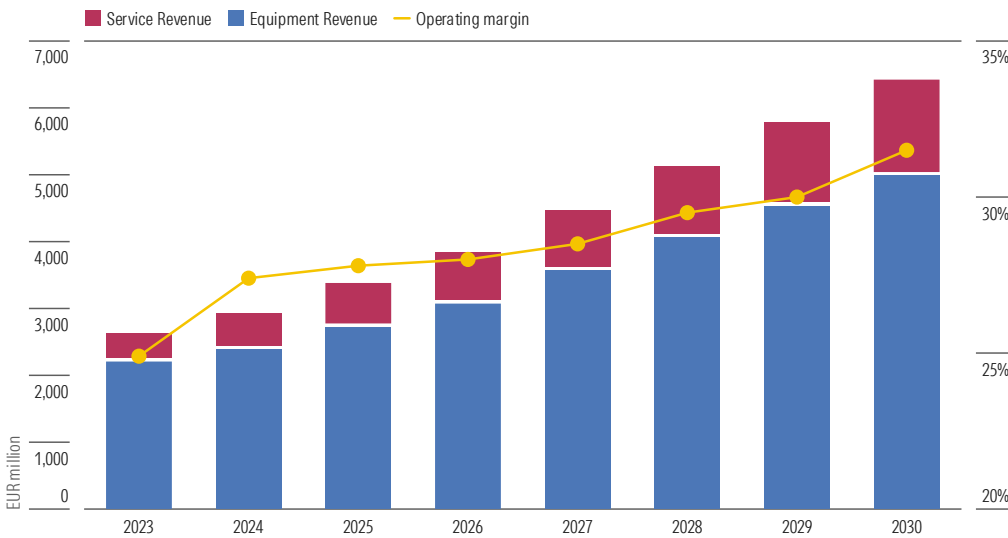
Source: Morningstar analyst estimates, PitchBook.

We credit most of this order volatility to choppy investment among a concentrated group of foundry customers. Order choppiness isn't new to WFE, nor exclusive to ASM. Intel and Samsung are struggling to compete with TSMC at the cutting edge. Short-term orders show choppy share shifts between Intel, Samsung, and TSMC, and higher concentration at TSMC leads to lumpier orders. We expect lower investment at Intel and Samsung in the short term, but we expect this supply to be made whole by TSMC's share gains longer term. In short, we see WFE demand as a function of global chip demand. Share shifts between TSMC, Intel, and Samsung can create choppy results in the short term, but long term we expect growth to align with chip demand growth, where we are bullish.

We believe the second half of 2025 will be a bump in the road before sales continue to grow at a low-teens pace in the next three years. These short-term order swings don't affect our growth expectations over a longer time horizon. Our longer-term belief is driven by our expectations for high AI investments, and AI chips require more penetration of ALD, where ASM is positioned to capture demand. We model EUR 3.8 billion in 2026 sales and EUR 4.4 billion in 2027, compared with management's guidance of EUR 4.0 billion-EUR 5.0 billion in 2027 sales. We also see a potential short-term catalyst in the investor day in September 2025, which should reassure investors that the long-term path remains intact.

Longer term, we model revenue growth at a 13% CAGR through 2034, predominantly driven by our view that ALD will take up a greater portion of overall deposition spending, and ASM is the primary beneficiary of ALD. With modular project design, operating leverage, and the shift toward outcome-based services, we expect gross and operating margins can expand to 52% and 31%, respectively, compared with 50% and 27% currently.

Exhibit 67 We Expect Rising ALD Intensity to Drive 13% Annualized Growth and Margin Expansion for ASM



Source: Morningstar analyst estimates, company documents.

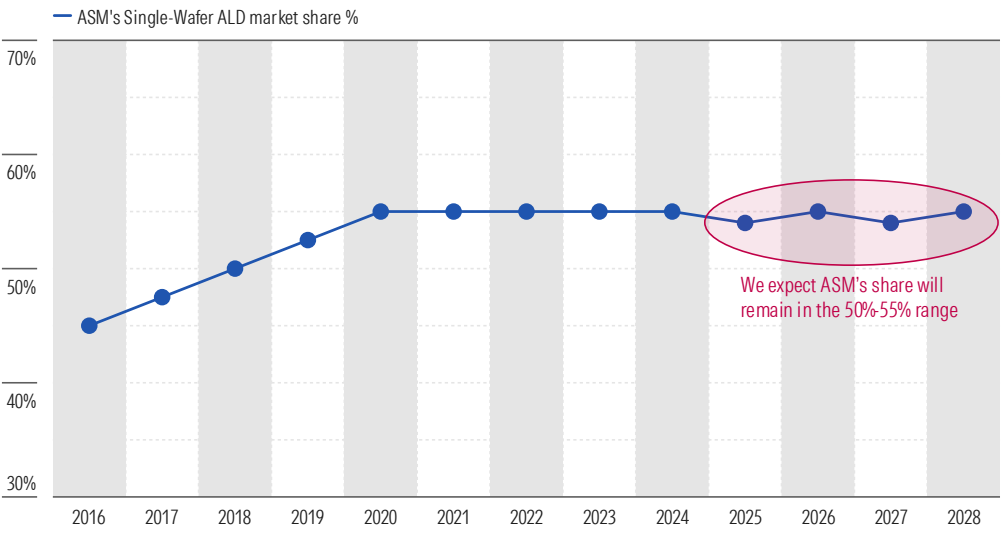
ASM's ALD Leadership Positions It To Capitalize on AI Investment

ASM is a significant share taker over our five-year WFE forecast, with its concentration in ALD raising its penetration in advanced chips over the next five years. Deposition creates insulating and conductive layers through chips by depositing very thin films of materials. Unlike more mature CVD/PVD technology, which throw many reactants into the chip at the same time, ALD deposits layers of one atom at a time, delivering the highest uniformity, conformality, and smoothness in the tiniest chip structures.

ASM established a lead in ALD through organic investment and its acquisition of Microchemistry in 1999. Its first major inflection came in 2007 when Intel adopted high-k dielectric ALD at the 45nm node. TSMC and Samsung followed shortly after, shifting ALD from a niche to a mainstream technology. Today, ALD has become indispensable for logic and memory roadmaps, and tools are deeply embedded into fab operations. Once qualified, tools are rarely replaced due to process-integration risks, creating switching costs and customer stickiness. ASM enjoys market share north of 50% in ALD, which we expect it will maintain due to know-how and visibility into customer roadmaps.

We expect ASM to retain this dominant share in ALD, allowing it to benefit from high growth as ALD becomes increasingly important in advanced nodes across logic and memory.

Exhibit 68 ASM Dominates ALD Market Share, Positioning It Well for AI Investment



Source: ASM International, Morningstar analyst estimates.

What peers Applied Materials or Lam Research offer in product breadth, ASM offers in depth. While these peers have larger R&D budgets than ASM, their efforts are spread across broader product portfolios, whereas ASM channels its R&D investment into ALD and epitaxy. We believe the market will reward this focused strategy, as it pays off in share gains and high growth going forward. We see room for both ASM (a concentrated ALD leader) and Applied (a broad leader across the rest of deposition) in this market, but we expect higher growth for ASM with higher penetration in more advanced chips.

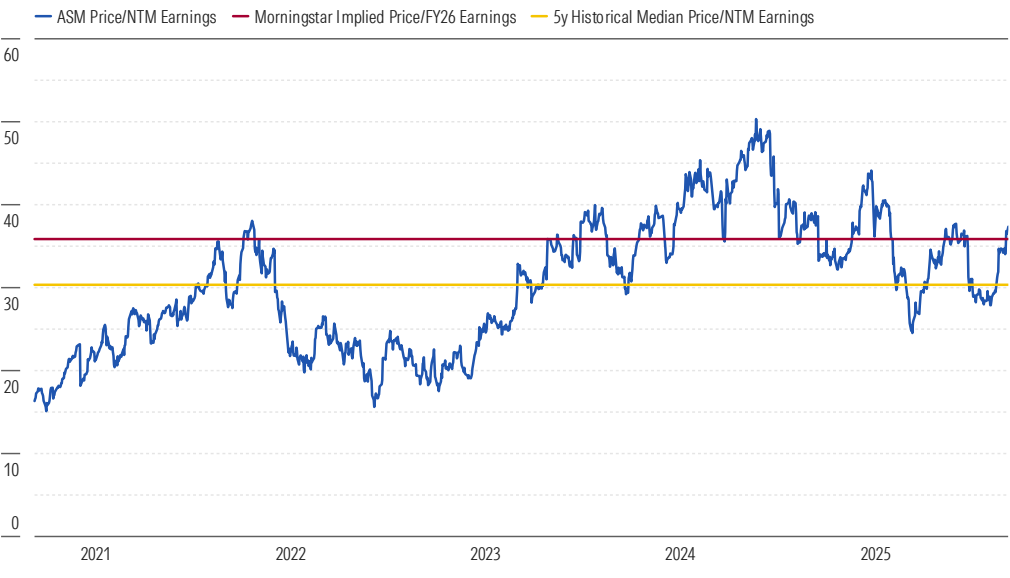
Epitaxy is ASM's second growth engine, and we see it as a strong complement to its ALD product portfolio. Epitaxy is a process where crystalline layers are grown atom by atom on top of a silicon wafer, and it is becoming increasingly important in GAA devices, where stacked transistors require precise epitaxial growth. ASM is leveraging its expertise to grow in this market, expanding share from the low-20% range currently to 30% in 2025 and creating a second growth driver. ALD and epitaxy are highly complementary, as both processes are about controlling the deposition of thin films in a structure, creating R&D synergies and cross-selling opportunities.

We Expect Higher Growth To Raise ASM's Valuation

Our EUR 635 fair value estimate represents a forward price/earnings ratio of 36 times for 2026, a premium compared with other peers given we see ASM as an above-average grower for the next five years. This represents a premium to ASM's historical median multiple, which we feel is deserved for its expanding position in AI chips and high growth.

Currently, our buy thesis for ASM rests on higher expected growth versus consensus, while our implied forward multiple is in line with the market's multiple on sell-side consensus forecasts. ASM has recovered in the past month toward our valuation but still represents the most attractively valued WFE stock today, in our view. Our model offers roughly 5% upside to FactSet consensus earnings estimates through 2026, largely due to higher growth assumptions from ALD penetration and share gains in epitaxy. We believe that high ALD growth manifesting over the next two years will drive sell-side estimates higher, awarding ASM a higher valuation on a similar multiple which should come closer to our EUR 635 fair value estimate.

Exhibit 69 Increased ALD Penetration for AI Chips Should Drive High Growth and a Higher Valuation for ASM



AI Chips Need ASML's Advanced Lithography

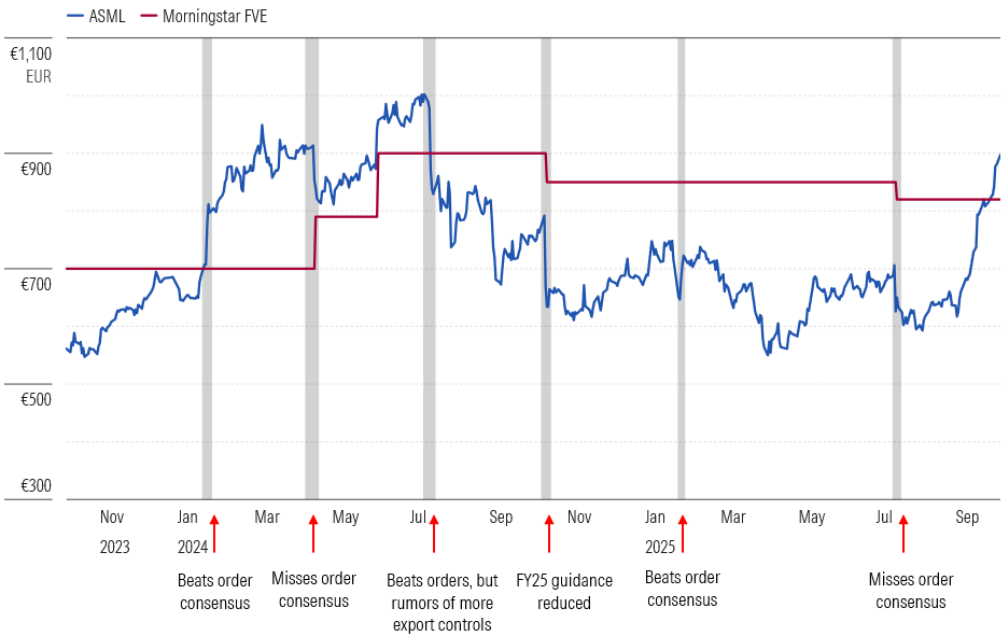
We see ASML as well positioned to capture AI demand over the next five years, and it looks fairly priced currently. It is overwhelmingly dominant in advanced lithography, which is used at higher rates for the most advanced chips for AI. We believe the market has grown overly concerned with investment in advanced packaging and vertical scaling, causing underperformance for ASML's revenue versus peers. For us, we see a higher mix of advanced logic chips for AI leading ASML to grow in line with the market in the short term, and the introduction of high-NA EUV at the end of the decade driving longer-term incremental share gains.

ASML's Underperformance Roots in Short-Term Concerns

Investor sentiment around wide-moat ASML has been volatile over the past 18 months. Order intake has swung between quarters, with very strong quarters like fourth-quarter 2024 and more disappointing ones like second-quarter 2025. We credit most of this order volatility to choppy investment from Intel and Samsung, which are struggling to compete with TSMC at the cutting edge. Order swings, together with macro concerns around tariffs, have created a perfect storm, raising doubts around 2026 visibility and portending potential underperformance longer term.

These concerns have led to roughly 3,000 basis points of stock price underperformance for ASML versus peers like Lam Research and KLA. ASML stock looks fairly valued against our EUR 820 fair value estimate after a strong market rebound in the past two months. Still, it presents a more attractive entry point than overvalued peers KLA and Lam.

Exhibit 70 Short-Term Order Concerns Weighed on ASML Stock After 2024 Highs, Until Recent Rebound



Source: Morningstar, PitchBook.

We see orders as a lumpy, short-term dynamic. While we expect lower investment at Intel and Samsung than previously, we expect this supply to be made whole by TSMC longer term. In short, we see WFE demand as a function of global chip demand. Share shifts between TSMC, Intel, and Samsung can create choppy results in the short term, but long term we expect growth to align with chip demand growth.

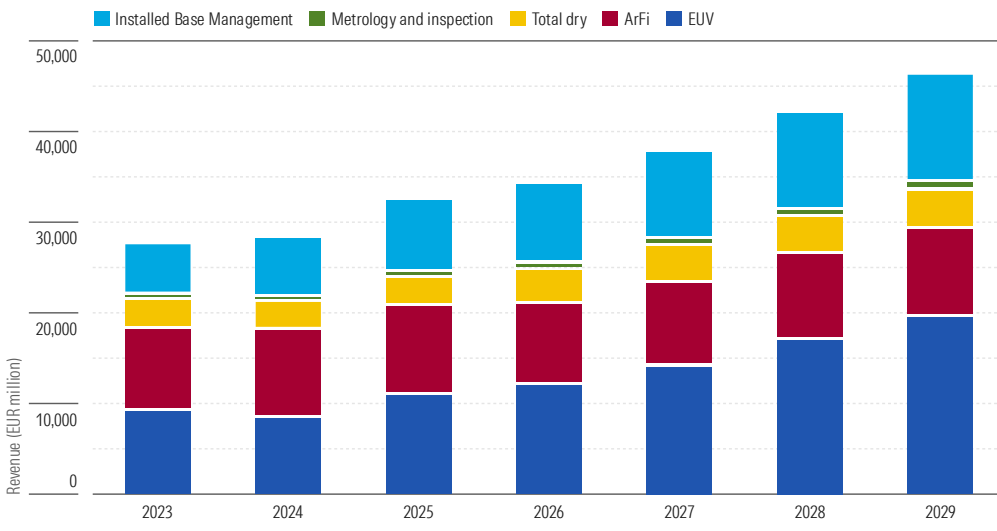
Lithography's Long-Term Prospects Remain Strong

Despite the near-term headwinds and relative stock price underperformance, ASML's long-term story remains compelling. These order swings through 2025 haven't affected our longer-term view for attractive growth, which is driven by continued AI infrastructure investments. Management's 2030 guidance of EUR 44 billion-EUR 60 billion in sales remains in place (EUR 32.5 billion in sales expected in 2025), and we model the firm reaching the midpoints of these targets. Our belief is underpinned by our AI growth expectations, which depend on EUV lithography from ASML.

We see horizontal scaling slowing down in the short term, with chipmakers prioritizing vertical scaling and advanced packaging over the next few years. Hence, we don't expect the same growth rates for ASML in the next decade as in the past one. This is baked into our forecast for ASML's higher growth over WFE to slow in the next five years, as chip complexity tilts more toward advanced packaging and vertical scaling in the next three years. Our valuation is not contingent on significant lithography outperformance, as we discussed earlier in our views for a plateau in lithography intensity.

We forecast ASML will grow revenue at a 9% CAGR in the next decade. We expect AI to drive expanding chip supply, more chip layers transitioning to EUV, and the introduction of high-NA EUV by the end of the decade. Higher prices per tool should continue to be supported by output improvements for its customers (more wafers per hour), which would also support revenue growth.

Exhibit 71 We Project 9% Annualized Growth for ASML Behind Cutting-Edge Chip Investment and High-NA



Source: Morningstar analyst estimates, company documents.

Our ASML forecast isn't contingent on Intel and Samsung having immense rebounds. Rather, in the long term we expect the lost volumes from Intel and Samsung to be filled by higher capacity at TSMC. Still, any marginal improvement across Intel or Samsung bodes well for ASML and would provide some upside to our existing forecast. Samsung's outlook has improved since July, when Reuters reported Samsung reached a \$16.5 billion chipmaking deal with Tesla over several years. Samsung is also mulling increased investments in its US Taylor, Texas, fabs and increased hiring in its HBM business.

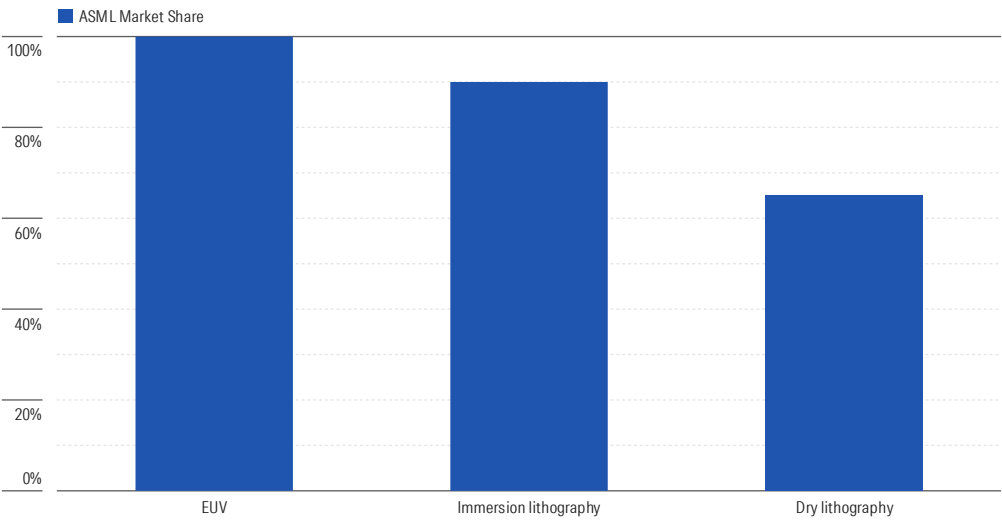
Even if Intel and Samsung revamp their foundry businesses, we expect they will remain behind TSMC, which is the indisputable leader in advanced logic semiconductors. Given TSMC's leadership and expansion plans in both Taiwan and the US, it should become an even larger ASML customer. This will come at the cost of even lumpier order patterns for ASML, with periods of very strong demand followed by other subdued ones. However, ASML will stop reporting quarterly orders from 2026 onward. We welcome this decision as quarterly order reporting has encouraged a lot of short-termism and volatility in the past 18 months, and the change should encourage a longer-term view on the stock.

ASML Should Retain Its Monopolistic Share

We also see low risk of technological disruption to ASML, either from Chinese or other lithography firms. ASML is the only firm in the world providing EUV lithography equipment and holds 90% share of the slightly less-advanced immersion lithography. We see ASML's monopoly on advanced lithography as an attractive investment characteristic, and it leads to a valuation premium versus peers that we agree with.

This dominance at the cutting edge of lithography allows ASML to capture outsize demand from the most advanced chips for AI investment over our forecast. AI chips across logic and DRAM use EUV at more layers, driving better penetration for ASML.

Exhibit 72 ASML's Market Dominance Positions It Well To Capitalize on AI Demand



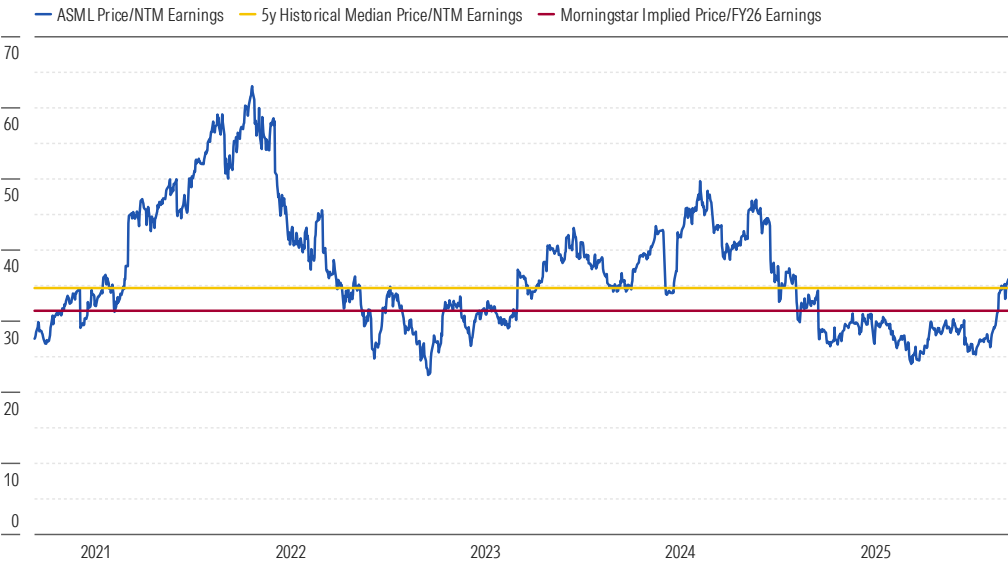
Source: Morningstar analyst estimates, Gartner.

ASML machines are a very complex combination of physics, electrical, and mechanical systems. An EUV machine takes 12-18 months to be assembled, weeks to get installed, and can occupy dozens of square meters and weigh up to 200 metric tons. These machines have so many subsystems that, according to ASML, a single engineer would not be able to understand the entire machine, but only his or her area of expertise. Japanese firms Nikon and Canon do not have the business focus and resources to catch up with ASML and are decades behind. Chinese lithography firms can come up with some competent dry lithography equipment, but ASML’s position in EUV and immersion lithography remains unmatched.

Our Valuation Is Closely Aligned With ASML's Historical Multiple

For investors assessing relative valuation, we believe it is reasonable to assume that, going forward, the stock will not enjoy as hefty a valuation premium versus peers it has sometimes enjoyed in the last decade. Our fair value estimate assumes a forward PE ratio of 31 times for 2026 and 27 times for 2027, below ASML's trailing five-year median price/earnings multiple of around 33 times. This accounts for weaker growth than ASML experienced historically but maintaining strong growth with AI investments. All in, we think investors should consider this as a fair valuation to buy into a strong business with a good AI growth opportunity.

Exhibit 73 We See ASML as Fairly Valued, and Closely in Line With Its Historical Multiple Currently



Source: Morningstar analyst estimates, PitchBook.

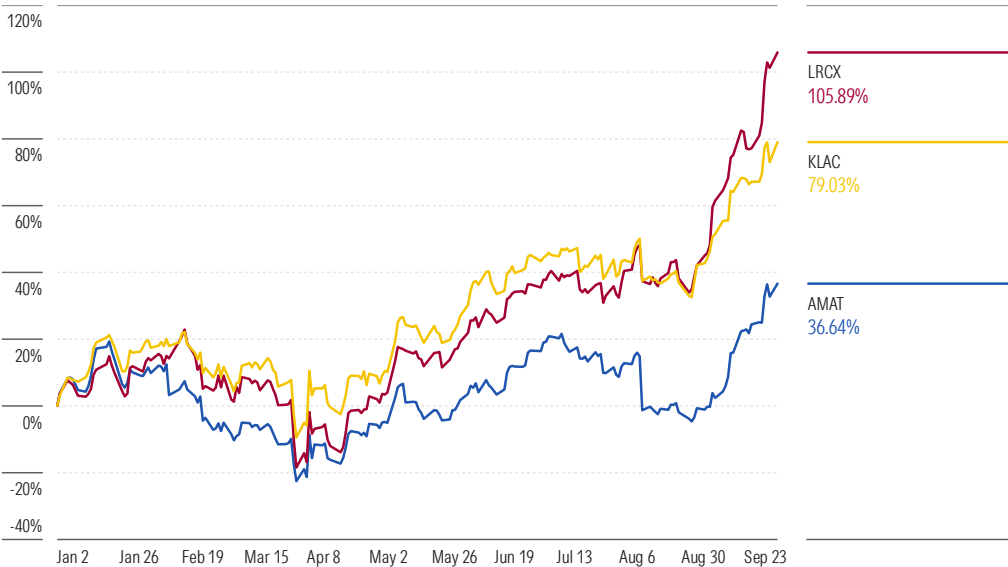
Applied Materials Is a Strong Play on Advanced Packaging at a Better Valuation Than Peers

We expect Applied Materials to broadly benefit from AI chip investments across its broad portfolio of deposition, etch, and advanced packaging. In particular, we see this stock as the best play on advanced packaging of the group. We believe the stock's underperformance against peers Lam and KLA has been myopic and overdone, and we see Applied as the best opportunity among these three for investors today.

Softer Growth in 2025 Has Weighed on Applied's Stock Performance...

Applied is up about 35% year to date, compared with appreciation of more than 75% for Lam Research and 100% KLA. We attribute the stock's underperformance to weaker revenue growth in fiscal 2025, capped off by disappointing guidance for the October 2025 quarter. We find Applied's performance thus far as warranted, and the stock currently trades close to our \$200 fair value estimate. Conversely, we believe Lam and KLA shares have been overbought, making Applied the better firm of the group to play into WFE's current AI growth.

Exhibit 74 We See a Better Opportunity in AMAT After Underperformance in 2025



Source: Morningstar analyst estimates, PitchBook. Figures represent YTD stock performance.

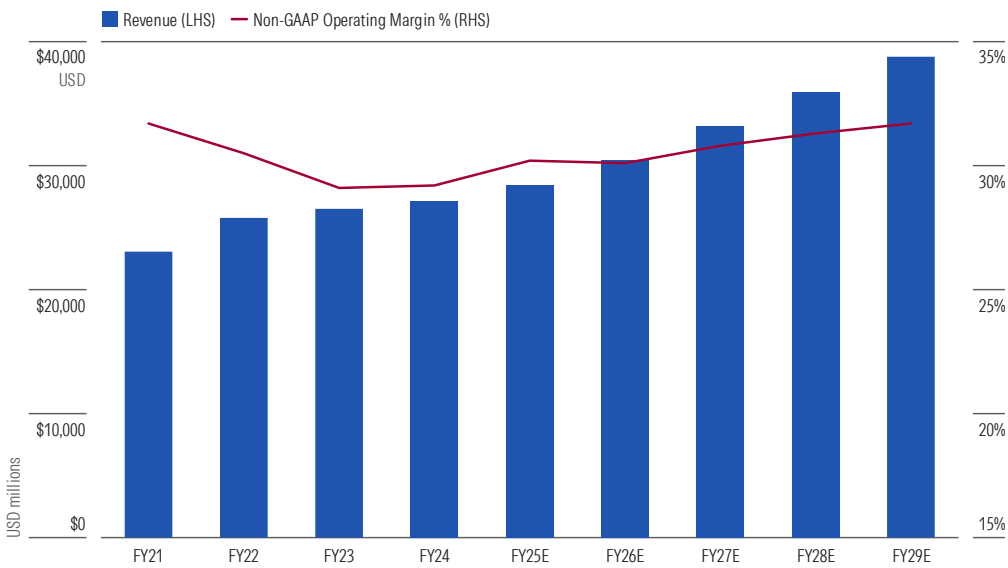
We believe the softer growth in fiscal 2025 has resulted from lumpy order patterns from TSMC—a similar dynamic to what we've seen from ASM and ASML. Leading-edge logic fabs can take years to build, with WFE installations coming over the course of 12 to 18 months, in staggered fashion. Installations for etch equipment from Lam, process control from KLA, and deposition from Applied don't come at the same time over this period and often occur in more of a step-by-step process. To us, Applied's weaker growth versus peers over this period displays this dynamic and leads to our expectations for better growth to follow in fiscal 2026 as orders and revenue for Applied follow the strong growth we've seen for Lam and KLA in 2025 thus far.

...But Our Long-Term Optimism Is Intact

Investors looking past softer growth in 2025 should see a rosy AI-driven growth opportunity ahead for Applied in the long term. With strong positions in etch, deposition, and advanced packaging, we see it well positioned to benefit from investments in leading-edge logic chips over the next five years. We expect somewhat lower growth for Applied than peers like ASML, Lam, and KLA, which is largely due to its high share in deposition, where we see slightly less investment over the next five years (with the exception of ALD, which drives ASM's growth). We see higher growth for the firm's etch products and advanced packaging portfolio. All in, we expect 7% growth over five years through 2029, roughly in line with the broader WFE market.

Applied's advanced packaging position is an attractive play for investors, in our view. Applied's heavy exposure to deposition implies some underperformance versus a peer like Lam over our forecast due to our expectations for higher etch intensity in the short term. However, we expect this to be offset by a stronger position in advanced packaging, where Applied can sell deposition, etch, and other equipment to fulfill TSMC's ambitious CoWoS expansion plans.

Exhibit 75 We See a Promising Long-Term Growth Runway for Applied, Driven by AI and Advanced Packaging



Source: Morningstar analyst estimates, company documents.

Myopic Worries Leave Applied at a Better Valuation Than Lam or KLA

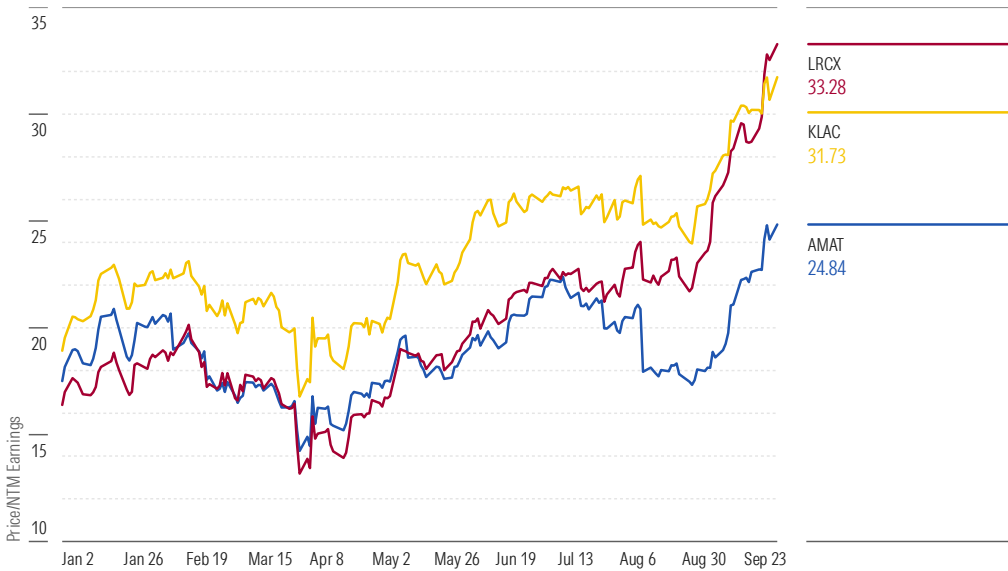
Overall, we believe Applied is trading as if it is a net loser versus Lam and KLA in this era of AI investment driving WFE growth, and we disagree. We see it as a market performer, maintaining its market share as it earns its fair share of AI equipment orders across WFE and advanced packaging. We believe weaker 2025 performance has been taken by the market to portend long-term share losses for Applied, and we disagree. We view this resulting from lumpy order dynamics between vendors from a

concentrated customer base. In our view, Lam and KLA have overappreciated this year, leaving Applied as a better buying opportunity today.

For investors looking at relative valuation, Applied's underperformance in 2025 leaves it well below the relative valuations of Lam and KLA, which looks like a disconnect to us. We generally view midcycle price-to-forward-earnings multiples for this group in the low 20s. Applied currently trades right around there, while Lam and KLA's appreciation has brought them up past 30 times forward earnings, which appears rich to us. We believe these three share a similar growth opportunity going forward, and all three are AI winners. We expect this disconnect to narrow over the next two years as these stocks experience similar growth.

We don't see Applied's softer growth in 2025 portending weaker long-term growth that would lead to a lower forward multiple versus its peers. We expect strong leading-edge WFE and advanced packaging demand to drive better results and guidance in 2026.

Exhibit 76 Applied Trades Well Below Peers With Similar Growth Opportunities, Creating an Opportunity



Source: Morningstar analyst estimates, PitchBook.

Tokyo Electron Is a Broad AI Beneficiary

Tokyo Electron and its peers stand to benefit from greater AI infrastructure investments driving an upward cycle for WFE demand. To us, Tokyo Electron represents a broader, agnostic play on this WFE opportunity, participating in core markets of etch and deposition. Similar to Applied Materials, we don't see the opportunity being priced into Tokyo's shares the same way it is for an etch peer like Lam Research, even inclusive of a recent market rebound.

2026 Guidance Revision Spooked the Market

At the end of July, Tokyo Electron lowered its revenue guidance for fiscal-year 2026 (ending in March 2026) by 9.6%. While the revenue guidance for the first half (the June and September quarters) was maintained, the revenue guidance for the second half (the December and March quarters) was cut by 17%. This caused an 18% drop in share price the following day. We believe the market was disappointed by the downward revision, given that the company had emphasized its ambitious midterm target of achieving approximately 25% revenue growth over the next two years. However, the revision resulted in guiding flat revenue growth for this fiscal year, raising concerns that the company's plan to expand sales, particularly in the etch field, is not working as planned and that it may be losing market share.

Exhibit 77 July's Fiscal-Year 2026 Guidance Cut Hurt Tokyo's Share Price, Which Has Since Recovered



Source: Morningstar analyst estimates, PitchBook.

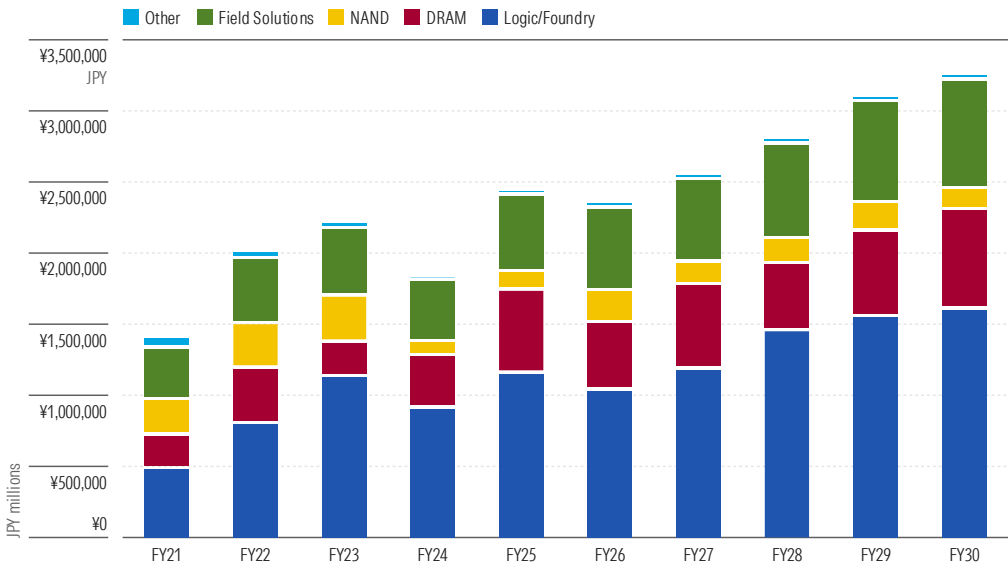
We attribute much of the downward revision to the timing of orders amid the ongoing shift in share from Intel and Samsung to TSMC, similar to ASML and Applied. Tokyo Electron originally expected the WFE market to remain largely flat in 2025 and grow by double digits in 2026. However, the company revised its outlook, stating that the expected pickup in the WFE market may not occur until the first half of 2026 at least. Tokyo Electron attributed this to the following: 1) revisions to Intel and Samsung's capital expenditure plans, 2) reduced investment in legacy nodes in China, and 3) revised investment in NAND-based on conservative forecasts. This aligns with comments from most peers.

Based on management's latest outlook, we lowered Tokyo Electron's revenue forecasts for fiscal 2026 and 2027 by around 11%, but we maintained our assumption of a 6% CAGR for our five-year forecasts, as we view the current stagnation is merely a timing issue. In short, we expect the orders pushed out from the second half of fiscal 2026 to be made whole in future years, as underlying chip demand continues to rise and AI infrastructure investments continue.

We Remain Optimistic About Tokyo's Long-Term Demand

Our revenue growth forecasts for Tokyo Electron (6% annualized) come in lower than other wide-moat peers in our coverage, which we attribute in part to weaker etch share than Lam Research and relatively more deposition exposure. We also attribute this to timing issues and continue to see Tokyo as a prime beneficiary of AI investments in WFE. Tokyo Electron's sales growth significantly outperformed that of the entire WFE market in 2024, resulting in lower assumptions for the future growth rate due to the high base.

Exhibit 78 We Expect Strong Growth After Modest Correction in Fiscal-Year 2026 for Tokyo Electron



Source: Morningstar analyst estimates, company documents.

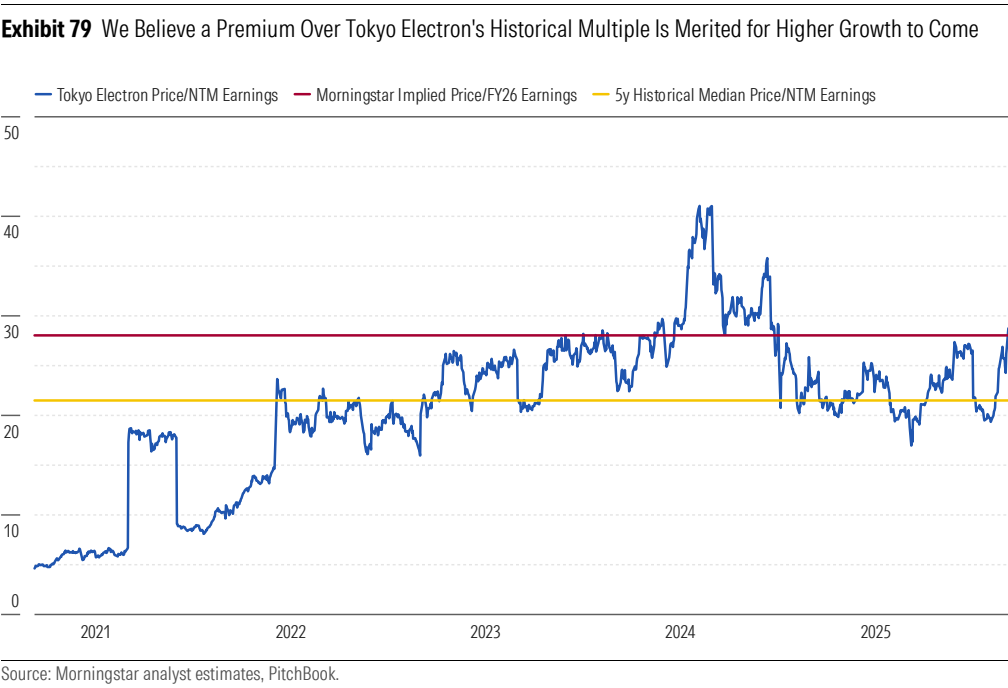
Nevertheless, we maintain our view that Tokyo Electron's medium-term revenue growth will exceed that of the rest of the WFE market outside of our wide-moat coverage, as the increasing complexity of semiconductor manufacturing driven by AI will create more business opportunities for these technology leaders, including Tokyo Electron. We agree with management's view that accelerated investment in WFE will be necessary by the end of 2026 to meet the massive anticipated demand for Nvidia's Rubin Ultra GPU architecture, which is scheduled for release in late 2027. This architecture will increase the number of GPU dies from two to four and the DRAM capacity from 288 gigabytes to 1 terabyte, which will be a catalyst for the WFE demand.

Our forecast for Tokyo Electron is not reliant on the firm meeting its previously provided aggressive medium-term targets. Originally, Tokyo Electron had set an aggressive sales target of JPY 3 trillion for fiscal 2027, up from JPY 2.4 trillion in fiscal 2025. However, we believe this will be delayed by about two years. A push-out of this guidance would fit with our forecast and wouldn't deter our conviction in the name.

Tokyo Electron Trades at a Fair Price, in Contrast With Overappreciated Peers

Although Tokyo Electron's stock price fell 18% the day after the announcement, we were confident that this was an overreaction. In fact, Tokyo Electron's stock price has come back up to our valuation since then and currently looks fairly valued. Based on a fiscal 2026 earnings basis, the current stock price trades at a price/earnings of 28 times, which is above its five-year historical median of 22 times (though closer in line with its median over the last two years). Our own valuation implies 28 times Tokyo's fiscal 2026 earnings, right in line with the market, which we believe is merited for the higher growth we expect in the coming five years resulting from AI investment.

Investors looking to play into AI's impact on WFE demand may find Tokyo Electron as a better-priced opportunity than peers like Lam and KLA that have appreciated significantly this year. We expect it to share in the AI growth opportunity with these peers, along with the likes of Applied, as a technology leader.



The Next Era of WFE Stock Outperformance, Brought to You by AI

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Key Takeaways

- ▶ ASML, Applied Materials, Lam Research, Tokyo Electron, KLA, and ASM International have all significantly outperformed the underlying market historically, which we credit to structural demand growth in semiconductors and WFE.
- ▶ We see AI as the next structural driver of outperformance, which should disproportionately benefit these wide-moat technology leaders. We expect this to drive strong earnings growth for these six above the rest of the market, which should support stock price performance.
- ▶ WFE is cyclical, and so are these stocks. We generally see more attractive valuations during short-term market downturns, and investors should be confident in structural fundamental outperformance across the course of market cycles in the long term.

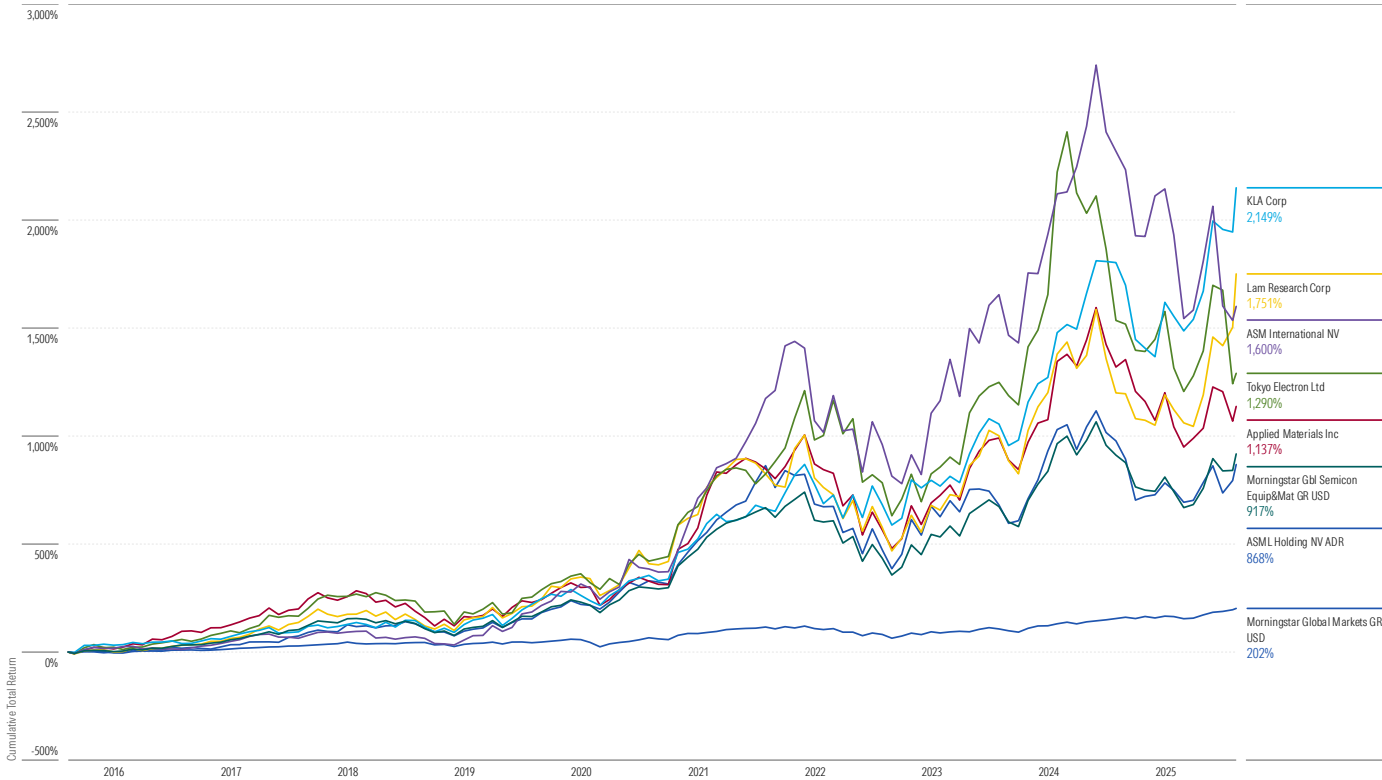
WFE Technology Leaders Are Best Positioned for Structural AI Outperformance

Investors often ask us how to pick which WFE stock to own. The short answer is that all six of the wide-moat technology leaders under our coverage are strong holdings. The longer answer is that the firms that receive greater structural growth from secular demand drivers, like AI will be going forward in our forecast, are our preferred picks. Stocks that sell off on short-term market concerns, whether cyclical or idiosyncratic, can create an even better buying opportunity. The latter leads to us viewing ASM as our top pick in WFE today and better relative entry points for ASML and Applied Materials versus peers. Nevertheless, we expect all six of this group to be prime beneficiaries of AI investment going forward, which should support stock performance for this select group.

WFE Has Outperformed Over the Past 10 Years

Historically, all six of these technology leaders have greatly outperformed the underlying global market over the past decade. Practically all of them have even outperformed Morningstar's Global Semiconductor Equipment and Materials index, which shows outperformance even relative to peers. We credit the group's outperformance to technology leadership that allows them to capture an outsize portion of WFE demand. This has resulted in market share gains across the group over 10 years and has translated directly to impressive share price appreciation.

Exhibit 80 Our Wide-Moat WFE Coverage Has Greatly Outperformed the Stock Market Over the Last 10 Years



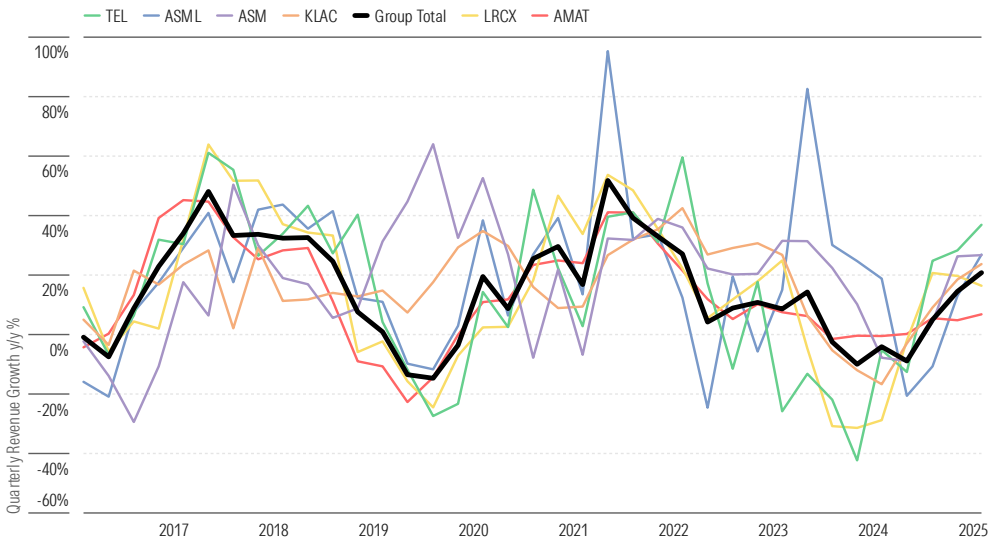
Source: Morningstar Direct data.

Growth Over the Course of Market Cycles Has Driven Share Price Performance

We see revenue as the predominant driver of stock appreciation, and volatility, for these WFE leaders. This is a cyclical industry. Semiconductors broadly are cyclical from the perspectives of both demand and supply. Demand in a given end market is not constant and can turn down over a short-term period—we’ve seen this over the past two years in the automotive and industrial chip markets, with softer end product demand leading to weaker performance for exposed vendors.

WFE experiences cycles aligned with the chip industry. In a chip industry downturn, chipmakers reduce their capacity and lower orders for WFE. When the cycle turns back up, orders increase. We’ve seen cyclicalality exhibit itself time and time again over the last decade.

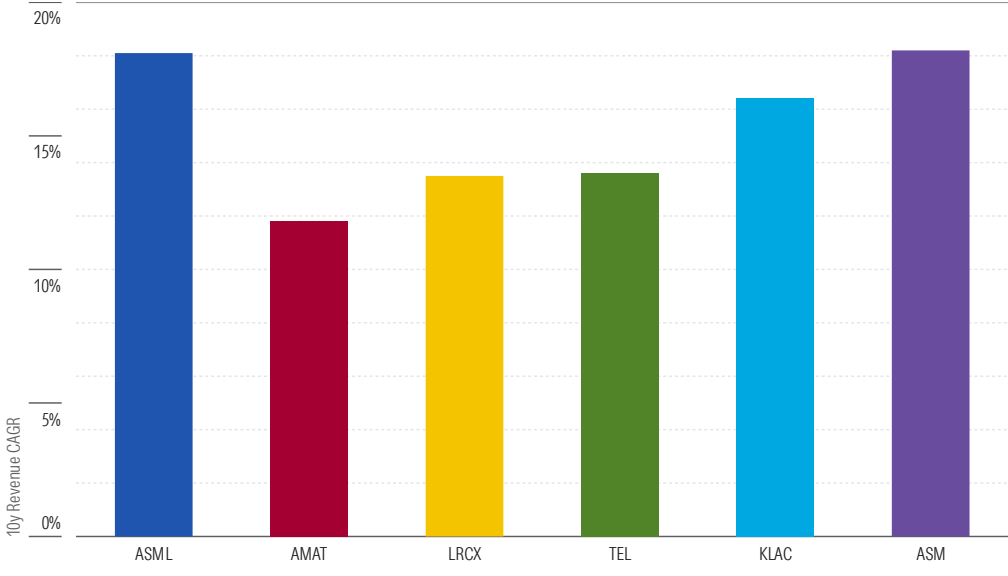
Exhibit 81 We've Seen Revenue Exhibit Continued Cyclicalty in the WFE Market



Source: Morningstar, PitchBook.

At Morningstar, we focus on the long term. Over the course of three separate cyclical market troughs in WFE over the past 10 years, our covered group of six technology leaders have shown durable, through-cycle growth above 10%, annualized. To us, this shows a superior ability for this group to drive technological advancements and capture rising investment from secular trends. Over the past 10 years, technology transitions to smaller transistors, 3D NAND chips, and increasing DRAM density have disproportionately benefited these well-positioned vendors.

Exhibit 82 WFE Leaders Have Shown Strong Through-Cycle Revenue Growth, Contributing to Stock Performance



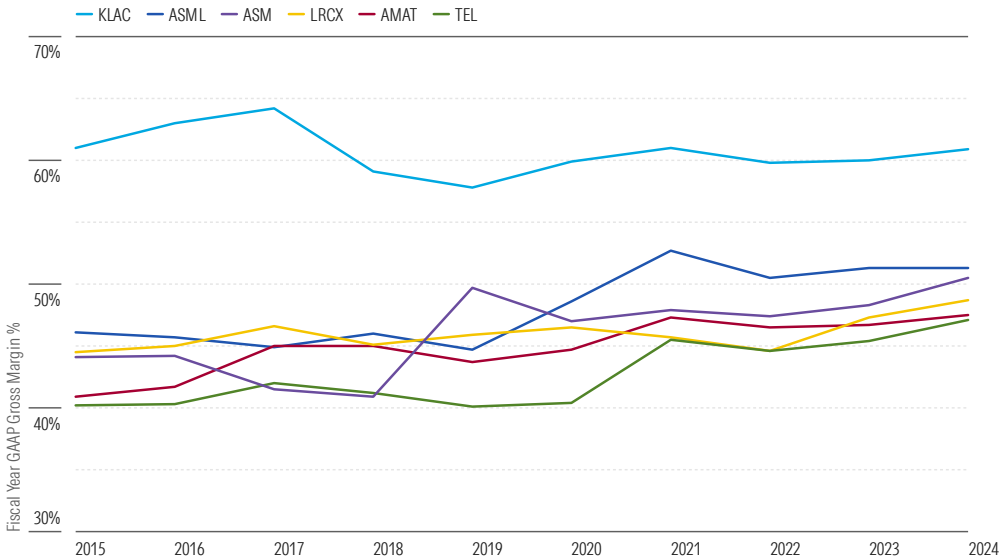
Source: Morningstar, PitchBook.

Superior Technology Expands Profits, Too

The technology leadership that enables revenue outperformance for this top-tier group also generates improved profitability. We've seen expanding gross margins over the past 10 years being driven by chip complexity, as new equipment enables higher manufacturing throughput and enables pricing power for WFE suppliers. In essence, we see this group of six technology leaders driving the cutting edge of chip manufacturing together, which enables above-market growth, market share gains, and margin expansion. Put together, these compound for highly attractive earnings growth and strong stock performance.

We note KLA as an exception here, with by far the best gross margins of the group and flat margins over the past 10 years. This results from its command of the profitable process control niche of the market, but we see less room for margin expansion from these exceptional levels.

Exhibit 83 Technology Leadership Enforces Pricing Power and Drives Gross Margin Expansion



Source: Morningstar, PitchBook.

AI Is WFE's Next Structural Growth Driver

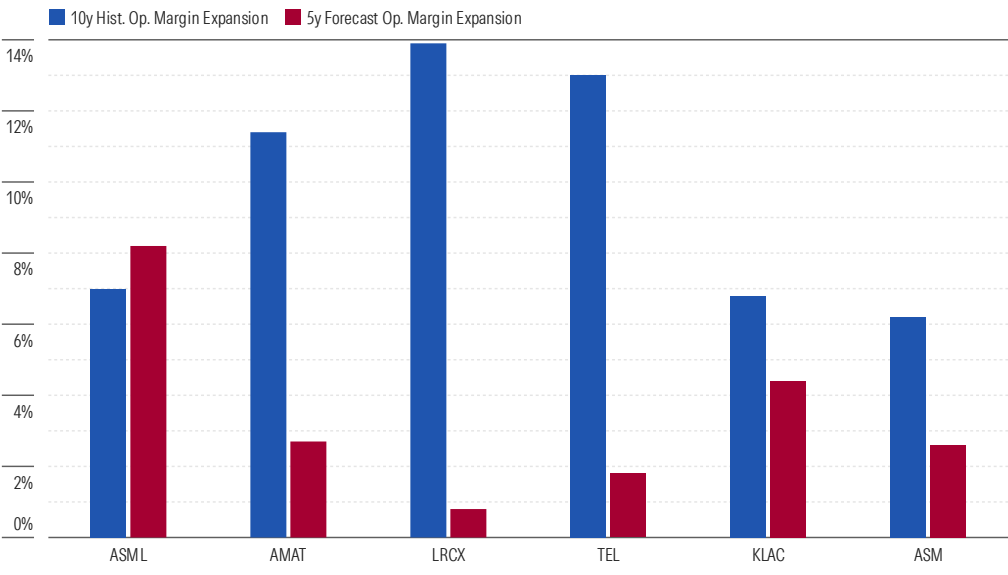
Our forecast calls for a strong five-year growth cycle for WFE, supported by strong AI infrastructure investments that require more GPUs and memory. We believe AI investment will drive strong through-cycle growth and continued margin expansion for these six vendors as the predominant drivers of chip complexity. We reiterate that these six are the best-positioned WFE firms, in our view, and we expect all six to grow revenue faster than the rest of the WFE market.

Going forward, our valuations on these leading six vendors are predominantly driven by revenue growth, with more modest margin expansion in our models than we've seen over the past 10 years. Basically, we've seen these firms exert their pricing power over the past decade, receiving more value for passing

on efficiency gains to customers. We now believe strong gross margins across the group accurately reflect the value provided to customers and don't see significant room for greater expansion from here.

The exception is ASML, where we believe the move to high-NA EUV toward the end of the decade will drive pricing increases and margin expansion. ASML's gross margin remains below where we would expect for a monopolistic lithography player, especially compared with KLA's high gross margin with a 60% share of process control. We attribute this in part to the sheer complexity of building lithography machines, but we also believe there is significant room for expansion as it delivers further yield improvements to customers. This should be attractive to investors and adds to our conviction in ASML as a preferred pick.

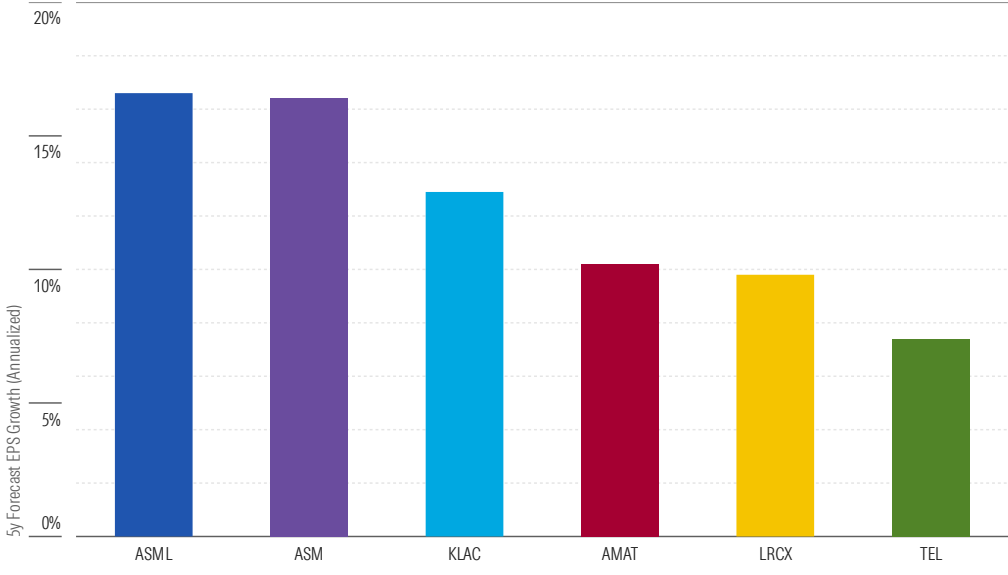
Exhibit 84 We Expect Slower Margin Expansion Going Forward for Most Firms but See an Acceleration for ASML



Source: Morningstar analyst estimates, PitchBook.

Put together with our revenue growth forecasts, we anticipate strong earnings growth for all six of these firms over the next five years (Exhibit 85). In particular, we expect the highest earnings growth for ASML and ASM over the next five years. We see both firms experiencing the highest growth among peers over this period, with ASML benefiting from lithography investment for AI chips, and ASM benefiting from greater ALD penetration in AI chipmaking. ASML has the largest margin expansion potential, in our view, while ASM's earnings growth is largely driven by revenue. Our strong earnings growth expectations reinforce our confidence in these stocks.

Exhibit 85 We Expect the Highest EPS Growth for ASML and ASM Over the Next Five Years



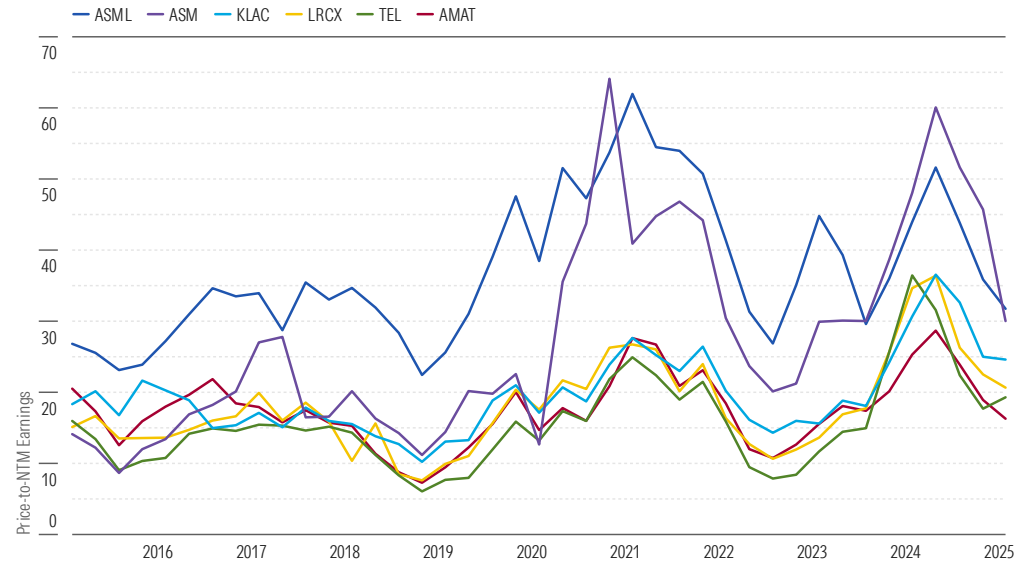
Source: Morningstar analyst estimates, company documents.

We expect low-double-digit earnings growth for KLA, Applied, and Lam. These firms are broader and less directly exposed to specific technologies like EUV and ALD. With more relative exposure to non-cutting-edge technologies than ASML and ASM, we expect slightly lower growth for this trio. We believe in a similar growth opportunity across this trio, but they haven't traded as such. We see KLA's and Lam's opportunities being priced into shares currently, while Applied trades well below both. To us, this is an actionable disconnect, as we expect Applied's valuation to rerate toward its peers as this growth manifests.

Earnings Growth Translates to the Multiple

For investors looking at relative valuation and multiples, we see cyclicalities as a useful tool. Price-to-earnings multiples move cyclically in this group, correlated with cyclical results and driving stock price cyclicalities. In Exhibit 86 we show that these multiples have oscillated over rough medians over the past years and generally cycle in line with the rest of the group. When a firm's multiple drops below its median on short-term cyclical weakness, we usually would expect it to revert in the future when a cyclical rebound occurs, making for a buying opportunity.

For the group of Applied, Lam Research, KLA, and Tokyo Electron, we see a tight grouping around a median price/earnings multiple in the low 20s. We believe the median multiple for ASML and ASM is higher, resulting from ASML's monopoly in lithography and ASM's high concentration in advanced atomic-layer deposition. This agrees with our expectations for the highest earnings growth from ASML and ASM over the next five years.

Exhibit 86 We've Seen WFE Multiples Show Cyclical, but We Observe Steadier Medians Over Time

Source: Morningstar, PitchBook.

Looking at valuations through this lens, we see Applied's multiple having overcontracted compared with peers Lam and KLA. We believe Applied merits a similar multiple to these two, which is implied by our \$196 fair value estimate. For ASM and ASML, we believe multiples have also contracted excessively, as if there is a severely lower growth opportunity going forward. We disagree and see these firms as two significant AI winners. In our view, multiples for Applied, ASML, and ASM should all rise over the next two years as the market reacts to the growth we expect from AI investments.

Right now, ASML, Applied, and ASM look the most attractive to us. Nonetheless, we see attractive opportunities for the whole group to outperform the market with attractive earnings growth, underpinned by AI investments, ahead. Long-term investors should also view future cyclical dips as additional buying opportunities for this whole group of high-quality, wide-moat WFE leaders. We expect durable through-cycle growth for this group of six, and when multiples contract during a cyclical downturn, investors should look to buy in.

Appendix - Forecast Tables

Exhibit 1A We Built Our WFE Forecast Bottom-Up Using Our Valuation Models Across Our WFE Coverage. We Assume the Highest Growth for ASM

USD millions	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029		4y Hist CAGR	5y Fcst CAGR
WFE Market Forecast													
ASML	11,758	16,150	16,019	23,725	23,550	26,499	27,465	30,017	32,681	35,915			
Growth y/y %		37.4%	-0.8%	48.1%	-0.7%	12.5%	3.6%	9.3%	8.9%	9.9%		19.0%	8.8%
Market Share %	18.1%	17.4%	15.9%	23.1%	21.1%	20.9%	20.8%	20.9%	21.1%	21.5%			
Applied Materials	12,079	17,738	19,992	20,352	21,439	21,780	23,456	25,514	27,408	29,294			
Growth y/y %		46.9%	12.7%	1.8%	5.3%	1.6%	7.7%	8.8%	7.4%	6.9%		15.4%	6.4%
Market Share %	18.6%	19.1%	19.9%	19.8%	19.2%	17.2%	17.8%	17.7%	17.7%	17.5%			
Lam Research	9,723	13,746	15,616	11,540	12,753	16,452	17,510	19,439	20,523	21,722			
Growth y/y %		41.4%	13.6%	-26.1%	10.5%	29.0%	6.4%	11.0%	5.6%	5.8%		7.0%	11.2%
Market Share %	15.0%	14.8%	15.5%	11.2%	11.4%	13.0%	13.3%	13.5%	13.3%	13.0%			
Tokyo Electron	8,711	14,129	13,327	10,267	12,651	17,152	15,944	17,787	19,354	21,658			
Growth y/y %		62.2%	-5.7%	-23.0%	23.2%	35.6%	-7.0%	11.6%	8.8%	11.9%		9.8%	11.4%
Market Share %	13.4%	15.2%	13.2%	10.0%	11.3%	13.5%	12.1%	12.4%	12.5%	13.0%			
KLA	4,186	6,013	8,231	7,646	8,529	10,047	10,599	11,341	12,139	12,995			
Growth y/y %		43.6%	36.9%	-7.1%	11.5%	17.8%	5.5%	7.0%	7.0%	7.1%		19.5%	8.8%
Market Share %	6.5%	6.5%	8.2%	7.4%	7.6%	7.9%	8.0%	7.9%	7.9%	7.8%			
ASM International	1,198	1,666	2,111	2,385	2,581	2,942	3,325	3,857	4,397	4,902			
Growth y/y %		39.0%	26.7%	13.0%	8.2%	14.0%	13.0%	16.0%	14.0%	11.5%		21.1%	13.7%
Market Share %	1.8%	1.8%	2.1%	2.3%	2.3%	2.3%	2.5%	2.7%	2.8%	2.9%			
All Other	17,233	23,401	25,345	26,905	30,133	31,882	33,776	35,832	38,068	40,506			
Growth y/y %		35.8%	8.3%	6.2%	12.0%	5.8%	5.9%	6.1%	6.2%	6.4%		15.0%	6.1%
Market Share %	26.6%	25.2%	25.2%	26.2%	27.0%	25.2%	25.6%	24.9%	24.6%	24.3%			
Global WFE	64,889	92,843	100,641	102,820	111,636	126,754	132,076	143,788	154,570	166,993			
Growth y/y %		43.1%	8.4%	2.2%	8.6%	13.5%	4.2%	8.9%	7.5%	8.0%		14.5%	8.4%

Source: Morningstar analyst estimates, Gartner.

Exhibit 2A We Assume the Highest Growth for Leading-Edge Logic Over Our Five-Year Forecast, Led by AI Investments

USD millions	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029		4y Hist CAGR	5y Fcst CAGR
WFE Market Forecast													
Leading-Edge Logic	16,027	29,246	37,948	25,344	24,113	33,759	38,822	42,705	46,975	51,673			
Growth y/y %		82.5%	29.8%	-33.2%	-4.9%	40.0%	15.0%	10.0%	10.0%	10.0%		10.8%	16.5%
Market Share %	24.7%	31.5%	37.7%	24.6%	21.6%	26.6%	29.4%	29.7%	30.4%	30.9%			
Lagging-Edge Logic	21,385	28,112	30,251	46,141	44,547	42,311	40,388	43,185	46,943	49,363			
Growth y/y %		31.5%	7.6%	52.5%	-3.5%	-5.0%	-4.5%	6.9%	8.7%	5.2%		20.1%	2.1%
Market Share %	33.0%	30.3%	30.1%	44.9%	39.9%	33.4%	30.6%	30.0%	30.4%	29.6%			
Total Logic	37,413	57,358	68,200	71,485	68,660	76,070	79,210	85,889	93,918	101,035			
Growth y/y %		53.3%	18.9%	4.8%	-4.0%	10.8%	4.1%	8.4%	9.3%	7.6%		16.4%	8.0%
Market Share %	57.7%	61.8%	67.8%	69.5%	61.5%	60.0%	60.0%	59.7%	60.8%	60.5%			
DRAM	9,336	14,230	12,469	13,594	23,359	26,047	26,539	29,512	30,429	33,267			
Growth y/y %		52.4%	-12.4%	9.0%	71.8%	11.5%	1.9%	11.2%	3.1%	9.3%		25.8%	7.3%
Market Share %	14.4%	15.3%	12.4%	13.2%	20.9%	20.5%	20.1%	20.5%	19.7%	19.9%			
NAND	12,612	17,337	15,832	10,481	12,324	15,972	17,372	18,336	18,898	19,739			
Growth y/y %		37.5%	-8.7%	-33.8%	17.6%	29.6%	8.8%	5.6%	3.1%	4.5%		-0.6%	9.9%
Market Share %	19.4%	18.7%	15.7%	10.2%	11.0%	12.6%	13.2%	12.8%	12.2%	11.8%			
Other Memory	5,528	3,919	4,140	7,260	7,293	8,665	8,954	10,050	11,325	12,951			
Growth y/y %		-29.1%	5.6%	75.4%	0.4%	18.8%	3.3%	12.2%	12.7%	14.4%		7.2%	12.2%
Market Share %	8.5%	4.2%	4.1%	7.1%	6.5%	6.8%	6.8%	7.0%	7.3%	7.8%			
Total Memory	27,476	35,486	32,441	31,335	42,976	50,684	52,866	57,898	60,652	65,957			
Growth y/y %		29.2%	-8.6%	-3.4%	37.1%	17.9%	4.3%	9.5%	4.8%	8.7%		11.8%	8.9%
Market Share %	42.3%	38.2%	32.2%	30.5%	38.5%	40.0%	40.0%	40.3%	39.2%	39.5%			
Global WFE	64,889	92,843	100,641	102,820	111,636	126,754	132,076	143,788	154,570	166,993			
Growth y/y %		43.1%	8.4%	2.2%	8.6%	13.5%	4.2%	8.9%	7.5%	8.0%		14.5%	8.4%

Source: Morningstar analyst estimates, Gartner.

Exhibit 3A We Project a Rising Concentration Across China, Taiwan, Korea, and the Americas Over Our Forecast

USD millions	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029		4y Hist CAGR	5y Fcst CAGR
WFE Market Forecast													
China	14,358	22,657	19,659	33,328	40,444	39,509	38,525	41,379	45,291	49,176			
Growth y/y %		57.8%	-13.2%	69.5%	21.4%	-2.3%	-2.5%	7.4%	9.5%	8.6%		29.6%	4.0%
Market Share %	22.1%	24.4%	19.5%	32.4%	36.2%	31.2%	29.2%	28.8%	29.3%	29.4%			
Taiwan	13,868	21,113	24,764	17,753	16,882	27,907	30,242	33,643	36,420	39,631			
Growth y/y %		52.2%	17.3%	-28.3%	-4.9%	65.3%	8.4%	11.2%	8.3%	8.8%		5.0%	18.6%
Market Share %	21.4%	22.7%	24.6%	17.3%	15.1%	22.0%	22.9%	23.4%	23.6%	23.7%			
Korea	16,438	20,149	21,109	17,881	19,549	22,723	24,643	26,869	28,163	29,594			
Growth y/y %		22.6%	4.8%	-15.3%	9.3%	16.2%	8.5%	9.0%	4.8%	5.1%		4.4%	8.6%
Market Share %	25.3%	21.7%	21.0%	17.4%	17.5%	17.9%	18.7%	18.7%	18.2%	17.7%			
Americas	9,522	13,161	13,166	13,456	14,922	15,330	18,370	20,298	22,344	24,547			
Growth y/y %		38.2%	0.0%	2.2%	10.9%	2.7%	19.8%	10.5%	10.1%	9.9%		11.9%	10.5%
Market Share %	14.7%	14.2%	13.1%	13.1%	13.4%	12.1%	13.9%	14.1%	14.5%	14.7%			
Japan	4,270	6,152	7,490	5,980	7,828	9,551	9,061	9,296	9,627	10,266			
Growth y/y %		44.1%	21.7%	-20.2%	30.9%	22.0%	-5.1%	2.6%	3.6%	6.6%		16.4%	5.6%
Market Share %	6.6%	6.6%	7.4%	5.8%	7.0%	7.5%	6.9%	6.5%	6.2%	6.1%			
Europe, Middle East, and Africa	2,232	4,645	9,401	10,158	7,771	7,255	7,050	7,902	8,161	8,517			
Growth y/y %		108.1%	102.4%	8.1%	-23.5%	-6.6%	-2.8%	12.1%	3.3%	4.4%		36.6%	1.9%
Market Share %	3.4%	5.0%	9.3%	9.9%	7.0%	5.7%	5.3%	5.5%	5.3%	5.1%			
Other Asia Pacific	4,200	4,967	5,053	4,263	4,241	4,478	4,185	4,401	4,564	5,262			
Growth y/y %		18.2%	1.7%	-15.6%	-0.5%	5.6%	-6.5%	5.2%	3.7%	15.3%		0.2%	4.4%
Market Share %	6.5%	5.3%	5.0%	4.1%	3.8%	3.5%	3.2%	3.1%	3.0%	3.2%			
Global WFE	64,889	92,843	100,641	102,820	111,636	126,754	132,076	143,788	154,570	166,993			
Growth y/y %		43.1%	8.4%	2.2%	8.6%	13.5%	4.2%	8.9%	7.5%	8.0%		14.5%	8.4%

Source: Morningstar analyst estimates, Gartner.

Exhibit 4A We Project the Strongest Outperformance for Etch Demand Over Our Forecast, as Chipmakers Pursue Vertical Scaling

USD millions	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029		4y Hist CAGR	5y Fcst CAGR
WFE Market Forecast													
Material Removal (Etch)	19,514	29,041	30,417	24,532	28,342	37,490	37,322	41,531	44,489	48,397			
Growth y/y %		48.8%	4.7%	-19.3%	15.5%	32.3%	-0.4%	11.3%	7.1%	8.8%		9.8%	11.3%
Market Share %	30.1%	31.3%	30.2%	23.9%	25.4%	29.6%	28.3%	28.9%	28.8%	29.0%			
Lithography	13,537	17,131	17,525	25,947	25,612	28,818	29,870	32,644	35,542	39,059			
Growth y/y %		26.6%	2.3%	48.1%	-1.3%	12.5%	3.6%	9.3%	8.9%	9.9%		17.3%	8.8%
Market Share %	20.9%	18.5%	17.4%	25.2%	22.9%	22.7%	22.6%	22.7%	23.0%	23.4%			
Deposition	13,924	20,795	22,790	22,613	25,628	26,378	28,574	31,338	33,935	36,487			
Growth y/y %		49.3%	9.6%	-0.8%	13.3%	2.9%	8.3%	9.7%	8.3%	7.5%		16.5%	7.3%
Market Share %	21.5%	22.4%	22.6%	22.0%	23.0%	20.8%	21.6%	21.8%	22.0%	21.8%			
Process Control	7,263	10,468	13,525	12,707	14,250	16,644	17,392	18,436	19,548	20,731			
Growth y/y %		44.1%	29.2%	-6.0%	12.1%	16.8%	4.5%	6.0%	6.0%	6.1%		18.4%	7.8%
Market Share %	11.2%	11.3%	13.4%	12.4%	12.8%	13.1%	13.2%	12.8%	12.6%	12.4%			
Doping, Implant, etc.	1,651	2,089	2,521	3,533	3,469	3,524	3,795	4,128	4,435	4,740			
Growth y/y %		26.5%	20.7%	40.1%	-1.8%	1.6%	7.7%	8.8%	7.4%	6.9%		20.4%	6.4%
Market Share %	2.5%	2.2%	2.5%	3.4%	3.1%	2.8%	2.9%	2.9%	2.9%	2.8%			
Oxidation, RTP, etc.	1,537	2,462	2,875	3,211	3,150	3,200	3,446	3,749	4,027	4,304			
Growth y/y %		60.1%	16.8%	11.7%	-1.9%	1.6%	7.7%	8.8%	7.4%	6.9%		19.6%	6.4%
Market Share %	2.4%	2.7%	2.9%	3.1%	2.8%	2.5%	2.6%	2.6%	2.6%	2.6%			
All Other	7,463	10,858	10,988	10,278	11,185	10,700	11,675	11,961	12,595	13,275			
Growth y/y %		45.5%	1.2%	-6.5%	8.8%	-4.3%	9.1%	2.4%	5.3%	5.4%		10.6%	3.5%
Market Share %	11.5%	11.7%	10.9%	10.0%	10.0%	8.4%	8.8%	8.3%	8.1%	7.9%			
Global WFE	64,889	92,843	100,641	102,820	111,636	126,754	132,076	143,788	154,570	166,993			
Growth y/y %		43.1%	8.4%	2.2%	8.6%	13.5%	4.2%	8.9%	7.5%	8.0%		14.5%	8.4%

Source: Morningstar analyst estimates, Gartner.

Research Methodology for Valuing Companies

Overview

At the heart of our valuation system is a detailed projection of a company's future cash flows, resulting from our analysts' research. Analysts create custom industry and company assumptions to feed income statement, balance sheet, and capital investment assumptions into our globally standardized, proprietary discounted cash flow, or DCF, modeling templates. We use scenario analysis, in-depth competitive advantage analysis, and a variety of other analytical tools to augment this process. We think analyzing valuation through discounted cash flows presents a better lens for viewing cyclical companies, high-growth firms, businesses with finite lives (mines, for example), or companies expected to generate negative earnings over the next few years. That said, we don't dismiss multiples altogether but rather use them as supporting cross-checks for our DCF-based fair value estimates. We also acknowledge that DCF models offer their own challenges (including a potential proliferation of estimated inputs and the possibility that the method may miss short-term market-price movements), but we believe these negatives are mitigated by deep analysis and our long-term approach.

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Four key components drive the Morningstar rating:

- ▶ our assessment of the firm's economic moat.
- ▶ our estimate of the stock's fair value.
- ▶ our uncertainty around that fair value estimate.
- ▶ the current market price.

This process ultimately culminates in our single-point star rating.

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Fair Value Estimate

Each stock's fair value is estimated by using a proprietary discounted cash flow model, which assumes that the stock's value is equal to the total of the free cash flows of the company is expected to generate in the future, discounted back to the present at the rate commensurate with the riskiness of the cash flows. As with any DCF model, the ending value is highly sensitive to Morningstar's projections of future growth.

Fair Value Uncertainty

The Morningstar Uncertainty Rating represents the analysts' ability to bound the estimated value of the shares in a company around the fair value estimate, based on the characteristics of the business underlying the stock, including operating and financial leverage, sales sensitivity to the overall economy, product concentration, pricing power, exposure to material ESG risks, and other company-specific factors. Based on these factors, analysts classify the stock into one of several uncertainty levels: Low, Medium, High, Very High, or Extreme. Our recommended margin of safety—the discount to fair value demanded before we'd recommend buying or selling the stock—widens as our uncertainty of the estimated value of the equity increases.

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Morningstar Rating for Stocks

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