

# Anatomy of a Semiconductor Cycle

10.20.2023

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- I believe we're seeing the promise of a new wave of growth in the semiconductor sector, as so many items we use in our daily lives are increasingly driven by technology.
- The key to assessing the opportunities and risks in the semiconductor industry is to understand what drives the manufacturing cycles. And the key that unlocks growth is innovation.
- Semiconductors are currently in a recovery, and we are optimistic about the industry over the long term as we enter a period of secular growth, with advanced chips creating new areas of computing.

When I started my career as an analyst in the mid 1990s at Parnassus, I was 22 years old. Personal computers were becoming mainstream at home and at work. Michael Dell was on his way to becoming a billionaire, and millions of people were logging onto the Internet to send emails or surf with the new Netscape browser. That's when I began researching semiconductor stocks. Since then, I've been through eight semiconductor cycles, witnessing what has driven the cycles' peaks and recessions, and bringing insights to our research approach of the industry to help us select high-quality companies for our portfolios.

The semiconductor industry has grown from around \$154 billion when I started following it in 1995 to almost \$600 billion today. It's a growth business because it powers waves of innovation. I've seen firsthand what makes the leaders and what drives the cyclical nature. And I believe we're seeing the promise of a new wave of growth in the semiconductor sector, as so many items we use in our daily lives are increasingly driven by technology.

## The Tiniest but Mightiest Productivity Driver

Taking a step back, what exactly is a semiconductor? Semiconductors—also called integrated circuits, microchips or simply chips—combine with software to provide a foundational layer for a base level of intelligence in computing devices. They are substrates that conduct electricity and can contain billions of transistors that can transmit signals and electrical power. The transistors are essentially tiny switches that form a foundation for digital computing. For decades, they have evolved to provide better power and performance, even as they have reduced in size.

Semiconductors are helping to power productivity and the economy—supporting the way we work and live as they enhance the functionality of everything from cars and planes to microwaves and refrigerators to PCs and mobile handsets. The wide variety of products to support means that there are several types of semiconductors. For example, there are specific types of chips for automotive use, data storage, consumer applications, industrial and military applications, and wired and wireless applications.

Within the semiconductor industry, different companies focus on the design and/or the manufacturing of different types of chips. It's a broad industry with dozens of companies, such as Intel, Qualcomm and Texas Instruments, facilitating the manufacturing and delivery of the range of chips and related services. Another key segment of the semiconductor industry is the chip-equipment makers, the companies that build the machines that make the chips. They include Applied Materials, Lam Research, KLA and ASML.

Over the years, Parnassus has taken positions in chipmakers, but we have found our sweet spot to be semiconductor-equipment providers. These companies work with their customers in advance of a manufacturing cycle to support the

technology needed to manufacture new semiconductors. Once the new equipment has been designed and built specifically for a chip-manufacturing plant, semiconductor-equipment providers can establish an incumbent leadership due to high competitive barriers that can be longer than those of chipmakers. In our view, their total addressable market should grow as new technologies demand new, more powerful chips.

In my 28 years as an investor, I've learned that the key to assessing the opportunities and risks in the semiconductor industry is to understand what drives the manufacturing cycles. And the key that unlocks growth is innovation. Currently, there is a proliferation of microchip penetration resulting from an incredible set of innovations in the past 25+ years.

### **Breaking Down the Cycle—The Supply-Demand Bullwhip**

Other industries—including retail, oil and consumer discretionary goods—also have business cycles, but none have the dynamics of semiconductor cycles. The difference lies in the constant rotation between chip scarcity and oversupply, which, in supply chain terms is called the “bullwhip effect.”

When product or technology innovations happen, they create rising demand for the new chips that will be needed to power those innovations. Semiconductor companies need to build new capacity in chip-fabrication plants, or “fabs.” Fabs are capital intensive and can take a while to build because of the complex features needed to support technology, such as clean rooms and robotic and cooling equipment. Building chip plants is an expensive journey.

The more chip demand exceeds available supply, the more likely customers are to place double or triple orders, pushing prices higher and potentially creating a false sense of demand. Once the capital investments have been completed and the manufacturing facility is up and running, chipmakers can see revenue, profits and stock prices soar. Often, they will over-extrapolate by adding excess capacity to meet demand. As supply meets and exceeds demand, customers will typically stop placing orders or cancel them. Chipmakers, saddled with excess inventory, slow or stop manufacturing until orders pick up again. During this part of the cycle, revenue, earnings and stock prices typically fall significantly.

The supply and demand bullwhip starts all over, moving from scarcity to oversupply and back to scarcity. Historically speaking, the downturns have typically lasted between 6 and 18 months, but upturns have tended to be much longer because of the impact of innovation and secular growth. The major disruptors are the economic cycle and outside shocks like 9/11 or Covid-19.

Like the stock market itself, it can be difficult to try to time a semiconductor cycle. Semiconductor stocks can fall dramatically in downcycles, recover those losses and rise several times over during upcycles. It takes a deep understanding of product innovation to avoid being too positive or negative about business growth at the wrong time. Double or triple orders make it hard for chipmakers to know when demand is peaking. Excess inventory and weak demand can create negative dynamics, which makes it difficult to see the bottom of a cycle.

Yet, in my experience investing in the semiconductor sector, the time to buy is when there's an oversupply—typically occurring a few quarters after companies begin to face excess inventory and capacity. The more difficult decision is knowing when to sell. We tend to take the contrarian view and aim to sell when things are going well and companies' chips are in strong demand. You need contrarian genes to be a successful semiconductor investor.

### **Where We're Finding Opportunity**

Investing in semiconductors requires patience and a counterintuitive approach to navigate the cycles. We want to own the companies that come out of each cycle stronger because they are well capitalized, innovating and bringing out new products and services. We evaluate changes in market leadership, look for broad competitive advantages and identify areas that may see strong and long-term secular growth.

As investors, we're interested in a few semiconductor stocks for our portfolios, including Intel, Applied Materials and Texas

Instruments.

**Intel** (INTC) long dominated in central processing units (CPUs) for personal computers before losing ground in mobile, AI and manufacturing technology to rivals. Now, however, Intel's PC and server-chip business is emerging from a period of excess inventory just as its roadmap for new products is showing improvement. Intel may have lost out in the last cycle, but the company could enjoy a double benefit of the cycle coming back just as they are regaining market share. We believe orders for Intel servers could rebound next year, helping the company to play a crucial role in deploying computing and AI infrastructure. Intel is also a national security asset and should benefit from funding through the 2022 Chips and Science Act.

We consider **Applied Materials** (AMAT) to be an irreplaceable asset because of its ultrawide economic moat in a digitizing economy. Applied Materials has created close partnerships with chipmakers to solve their most complex challenges, and no other company can do the fabrication manufacturing steps that it can. As devices shrink, the company's total addressable market grows, including a chance to build recurring revenue streams through long-term service agreements for its tools. Their machines are also used by foundries such as TSMC to build chips designed by Apple, capturing their growth as well.

**Texas Instruments** (TXN), as I mentioned above, makes analog chips that involve longer manufacturing cycles. Because the company can produce a chip and still sell it seven years later, it's insulated from much of the volatility inherent to semiconductor cycles. Their chips can have a wide, dispersed impact on the economy. The stock has been trading water as it faces a lot of inventory, but we think it's at an attractive price given the high barriers to entry and switching costs surrounding its business. We also like its ability to generate impressive cash flow, which can be reinvested into its business to capitalize on durable growth in its end markets.

### **Our Outlook on the Current Cycle**

Where are we now in terms of the semiconductor cycle? There has been a contraction in demand that began in late 2021, and stocks in the sector reached a market bottom in October 2022. Now we're at a point where many companies still have a lot of inventory they are burning off. The uncertainty in the economic environment could prolong the downturn or create additional volatility in the sector, especially if the U.S. is not able to accomplish a soft landing in 2024. But the good news is that semiconductors are in a recovery, and we are optimistic about the industry over the long term.

Longer term, I believe we may be entering another period of secular growth for semiconductors, with advanced chips creating new areas of computing. Generative AI is going to create a major wave of computing power, increasing demand for everything from GPUs and CPUs to memory to server chips. There are other drivers on top of that: The electrification of cars with sensors and autonomous driving; the upgrade of the power grid with wind and solar power; the Internet of Things and smart appliances; biotechnology research; and other innovations. Chips are a foundational element of all these promising areas.

Semiconductors have played an increasingly important role in the global economy over the past several decades. Today, the sector comprises 0.6% of the world's economy, and I believe it will grow to 1% by 2030. That may not seem significant, but it is when the overall economy is growing. As for semiconductor cycles, I don't see them going away. Each cycle will surprise in an interesting way as the innovations continue to evolve.

At Parnassus, we will still aim to buy during oversupplies and low prices and sell during scarcity. And we will continue to maintain our high standards for selecting quality companies in our portfolios. The experience and knowledge we've gained from our deep research and close study of the semiconductor industry over many years is part of the value we provide as an active manager in our pursuit to build wealth responsibly for long-term investors.

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