

The Growth Factor - Commentary by John Barr, jbarr@needhamco.com
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The CHIPS and Science Act - The Importance of U.S. Manufacturing of Semiconductors

On August 9, President Biden signed the long-awaited CHIPS and Science Act (the Act or the CHIPS Act). Passage of the CHIPS Act is an important step toward revitalizing semiconductor manufacturing in the United States.¹ The bill provides \$52.7 billion in funding for American semiconductor research, development, manufacturing, and workforce development. The U.S. needs domestic semiconductor manufacturing capabilities in order to have a reliable source of supply. Semiconductors are used in all types of manufactured products. Since the start of the COVID-19 pandemic, the world has experienced a crippling shortage of semiconductors. Some of this shortage in the U.S. was caused by supply chains dominated by overseas manufacturing.

Geopolitics are an even more critical reason for domestic manufacturing. Taiwan Semiconductor Manufacturing Co., Ltd. (TSM – ADR) is the world's only leading-edge semiconductor manufacturer. As long as the U.S and China are dependent on Taiwan Semiconductor Manufacturing Co., Ltd., commonly known as TSMC, both sides are vulnerable, which exacerbates other tensions.² In the event of a political takeover of Taiwan, the U.S. would be reliant on China. In the event of a Chinese attack on Taiwan, production at TSMC would come to a halt. It is nearly impossible to do advanced semiconductor manufacturing in a war zone.

The CHIPS Act is an important step toward shortening supply chains, establishing U.S. self-sufficiency, and defusing tensions. Capital is not enough. The beneficiaries also need the entrepreneurial leadership to succeed.

Passage of the CHIPS Act - Years in the Making

On July 28, the House passed The CHIPS (Creative Helpful Incentives for the Production of Semiconductors for America Act) and Science Act, which the Senate had passed the day before. President Biden signed the Act on August 8 with a White House Rose Garden ceremony attended by leaders of the U.S. industry. The bill had been in the works for over three years.

During his January 2022 State of the Union Address, President Biden not only pushed for the passage of the CHIPS Act but also made a symbolic gesture by inviting Intel Corporation's (INTC) CEO, Patrick Gelsinger, as a guest of honor. Mr. Gelsinger's attendance was even more significant, given Intel's January announcement of a \$20 billion investment, contingent on government support, into a new semiconductor manufacturing complex in Licking County, Ohio.³ Mr. Gelsinger has been the public face of the lobbying for the bill.

The Act provides \$280 billion in funding. The CHIPS portion of the bill provides \$52.7 billion, including \$39 billion in manufacturing incentives, spread over five fiscal

years. The 1,054-page bill covers much more than funding for the semiconductor industry. There's an additional \$228 billion in funded programs; the list is a cornucopia of science projects. By my count, there are over 200 areas of funding in the bill. Nuclear energy and high-intensity laser research are two interesting areas.

What is the state of U.S. manufacturing of semiconductors?

The United States' share of the world's leading-edge semiconductor manufacturing capacity has fallen from **37%** in 1990 to **12%** today.⁴ TSMC is the foremost manufacturer of leading-edge semiconductors.⁵ Its success is the result of brilliant strategic and technical execution led by founder Dr. Morris Chang. Intel is the last leading-edge logic manufacturer, and the United States is at risk of losing leading-edge production due to Intel's struggles. Intel Corporation trails in technology, but its plans for a new manufacturing facility in Ohio, funded by the Act, could be the start of a revitalized Intel. Before the appointment of Mr. Gelsinger as CEO, Intel considered becoming a fabless company. It lacked the leadership, capital, technology, and business plan to compete as a foundry on the leading edge.

There are great analog and power device companies with domestic manufacturing, such as Analog Devices, Inc. (ADI), Texas Instruments, Inc. (TXN), and ON Semiconductor Corp. (ON). Micron Technology, Inc. (MU), a leading memory manufacturer, has plants in Idaho.

Three Issues Related to Domestic Semiconductor Manufacturing:

1) Leading-edge technology dominated by Taiwan

Taiwan Semiconductor's 3nm process is in production for Apple and other leading customers. TSMC is a leader in developing technologies of the future, such as the 2nm process, advanced packaging, and the adoption of EUV (extreme ultra-violet) manufacturing equipment from ASML Holding NV (ASML). Samsung Electronics (005930-KRX) is close to TSMC in technology but does not have a business plan to win foundry business. Intel is several years behind on technology and lacks a foundry business model. Intel is the best chance the United States has to compete in technology development and manufacturing, and the Ohio complex backed by the CHIPS Act is the best chance for Intel.

2) Geopolitics

The division between the United States and China over trade and human rights is exacerbated by semiconductors. China is just as worried about access to semiconductor manufacturing as the United States and is on a crash course to self-sufficiency in semiconductors by 2030. China produces only 16% of its internal consumption. Despite significant government funding, China has failed to develop leading-edge capabilities. This failure has led to corruption investigations into industry officials.⁶ As China has learned, government capital alone is insufficient. We hope Pat Gelsinger provides the strategy and inspiration needed for Intel to deploy the CHIPS Act capital effectively.

Foreign policy blunders are often the result of unrelated, unintended actions. We fear

that access to and control of TSMC may be a flashpoint between the United States and China. Taiwan produces 61% of the world's semiconductors at 16nm or below. Today, most Chinese companies (except Huawei) can have their semiconductors manufactured at TSMC. China is worried that the United States could further restrict TSMC's ability to serve Chinese companies. The U.S. is worried that China could restrict access to TSMC for our companies.

Beyond semiconductors, China believes there is only one China and that Taiwan is part of it. American policy has been to back Taiwan without antagonizing China. The U.S. is worried that China will move militarily on Taiwan, with an underlying reason to secure access to TSMC.⁷ Both the United States and China need to develop alternatives to TSMC. It is a battle of brinkmanship unimaginable a few years ago and worthy of a James Bond movie.

Beyond the United States, China, and Taiwan are Japan, Europe, and India, all of which need to build domestic capabilities.

3) Semiconductor shortages and supply chains

When COVID-19 hit in March 2020, automakers reduced semiconductor orders, and the excess capacity was absorbed by companies making computers and other technology for remote work. It was not until January 2021 that Ford Motor Company (F) first disclosed semiconductor shortages. To this day, automakers suffer from reduced production schedules due to shortages of semiconductors, analog and power devices, and microcontrollers.

Semiconductors are used in consumer, business, and industrial products, including TVs, Smart Homes, and Internet-of-Things (IoT) devices. Electric vehicles use at least 4x as many semiconductors as cars with internal combustion engines. These semiconductors are manufactured worldwide on trailing-edge processes, and many are still short of supply. The CHIPS Act will also support domestic trailing-edge capacity additions.

COVID shut-downs have caused supply chain issues for all industries. China's Zero-COVID policy has led to shutdowns in Shanghai, Beijing, and other cities as recently as last month. It is difficult to predict when a key part will arrive from a distant supplier. The auto industry has run on just-in-time manufacturing for decades, but since the pandemic, it is no longer the preferred strategy. We expect closer cooperation between suppliers and customers. We also expect manufacturing and suppliers to move closer together and closer to their end markets. The CHIPS Act includes funding for manufacturing equipment suppliers.

How did the United States Lose its Edge?

The United States has suffered a general decline in manufacturing since the 1970s. One could blame politicians, corporate managers, labor, and financial markets. Ultimately, companies decided that engineering and manufacturing could be separated. In some industries, design work followed manufacturing abroad. TSMC innovated this strategy for the semiconductor industry and it worked for all parties. The problem for the United States is that TSMC is so good that no other companies have been able to compete.⁸

The hero in this story is Dr. Morris Chang. ⁹ Dr. Chang was born in China and lived through the Sino-Japanese War, World War II, and the Communist Revolution in China before coming to the United States in 1949. He was educated at MIT and Stanford and spent 25 years at Texas Instruments in its early years in the semiconductor industry before moving to Taiwan to head ITRI (Industrial Technology Research Institute) in 1985.

Dr. Chang and TSMC made the brilliant decision in 1987 to manufacture semiconductors designed by other companies. At its beginning, TSMC provided flex capacity. TSMC was very customer-focused and made it easy for customers to move their designs from engineering to manufacturing. TSMC enabled a generation of fabless semiconductor companies, including Broadcom, Inc. (AVGO), NVIDIA Corp. (NVDA), Qualcomm, Inc. (QCOM), Apple, Inc. (AAPL), and Marvel Technology, Inc. (MRVL), to thrive. No American company recognized the opportunity of manufacturing for fabless customers.

TSMC built an ecosystem with electronic design automation tools from Synopsys, Inc. (SNPS), Cadence Design Systems, Inc. (CDNS), Mentor Graphics, now known as Siemens EDA (SIEGY), and others. It supported intellectual property from ARM (now owned by Softbank) and others. TSMC gained critical mass that gave cost advantages. Scale allowed TSMC to invest in leading-edge manufacturing, which it executed to near perfection. TSMC kept its culture simple by staying primarily in Taiwan.

CHIPS Act Manufacturing Plans are Ready to Go

Under Mr. Gelsinger, Intel plans to build Intel Foundry Services as a leading-edge manufacturer for fabless customers and, with government support, to build new, leading-edge manufacturing in the United States. Success in the foundry business requires a new mindset for Intel. Last week, Intel Foundry Services announced a great start with MediaTek, Inc. (2454-TW) as a fabless customer. ¹⁰ It is interesting that this new customer is a leading Taiwan-based company. At the least, Intel could capture the 10-20% of the market that is the non-TSMC foundry market and, most importantly, provide the United States with a secure domestic supplier.

The manufacturing complex near Columbus, Ohio, that Intel announced in January can potentially be the new center of semiconductor manufacturing in the United States. The CHIPS Act provides significant funding for this location.

Additionally, GlobalFoundries, Inc. (GFS) announced plans to expand its manufacturing in Malta, NY. Several years ago, GFS announced a business plan focused on trailing-edge technology, as they gave up on the race to compete with TSMC on the leading-edge.

In July, SkyWater Technology, Inc. (SKYT), the State of Indiana, and Purdue University announced plans to seek CHIPS Act funding to build a \$1.8 billion semiconductor manufacturing plant on the Purdue campus. ¹¹ SkyWater has plants in Minnesota and Florida and has worked with the Department of Defense and MIT Lincoln Labs for a radiation-hardened process that is useful for aerospace and defense applications. ¹²

Conclusion

Passage of the CHIPS Act is essential for revitalizing semiconductor manufacturing in the United States, but it is not sufficient. Today, Intel trails in technology and lacks a semiconductor foundry mindset. We need Intel and the other recipients to develop competitive businesses around these new plants. Leadership is key.

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