

**Project Report**

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MBA 522.30  
Spring, 2023  
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## **Research Thesis: Potential Opportunity to Increase Profits**

Nvidia has the opportunity to increase long-term profits by developing and implementing their own microchip manufacturing operations.

### **Fully Researched Background: Client, Thesis, and Anti-Thesis**

#### **NVIDIA Corporation**

Nvidia currently utilizes a fabless manufacturing strategy. These microchips are then used to generate profit in two business segments, the graphics segment where microchips are put into products designed by Nvidia called graphic processing units (GPU) used for gaming devices, crypto currency mining and other professional applications. As well as their compute and networking segment, including system on chips (SoC) or tegra processors. All of which are sold to consumers and businesses (Trefis Team, 2019).

GPU sales accounted for 87% of Nvidia's total revenue in 2019. The other 13% of revenue being from their compute and networking segment (Trefis Team, 2019). All Nvidia's revenue is reliant on microchip supply for use in various products and systems. Taking those products and systems and leveraging them for the development of computationally intensive fields (Huang, 2022).

#### **Fabless Manufacturing**

Microchips used in a company's electronic products are not manufactured in-house and instead through a third party. Most companies before the 1980s were integrated device manufacturers (IDMs), meaning they controlled the design and manufacturing of their chips. Chips made by Taiwan Semiconductor Manufacturing Company (TSMC) are sold to system companies like Nvidia for the use in their "smart" electronic products.

#### **Graphic Processing Units (GPU)**

A Graphic Processing Unit (GPU) is a computer component that can be used in a variety of ways, the biggest uses being graphics and video rendering. These applications are mostly known for and used in gaming. However, creative and artificial intelligence (AI) spaces are finding ways to utilize GPUs as well. GPU's allow computers to display interesting and realistic scenes using various techniques created by programmers (Intel, 2023).

#### **Compute and Networking**

Compute and networking systems are within products used by consumers every day. These systems on chips are used in mobile devices, vehicles, robotics, artificial intelligence (AI), high performance, and accelerated computing developed in-house by Nvidia (Huang, 2022). The systems are used through microchips and connect various applications and networks to collaborate with one another.

## **Computationally Intensive Fields**

Computationally intensive fields is a broad term for industries, sectors or products that require the use of advanced computer components. In this case, the use of microchips in GPUs and other compute and networking segments. Within these fields there becomes a cycle effect when creating “smart” products, to need the implementation of “smart” networks to enable the creation and advancement of “smart” environments and integrated ecosystems (Maiti, 2018).

## **Thesis**

Nvidia has the opportunity to increase long-term profits by developing and implementing their own microchip manufacturing operations. Developing and implementing microchip operations consists of opening a factory in the United States, more control over in-house operations, lowering cost of goods sold and third-party costs, cutting out current microchip suppliers, and the continued development of Nvidia’s supply chain. (Reuters, 2017; Zhu, 2002; Trading Economics, 2023; The White House, 2022; ZenBusiness, 2021; Kaya, 2011; WSJ, 2023; Fernando, 2023; UV & DBP, 2022; Dutta, 2023; Soleimani, 2018; CSCMP, 2023)

## **An NVIDIA Owned Factory in the United States**

The cost for a microchip factory is difficult to estimate. A factory built by TSMC in 2017, projected by Reuters, was estimated to cost them twenty billion dollars (Reuters, 2017). Going off Reuters estimates and the fact that TSMC serves most of the microchip market, Nvidia manufacturing operations could cost less than a TSMC factory. The difference between TSMC’s factory cost and Nvidia’s COGS excluding D&A is not too far apart when considering the size difference between TSMC and Nvidia. In other words, there is a possibility of purchasing and implementing a factory at a lower price. The timing and execution of the purchase of factory or real estate is entirely dependent on estimated costs and profits after implementation.

## **Benefits of a Factory**

There are many inherent advantages that come along with implementing a factory in the United States. For example, stimulating the United States job market i.e., creating more jobs for United States citizens. In house manufacturing can create a new revenue stream between other companies that are struggling in this time of microchip supply chain disruption by buying microchips directly from Nvidia's manufacturing operations. Other benefits include flexibility of changes to production, better overview of quality control of the product, reduction in manufacturer management costs associated with outsourcing, more involvement with the supply side to help meet demand, a reduction in carbon footprint by streamlining processes and supply chain data under one roof can be more secure (ZenBusiness, 2021) (Kaya, 2011).

## **Lowering Cost of Goods Sold (COGS)**

Nvidia’s total COGS, excluding D&A, was more than eight billion dollars in 2022 (WSJ, 2023). Nvidia could lower their COGS and third-party fees. It is important to develop and implement new strategies to increase profit because a company can continuously lessen their profit margins

throughout time if not accounted for. Nvidia and their business relationships with third party suppliers seem like it has created excessive costs for Nvidia. Reducing third party costs could be aided by the implementation of an Nvidia supplied and owned factory in the United States.

### **Cutting Out Intermediaries**

Nvidia could cut out their main intermediary, TSMC, receive the silicon metalloid supply directly and develop and implement their own microchip processing and manufacturing operations in the United States. Latest news shows that Nvidia will solely rely on Taiwan Semiconductor Manufacturing Company (TSMC) for their microchip supply and manufacturing in 2022 (UV & DBP, 2022). Meaning, Nvidia will have to cut out their other wafer manufacturers like Samsung, and those who conduct shipping and handling as well. There is a possibility of reducing third party costs by cutting out unnecessary intermediaries.

### **Development of Supply Chain**

Nvidia is constantly updating and developing their supply chain processes. Nvidia recently introduced Artificial Intelligence (AI) into their supply chain system (Soleimani, 2018). Being that there are experts already optimizing Nvidia's supply chain, it is possible that these experts can be placed with greater ease throughout the development of manufacturing operations. Their ongoing effort to optimize supply chain operations could be accelerated with the implementation of their own manufacturing.

### **Anti-Thesis**

Engaging in the development and implementation of microchip manufacturing operations might not generate increased profits for Nvidia due to the high costs short term, COVID-19 and political supply chain issues and poor supply chain management and execution. (Reuters, 2017; Clark, 2021; ASML, 2023; Shattuck, 2021; Marinova & Bitri, 2021; Newman, 2021; Martin & Hawkins, 2023; Capelouto, 2017; Nurminen et al., 1992; Scott, 2023)

### **High Costs Short Term**

The implementation of a factory will be costly in the short term. The initial costs of outfitting and purchasing real estate for a factory could be several billion dollars. As well as the shipping and handling costs for suppliers of silicon. Nvidia's headquarters is in Santa Clara, CA. Assuming that the factories would also be in California, this presents some issues surrounding estimating factory and manufacturing costs. The average cost of a factory can vary depending on a few factors such as its size, location, and the specific industry it serves. Referring to Reuters estimates, a microchip factory could cost upwards of twenty billion dollars. Running the risk of it being even more when all cost aspects of the supply chain are not considered (Reuters, 2017).

### **COVID-19 and Political Supply Chain Issues**

The COVID-19 pandemic supply chain issues have become a huge issue for companies that rely on the use of microchips in their products. On top of it, President Donald Trump's

administration efforts to restrict China's ability to manufacture and acquire resources for microchips has also hindered the market (Shattuck, 2021). The silicon industry is competitive and there is limited supply (Marinova & Bitri, 2021). The relations between China and the United States have the potential to affect the silicon supply (Shattuck, 2021). Finding suppliers for silicon early in the process to be directly delivered to Nvidia's factories is crucial to the early success of implementing manufacturing operations.

### **Supply Chain Management**

Supply chain experts are already in place implementing new systems and technologies at Nvidia. However, cutting out an experienced third party, like TSMC and Samsung, could cause issues if the correct supply chain experts are not put in the proper roles to oversee such operations. Therefore, causing Nvidia to have to work directly with overseas silicon mining companies. This could warrant geopolitical issues for new or existing mismanagement. Since mining is conducted in other countries, there could be issues surrounding unfair labor conditions, third-party mismanagement and Nvidia's control over it (Capelouto, 2017). Studies show that the presence of airborne silica in raw metal mines may cause lung cancer (Nurminen et al., 1992). Nvidia can face bad publicity by collaborating directly with companies that are associated with poor labor conditions and mismanagement.

### **Methodology**

I researched this opportunity over the course of 6 weeks, ending on April 23<sup>rd</sup>, 2023, through a comprehensive review, evaluation, and analysis of all the published information available via the internet.

Sources include academic journals, scholarly articles, semiconductor industry research reports, Nvidia's company website, online newspapers, and articles.

### **Findings**

#### **Thesis**

The research thesis that Nvidia has an opportunity to increase profits long-term by developing and implementing their own microchip manufacturing operations was supported in whole or in part by Developing and implementing microchip operations consists of opening a factory in the United States, more control over in-house operations, lowering cost of goods sold and third-party costs, cutting out current microchip suppliers, and the continued development of Nvidia's supply chain. (Reuters, 2017; Zhu, 2002; Trading Economics, 2023; The White House, 2022; ZenBusiness, 2021; Kaya, 2011; WSJ, 2023; Fernando, 2023; UV & DBP, 2022; Dutta, 2023; Soleimani, 2018; CSCMP, 2023)

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off Reuters estimates and the fact that TSMC serves most of the microchip market, Nvidia manufacturing operations could cost less than a TSMC factory. The difference between TSMC's factory cost and Nvidia's COGS excluding D&A, eight billion dollars, is not too far apart when considering the size difference between TSMC and Nvidia. In other words, there is a possibility of purchasing and implementing a factory at a lower price. The timing and execution of the purchase of factory or real estate is entirely dependent on estimated costs and profits after implementation.

In the 1990s, the commercial real estate market was highly cyclical and had a hand in the global economic downturn (Zhu, 2002). This information is from the early 2000s, however, it is still relevant to current commercial real estate market conditions to show recent appreciation of commercial real estate. The business cycle and fluctuations of the commercial real estate market were much less pronounced than they used to be. Comparing residential to commercial real estate, house prices have risen steadily while commercial real estate has reached higher levels than it had decades ago (Trading Economics, 2023). Timing prices and interest rates in today's market is crucial for the success of minimizing excessive costs.

Since President Biden has enacted the bipartisan CHIPS and Science Act of 2022, construction of new manufacturing facilities has increased 116% over 2021. This act is an effort to invest in America and bring chip manufacturing to the United States. The act provides over fifty-two billion dollars for American semiconductor research, thirty-nine billion dollars in manufacturing incentives, five-hundred million dollars to support and protect international communication, and a 25% investment tax credit for capital expenses related to the construction and outfitting of a microchip factory. Nvidia could use the bipartisan CHIPS and Science Act of 2022 to their advantage in reducing short term costs if a factory were to be implemented (The White House, 2022).

### **Benefits of a Factory**

There are many inherent advantages that come along with implementing a factory in the United States. For example, stimulating the United States job market i.e., creating more jobs for United States citizens. In house manufacturing can create a new revenue stream between other companies that are struggling in this time of microchip supply chain disruption by buying microchips directly from Nvidia's manufacturing operations. Other benefits include flexibility of changes to production, better overview of quality control of the product, reduction in manufacturer management costs associated with outsourcing, more involvement with the supply side to help meet demand, a reduction in carbon footprint by streamlining processes and supply chain data under one roof can be more secure (ZenBusiness, 2021) (Kaya, 2011).

### **Lowering Cost of Goods Sold (COGS)**

Nvidia's total COGS, excluding depreciation & amortization, was more than eight billion dollars in 2022 (WSJ, 2023). Nvidia could lower their COGS and third-party fees. It is important to develop and implement new strategies to increase profit because a company can continuously lessen their profit margins throughout time if not accounted for. Nvidia and their business relationships with third party suppliers seem like it has created excessive costs for Nvidia.

Reducing third party costs could be aided by the implementation of an Nvidia supplied and owned factory in the United States.

Cost of goods sold (COGS) is defined as the costs of producing the goods sold by a company (Fernando, 2023). This is directly associated with the cost of manufacturing and the fees that go along with it. If there is a possibility of gaining cheaper factories, labor, and supply than what it is costing to use TSMC, this could solve Nvidia's excessive third-party fees. It is important to note that factory, labor, and supply cost information is not readily available online. Therefore, it is difficult to estimate the comparison in costs to an Nvidia owned factory in the United States and a TSMC factory overseas. However, since Nvidia works closely with TSMC this information could be obtained by upper management.

### **Cutting Out Intermediaries**

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According to Sumit Dutta of Ernst & Young Pvt. there is a most optimized way to perform the duties of a supplier to reduce costs. Dutta takes four broad aspects of developing supply chain; plan, source, make, and deliver. Planning the improvement of supply chain management, sourcing raw materials from risk averse and low-cost suppliers, making a workforce optimization model that develops and changes over time, and delivering your product effectively and efficiently (Dutta, 2023). Supply and operations directly from Nvidia could reduce costs by implementing practices that follow the four broad aspects above.

### **Development of Supply Chain**

Nvidia is constantly updating and developing their supply chain processes. Nvidia recently introduced Artificial Intelligence (AI) into their supply chain system (Soleimani, 2018). Being that there are experts already optimizing Nvidia's supply chain, it is possible that these experts can be placed with greater ease throughout the development of manufacturing operations. Their ongoing effort to optimize supply chain operations could be accelerated with the implementation of their own manufacturing.

Once manufacturing operations are in place there are benefits that come along with making the in-house supply chain more efficient and effective. Customer service and profits can be boosted by being able to meet demand and deliver products on time. Nvidia, with its ability to deliver products and receive materials for such products quickly, could reduce inventory and plant shut down costs. Implementing an effective supply chain manager and reducing costs by even one cent can reduce costs companywide (CSCMP, 2023).

## **Anti-Thesis**

The research thesis that Nvidia has an opportunity to increase profits long-term by developing and implementing their own microchip manufacturing operations was not supported in whole or in part by high costs short term, COVID-19 and political supply chain issues and poor supply chain management and execution. (Reuters, 2017; Clark, 2021; ASML, 2023; Shattuck, 2021; Marinova & Bitri, 2021; Newman, 2021; Martin & Hawkins, 2023; Capelouto, 2017; Nurminen et al., 1992; Scott, 2023)

## **High Costs Short Term**

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ASML Holding, an innovation leader in the semiconductor industry, has created a leading manufacturing machine for microchips. These machines are available to companies across the world but at a premium. This machine was introduced for high volume microchip manufacturing and costs more than \$150 million per machine. Mostly for its involved delivery and the costs that come along with it. This machine is widely known for being a necessary tool to make current and advanced microchips and there are no other machines like it readily available on the market (Clark, 2021). Additionally, there are cleanliness requirements that come along with owning and operating such a machine. To put this in perspective, a small speck of dust can ruin a microchip during that manufacturing process. A microchip is complex and is made up of up to one-hundred layers, making precise and clean manufacturing a requirement, which will inevitably cost Nvidia more money to meet these requirements (ASML, 2023).

## **COVID-19 and Political Supply Chain Issues**

The COVID-19 pandemic supply chain issues have become a huge issue for companies that rely on the use of microchips in their products. On top of it, President Donald Trump's administration efforts to restrict China's ability to manufacture and acquire resources for microchips has also hindered the market (Shattuck, 2021). The silicon industry is competitive and there is limited supply (Marinova & Bitri, 2021). The relations between China and the United States have the potential to affect the silicon supply (Shattuck, 2021). Finding suppliers for silicon early in the process to be directly delivered to Nvidia's factories is crucial to the early success of implementing manufacturing operations.

Silicon supply is a crucial material when manufacturing microchips. Unfortunately, silicon is not an easily accessible resource for United States companies. Short-term disruptions of the chip market such as, remote workers buying chip heavy computers and chip plant fires, are far less



relevant than the long-term impact that President Trump's trade war with China has had on the microchip market. In 2018 Trump's administration had imposed a 25% tariff on Chinese imports, which included microchips (Newman, 2021). While these tariffs were set to expire in 2022, they are still in effect today (Martin & Hawkins, 2023). Silicon is most abundant in China and this tariff could affect Nvidia's profits when figuring out who will supply them with raw materials.

### **Supply Chain Management**

Supply chain experts are already in place implementing new systems and technologies at Nvidia. However, cutting out an experienced third party, like TSMC and Samsung, could cause issues if the correct supply chain experts are not put in the proper roles to oversee such operations. Therefore, causing Nvidia to have to work directly with overseas silicon mining companies. This could warrant geopolitical issues for new or existing mismanagement. Since mining is conducted in other countries, there could be issues surrounding unfair labor conditions, third-party mismanagement and Nvidia's control over it (Capelouto, 2017). Studies show that the presence of airborne silica in raw metal mines may cause lung cancer (Nurminen et al., 1992). Nvidia can face bad publicity by collaborating directly with companies that are associated with poor labor conditions and mismanagement.

The imbalance in supply and demand has overshadowed some of the issues that surround the supply chain management of microchips. Creating a new factory will not simply solve the constraints that are on the microchip market and could present a problem for a Nvidia factory in the long term. TSMC and other manufacturers of chips are investing billions of dollars into new factories to meet demand. This will consume more supply and ramp industry competition (Scott, 2023). Nvidia, after the implementation of their own factory, could experience a drastic decline in demand. Managing the chip supply internally is crucial to the longevity of a Nvidia factory. Monitoring data that would indicate supply and demand variance of Nvidia products in the public or retail market could help in the forecast of industry changes.

### **Miscellaneous but Related**

Although the following aspects of this research project were not characterized as germane to the research thesis, they might be valuable to Nvidia and are, thus provided. (Leswing, 2022; Fung, 2023)

#### **Apple**

Apple, who also outsources through TSMC for their microchips, is said to be partnering with the chip manufacturer to open a factory in Arizona. This factory would still be owned and operated by TSMC however, this shows that a United States microchip factory is both plausible and profitable long term. This factory will have the ability to develop the most advanced microchips. Showing United States companies that such an arrangement can be implemented for them to meet advanced chip requirements (Leswing, 2022).

## **Tik Tok**

Tik Tok is directly affecting the relationship between the United States and China. While Tik Tok is not at all involved in the microchip manufacturing industry, it is important to note that the current political state may affect trading with Chinese territories in the future. Banning the app in the United States is only the beginning of some things that could transpire. If issues surrounding privacy and the American people are resolved, it could be a positive outcome in terms of relations. However, if things worsen it could mean a rough future ahead for all China relations. While there is no guarantee of knowing the outcome, it is crucial that Nvidia management keep an eye on this news and act as quickly as they can, whatever the outcome may be (Fung, 2023).

## **Summary, Conclusions, and Recommendations**

### **Summary**

Nvidia has the opportunity to increase long-term profits by developing and implementing their own microchip manufacturing operations.

Nvidia currently utilizes a fabless manufacturing strategy. These microchips are then used to generate profit in two business segments, the graphics segment where microchips are put into products designed by Nvidia called graphic processing units (GPU) used for gaming devices, crypto currency mining and other professional applications. As well as their compute and networking segment, including system on chips (SoC) and tegra processors. All of which are sold to consumers and businesses (Trefis Team, 2019).

Nvidia has the opportunity to increase long-term profits by developing and implementing their own microchip manufacturing operations. Developing and implementing microchip operations consists of opening a factory in the United States, more control over in-house operations, lowering cost of goods sold and third-party costs, cutting out current microchip suppliers, and the continued development of Nvidia's supply chain.

Engaging in the development and implementation of microchip manufacturing operations might not generate increased profits for Nvidia due to the high costs short term, COVID-19 and political supply chain issues and poor supply chain management and execution.

I researched this opportunity over the course of 6 weeks, ending on April 23<sup>rd</sup>, 2023, through a comprehensive review, evaluation, and analysis of all the published information available via the internet.

The research thesis that Nvidia has an opportunity to increase profits long-term by developing and implementing their own microchip manufacturing operations was supported in whole or in part by lowering cost of goods sold and third-party costs, opening a factory in the United States, cutting out current microchip suppliers, the continued development of Nvidia's supply chain and more control over in-house operations. (Reuters, 2017; Zhu, 2002; Trading Economics, 2023;

The White House, 2022; ZenBusiness, 2021; Kaya, 2011; WSJ, 2023; Fernando, 2023; UV & DBP, 2022; Dutta, 2023; Soleimani, 2018; CSCMP, 2023)

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Additional findings that were not characterized as being germane to the research thesis were also provided in the findings section.

## **Conclusions**

Although the research thesis was not fully supported by the information and analysis in the findings, based on my understanding of Nvidia and microchip manufacturing, it seems reasonable to conclude that Nvidia should consider implementing a plan to begin engaging in the development and implementation of their own microchip manufacturing operations.

## **Recommendations**

Based on my understanding of Nvidia, microchip manufacturing, my findings and conclusion regarding the research thesis, it seems reasonable that Nvidia should formulate a strategy to begin engaging in the development and implementation of their own microchip manufacturing operations. I think the implementation strategy should seek to mitigate the effects of negative findings to the extent practicable, perhaps building on the ideas provided in the anti-thesis section of this report for each of the negative findings.

Nvidia should start the process of tracking down real estate and suppliers by announcing requests for proposals (RFP) and requests for information (RFI). RFPs define a project to the public allowing the submission of bids and proposals from contractors or suppliers to complete a job. RFIs are used to show a company's interest in a particular industry, such as commercial real estate, where the company can narrow down a list of potential factories. Eventually ending with a request for quotation (RFQ), a more detailed document that outlines exact specifications required to complete or achieve such a task (Inman, 2023).

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