TECH TITANS CLASH: NAVIGATING THE US-CHINA RACE FOR SILICON SUPREMACY

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DECLARATION BY STUDENT

I hereby declare that the data presented in this Dissertation report entitled, "Tech Titans Clash: Navigating The US-China Race For Silicon Supremacy" is based on the results of investigations carried out by me in the International Studies at the School of Inteinspiratio and Area Studies, Goa University under the Supervision of Dr. Almin Cicily Jose and the same has not been submitted elsewhere for the award of a degree by me. Further, I understand that Goa University or its authorities will be not be responsible for the correctness of observations / experimental or other findings given the dissertation.

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This is to certify that the dissertation report "**Tech Titans Clash: Navigating The US-China Race For Silicon Supremacy**" is a bonafide work carried out by **Ms.** Sarvashi Satyawan Naik under my supervision in partial fulfilment of the requirements for the award of the degree of Mater of Arts in International Studies in the discipline International Studies at the School of International and Area Studies, Goa University.

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PREFACE

The US-China semiconductor race is a critical and dynamic competition between two global economic giants. Control over semiconductors industry establish a pivotal stance in global affairs profoundly shaping the future landscape of the world order. Both nations are heavily investing in semiconductor technology by recognising its strategic importance in digital era. This race not only highlights technological advancements but also influences diplomatic relations. With export control measures and restrictions shaping the geopolitical tensions, China's pursuit of self-reliance in chip technology intensifies the rivalry. This battle underlines the intricate dynamics of great power politics between the USA and China thereby reflecting a broader narrative of strategic competition in the tech sector. The US-China chip conflict allows to analyse the complex fusion of technology, economics and power within the present day global framework. This understanding is crucial for grappling with evolving dynamics of International Relations and forming knowledgeable viewpoints on the challenges and opportunities present in the competition makes the study interesting.

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ABBRIVIATIONS USED

Entity	Abbreviation
Artificial Intelligence	AI
Advanced Micro Devices	AMD
Advanced Semiconductor Materials Lithography	ASML
Assembly Test and Packaging	ATP
Assembly, Test, Marking and Packaging	ATMP
Advanced Research Projects Agency	ARPA
Advanced Research Project Agency Network	ARPANET
Application Specific Integrated Circuit	ASIC
Arsenic	As
American Telegraph and Telephone Company	AT&T
Advanced Micro-Fabrication Equipment Inc. China	AMEC
Bureau of Industry and Security	BIS
Boron	B
Belt and Road Initiative	BRI
Complementary Metal-Oxide-Semiconductor	CMOS
Creating Helpful Incentives to Produce Semiconductors Act	CHIPS Act
Code Division Multi Access	CDMA
Central Processing Unit	CPU
Centre for Development of Advanced Computing	CDAC
China Integrated Circuit Investment Industry Fund	CICIIF
Crompton Greaves Limited	CG
Canter for Strategic and International Studies	CSIS
Chinese Communist Party	CCP
Central Intelligence Agency	CIA
Deep Ultraviolet lithography	DUV
Dynamic Random Access Memory	DRAM
Department of Defence	DOD
Democratic Progressive Party	DDP
Electrical Vehicle	EV
Extreme Ultraviolet lithography	EUV
Electro-Optical System	EO
Field- Programmable Gate Arrays	FPGAs
Fin Field-Effect	Fin-FET
Foreign Direct Product Rule	FDPR
Gross National Product	GNP

Gross Domestic Product	GDP
Gallium	Ga
Graphics Processing Unit	GPU
Integrated Circuits	ICs
International Telephone and Telegram	ITT
India Semiconductor Mission	ISM
Introduce-Digest-Assimilate-Re-innovate	IDAR
Indian Institute of Science	IISc
India Semiconductor Mission	ISM
Intellectual Property	IP
International Business Machines Corp.	IBM
Kuomintang	KMT
Large-scale Integrated Circuits	LSI
Ministry of Commerce, People's Republic of China	MOFCOM
Made in China	MIC
Medium and Long-term Plan	MLP
Ministry of International Trade and Industry	MITI
Nanometer	Nm
Nippon Electric Company Ltd	NEC
National Aeronautics and Space Agency	NASA
Nano Science and Technology Council	NSTC
People's Liberation Army	PLA
People's Republic of China	PRC
People's Liberation Army	PLA
Power Semiconductor Manufacturing Corporation	PSMC
Phosphorus	P
Programmable Logic Devices	PLD
Republic of China	ROC
Research and Development	R&D
Reduce Instruction Set Computing	RISC-V
Semiconductor Manufacturing International Cooperation	SMIC
Semiconductor Industry Association	SIA
Self-Allianed Quadruple Patterning	SAQP
Semiconductor Manufacturing Equipment	SME
Taiwan Semiconductor Manufacturing company	TSMC
Texas Instrument	TI
Tata Electronics Private Limited	TEPL
Television	TV
Taiwan's Relations Act	TRA
United States of America	USA
United States	US
Union of Soviet Socialist Republic	USSR
Ultra Pure Water	UPW
World Trade Organization	WTO
Yangtze Memory Technologies Corporation	YMTC

Zhongxing Telecommunication Equipment Corporation	ZTE

ABSTRACT

The US-China competition in semiconductor technology is a critical aspect of their broader techno-economic rivalry. The US having strong position, aims to maintain its dominant status of designing is now focusing on areas like nanotechnology, AI, military applications in national security and their manufacturing. In contrast, China driven by initiatives like Made in China 2025, faces challenges due to limited R&D and dependence on foreign materials. The US has imposed restrictions on advanced chips exports to China, affecting China's semiconductor ambitions. China has retaliated with export restrictions on crucial materials, escalating a broader chip rivalry. The competition between the US and China extends beyond the semiconductor sector resulting in great power politics.

The study aims to understand the critical role of semiconductors in the US-China conflict and analyse the effectiveness of the US sanctions on China. The findings suggest that semiconductors have become strategic commodity with governments worldwide trying to acquire critical technology. The US through plans and policies like the Chips Act, is trying to attract investments and to collaborate to boost its domestic semiconductor production capabilities while imposing export controls on China to limit their advancement in the sector. The recent development of China's 7nm chip raises doubts about the effectiveness of US sanctions on China and demonstrates China's commitment to becoming self-sufficient in chip design and manufacturing. The competition for acquisition, innovation, and control of technologies among nations will shape the global world order with semiconductors playing a central role due to their widespread use across various sectors.

CONTENTS

CHAPTER I

INTRODUCTION

United States and China, the two largest economies in the world are engaged in a complex geopolitical and economic competition for global supremacy. This competition spans into various areas, including trade, technology, military applications, and ideological influence. Both countries seek to assert dominance in emerging technologies. Additionally, issues like territorial disputes, human rights concerns, and differing political ideologies contribute to the multifaceted nature of their competition. This dynamic relationship significantly shapes international relations and has implications for the global balance of power. One of the main competition is US-China race for technological supremacy is their race in having a leading edge in the semiconductor industry and their ability to produce and utilise it.

US-China digital cold war is a technology dispute with significant global implication. The United States has raised concerns about the Chinese tech companies like Huawei[1] and Semiconductor Manufacturing International Corporation[2] (SMIC), citing potential national security risks. The battle extends to the technological supremacy in areas like 5G[3], Artificial Intelligence[4](AI), and advance semiconductors shaping the future of global

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[1] Huawei is a leading Chinese multinational company that designs, develops and sells telecommunications equipment, consumer electronics and smart devices. It is significant in the global chip war due to its role as a major consumer for chip producers, leading chip designer and provider of engineering expertise and financial support to smaller companies in strategic areas of chip industry.

[2] Semiconductor Manufacturing International Corporation (SMIC) is a Chinese state-owned foundry company, headquarter in Shanghai and is the largest contract chip maker in mainland China. SMIC provides integrated circuit (IC) manufacturing services from 350 nanometer (nm) to 14 nm process technologies.

[3] 5G is the newest type of 5th generation mobile network, following 1G, 2G, 3G, and 4G. It's like an upgraded version that's meant to link up pretty much everything and everyone, like machines, objects, and devices, all around the world.

[4] Amidst the US-China chip war, AI, a branch of computer science, empowers machines to mimic human intelligence, aiding in problem-solving, decision-making, and data analysis. Its applications span industries,

landscape (Miller, 2022). The semiconductor industry is responsible for the creation of technology that drives electronic equipment from smartphones, laptops, electrical appliances to self driving cars, spacecraft and military capabilities making it one of the largest and important industries in the world with critical components compassed within it (Eurasia, 2022). Semiconductors function as the brains of electronic devices, playing a significant role in the digital economy by overseeing electric currents, enabling digitisation, and ensuring robust data management. At the core of this technology are advanced logic chips, intricate and costly pieces of silicon that provide computers and smartphones with their intelligence (South China Morning Post, 2021, April 23).

These chips are designed by the US firms in Cupertino in California are outsourced for manufacturing in Taiwan Semiconductor Manufacturing Corporation (TSMC) in Taiwan then packaged in Philippine and that makes its way to China where it gets plugged into an iPhone then the iPhone gets on a plane and sold in Europe, or comes back to California to be sold in the Apple stores (Eurasia, 2020).

1.1: Background

The race for technological dominance can be traced back to 2018 when President Donald Trump imposed 27% tariff on China's chip imports for domestic consumption which started the trade dispute. More tariffs and sanctions were imposed later in 2018 and 2019 (South China Morning Post, 2021, April 23). However, the trade war soon overshadowed by a digital cold war driven by concerns that China was using unfair means, including state

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with potential for automating tasks and enhancing efficiency. Major tech players like Google and OpenAI are heavily invested in AI research, aiming for safe and beneficial AI aligned with human values.

power and Intellectual Property (IP) theft to achieve its goal of becoming self-sufficient and a global leader in core technologies (Champion, 2024). China wants to become self-sufficient in the technology that powers all the mankind's future scientific advances (Chan, 2021). Therefore China is giving same strategic importance to the chip industry, as it gave to its Nuclear Programme (King, 2021).

The tech rivalry involves direct actions against Chinese companies. America has blacklisted over 140 Chinese companies, limiting their access to US-made components, causing crises for Chinese firms like Huawei. China in retaliation has initiated a lawsuit against the US, alleging that its chip export controls constitute trade protectionism (Kharpal, 2022). The Chinese Ministry of Commerce acknowledged the trade dispute and accused the U.S. of misusing export control measures, which it claims are hindering usual course in international chip trade (Kharpal, 2022). The Chinese state-owned companies are blocking deals for US firms like Cisco (Kynge, 2019). This could harm US companies significantly, as they sell nine times more to Chinese consumers than Chinese firms operating in the US to sell to Americans (Kynge, 2019). Qualcomm, a major US chip maker, has reported weaknesses in its China business, with 65 percent of its revenue coming from China (Wheatley, 2019). China's dominance in supplying crucial semiconductor raw materials like gallium and germanium (D'cruze, 2023) has led to export controls in response to US sanctions, causing prices to rise (Al Jazeera, 2023, 5 August). Analysts suggest Beijing's move serves as a warning to the US, but business confidence has eroded amidst the superpowers' crossfire (Al Jazeera, 2023, 5 August). Beijing asserts these measures protect China's national security without targeting third parties (Al Jazeera, 2023, 5 August). The export controls imposed on the US imports of crucial semiconductor raw materials by the Ministry of Commerce of China likely to affect the US defence industry since these materials plays a crucial role in certain modern military systems such as advanced radar system, warships and ground installations (Holderness et. al., 2023). Besides China strongly opposes US export control on it.

China has launched plans and policies to attain its goal of self-sufficiency. Over the past few years, China has become a key player in the global semiconductor industry, investing heavily in chip design and manufacturing. This move is not just a economic growth but also aims to reduce reliance on foreign technology, making China a leader in the field. Moreover, the initiative holds significance for modernising military capabilities, as advanced chip technology is considered crucial in modern warfare. The China’s semiconductor industry began when China created its first ICs in 1956 (VerWey, 2019). From 1956 onward, China has actively planned and prioritised its semiconductor industry. The government looks at semiconductors as crucial for both economic and national security, driving its continuous efforts in this sector. The initial phase of China's semiconductor industry, spanning from 1965 to 1990. China’s 2014 onwards plans and policies are more robust in nature, one such important policy is Made in China 2025 (MIC2025) Industrial strategy in order to boost its domestic chip design and manufacturing by 2025 (CRS, 2021). China’s goal of becoming self sufficient in chip design and manufacturing gained more importance since the US restrictions, sanctions and series of export controls hit China’s chip imports.

Currently, One company is crucial when it comes to advance logic chip manufacturing; TSMC[5]. Shortages in TSMC means entire electronic industry is shut down. The major shortages were seen during the Covid-19 pandemic where Automotive industry was loosing a lot and cars were lined up waiting for their chips without which cars cannot function. Hence the world is dangerously dependent on Taiwan for semiconductors specifically western countries. Since China claims Taiwan which is a democratically self governing island and China remarks it will takeover Taiwan with force if necessary (South China Morning Post, 2021, April 23). But China is also worried as they too are dependent on Taiwan which has strong ties with the US for their chips import. As a result, a trillions of dollar by multiple companies and countries in a race to dominate the cutting-edge technologies. Besides TSMC, two other companies Samsung and Intel produce the leading-edge chips but Samsung mainly focuses on memory chips rather than custom-made-logic chips for which company is dependent on Taiwan and Intel is far behind from TSMC in innovation and manufacturing (Capri, 2020).

Microchip is at the heart of the US-China technological conflict which is a new age battle for supremacy. United States perceives China's advancements as a threat to its national security (Capri, 2020). This struggle reflects a broader power struggle where nations compete for dominance in emerging technologies to shape the global order and influence economic and security dynamics. Previously, during the first Industrial revolution established its leadership in textile manufacturing and become a imperial power, followed by second Industrial revolution which marked the advancement in steel production,

[5] TSMC is a company that makes customised microchips for lot of tech companies including Apple, Nvidia, MediaTek and also for Chinese tech companies like Huawei.

railroad, later electrical and automotive industries wherein United States marks its dominance thereby becoming an economic power (Roberts and Westad, 2013). Similarly, United States become sole global power post world war II (Roberts and Westad, 2013). In past, the leading superpowers were characterised by its ability to harness and innovative (Roberts and Westad, 2013). Similarly, today semiconductor industry serves as a cornerstone in technological advancement with control over semiconductors provide a strategic edge. Hence, whoever controls the chip industry has a leading edge in the world.

The demand for the semiconductor in modern world continues to grow rapidly with the industry being worth of hundreds of billion of dollars (Bhatiya, 2022). The semiconductor industry's growth and technological advancements have profoundly changed the world. Semiconductors are now a crucial part of modern technology, and it is important to note that these semiconductors keep shaping the world as the industry expands (Bhatiya, 2022).

1.2: Research Objectives

This research would aims at:

- The study seeks to understand crucial role of semiconductors in today’s modern age.
- To explain the implications of US-China trade war on the semiconductor industry and global economy.
- To understand the role of US-China in tech war and impact on supply chain on semiconductor industry.
- To analyse the effectiveness of US sanctions on Chinese semiconductor industry.

1.3: Research Questions

This study seek to answer the following research questions:

- How US restricted tech transfer of the most advance chipmaking technology to China?
- How the US sanctions on China in trying to keep its dominance in semiconductor technology globally along with its allies such as Japan, South Korea, Taiwan and Netherlands.
- Has the current technological advancement by SMIC and Huawei reduced the tech gap between the US and China?

1.4: Hypothesis

1. The United States in collaboration with its allies such as Japan, South Korea, and Taiwan is endeavoring to secure a dominant position in the semiconductor industry while imposing sanctions on China. This trajectory has sparked a semiconductor rivalry and heighten geopolitical tensions between these two economic giants.
2. Through the utilization of cutting-edge technology and government subsidies, SMIC has manufactured a most advanced chip thus closing the gap of tech race for silicon supremacy circumventing the sanctions brought by the US.

1.5: Academic Rationale

This research is significant in order to understand the critical role of semiconductors in today's digital world. Chip production has been deeply engrossed in consumer market from smartphones to usage in military technology, semiconductor are a essential component.

Semiconductors in the US-China trade war context is to examine the strategic importance of technology, how it shapes diplomatic relations and its impact on global economic and security dynamics. This research helps us to understand the evolving landscape of power and competition in the 21st century.

1.6: Literature Review

Miller in his book titled, "Chip War: The Fight for the World's Most Critical Technology", explores the historical evolution of the semiconductor industry, particularly focusing on the dynamics of US-China chip supremacy. Delving into key developments, Miller provides insights into the critical moments and strategies that have shaped the semiconductor landscape, offering a comprehensive perspective on the ongoing competition for technological dominance. The book highlights the significance of semiconductor in modern world, detailing the US's edge in chip design and manufacturing. Miller traces the industry's evolution from the transistors invention to the development of integrated circuits in 1960s, showcasing its pivotal role in contemporary technology and in military capabilities. While emphasising America's chip superiority the book also underscores the current risk of the USA losing the edge. Notably China is investing heavily in a chip-building initiative, aiming to narrow the tech gap with the US for its economic and national security interest. Miller (2022) explores the alignment of china's military modernisation efforts with its ambitions in chip development proving insights into the global dynamics of semiconductor dominance which is significant in order to understand the US-China tech war. In addition, Miller highlights the Taiwan's chip achievements from the establishment of Taiwan Semiconductor Manufacturing Company (TSMC) in 1987 by Morris Chang[6] towards the manufacturer of 90 percent of cutting edge chip currently.

While Khairnar (2021) outlines the properties of semiconductors, an overview of global semiconductor market; Asia in specific, future of Indian semiconductor market and addresses the impact of shortages led due to 2008-09 financial crises and covid-19 pandemic. It also traces the different types of semiconductor companies and production of semiconductors (design and fabrication).

VerWey (2019) draws attention to China's attempt to support and grow its domestic semiconductor with the aim of becoming self reliant by 2030. He further describes the China's plans from 2014 to the present with attention given to the role of subsidies, negotiations for a joint venture with Lucent Technologies (USA) aimed at facilitating technology transfer and effect of these plans on the US semiconductor firms. China drives long term history of strategic industrial planning related to semiconductors from 1956 till date. China is investing in billions to boost its domestic semiconductor industry and in an attempt to achieve this goal, China has launched a series of policies and plans. Chinese government identified semiconductors as 'key priority' during 1956-1967. China is focused on R&D and manufacturing done by state-owned factories. China's 2014 onwards semiconductor industrial policies such as Made in China 2025 initiative is designed to develop manufacturing sectors wherein China's focus is on next generation information technology specifically to semiconductor technology.

[6] Taiwanese-American businessman, electrical engineer founder and former chairman and CEO of Taiwan Semiconductor Manufacturing Corporation (TSMC).

Eurasia Group (2020) opined that the semiconductor competition between the US-China for technological supremacy will have a global consequences. From the origin of semiconductors in silicon valley, the industry has evolved over decades into a highly specialised and complex global industry. Since the US-China technological confrontation spilled into public view in 2017, it has cantered on trade conflict between these two countries. In an attempt to halt the technological advancement by China, the United States have imposed sanctions to cut off the supply of cutting-edge semiconductors to Huawei and other Chinese tech companies and encouraged the construction of advanced chip factories on US soil which has drawn the semiconductor industry into the US-China tech war. The Eurasia group argues that the mounting US pressure on China's technology development and the US sanctions on China's domestic tech companies will affect the bilateral relations and create new risks for companies, market participation and the global technology supply chain.

Financial Times (2019) analysis the US and China are embroiled in a tech standoff, with direct actions against Chinese firms like Huawei causing ripple effects. China's retaliatory measures are hitting some US firms including Cisco, which faces hurdles in securing deals. This could spell significant losses for US firms, particularly since they sell substantially more than Chinese companies to American consumers. Qualcomm, a major chip maker, is already feeling the strain with a large portion of its revenue tied to China. Additionally, China's dominance in supplying key semiconductors raw materials has led to export controls and prices hikes in response to US sanctions. Analysts see Beijing's actions as warning, dampening business confidence amid the escalation conflict. China asserts these measures aim to protect its national security without targeting third parties.

Nicosia (2023) the book titled “The Ultimate Chip War: The Battle for Tech Supremacy, Exploring the History, Science, and High-Stakes Battle for Dominance in the Global Chip Industry” provides a brief introduction on the history of semiconductor inventions and further deals with the use of microchips in military capabilities. Nicosia (2023), states that the semiconductors are used in advancement of military capabilities and it states that the US military was predominately relied on chip technology to maintain its global dominance. The United States of America holds a edge in chip design and manufacturing which is being threatened by the USA's growing competitor in semiconductor industry; China. In addition, Nicosia illustrates the global consequences of chips and science act formulated by the US in January 2021. The CHIPS Act (Creating Helpful Incentives to Produce Semiconductors), seeks to boost the US domestic semiconductor production and research to enhance national security and reduce dependence on foreign sources. As a response, China plans to invest in billion to enhance its domestic semiconductor industry thereby reducing the dependence on foreign-made chips and aims to become a leading chip manufacturer by 2030. This scenario has escalated a potential tech altercation between the US and China.

Morris (1990) entitled “A History of world Semi-Conductor Industry” provides general historical survey of the semiconductor industry and its subsequent development till 1980s. The book describes the technical development of the semiconductor devices. Morris mentions the origins of semiconductor development are largely bound from the development of thermionic valve. He further marks the growth of semiconductor industry within four basic geographical divisions namely the United States, Western Europe, Eastern Europe and Japan from a historical point of view.

Webb (2023) entitled “When Huawei Shocked America With a Smartphone” In August 2023, Huawei unveiled a new smartphone with 5G capabilities and a cutting-edge processors. A teardown of the Mack 60Pro mobile by Techinsights for Bloomberg revealed the chip powering the cutting-edge 7nm chip is manufactured by (SMIC). This raised questions about SMIC’s capabilities and the effectiveness of US led controls.

How Huawei's chipmakers turned US sanctions into a china success story (November 2023) notes that China’s rapid advancement in the semiconductor technology was seen when Bloomberg conducted a teardown inspection of the $900 Huawei smartphone which consisted of 7-nanometer processor chip. SMIC, well known as Shanghai company has been facing the US restrictions for more than a decade followed by formally backlisted in 2020 amid US-China tensions. US government claims that its chip strategy is not aimed at China’s smartphones rather in military capabilities. The semiconductors constitute the foundation of the tech industry, enabling Al model, and cloud computing to drones, tanks, and missiles other than the commercial use. The question here arise is that, whether China con produce sophisticated chips in volume or US will drag down its capabilities. According to the Commerce Secretary Gina Raimondo said that China lacks the capacity to make such components at scale, on the other hand TSMC's vice president argues that the US underestimates China's capabilities. This events hits up the US-China race for technological supremacy.

Easton in his book entitled “The Chinese Invasion Threat: Taiwan’s Defence and American Strategy in Asia, discusses the potential for China to invade Taiwan and the implications for American Strategy in Asia. Due to growing tensions between Taiwan and China, the book delves into the clandestine realm of war strategy and national security, drawing from internal Chinese military document. As Taiwan gears up for potential conflict with military drills, the US stands by offering support in the form of advanced weaponry. The book sheds light on one of the most dangerous flashpoint in the world today.

1.6: Research Methodology

This research is based on the qualitative study and utilise historical and descriptive approach to understand the ongoing US-China technological conflict by gathering primary data and secondary data. The primary data is collected through Government bills, Government policies, reports and the official statements of leaders like President Joe Biden and US Secretary of commerce Gina Raimondo similarly understanding China's counterpart through Statements from President Xi Jinping and Chinese Ministry of Commerce. Secondary data compiled through books, eBooks, Journal articles, news articles or reports, news websites, online webinars and research journals published by various think tanks in general which will provide in-depth understanding of the research topic, and provide reference material in answering research questions and providing conclusion and findings.

1.7: Limitations of study.

Studying the interaction of the US-China trade in the semiconductor sector faces several limitations. Firstly, access to sensitive data can be restricted thereby hampering in-depth analysis. The US-China chip war is as recent as 2018 and research is mainly based on recent development in the field as a result news articles and reports are important source of literature. Many of these news reports require premium subscription which limits the literature is the top limitations in understanding this critical and evolving aspect of

International relations. Semiconductors evolve quickly, which can render research outdated before publication.

1.8: Theoretical Framework

In anarchism all the countries are working towards maximizing their power to have dominance and secure their national interest in particular on global stage, so in this regard the silicon tussle is going on between US and China offers a critical lens to comprehend the ongoing race for the tech supremacy between the United States and China in the acquisition of cutting-edge technologies. Both the US and China are fiercely competing to secure dominance in critical technologies like semiconductors recognising their pivotal role in bolstering economic, military, and strategic Power. This race is a manifestation of the intense power struggle in the realm of technology, when each nation aims to gain a decisive advantage for economic security.

The US-China trade war commenced during the Trump administration in 2018. This further resulted in security dilemma between the rival economic giants. Furthermore, America is encouraging manufacturing companies like TSMC, Samsung, and Intel itself by providing huge subsidies to produce cutting-edge chip on the US soil, thereby boosting the domestic production and reduce the dependencies on foreign imports as a part of risk management (WH. Gov, 2022). Besides US, Japan and South Korea are also investing in TSMC manufacturing foundries in their own country which depicts the de-globalisation[7] around

[7] Globalisation is a term used to describe how trade and technology have made the world into a more connected and independent place. Globalisation also captures in its scope the economic and social changes that have come about. But in recent years, the trend of deglobalisation is seen around the world due to events like pandemic, Russia-Ukraine war etc. as a part of de-risking the value chains. Deglobalisation is a movement towards less connected world characterised by Powerful nations States local solutions and border controls rather than global institutions, treaties and free movement.

the world in order to avoid the risk of supply chain which was widely seen during the Covid -19 pandemic when the electronic industries such as automotive companies were loosing millions of dollars and cars were waiting for their microchips without which they cannot function (Eurasia, 2020). TSMC's plan to develop manufacturing facility in Arizona is a example of de-globalisation trend (Robinson, 2023).

The USA imposed sanctions and trade restrictions on export of cutting edge technology to China which made it difficult for China to access the semiconductor design and manufacturing. Prior to the US-China tech war; China was dependent on the US for these technologies (VerWey, 2019). The silicon battle resulted in China deepening its ties with TSMC. Further restrictions were imposed on China and Semiconductor Manufacturing International Corporation (SMIC) and also passed similar restrictions on Huawei limiting its ties with Chinese companies (WH. Gov, 2022). As a counter to US sanction it restricted the supply of germanium and gallium an essential component in semiconductor manufacturing to the US. At the same time China is rigorously investing in its domestic semiconductor industry and appointing Taiwanese scientist that will benefit China in getting the know-how of advanced semiconductors (Ting-Feng, 2017).

The USA has a monopolistic view on cutting-edge technology along with its allies like Advanced Semiconductor Materials Lithography (ASML), Dutch company that supplies advanced chip-making equipment. But the ASML's Extreme Ultraviolet (EUV) tools were not really Dutch. Crucial components largely came from Cymer in California and Zeiss[8]

[8] Zeiss is a German manufacturer of optical systems and optoelectronics. The company has history of innovation including the world's first 35nm single-lens reflex camera and the first miniature camera with good picture quality developed before world war II. Today, Zeiss is active in business in segments like industrial Quality and Research, Medical Technology, consumer markets and Semiconductor Manufacturing technology.

in Germany (Miller, 2022) which shows contradiction in the theory. Hence it is more of restricting supply chain.

Artificial Intelligence (Al) is the next revolution in semiconductor industry. Companies like Intel, Nvidia are using Al in order to improve the performance of semiconductor manufacturing process, optimising placement of transistors on semiconductor chips using Al. This technology has sought super changes in the semiconductor industry and it endues to push the boundaries of chip design, manufacturing and application (Yao, 2023). DGX A100 and H100 are the flagship Al chips of Nvidia design for Al training and in data centres (Nvidia, 2021). Nvidia focused on parallel computing, key technology in Artificial intelligence (First post, 2024). Nvidia has a border line monopoly on Al chips with technologies like ChatGPT hit the market which was build on 10,000 Nvidia chips (First post, 2024, April 10). Most of the semiconductor technology are invented by the US companies from transistors to the cutting-edge chip-building machines (Miller, 2022). Hence US is restricting its technology to China to curtail their advancement and restrict the use of chip technology into military capabilities. This trajectory escalates chip war between both the two major countries.

1.9: Chapterisation

This study consist of a total five chapters and they are as follows:

Chapter 1 entitled: **"Introduction"** includes synopsis of the study with briefly introducing the domain of study followed by academic rational, research objectives, research questions, research hypothesis, research methodology and chapterisation. The chapter also includes literature review used to study the US-China tech conflict.

Chapter 2 entitled: **“Evolution Of Semiconductors in Global Arena”** will explain what are semiconductors followed by the historical evolution of the semiconductor industry and brief overview of the integration of semiconductors into military technology that enhance operational efficiency in history.

Chapter 3 entitled: **“The Race for Technological Supremacy”** will provide the brief understanding on the US-China tech conflict, the factors that led to the conflict and analysis of the critical semiconductor technologies. Further, this chapter analysis the US-China relations in technological advancement and it analyse comparative strengths and weaknesses.

Chapter 4 entitled: **“Security Dilemma Escalation and Geopolitical Alliance”** will examine the security and economic interests driving the tech war and their impact on diplomatic relations between the USA-China. The chapter will focus on realist Perspective on security concerns amid escalation of chip war. The chapter analysis strategic alliance formed by the US to restrict the access of advanced tech to China. It will deal with the implications of the tech competition on the US allies.

Chapter 5 entitled: **“Future Projections and Scenarios”** will discuss the future projections and scenarios of the US-China high-tech dispute with a particular focus on the China-Taiwan conflict and the implications for supply chain in the event of a potential Chinese invasion.

Chapter 6 entitled **“Conclusion”** will summarise key findings, insights and will provide closing thoughts on the future of the US-China digital cold war. Further, the chapter discusses about the recent incentives to build India’s semiconductor industry.

The research framework set out to explore the details of semiconductor technology covering basic properties in chapter two followed by a look how semiconductor industry evolved over time.

CHAPTER II

The Evolution Of Semiconductors In Global Arena

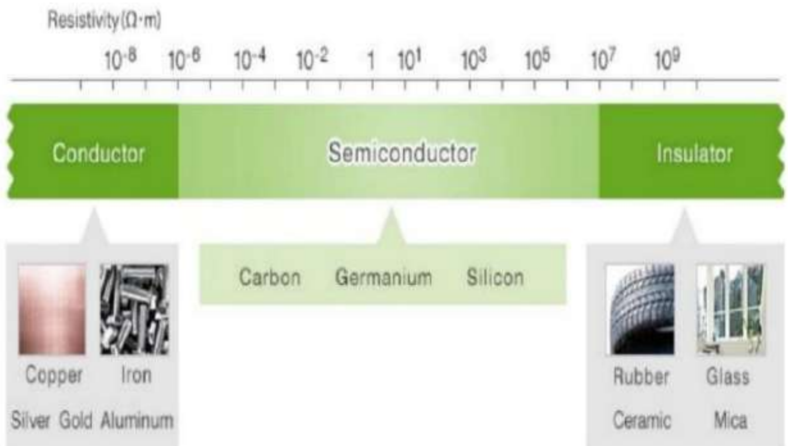
The chapter one provides a brief overview of the US-China technological competition that spans across cutting-edge semiconductor chips, 5G technology and Al to outline the various dimensions of the rivalry and sets out objectives, methodology and rational of the study in international relations. Given the completion between largest economies over semiconductor technology it is crucial to grasp the functionality and evolution of semiconductor industry in global arena.

2.1: What Are Semiconductors

Semiconductors also known as Integrated Circuits (ICs), microchips or simply chips possess specific electrical properties and act as the brain of electronic products, making them an essential component of most modern electronics. Khairnar (2021) describes semiconductors are substances with properties somewhere between conductor and insulators (Shown in figure, 2.1). They are most commonly made of silicon, germanium and gallium arsenide (Khairnar, 2021). The resistivity of semiconductors may change according to the temperature. At low temperature no electricity passes through, but with the rise of temperature, electricity passes through them smoothly (Khairnar, 2021). The unique properties of semiconductors are positioned between high-conducting materials like copper, silver or aluminium and non-conductors like rubber or glass (Khairnar, 2021).

Conductors such as gold, silver and copper low resistivity and easily conduct electricity (Khairnar, 2021). Insulators such as rubber, ceramics and glass have high resistance making it difficult to conduct electricity (Khairnar, 2021).

Figure 2.1: Represents Properties of Semiconductor



Source: Khairnar (2021).

2.2: Why Semiconductors Behave the Way They Do?

Silicon is the most common element in semiconductors. Carbon, silicon and germanium all possesses a unique structure with four electrons in their outer orbital, allowing them to form orderly crystals through covalent bonds with neighbouring atoms (Brain, 2001). Diamond is the crystalline form of carbon, while silicon appears as a silvery substance with metallic characteristics (Brain, 2001). Unlike metals, silicon crystals does not conduct electricity (Brain, 2001). However, through process of doping impurities are added to change the electrical properties of silicon to allow the electric current flow through them (Brain, 2001). Semiconductor crystals utilised in Integrated Circuits (IC) are high-purity single crystal silicon, typically reaching a purity of 99.99% (Khairnar, 2021). During the fabrication of circuits, intentional addition of impurities modifies electrical properties.

Depending on the type of added impurities, semiconductors can become either n-type or p-type (Khairnar, 2021).

There are two types of impurities, namely N-type and P-type. In n-type doping involves introduction small amounts of phosphorus or arsenide into silicon, both of which have five outer electrons (Brain, 2001). When these atoms are incorporated into the silicon lattice[9], their extra electrons become free to move, creating a surplus of negatively charged carriers, hence the name N-type where 'N' indicates negative (Brain, 2001). These additional electrons facilitate electrical conduction by allowing the flow of current through the material (Brain, 2001). Pentavalent elements such as Phosphorus (P) or Arsenic (As) are introduced into high-purity silicon to create n-type semiconductors, and these added impurities are termed donors (Khairnar, 2021). On the other hand, P-type doping entails adding Boron (B) or Gallium (Ga) to silicon (Si), acting as acceptors both of which have only three outer electrons (Brain, 2001). When these atoms are inserted into silicon lattice, they create holes[10] where silicon electron would normally bond, resulting in a absence of an electron creates the effect of a positive charge, hence the name P-type where 'P' stands for positive (Brain, 2001). Despite being positively charged, these holes can also conduct current by accepted electrons from neighbouring atoms (Brain, 2001). These holes significantly contribute to the overall conductivity of the semiconductor (Khairnar, 2021).

[9] A lattice refers to a regular and repeating three-dimensional arrangement of atoms, ions, or molecules in a crystalline solid. It forms the structural frame work and influences properties like shape, strength and conductivity. In semiconductors such as silicon, the lattice enables the formation of covalent bonds between atoms, impacting the materials electrical characteristics.

[10] In a semiconductor, when an electron gains energy and moves away from its position, it leaves behind a place known as hole. This hole represents a positively charged region where the absence of an electron has left an opening in the covalent bond between atoms.

2.3: Understanding Nanometer Technology: Why Smaller Sizes are Better?

The majority of commercially available chips are constructed using tiny silicon transistors, which are known for their exceptionally small size. These chips can carry millions and even billions of such transistors on a single chip.

A nanometer, abbreviated as nm[11], is a crucial unit of measurement for scrutinising dimensions at the atomic level (Vyrian, 2022). Vyrian (2022) notes, nm is commonly denoted as a technology or process node, signifying a scale relevant to microscopic entities such as transistors within Central Processing Units (CPU) and atomic structures. One nanometer corresponds to one billionth of a meter, making it unsuitable for measuring extensive distances but highly applicable to the microscopic scale (Vyrian, 2022). The more transistors a chip has, the better and more powerful its performance in tasks and calculations (Vyrian, 2022). Prominent manufacturers like TSMC, Intel and Samsung, utilise nm technology to measure the spacing between transistors in processors and their sizes, particularly in devices such as tablets, laptops, and smartphones (Vyrian, 2022). The importance of nm lies in the precise measurement of integrated circuit dimensions,

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[11] The evolution of nanometer technology has been a remarkable journey, driven by innovation and a quest for enhanced performance. In 1971, Intel's introduction of 10 µm technology marked a significant milestone, laying the foundation for microprocessors and digital devices. Subsequent advancements, such as the transition to 1 µm in 1979 and the progression to 90 nm in 2004, shaped the landscape of computing with self-aligned processes and strain engineering. Intel's move to 22 nm in 2012 introduced FinFET technology, focusing on ultra-low-power devices. The shift to 14 nm in 2015, involving Intel and Samsung, brought about multi-patterning lithography and 3D interconnects, impacting high-performance gaming and cloud computing. TSMC's 10 nm technology in 2017 influenced flagship smartphones and 5G networking. Continuing innovation, TSMC's 5 nm era in 2020 showcased advancements in EUV (Extreme Ultra violet) lithography and GAA transistor technology, benefiting premium smartphones and cutting-edge AI. Looking ahead to 3 nm in 2022, TSMC anticipates further optimization for next-generation computing and mobile devices, highlighting the relentless pursuit of miniaturisation and innovation in semiconductor manufacturing.

especially in computer processors, where smaller nanometer values (e.g., 3nm, 4nm, 5nm, 7nm, 10nm) indicate denser transistor configurations, resulting in more efficient and faster processors (Vyrian, 2022). In the early 1990s, individual transistors had a size of few hundred nm such as 28nm, 40nm, 65nm, 90nm etc. (Vyrian, 2022). Thanks to continuous research and development, today's smartphones and computing devices feature chips as small as 5nm, 4nm and 3nm (Vyrian, 2022). Research is also being conducted on 2nm and 1nm chip development. Companies such as Qualcomm, Samsung, and Apple are pushing the boundaries further, with the aim of launching 3nm chips in 2023 for even more advanced and compact devices (Vyrian, 2022). As AI applications continue to advance in the digital era, the demand for specialised processors tailored to the unique needs of AI systems is on the rise (Cio, 2023, January 2). AI-specific chips are gaining significance as AI applications advance, demanding robust processors for tasks like training and inference (AP, 2023, January 2). Nvidia stands out as a top player in this field, exemplified by its H100 Graphics Processing Unit (GPU) boasting 80 billion transistors, catering perfectly to the needs of AI systems (AP, 2023, January 2).

Chips with smaller nanometer sizes tightly pack transistors, allowing electrons to travel shorter distances which speeds up electrical signals, making processing faster and more efficient (Bhatiya, 2022). For example, Apple's M1 chip outperforms older ones with larger nanometer technology, delivering better performance at the same power level (Bhatiya, 2022). In smaller nanometer chips, electrons flow more easily, requiring less energy which reduces heat generation (Bhatiya, 2022). This is a major advantage over older chips where excess heat is why laptops and smartphones get hot during extended use (Bhatiya, 2022). Chips with smaller nanometer sizes stay cooler, providing sustained performance over time

(Bhatiya, 2022). It is important to note that nanometre technology may differ among manufacturers when aiming for better and more efficient chipsets. For instance, Intel's 10nm transistor density is similar to Samsung's 7nm chipset and comparable to TSMC's 7nm technology (Bhatiya, 2022).

Bhatiya (2022) argues, the domain of semiconductor technology has experienced a remarkable progression since the introduction of transistors in the early 20th century. The evolution of transistor nodes, indicative of the smallest features on semiconductor chips today, has undergone substantial changes over the course of several decades (Bhatiya, 2022).

2.4: Historical Evolution of Semiconductor Industry

The development of the semiconductor industry stands as a noteworthy technological milestone in human history, underscoring a profound achievement in the field of technology and innovation. Morris (1990) describes 1945, Dr. William Shockley of Bell Labs (figure 2.2 illustrates Bell labs where first transistor was invented) first hypothesize the placing of a semiconductor material like silicon attached to a ninety-volt battery, a theory he called solid-state valve which was proved by Walter Brattain and John Bardeen in December 1947 with the invention of point contact transistors. Soon after, Shockley invented the junction transistor in June 1948 (Khairnar, 2021). Shockley introduced the early version of the junction transistor during the Reading Conference on Semi-Conducting Materials which took place from July 10 to 15, 1950 (Miller, 2022). This conference is now recognized as the First International Conference on the Physics of Semiconductors, where Shockley presented his paper as a post-deadline submission (Esaki, 1989). The transistors replaced the bulky, power-hungry and frequently failing vacuum tubes (Miller, 2022).

Figure 2.2: AT&T Bell Telephone Labs in 1950s

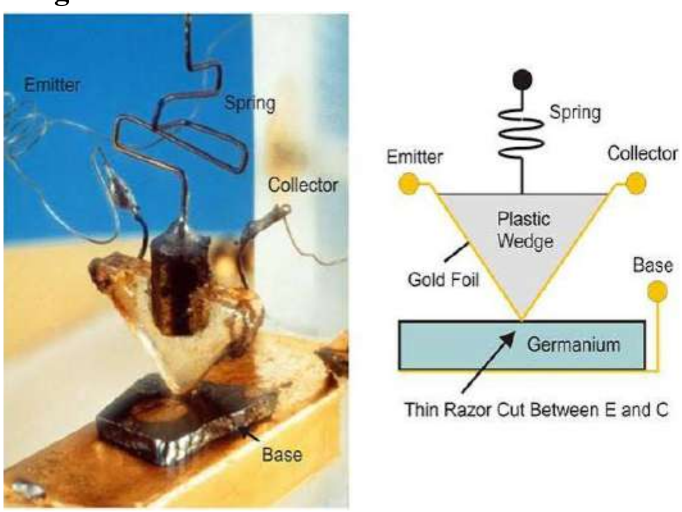
Bell Telephone Laboratories in Murray Hill, New Jersey, as it appeared in the 1950s. In 1947 Bardeen, Brattain, and Shockley worked in the large building in the foreground at right.

Source: Riordan & Hoddeson (1998).

A transistor is a device, either a resistor or semiconductor, capable of amplifying electrical signals as they pass through it (Morris, 1990). Initially, in the early stages of transistor development it could handle low power and frequency response was limited which stimulated the development of alternative methods of device fabrication (Morris, 1990). The Junction transistor (Illustrated in figure 2.4) compared with the point-contact transistor device (Illustrated in figure 2.3) had limited frequency response (Morris, 1990). Hence, attempts were made to overcome the hurdles by using alternative methods of construction to achieve a narrow basewidth device and these efforts led to the development of the Germanium Alloy junction transistor 1952 by General Electric company (Morris, 1990). Meanwhile, silicon-grown junction transistors made be Texas Instrument (TI) of Dallas entered into production in May 1954 which were introduced in US stores at a price of $49.95 (Morris, 1990).

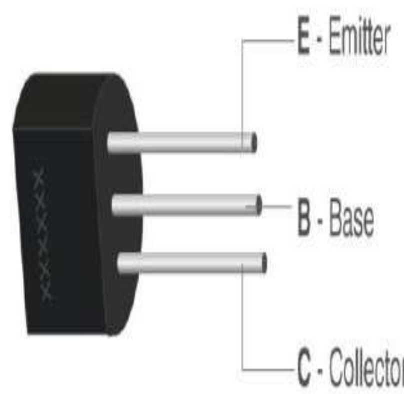
Surprisingly, Riordan & Hoddeson (1998) asserts, Texas Instruments opted out of this market, allowing a relatively obscure Japanese company named Sony to dominate. In 1954, the transistor was mostly regarded as a costly laboratory novelty, finding limited applications in specialised areas like hearing aids and military communications (Riordan, 1998). Miller (2023) affirms in 1956, Japan's first transistor radio is released by Tokyo Telecommunications Engineering Corporation (now Sony). Previously broadcast radio receivers used vacuum tubes (Miller, 2022). The use of transistors instead of vacuum tubes made radio smaller, lighter and less power consuming (Khairnar, 2021). Sony aimed to sell transistor devices not only to Japanese customers but also to the wealthiest consumer market in the world, America (Miller, 2022).

Figure 2.3: Point-contact



The point-contact transistor, this replica features a plastic triangular wedge covered in gold foil, halved at the tip. One side of the wedge serves as the emitter, and the other functions as the collector. Measuring approximately 1.25 inches per side, the wedge is pressed against a slender germanium slab, acting as the base. Impressively, this device is capable of amplifying signals by around a hundred times.

Figure 2.4: Junction Transistor



Source: Linda Hall Library

(December, 2022)

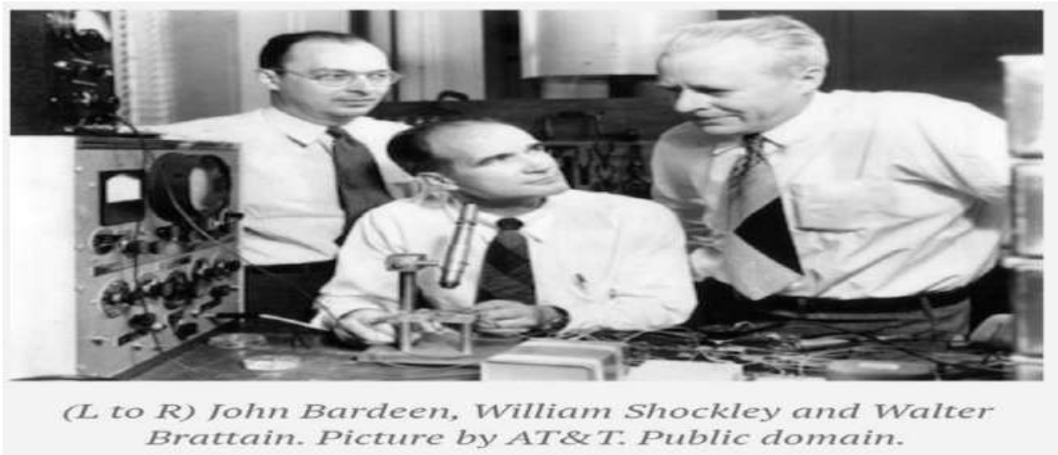
The Japanese government also indicated its support for high tech manufacturing with the Japan's Ministry of International Trade and Industry (MITI) pleading to support electronics firms (Miller, 2022). Sony's major success was transistor radio (Miller, 2022).

In 1956, Shockley, Bardeen and Brattain (figure 2.5 shows three scientists in Bell labs in 1954 when transistor was invented) were awarded the Nobel Prize for their contribution to semiconductor research and the invention of transistors (Miller, 2022). Post World War II, American Telegraph and Telephone (AT&T) Company Bell Telephone labs became the leading force in the future development of the semiconductor industry (Hoeren, 2015). Shockley left Bell labs to establish his own semiconductor company named Shockley Semiconductor in San Francisco which was the first semiconductor company in the Silicon Valley (Miller, 2022). Many accomplished scientists and engineers were enticed away from Bell labs and other companies to join Shockley who eventually departed to initiate their own semiconductor firms thus originating what now globally renowned as Silicon Valley (Riordan & Hoddeson, 1998). However, Shockley's company saw a downfall and eight engineers resigned due to Shockley's incompetence as a manager (Athanasia, 2022). Shockley viewed transistors as the nerve cells of the Information Age, recognising their indispensability in the creation of nearly all electronic equipment today. In later years Jack Kilby of Texas Instrument and Robert Noyce of Fairchild Semiconductor in the US developed integrated circuits (ICs)[12] which came to be known as "semiconductors" or simply "chips" that packed a number of transistors on a single chip followed by large-scale integrated circuits (LSIs) with an integration level of 1,000- 100,000 components or more

[12] Tiny electronic circuit that contains million of transistors, resistors and capacitors all integrated into a single chip of silicon.

on a chip were invented (Khairnar, 2021). Noyce and Moore realised the importance of the combination miniaturisation and electric efficiency (Miller, 2022). Transistors were a clever and brilliant invention but they needed a market (Miller, 2022). During this time, USSR (Union of Soviet Socialist Republics) launched the world's first satellite Sputnik, followed by the cosmonaut Yuri Gagarin becoming the first person in space (Miller, 2022). Concerns arose among Americans about the Russians holding a strategic edge in space, despite the U.S. being a global science powerhouse it seems falling behind, President F. Kennedy committed the U.S. to a moon mission, sparking a demand for integrated circuits in the space industry (Miller, 2022). The chips were used to design a computer for Apollo spacecraft and in the following years in 1959 chips were used for the US Navy missile program (Miller, 2022). Early customers of Sherman Fairchild were federal agencies, including Department of Defence (DOD) and NASA (National Aeronautics and Space Administration) (Athanasia, 2022). During this period according to Central Intelligence Agency (CIA) report of 1959, America was only two or four years ahead of the soviets in quality and quantity (Miller, 2022). By 1950s, USSR assigned its best scientist to establish a new semiconductor industry which resulted in the use of semiconductor devices in space programs (Miller, 2022).

Figure 2.5: John Bardeen, William Shockley and Walter Brattain at Bell Labs in 1954



Source: (Riordan & Hoddeson, 1998).

The invention of transistors was a major breakthrough in the history of electronics but with the development of ICs the in 1960s, the semiconductor industry grew rapidly. In 1960s Sony introduction of transistor-powered Television (TV) sets causing United States to lose its dominant position within the consumer electronics industry (Riordan & Hoddeson, 1998). The ICs are capable of complex tasks and reduce the size and cost of electronic device. This invention led to the development of modern computers and played a major role in the digital revolution.

In many thousands, and even millions, these tiny components are routinely integrated with other microscopic particles onto slim crystalline slivers of silicon known as microprocessors[13], more commonly referred to as microchips (Riordan & Hoddeson, 1998). By 1961, transistors had become the cornerstone of a billion-dollar semiconductor industry, experiencing annual sales doubling almost every year (Riordan & Hoddeson, 1998). Fast forward over three decades, and the computing power that once demanded

[13] A micro-programmable computer on a chip.

rooms filled with bulky electronic equipment is now effortlessly contained in units that can sit on a desktop, fit in a briefcase, or even rest in the palm of one's hand (Riordan & Hoddeson, 1998). Words, numbers, and image flash around the world instantly via transistor-powered satellites, fiber-optic networks, cellular phones, and telefax machines (Riordan & Hoddeson, 1998). The transformative amplifying discovery at Bell Labs in 1947–1948 occurs within a minuscule semiconductor sliver, unlike the heat-producing vacuum tubes. This unique characteristic of transistors facilitates their integration into miniaturisation leading to remarkable cost reductions, making digital computers accessible to almost everyone (Riordan & Hoddeson, 1998). The transistor's pivotal role is evident, as without it, the concept of personal computers would have been unimaginable, and the subsequent Information Age would not have materialised (Riordan & Hoddeson, 1998).

While our parents acquired knowledge through newspapers, magazines, and radios, the global communications network, transformed by transistors, has undergone a profound revolution. Computers are now reshaping how we access and disseminate information, marking a significant shift in the way we learn about the world. A simple click of a mouse now grants us access to a vast amount of information, sourced from an incredibly diverse range of channels. By this time USA was dominating the chip design and manufacturing but soon by 1964, Japan overtook the US in production of discrete transistors while the US firms like Fairchild semiconductor company continued to dominate the cutting edge technology and TI became the first foreign chipmaker which was a victorious move to Prime Minister Ikeda (Miller, 2022).

In 1965, Electronics magazines asked Moore to write a short article on the future of integrated circuits (Miller, 2022) He made the greatest technological prediction; he anticipated that every year for the next decade the number of transistors on ICs would double as prices per transistor lower (Arcuri, et al., 2022). The number of users would grow as costs fell (Arcuri et al., 2022). This prediction of growth in computer power soon came to be known as Moore's Law in 1965 (Miller, 2022). At Fairchild, Noyce and Moore were already envisioning personal computers and mobile phones (Miller, 2022). Fairchild, in to attract more consumers for their chips it sold chips at lower cost, at times sold products below manufacturing cost (Miller, 2022). Previously sold for $20 were cut to $2 (Miller, 2022). The hardwork payed off, Fairchild started winning contracts in private sector. By the mid-1960s, nearly all of these computers depended on ICs (Miller, 2022). Intel, Advanced Micro Devices (AMD), and National Semiconductor which is today part of TI have their roots in Fairchild in some or other way (Khairnar, 2021).

Fairchild Semiconductor continued producing silicon wafers in California and began shipping semiconductor components to Hong Kong for ultimate assembly that marked Fairchild Semiconductor as the pioneer in offshoring assembly to Asia (Miller, 2022). However, Texas Instruments, Motorola, and other companies swiftly replicated this practice. Decades later almost all the US firms has foreign assembly (Miller, 2022). Fairchild established semiconductor facility in Singapore, subsequently expanding a facility in the Malaysian city of Penang. The semiconductor industry underwent globalisation before the term semiconductor became widely known, laying the foundation for today's Asia-centric supply chains (Miller, 2022).

In the landscape of semiconductor industry evolution, Advanced Micro Devices (AMD) established in 1969 as a derivative of Fairchild Semiconductor, emerged as a pivotal contributor (Khairnar, 2021). During 1971, Intel launched its first microprocessor, concurrently obtaining the chip's potential versatility and securing sales rights for the product (Khairnar, 2021). In 1977, the world witnessed the release of the Apple II the first personal computer (Khairnar, 2021). Although its manufacturers referred it as a minicomputer, it was also designated as a microcomputer and a home computer (Khairnar, 2021). The commercial success of the Apple II firmly established its presence in the market (Khairnar, 2021).

In 1980, Flash memory[14] a rewritable semiconductor memory device with non-volatile characteristics, was innovated by Fujio Masuoka, then an employee at Toshiba (Khairnar, 2021). Presently, Flash memory is ubiquitous in everyday devices such as personal computers, mobile phones, digital cameras, IC cards, and various other appliances (Khairnar, 2021). In 1983, Nintendo introduced a video game console equipped with an 8-bit CPU (Khairnar, 2021). The Family Computer, or Famicom, gained widespread popularity, especially with the success of Nintendo's game, Super Mario Bros (Khairnar, 2021). This success prompted the evolution of a 16-bit game console known as the Super Famicom in 1990 (Khairnar, 2021). The semiconductor industry experienced continuous growth from the 1970s to the 1980s, marked by advancements in Complementary Metal-Oxide-Semiconductor (CMOS) technology and the emergence of microprocessors (Nicosia, 2023). CMOS innovation facilitated the development of energy-efficient, high-performance circuits, while microprocessors played a pivotal role in the evolution of computer systems (Nicosia, 2023). In recent decades, the semiconductor industry has witnessed substantial growth, driven by the advent of technologies such as flash memory,

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[14] Flash memory preserves information even when power is turned off. While previous rewritable memory could only erase information one byte at a time, flash memory was innovatively designed to erase the entire block of data at once, leading to a significant reduction in cost per bit by 75% or more.

digital signal processors, and Field-Programmable Gate Arrays (FPGAs) (Nicosia, 2023). The digital signal processors are used in a wide range of applications including telecommunication and industrial automation (Nicosia, 2023).

Notably, Advanced Micro Devices' (AMD) 2003 introduction of the AMD Opteron, the inaugural 64-bit processor, represented a substantive advancement within the realm of high-performance computing. Concurrently, Qualcomm, founded in 1985, directed its efforts toward the refinement of wireless communication technologies. Noteworthy among these endeavours was the inception of the initial CDMA (Code Division Multiple Access) chipset in 1989 (Nicosia, 2023). This technological innovation subsequently underpinned the architecture of contemporary 3G and 4G mobile networks (Nicosia, 2023).

2.5: Semiconductors In Advancing Military Efficiency

The transistors invented in 1947 faced challenges in mass production with uniform characteristics, making immediate military application impractical until 1951 but the significance of junction transistor which was more efficient than point-contact transistor was rapidly appreciate by US military authorities (Morris, 1990). During the early stages of development, transistors could only handle low powers, and the frequency response was limited particularly in the realm of airborne equipment (Morris, 1990).

TI president Pat Haggerty focused on selling electronic systems to US military (Miller, 2022). In 1962, the search for a new computer to guide the Minuteman II missile that was designed to launch nuclear warheads into space was initiated by the Air Force (Miller, 2022). The initial version struggled to reach Moscow (Miller, 2022). Assurance was given to the Air Force by Haggerty that a computer, utilising Kilby's integrated circuits, could achieve double the computation with half the weight (Miller, 2022). By the end of 1964, one hundred thousand circuits had been provided to the Minuteman program by Texas Instruments (TI) (Miller, 2022). In 1965, twenty per cent of sold integrated circuits were allocated to the Minuteman program. The sale of chips to the US military was proving to be profitable. The computers that guided the Apollo spacecraft and the Minuteman II missile fuelled the beginning of America's integrated circuit industry. At this point the challenge was, how to mass produce chips?. The Fairchild Research and Development (R&D) focused on the mass market products (Miller, 2022). Noyce reasoned that chips used in satellites or rockets will also have civilian use too (Miller, 2022). Texas Instruments (TI) employees in Singapore and Hong Kong primarily focused on chip manufacturing, even amid the Vietnam War (Miller, 2022). The conflict demanded precision strikes, recalling World War II's limited impact on North Vietnam's military (Miller, 2022). Various guidance methods, such as the Shrike missile[15], were tested which were accurate but many others guidance system hardly worked (Miller, 2022). With vacuum tubes caused issues in the guided munition, the U.S. military identified this flaw and aimed to enhance guided munitions (Miller, 2022). Striking ground targets in Vietnam posed a significant challenge, with early statistics indicating bombs falling around 420 feet from their intended mark (Miller, 2022). Engineer Weldon Word, in the mid-1960s, envisioned leveraging microelectronics to revolutionise the military's kill chain (Miller, 2022). Weldon Word believed that Texas Instruments' proficiency in semiconductor electronics could enhance the precision of the Air Force's bombs (Miller, 2022). Despite lacking expertise in bomb design, World began by working on a common issue bomb – the 750-pound M117 (Miller,

[15] Shrike missile was a Cold war-era American anti-radiation missile designed to target hostile aircraft radar system. It was developed in the early 1960s and used during conflicts like the Vietnam War.

2022). Notably, 638 of these bombs had previously been dropped unsuccessfully near the Thanh Hoa Bridge (Miller, 2022). Weldon Word introduced a modification to bombs by adding small wings that could guide their flight (Miller, 2022). He incorporated a straightforward laser-guidance system controlled by the reflection of laser beams off targets, shining through a lens onto silicon. This uncomplicated design proved successful in Air Force tests (Miller, 2022). In May 1972, U.S. aircraft dropped twenty-four bombs on the Thanh Hoa Bridge, previously left standing with numerous cracks (Miller, 2022). This time, the American bombs achieved direct hits, impacting dozens of bridges, rail junctions, and strategic locations with newfound precision (Miller, 2022). The arrival of TI Pave way laser-guided bombs marked a significant advancement, utilising a simple laser sensor and a few transistors to create a weapon with precise destructive capabilities (Miller, 2022). However, the guerrilla warfare[16] in Vietnam's countryside proved resistant to the impact of bombings (Miller, 2022). The TI Pave way's success coincided with America's ultimate defeat in the Vietnam War (Miller, 2022). Vietnam served as a testing ground where weapons incorporating electronics and explosives transformed the U.S. military's capabilities (Miller, 2022). Fairchild's R&D (Research and Development) team under the guidance of Garden Moore devised new technology and opened new civilian market use as well (Miller, 2022). The US military officials largely recognised the potential of semiconductor devices in enhancing military systems, leading them to sponsor Research and Development (R&D) in the field (Morris, 1990). There was a military market existing

[16] The guerrilla warfare in Vietnam involved complex strategies against both Viet Cong guerrilla and North Vietnam's conventional forces. For US and South Vietnamese forces distinguishing between friend and foe, confronting hidden enemies navigating the uncertainties of anti-guerrilla warfare posed significant challenges such as fighting an unseen enemy in a hostile environment where identifying threats and taking decisive actions were critical amidst the chaos of war.

for semiconductor devices that could observe the product (Morris, 1990). The semiconductor technology provided ability to accurate strike targets and precision to America's weapons. During the early Cold War era, the Soviet Union initially kept pace with the United States in technological advancements. However, the emergence of silicon chips as a driving force in military power left the Soviet Union significantly lagging behind (Miller, 2022). By the mid-1980s, America's new MX missile boasted an impressive accuracy, hitting targets within 364 feet, while the comparable Soviet SS-25 missile had a much larger margin of error, averaging hits within 1200 feet, according to a former Soviet defence official (Miller, 2022). Both nations possessed enough firepower to devastate cities, but sought the capability to target each other's nuclear arsenals (Miller, 2022). The USSR relied on long-range bombers and missile submarines for nuclear attacks, with bombers considered vulnerable due to radar detection upon take-off, unlike the stealthy US nuclear missile submarines (Miller, 2022). By leveraging computing power and semiconductor technology, particularly through advanced sensors and supercomputers like the Illiac IV[17], the US significantly enhanced its capabilities in missile accuracy, anti-submarine warfare, surveillance, and command and control, posing a threat to the survivability of the Soviet nuclear arsenal (Miller, 2022). By 1991, during the Persian Gulf War, the US showcased its military dominance, utilising Intel's microprocessors extensively and employing semiconductor-based systems in laser-guided bombs and upgraded air-to-air missiles like the Sidewinder, resulting in vastly improved accuracy compared to previous conflicts like the Vietnam War (Miller, 2022).

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[17] Iliac IV was the first massively parallel computer. The machine was build to answer the large computational requirements such as ballistic missile defence analysis, climate modelling etc.

In modern age warfare, Military systems rely on various semiconductor products, such as sensors, memory chips for storing extensive data, microcontrollers, logic devices, and discrete components.

Wireless sensors are increasingly vital in military and aerospace sectors (Gargeyas, 2022). They play a crucial role in aircraft design, optimising diagnostics, and conducting regular health checks, essential for military vehicle construction (Gargeyas, 2022). Sensors enhance aircraft control via advanced simulation by enabling lighter construction for improved weight performance (Gargeyas, 2022). In military aerospace, sensors are equipped with radio transceivers and independent power sources (Gargeyas, 2022). They enhance signal quality and enable precise landings using GPS-guided navigation systems due to efficient electronic components and optimised protocols, crucial for operational effectiveness (Gargeyas, 2022). Besides, the significance of Electro-Optical (EO) systems, particularly in military contexts, has notably increased (Gargeyas, 2022). There has been a progressive integration of EO systems into military vehicles and weaponry, primarily driven by their advantageous features (Gargeyas, 2022). Within the defence sector, EO systems serve various purposes, including furnishing precise optical data for aerial security, surveillance, patrol operations, search and rescue missions, and reconnaissance initiatives (Gargeyas, 2022). Their adoption within military contexts is increasingly preferred due to their image stabilisation and long-range imaging capabilities (Gargeyas, 2022). Reliability is paramount in military technology, leading to a surge in the production and utilisation of specialised microcontrollers designed for harsh environments (Gargeyas, 2022). As a result, there has been significant growth in the deployment of microcontrollers or integrated circuits (ICs) within military applications (Gargeyas, 2022). A programmable logic device (PLD) is an electronic component used for building adaptable digital circuits like logic arrays (Gargeyas, 2022). Recent advancements in logic devices, such as Field Programmable Gate Arrays (FPGAs), are being tailored to meet the needs of military forces. American companies such Xilinx, leads research on "defence-grade" programmable logic chips. These military-grade logic devices, currently in development, are expanding their applications to include machine learning and AI. Additionally, they feature enhanced security measures at the network edge level (Gargeyas, 2022). Some of these logic devices have already been integrated into prominent frontline weapons, like the F-35 fighter jet utilised by the US military (Gargeyas, 2022). The implementation of advanced discrete semiconductor devices has been acknowledged in subsystem communications to achieve faster response times (Gargeyas, 2022).

2.6: Intel Story

Bob Noyce and Gordon Moore, the founders of Fairchild Semiconductor, departed from the company in order to establish Intel in the year 1968 with the vision to produce transistors at the most affordable prices, in anticipation of a global demand reaching trillions (Miller, 2022). In just two years, Intel introduced its first product, a chip referred to as Dynamic Random Access Memory (DRAM). Miller (2022) asserts that data storage in computers typically relied on a device known as a magnetic core, prior to 1970s. DRAM chips continue to serve as the foundation of computer memory up to the present time (Miller, 2022). The circuits of DRAM were etched onto silicon, reducing the likelihood of malfunctions as they did not require manual wiring (Miller, 2022). Furthermore, Intel initially aspired to dominate the DRAM chip business but faced increased costs producing various logic chips before the 1970s (Miller, 2022). Recognising the feasibility of mass production, Intel strategically shifted its focus to memory chips (Miller, 2022). In 1969, Busicom[18] sought Robert Noyce's expertise for a complex calculator, often likened to the iPhone of the 1970s, showcasing its significance in cutting-edge computing technologies (Miller, 2022). Silicon Valley played a crucial role as many Japanese companies heavily relied on its expertise for both chip design and manufacturing processes (Miller, 2022). During this era, Intel emerged as the leading producer of powerful memory chips (Miller, 2022). Simultaneously, a defence contractor secretly developed a chip similar to Intel's specialised logic chip, employed in the F-14 fighter jet, maintaining confidentiality until the 1990s. Meanwhile, Intel launched their own chip known as the 4004, branding it as the world's first microprocessor in 1972 (Miller, 2022).

In addition, Miller (2022) points out, 1972 Bob Noyce made a significant declaration while holding a silicon wafer, stating, "This is going to revolutionize the world". The field of computing was poised for its own digital revolution, and Intel possessed the most advanced assembly line worldwide, allowing for massive production of logic chips (Miller, 2022). The 1980s presented formidable challenges for the entire US semiconductor industry due to intense competition from Japan. Alongside American giants like Intel and TI, Japanese firms, including Toshiba and Nippon Electric Company Ltd (NEC), emerged as strong contenders in DRAM memory chip production (Miller, 2022). This led to disputes over intellectual property rights between American chipmakers and their Japanese counterparts (Miller, 2022). Disputes over intellectual property rights arose between American chipmakers and their Japanese counterparts (Miller, 2022). By the 1980s, consumer electronics was controlled by Japanese companies, with Sony leading the way in

[18] Japanese calculator manufacturing company.

introducing new products and gaining market dominance over American rivals (Miller, 2022). Initially, Japanese firms achieved success by replicating the US products and delivering them at a higher quality and lower cost (Miller, 2022). While Americans excelled at innovation, the Japanese were known for their expertise in large-scale production (Miller, 2022). Notably, Akio Morita[19], the driving force behind Sony, urged his engineers to not only create advance radios and (Television) TVs but also to envision entirely new types of products (Miller, 2022). Consequently, in 1979, Sony introduced the innovative Walkman[20] device, a true innovation made in Japan that went on to became the most popular consumer devices in history (Miller, 2022). Japan's productivity levels during this period significantly outpaced those of the United States, underscoring their dominance in the landscape of semiconductor and consumer electronics industries (Miller, 2022).

Intel's dominant position in the market for data centre processors is waning (Miller, 2022). The company's attempt to enter the foundry[21] sector in the mid-2010s proved unsuccessful as it faced challenges in competing with TSMC As Intel approached its fifth anniversary in 2018, it experienced a reduction in market share (Miller, 2022). The company encountered setbacks in implementing planned enhancements to its manufacturing process, and these issues persist. Notably, delays in the development of Intel's 10nm and 7nm manufacturing processes were repeatedly announced since 2015 (Miller, 2022). In contrast, competitors such as TSMC and Samsung made notable progress during this period. Intel's

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[19] Cofounder and Former CEO of Sony company.

[20] A portable music player that revolutionised the music industry in which five of company's cutting-edge integrated circuit in each device was incorporate in Sony's Walkman.

[21] A foundry in semiconductor manufacturing is a semiconductor fabrication plant that produces microchips for other companies also known as fabs. This foundries manufacture chips for fabless companies that only design but do not manufacture. One example for foundry is TSMC that manufactures chips for fabless companies like Apple, Qualcomm, MediaTek, Intel, AMD, Nvidia, etc.
Throughout the study fab, manufacturing plant, manufacturing unit are used as synonyms to foundry.

adoption of EUV tools faced delays, and by 2020, a substantial portion of these tools funded by Intel were utilized by TSMC, while Intel lagged behind in incorporating EUV in its manufacturing processes (Miller, 2022).

By the conclusion of the decade, only TSMC and Samsung emerged as the two entities capable of manufacturing the most advanced processors (Miller, 2022). This raised concerns in the United States, as both companies presented challenges due to their geographical locations (Miller, 2022). Consequently, the global production of cutting-edge processors consolidated in Taiwan and South Korea, situated in proximity to the emerging strategic competitor of the United States, the People's Republic of China (Miller, 2022).

The semiconductor industry has reached a high level of maturity, characterized by the dominance of a few major companies primarily located in Europe, the United States, South Korea, Japan, Taiwan, and China (VerWey, 2019). Thus producing the latest chips has become very expensive, and only the biggest companies can afford it (VerWey, 2019). In the last 20 years, many companies focused on older products because of the high costs of production (VerWey, 2019). This change has reduced the number of companies that can make the latest chips and brought in a new way of working in the industry (VerWey, 2019). (see figure 2.6).

Figure 2.6: Operating models in semiconductor industry and leading firms in the world

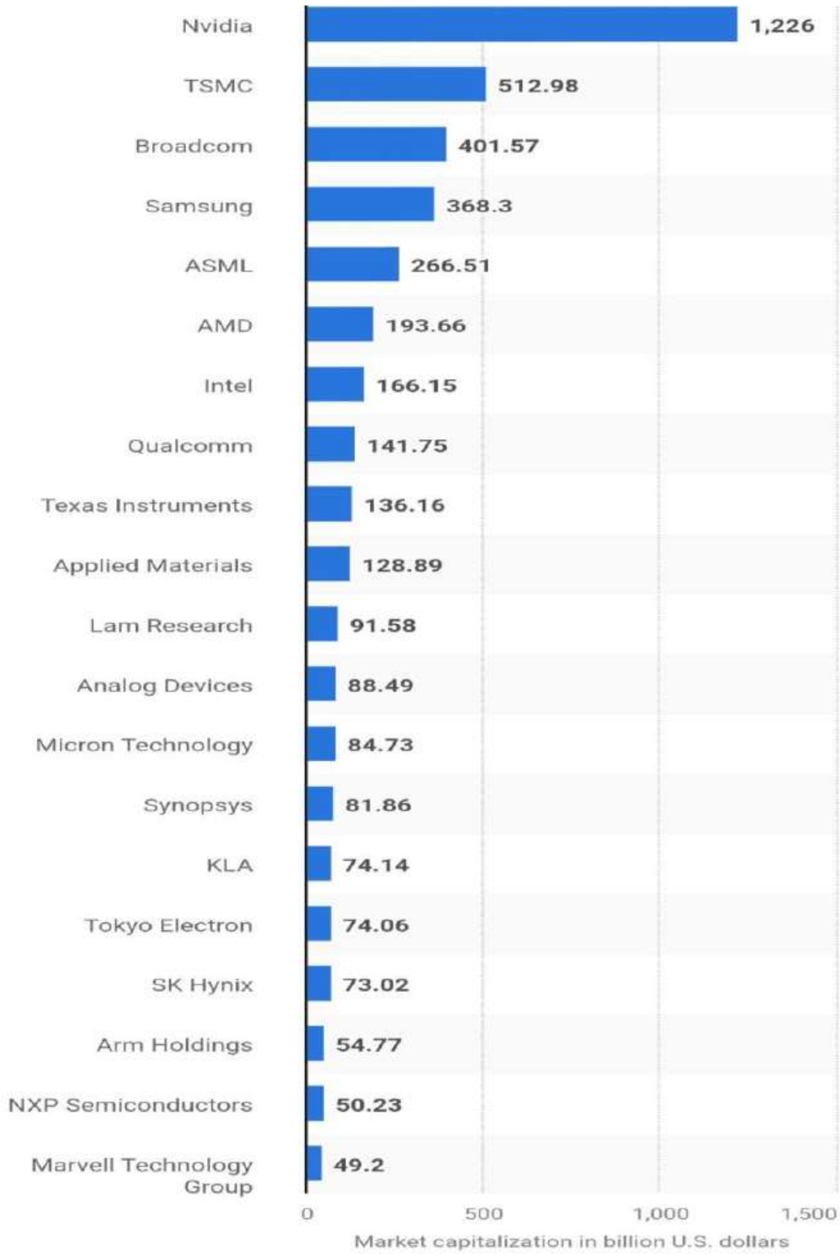
Integrated device manufacturer (IDM) model		
Intel, Micron, Samsung, Texas Instruments		
Fabless-foundry model		
Design (fabless)	**Manufacturing (foundries)**	**Assembly, test, and packaging (ATP)**
AMD, Broadcom, MediaTek, HiSilicon, Qualcomm	GlobalFoundries, SMIC, TSMC, UMC	Amkor, ASE, ChipPAC, JCET, J-Devices, Power-tech, SPIL

Source: VerWey, J. Chinese Semiconductor Industrial Policy: Past and Present. Journal of International Commerce and Economics, July 2019.

In the current landscape, a select few companies dominate the market by producing the most advanced and cutting-edge semiconductor chips, consequently securing significant market shares (Alsop, 2024).

As of January 2024, Nvidia is among the top semiconductor companies by market value, followed by others like Taiwan Semiconductor Manufacturing Company (TSMC), Broadcom, Samsung, and Advanced Semiconductor Materials Lithography (ASML) (Illustrated in figure 2.7) (Alsop, 2024). This mix of companies highlights the diverse and complex nature of the semiconductor industry, involving firms across different parts of the chip world (Alsop, 2024).

Figure 2.7: Leading Semiconductor companies Worldwide in 2024, by market capitasation in billion USD



Source: Statista. (2024, January 10).

2.7: The Semiconductor Supply Chain

The global supply chain is instrumental in facilitating the aforementioned technological advancements that is notably complex. Over the years, the semiconductor industry has evolved various business models, involving the diversification of value chains[22]. Various companies have diverse roles and others are highly specialised like TSMC (Thadani & Allen, 2023). However, it is important to note that at present, no single company neither country possesses the capability to independently performing every step of the supply chain for all types of semiconductors required for our modern economy (Thadani & Allen, 2023). This highlights the intricate interdependence and specialisation within the global semiconductor landscape (Thadani & Allen, 2023). According to estimates by Accenture, a consulting firm, the various inputs to a typical IC chip must pass through more than 70 international borders before a final product can be delivered to consumers (Thadani & Allen, 2023).

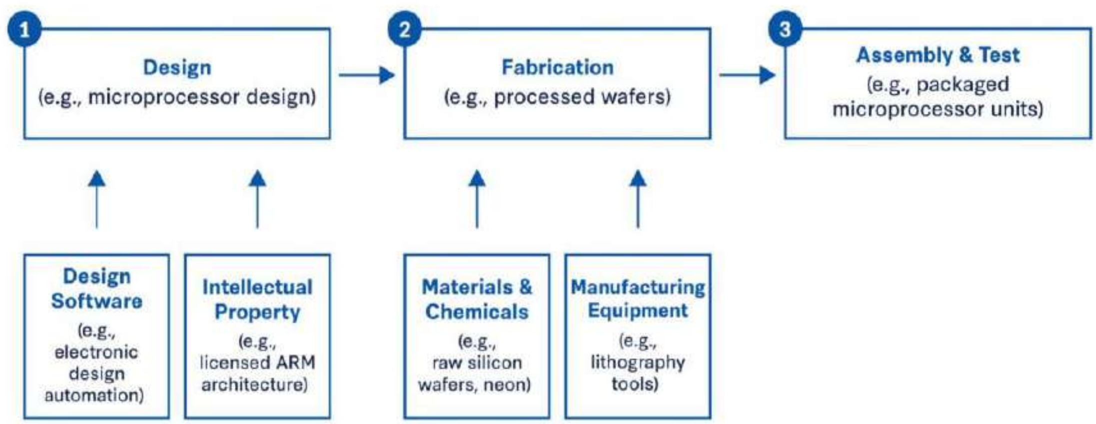
The semiconductor production involves multiple process which begins R&D and design of semiconductor chips in labs followed by the fabrication process that use raw materials like silicon, an primary component undergoes high-tech refinement process to create silicon wafers and carving out billions of tiny transistors on silicon wafers with complex pattering and precision (Ji & Nauta, 2023). This serves as the foundation for production if ICs (Ji & Nauta, 2023). The chips after manufacturing process are packaged and undergone test and evaluation before shipping it to countries like China where the semiconductor chips are embedded in final product such as iPhone Figure 2.8 depicts the ICs manufacturing processes (Ji & Nauta, 2023).

[22] A value chain is the series of steps to turn raw materials into finished products. Each step in this chain shows a connection between suppliers and customers, whether it's within a company or between different ones.

This process includes designing chips in fabs of the United States, fabricating and manufacturing them in Taiwan, testing in Malaysia, and finally assembling the chips into products like smartphones in China (VerWey, 2019). According to the Semiconductor Industry Association (SIA), approximately 90% of a chip's value is attributed equally to its design and manufacturing, while the remaining 10% is added during the assembly process by Assembly, Test and Packaging (ATP) firms (VerWey, 2019).

Comprehending the configuration of the worldwide semiconductor manufacturing framework is essential for grasping the significance of microchips in the contemporary technological era.

Figure 2.8: Streamlined representation of Semiconductor Value Chains



Source: Thadani, A., Allen G. (2023, May 30).Mapping the Semiconductor Supply Chain: The Critical of the lndo-Pacific Region. CSIS.

2.8: Global Influence of Taiwan in Supply Chain

During their 1968 Asian tour to choose a site for a new chip assembly facility, Texas Instruments executive Mark Shepherd and Morris Chang visited Taiwan (Miller, 2022). Although Shepherd's initial meeting with Taiwanese Foreign Minister K. T. Li was unsuccessful, marked by Li's remark that "intellectual property was something imperialists used to bully less advanced countries" (Miller, 2022). Shepherd later recognised the potential benefits for Taiwan in deepening ties with the United States (Miller, 2022). This was especially important considering the uncertainty of the security assurances provided by the USA's setback in the Vietnam war, despite the treaty alliance between Taiwan and USA since 1955 (Miller, 2022).

From South Korea to Taiwan, Malaysia to Singapore, anti-communist governments sought reassurance that America's withdrawal from Vietnam wouldn't leave them isolated (Miller, 2022). At the same time, they sought jobs and investments to address economic dissatisfaction, which had driven some of their population towards communism (Miller, 2022). Taiwan, was particularly concerned about a communist victory in Vietnam, while Beijing sought allies to probe U.S. weakness (Miller, 2022). Although the US marked economic prosperity for Taiwan, it posed challenges in foreign policy as Taiwan struggled for international recognition (Miller, 2022). The fear of China's dominance heightened with its atomic bomb test in 1964, prompting Taiwan to seek America's security guarantee (Miller, 2022). The semiconductor industry played a pivotal role in the US-Taiwan alliance, as Morris Chang, originally from Taiwan, aimed to establish a semiconductor facility on the island in 1968 (Miller, 2022). Strengthening economic ties with the United States and increasing semiconductor plants were seen as crucial for Taiwan's security (Miller, 2022). In 1968, with good relations with the Taiwanese government, Texas Instruments approved the construction of a facility in Taiwan (Miller, 2022).

With the support of Singaporean government, Texas Instruments (TI) and National Semiconductor established facilities in the Singapore, leading the way for many other chipmakers to follow (Miller, 2022). In the 1970s, several American semiconductor firms employed tens of thousands of workers globally mainly in Korea, Taiwan, and Southeast Asia (Miller, 2022). By the 1980s, Singapore's electronics industry constituted 7% of the country's Gross National Product (GNP), resulting in a surge in manufacturing jobs and accounting for 60% of semiconductor device production (Miller, 2022).

In Hong Kong, the electronics manufacturing sector became a significant job creator, along with the textile sector (Miller, 2022). Malaysia experienced a boom in semiconductor production in locations such as Penang, Kuala Lumpur, and Melaka, leading to an increase in manufacturing jobs and a notable shift as farmers moved to cities between 1970 and 1980 (Miller, 2022). By the late 1970s, America's allies in Asia had become deeply intertwined with the U.S., while Taiwan remained concerned about the persistent risk from China (Miller, 2022). Furthermore Taiwan's partnership with Silicon Valley, and this enduring partnership continues to exist until today (Miller, 2022).

2.9: China's Rise in Semiconductor Innovation: Unveiling Technological Milestones and Achievements

Prior to the last five years, China invested extensively spending tens of billions of dollars in constructing its domestic semiconductor industry (Thomas, 2021). This involved generously supporting national champions to rival Western companies (Thomas, 2021). Despite these substantial efforts, Chinese semiconductor firms, only hold a modest presence in the global market (Thomas, 2021).

Over the past few years, China has become a key player in the global semiconductor industry, investing heavily in chip design and manufacturing. This move is not just a but economic growth but also aims to reduce reliance on foreign technology, making China a leader in the field (VerWey, 2019). Moreover, the initiative holds significance for modernising military capabilities, as advanced chip technology is considered crucial in modern warfare (VerWey, 2019). The China's semiconductor industry began when China created its first ICs in 1956. From 1956 onward, China has actively planned and prioritised its semiconductor industry, aiming for competitiveness and commercial viability (VerWey, 2019). The government looks at semiconductors as crucial for both economic and national security, driving its continuous efforts in this sector (VerWey, 2019).

The initial phase of China's semiconductor industry, spanning from 1965 to 1990, was marked by state-led planning focused on indigenous innovation (VerWey, 2019). The State Council facilitated the development of an "Outline for Science and Technology Development, 1956–1967", designating semiconductor technology as a key priority (VerWey, 2019). Five major Chinese universities subsequently introduced semiconductor-related degree programs, and the Huajing Group's Wuxi Factory No. 742, established in 1960, played a crucial role in training early industry experts and contributing to strategic industrial plans (VerWey, 2019). By 1965, the Chinese Academy of Science initiated IC research (VerWey, 2019). During this period, research and development occurred in state-run labs, while manufacturing took place in state-owned factories, often lacking coordination (VerWey, 2019). This separation hindered the transfer of technology from labs to factories (VerWey, 2019). Additionally, in the 1970s, most of the roughly 40 semiconductor-related manufacturing factories focused on producing simple diodes[23] and

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[23] A diode is an electronic component with two terminals that allows current flow in only one direction, provided it operates within a specified voltage range. In one direction, an ideal diode exhibits zero resistance, while in the opposite direction, it shows infinite resistance. A diode serves as an electrical circuit valve.

transistors instead of ICs. The Cultural Revolution from 1965 to 1975 further impeded industry progress (VerWey, 2019).

The reform era, initiated by Deng Xiaoping in 1978, brought fundamental changes to the Chinese economy and the chip industry (VerWey, 2019). In the early 1980s, under the sixth Five-Year Plan (1981–85), the State Council established a "Computer and Large Scale IC Lead Group" to modernise the domestic semiconductor industry (VerWey, 2019). Despite these efforts, China's chip industry struggled to catch up with global leaders (VerWey, 2019). In the mid-1980s, an American researcher visiting a Shanghai factory discovered it was producing chips that were technologically outdated by 10–15 years on wafers (VerWey, 2019). Throughout the 1990s, the Chinese government pursued a hybrid industrial development model, allocating significant funds to a few major firms (VerWey, 2019). These firms engaged in partnerships with foreign companies such as Nortel (Canada), Philips (Netherlands), Nippon Electric Company Ltd (NEC) (Japan), and International Telephone and Telegraph (ITT) (Belgium) in the late 1980s and early 1990s. Additionally, negotiations for a joint venture with Lucent Technologies (USA) aimed at facilitating technology transfer (VerWey, 2019). However, the implementation of the plan, known as Project 908, took eight years in order to form realisation from ideas which resulted in a joint venture that used old manufacturing equipment and process technologies in order to produce chips were lagging behind the world leaders when they were brought to market (VerWey, 2019).

Among diodes, semiconductor diodes are the most prevalent. They conduct electricity solely when a specific threshold voltage is applied in the forward direction, denoted as the "low resistance" direction.

China's Ninth Five-Year Plan (1996–2000) introduced Project 909, emphasising the development of domestically produced chips by an internationally competitive firm using Chinese intellectual property and engineers (VerWey, 2019). Huahong, a designated Chinese firm, successfully partnered with NEC (Japan) to enter production without the delays experienced in Project 908 (VerWey, 2019). Notably, this success was influenced by terms in the joint venture, allowing NEC to replicate the fabrication facility's layout and primarily staff the Chinese facility with Japanese engineers (VerWey, 2019). Despite this strategic decision contributing to timely chip production, a downturn in the DRAM market in 2002 led Huahong to change its joint-venture partner and operating model, although it continued operations as of 2019 (VerWey, 2019).

China joined the World Trade Organization (WTO) on December 11, 2001, making it more attractive for big international companies to set up local operations (VerWey, 2019). Around the same time, Huahong faced difficulties in 2002, while another important player, Semiconductor Manufacturing International Corporation (SMIC), started production (VerWey, 2019). Founded in 2000, SMIC has become the largest and most advanced chip maker in China, ranking among the top five globally (VerWey, 2019). SMIC's successful strategy involves working closely with foreign firms and hiring Chinese engineers, often returnees from the United States, Taiwan, and Singapore (VerWey, 2019). This approach helps SMIC stay just a year or two behind the leading companies in the industry (VerWey, 2019). In 2005, the State Council of China issued the "National Medium- and Long-Term Science and Technology Development Plan Outline for 2006–20 (MLP) (VerWey, 2019)[24].

[24] MIC2025 (Made in China 2025) emphasises "indigenous" innovation, yet this often entails PRC (People's Republic of China) entities acquiring, absorbing, and adapting foreign technology, presenting these capabilities as domestically originated. The Medium and Long-term Plan (MLP) advocates various forms of

This document presented a comprehensive vision for the technology ecosystem, providing a strategic framework for medium and long-term science and technology development by recognition the significance of semiconductors as an enabling hardware and core technology for future advancements. China's current initiatives to bolster its semiconductor industry showcase the implementation of the Introduce-Digest-Assimilate-Re-innovate (IDAR) concept[25] (VerWey, 2019).

2.10: China's Present Semiconductor Industrial Policy: 2014 Onwards

China has set ambitious objectives for the advancement of its domestic semiconductor industry. “Without cybersecurity there is no national security”, President Xi Jinping declared at general secretary of the Chinese Communist Party in 2014 (Miller, 2022). Thereafter, in June 2014, China's government published a plan, Guidelines to Promote National Integrated Circuit Industry Development, “with the goal of establishing a world-leading semiconductor industry by 2030 in all areas of integrated circuit supply chain.” The outlined measures in the document aim to facilitate an assertive growth strategy, aspiring to fulfill 70% of China's semiconductor demand through domestic production by the year 2025 (CRS, 2021). In 2019, China revived its ambitious goal to increase domestic semiconductor production (CRS, 2021). This included output from both domestic and

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state ownership and control over PRC firms, enhancing their flexibility to operate globally. This approach may obscure the complete extent of the PRC state's involvement in business activities.

[25] The IDAR concept is a strategy employed by China to enhance indigenous innovation and technological advancement. The approach is implemented in various stages, initially introduction of foreign technology digestion and analysis of the acquired technology, integration into domestic industry and subsequently re-innovating to develop new, domestically produced products competitive on the global market. This approach has been applied across multiple sectors, including information communications technology, biotechnology, civil aviation, aerospace and eventually in developing semiconductor technology in China.

foreign companies operating within China, with the target of meeting 80% of the nation's semiconductor demand by 2030 (CRS, 2021). This strategic shift was in line with the overarching objectives articulated in the Made in China 2025 industrial strategy (CRS, 2021). The Chinese government is investing heavily to boost its semiconductor industry to reduce the dependence on foreign firms for its chip import and become self-sufficient in chip design and manufacturing by 2025 (CRS, 2021).

To execute its semiconductor strategy, China established the China Integrated Circuit Investment Industry Fund (CICIIF), a government fund to design to allocate around $150 billion in state funding (CRS, 2021). This financial support is directed towards bolstering the domestic semiconductor industry, facilitating state-directed overseas acquisitions, and the purchase of foreign semiconductor equipment (CRS, 2021). In addition October 2019, China introduced a second semiconductor fund with an estimated capitalisation of $28.9 billion, underscoring its dedication to enhancing its semiconductor capabilities (CRS, 2021). To support the Medium and Long-term Plan (MLP), China's State Council rolled out Made in China 2025 (MIC2025) in 2015 and this extensive set of industrial initiatives aims to boost competitiveness by propelling China up the global manufacturing value chain (CRS, 2023). The overarching goals involve swiftly embracing emerging technologies and reducing reliance on foreign companies (CRS, 2023).

The introduction of the Made in China 2025 initiative emphasised China's commitment to advancing next-generation information technology, particularly in the realm of semiconductors, with a specific focus on ICs (Capri, 2020). Chinese Communist Party’s funding estimates around $300 billion over a ten years period (Capri, 2020). Following the National IC guidelines and the broader framework of Made in China 2025, the State

Council further solidified its objectives by releasing a non-binding Technical Area Roadmap in October 2015 (VerWey, 2019). This roadmap outlines goals for the next generation information technology sector, providing a strategic direction to “develop the IC design industry, speed up the development of the IC manufacturing industry, upgrade the advanced packaging and testing industry, facilitate breakthroughs in the key equipment and materials of integrated circuits (VerWey, 2019). As of 2020, the Roadmap envisions China's semiconductor design and manufacturing should be one or two years behind global leaders (Capri, 2020). The plan underscores the significance of having a strong domestic supply chain, including equipment, materials, and Assembly Test Packaging (ATP) service providers (Capri, 2020). The Roadmap sets a target for 2030, indicating that the primary segments of the IC industry should achieve advanced international standards. As of 2019 official Chinese government records $29 billion funding has been provided for China’s National Integrated Circuit Industry investment fund (Capri, 2020). In another document, China's 13th Five-Year Plan (2016–20), released in 2015, takes a more detailed approach (VerWey, 2019). It specifically prioritises the development of DRAM chips, reminiscent of Huahong's Project 909 initiative, with the goal of reducing reliance on memory chips sourced from the United States (VerWey, 2019).

Despite significant efforts to strengthen the Chinese semiconductor industry, the overall structure of the industry, was essential unchanged in 2020 compared to 2014 (Thomas, 2021). There has not been a major shift to China during this period (Thomas, 2021). Chinese players still find themselves trailing by decades in crucial areas of manufacturing technology, such as cutting-edge EUV lithography and cutting-edge software design tools (Thomas, 2021). According to the Chinese Semiconductor Industry Association (SIA), meeting its policy goals will require China to address a talent gap of approximately 300,000 engineers (Thomas, 2021). In spite of facing challenges, there have been significant progress. China has nearly doubled its share in the labour-intensive back-end manufacturing process, where processed semiconductor wafers are turned into individual chips, packaged, and equipped with electrical connectors, reaching 40% since 2015, largely attributed to strategic acquisitions (Thomas, 2021). Additionally, the market share of Chinese companies in fabless design has nearly doubled, mainly by the contributions of HiSilicon, Huawei's semiconductor arm (Thomas, 2021). While the results of the Chinese semiconductor policy can vary based on tactics and the proficiency of execution by Chinese engineers, there is no doubt that the Chinese semiconductor industry will become more competitive in the next decade.

In today's digital economy, semiconductor chips having roots in silicon valley with invention by American scientists is the crucial factor driving the escalating competition between United States and China shaping the global economic landscape being discussed in chapter two in detail and also answers the laid hypothetical scenario of the study.

CHAPTER III

The Race for Technological Supremacy

Originating in American companies, the invention of semiconductors sparked a significant innovation that revolutionised the electronics industry discussed in earlier. Chapter three delves into the tussle for technologically supremacy highlighting semiconductors as the linchpin of this competition. This competition extends beyond mere economic interest, intertwined with the broader national strategies of both the United States and China.

The global stage witnesses an escalating struggle for microchip dominance between two economic powerhouses. At the core of this competition lie semiconductors, pivotal technology spanning from smartphones and computers to electronic appliances and in medicine to military advancements. Since the inception of transistors to the evolution of Silicon Valley, the United States has held a prominent position in the semiconductor industry, which in recent years being challenged by the

People's Republic of China. In response, the U.S., along with the Dutch government, Japan, and South Korea, seeks to restrict China's chip technology, citing national security concerns. The U.S. asserts that China's advancements in chip technology pose risks to national security, particularly in military capabilities. China refutes these claims, strongly opposing the weaponisation of export controls and any interference in common trade practices by USA. This paper study delves into the ongoing U.S.-China race for technological supremacy, highlighting recent developments and shedding light on China's breakthrough in the semiconductor industry and the subsequent U.S. response.

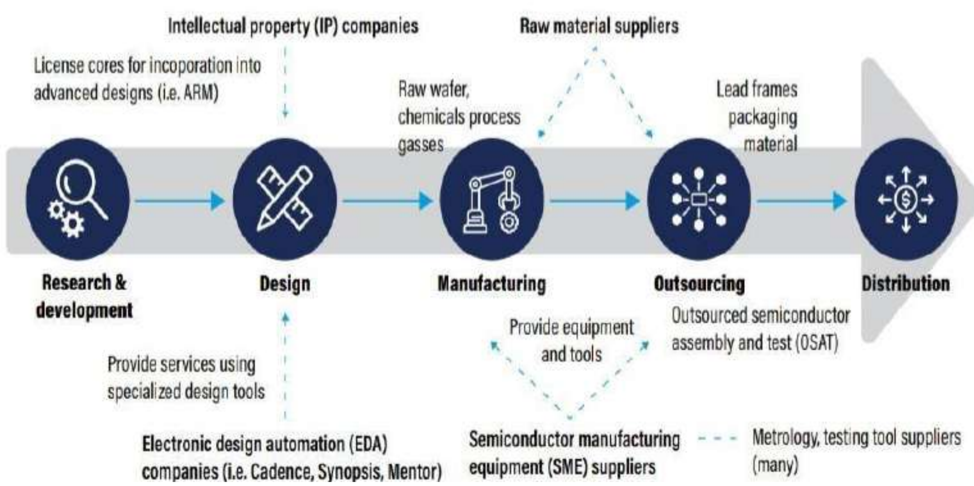
3.1: Unravelling the US-China Tech War

In the 21st century, microchips have become an indispensable part of modern life, permeating every facet of technology from smartphones to military capability and today referred as new oil for future decades. Importantly, China's chip imports even surpass its oil imports, (Palmisano, 2023) highlighting their significant role. The dominance of chips now plays a central role in military progress, economic prowess, and geopolitical influence, with the leading nation poised for a commanding edge (Palmisano, 2023).

While the US has been the leader in chip design and manufacturing since the invention of the technology, historical supremacy in the chip domain is being challenged by a rival economic power, China is using advanced military systems to gain a significant edge and establish itself as a superpower (Miller, 2022). Today the US accounts only 10 percent of global supply chain and none in the cutting-edge chips (WH.Gov, 2023). The global landscape is shifting, challenging America's historical supremacy in the chip domain. The competition for the future of technology not only revolves around microchips, but also the nations that command authority over them. As Miller, 2022 asserts, “supremacy in the chip industry translates into a considerable global advantage, influencing the trajectory of our world”. The ongoing global race for dominance in the semiconductor sector is emerging as a crucial geopolitical and economic contest shaping the contemporary era. China presents the primary obstacle the United States semiconductor sector by investing billions of dollars in an extensive chip-building initiative aimed at narrowing the gap and outpacing the United States in this critical field (Miller, 2022). China's significant investment in chips dwarfs its spending on any other product, highlighting its recognition of the strategic importance attached to this industry in its quest to catch up with and surpass the United States in semiconductor supremacy (Miller, 2022).

The race holds immense stakes not just for America's economic well-being but also its military supremacy, given the growing importance of computing power in military operations. (Miller, 2022) emphasises the pivotal role of government funding, like the CHIPS Act (Creating Helpful Incentives to Produce Semiconductors Act) by the United States, in curbing China's advancement in semiconductor technology and also highlights China's counterpart towards the collaboration between academia and industry. Furthermore, Miller (2022) explores the contemporary challenges confronting American chip manufacturers, notably in light of growing competition from Asia and China's substantial investments in its semiconductor sector. The revolutions of the 1980s, 1990s, and early 2000s, marked by personal computers, the internet, and smartphones with social media, were all underpinned by silicon technology. The forthcoming wave of transformative applications on 5G networks relies similarly on advanced chips, crucial for enhanced performance. Beyond consumer realms, access to cutting-edge semiconductors is pivotal for global military power, supporting high-performance computing, AI, Internet of Things, and modern weaponry (Eurasia Group, 2020). Due to the substantial expenses associated with supporting research and manufacturing for staying at the forefront of technology development, a limited number of major industry players now dominate advanced semiconductor manufacturing capabilities (Eurasia Group, 2020). These companies are primarily situated in a small set of countries, with geopolitical significance, including South Korea, Japan and notably, Taiwan (Eurasia Group, 2020). Semiconductor production begins with creating silicon wafers, then using photolithography to imprint circuit designs with Ultraviolet (UV) light (Kohli, 2023). Extreme Ultraviolet (EUV) lithography is now the leading method (Kohli, 2023). Etching removes excess materials, while ion implantation forms micro-transistors. This process is repeated across multiple layers (Kohli, 2023). Finally, wafers are cut into chips and packaged (Kohli, 2023). This complex procedure, with over 700 steps, is crucial for making semiconductors for various electronic devices (Kohli, 2023). Following figure 3.1 depicts the production stages of semiconductors (Eurasia Group, 2020).

Figure 3.1: Semiconductor Production Stages



Source: Eurasia Group

Presently, the predominant semiconductor manufacturers are Samsung from South Korea and TSMC from Taiwan, both engaged in substantial production at the cutting-edge 7-nanometer (nm) process node. This designation denotes a specific generation of manufacturing process, characterised by the smallest feature size (Eurasia, 2020). These industry leaders are actively pursuing advancements, aiming to transition to 5 nm and subsequently 3 nm by the mid-2020s. Intel, a prominent US integrated chip manufacturer, is also striving to achieve high-volume production at the 7 nm node; however, it has encountered challenges, leading to a delay in the release of its next-generation chips until 2022, as announced in July 2022 (Eurasia Group, 2020).

3.2: US-China Microchip War: What is it all About?

The US-China digital cold war[26] began in the Trump Administration and was continued by Biden Administration making microchips focal point global competitiveness. According to South China Morning Post (2021, June 8), the tech struggle which began as a trade dispute is today morphed into a battle for leadership in crucial technologies such as Artificial intelligence (Al), 5G and semiconductors (South China Morning Post, 2021, June 8). The United States long history with the invention and Research and Development (R&D) is being challenged by China which is investing in billions to develop its domestic chip manufacturing in an attempt to reduce the dependency on foreign chips for its consumption. Post 2014 and subsequent years China had launched series of plans and polices in order to boost its domestic semiconductor industry and surpass United States in the sector, one such policy was Made in China 2025 announced in 2015 where analysts believe might have triggered the chip conflict (SCMP, 2021, June 8). The escalation of the Chip war is further fueled by China's advancement in its military capabilities (Nathaniel Garcia, 2023). This includes the development of hypersonic missile systems, which are propelled by small chips produced by a Chinese company called Phytium Technology[27]

[26] Champion, M. How US-China Tech War rivalry Looks like a Digital Cold War. Bloomberg., https://www.bloomberg.com/quicktake/how-u-s-china-tech-rivalry-looks-like-a-digital-cold-war. accessed on January 20, 2024.

[27] Phytium Technology Co., Ltd., established in 2014, is a leading independent core chip provider in China. It focuses on design and development of computer microprocessors.

(Nathaniel Garcia, 2023). These chips are designed using American software and manufactured in Taiwan's highly advanced chip factory, which relies on American precision machinery (Nathaniel Garcia, 2023).

This is the early phase of techno-nationalism.[28] Data centers, robotics, machine learning, Al, surveillance, and 5G networking are the future industries and semiconductors are at core of these industries. Microchips acts as the central nervous system and brains of the new age technology (Capri, 2020). Due to the costly and complex nature of the semiconductor production, only handful of companies constitute the industry where this companies race for smaller nodes (nm) like 7nm, 5nm 3nm and even smaller in decades ahead. The manufacturing of these processor nodes requires highly complex and critical chip-making equipment currently Advanced Semiconductor Materials Lithography (ASML) monopolize. As per 2019 data inclined in Eurasia Group (2020), 7nm chips including Huawei's Kirin 990 series system-on chip is manufactured by Taiwan Semiconductor Manufacturing Corporation (TSMC) in Taiwan constitute the most advance semiconductors in commercial use (Bloomberg News, 2023, December 1).

Eurasia group (2020) stated, the US-China trade and technology confrontation spilled in 2017 since the trade conflict and the US campaign against Huawei, China's 5G leader and important global technology company began. From the origin of semiconductors in Silicon Valley today the critical technology has become a part of geopolitical consequences which has more fundamental problems to China. The United States of America's efforts to cut-off

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[28] Techno-nationalism is a new concept of mercantilist thought that links tech innovation directly to economic prosperity, social stability to national security policies of a state in which intervention of a government in market is justified frim protection against the opportunist or hostile state and non-state actors. Techno-nationalism seeks to attain competitive advantage for its own stakeholders on a global scale, to leverage this advantage for geopolitical gain.

to limit advanced semiconductor supply to Huawei and promote the construction of chip factories on American soil have brought the semiconductor industry into the U.S.-China technology cold war, significantly escalating trade tensions (Eurasia Group, 2020). Huawei is well-known in Washington for its telecommunications work, but it also contributed significantly to China's success in smartphone, computer, and AI chip design in the 2010s (Eurasia Group, 2020). By late 2018, only Apple and Huawei were selling smartphones with 7 nm processors, both designing them in-house (McLellan, 2018) and outsourcing manufacturing to Taiwan Semiconductor Manufacturing Corporation (TSMC). Allen (2023) marked that both smartphones had features equivalent to each other making competitiveness behavior and as a result Huawei was leading its sales putting Apple on 2nd position according to 2018 worldwide ranking. In the May 2019, Bureau of Industry and Security (BIS) of Department of Commerce added Huawei Technologies Co. Ltd into the entity lists[29] for concern over that Huawei was involved in activities which contrary to U.S. national security or foreign policy interest (BIS report, 2020). The Bureau of Industry and security (BIS) reported, initial purpose behind placing Huawei on the entity list in May 2019 was to penalise the company for selling technology to Iran, which violated U.S. sanctions (BIS report, 2020). This action was particularly prompted by Huawei's consistent dishonesty with U.S. officials, destruction of evidence, and attempts to obstruct justice (US dept. of commerce, 2019). Originally, the national security concern cantered on Huawei's

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[29] To sell or transfer American technology to an entity or individual on the Entity List, a license issued by the Bureau of Industry and Security (BIS) is necessary. The issuance of a license is contingent on the evaluation of potential harm to U.S. national security or foreign policy interests. The listing becomes effective upon publication in the Federal Register. The End-User Review Committee, consisting of officials from the Department of Commerce, Department of Defence, State Department, and Department of Energy, determines additions to the Entity List. In accordance with section 744.11(b) of the Export Administration Regulations, individuals or entities reasonably suspected of being involved or posing a substantial risk of involvement in activities contrary to the national security or foreign policy interests of the United States, along with those acting on their behalf, may be included in the Entity List. (US Dept. Of Commerce).

role in 5G telecommunications infrastructure, not smartphones (US dept. of commerce, 2019). However, Lualy, et. al., (2020) affirmed it expanded to prevent Huawei from using the U.S. technology to circumvent U.S. export controls. This broader perspective subsequently included scrutiny of Huawei's activities in chip design and manufacturing for smartphones (Lualy, et. Al., 2020).

According to CSIS report, imposing export controls on Zhongxing Telecommunication Equipment (ZTE) in April 2018 and subsequently on Huawei in 2019 marked a significant development in China’s national security policy landscape (Allen, 2023). The quest for semiconductor self-sufficiency had been a paramount goal in Chinese industrial policy since the initiation of the Made in China 2025 policy in 2015, and even earlier with the establishment of China’s “Big Fund” in 2014 (PRC State Council, 2019). Chinese government and chipmakers adopted de-Americanization[30] policy leading to focus on the self-sufficiency by investing $100 billion in Chinese financial support and attracting the attention of President Xi Jinping (DiPippo, et. al., 2023).

According to BIS (2020) report in May, the Department of Commerce determined that the 2019 entity listing of Huawei had an impact but did not meet its objectives. Major U.S. chip manufacturers, including Intel, Qualcomm, and Xilinx, continued to directly supply Huawei with various advanced chips (Shu, 2019). This continued commerce was facilitated by the fact that a significant portion of these chips was not manufactured in the United States, thus avoiding the export controls in effect. Trump Administration directed

[30] De-Americanization refers to the process of reducing or removing American influence irrespective of cultural, economic or political. It entails diminishing the presence of American culture and practices or values within a particular setting. The term is commonly used to pursuit the goal of mitigating or weakening the presence of American cultural norms, technologies or economic practices in other countries origins.

the US chipmakers to stop export of critical technologies to Huawei (King, et. Al., 2019). This blockade of sale impacted the American chip giant like Micron and US companies which are reliant on world's second largest economic for its growth (King, et. Al., 2019). The May 2020 export controls a revised version of the Foreign Direct Product Rule (FDPR)[31] was implemented. This aimed to hinder foreign support for Huawei and its chip design arm, HiSilicon, in creating chips directly derived from the U.S. technology (Federal Register, 2020, August 20). The Huawei's semiconductors drastically affected. Some of the less advance technological chipset were being approved, meanwhile the advance foreign chips which were not subjected to the US rules were stockpiled by China that Huawei embraced (Federal Register, 2020). Due to this massive stockpile Trump Administration totally cut off the Huawei's access to Foreign Direct Product Rule (FDPR) in August 2020 due to violations of same (Federal Register, 2020, August 20).

In December 2020, Huawei faced the US sanctions list similar to SMIC, and any company willing to sell technology to SMIC would require Washington's permission (Liu, 2023). By this time Trump Administration blocked EUV Lithography equipment's for which reached to an informal agreements with the Dutch government since the only supplier of EUV equipment is a Dutch Company, ASML (Allen, 2023). The Dutch Ministry of Defence also strongly supported restricting EUV exports to China, as indicated in a later published government document. U.S. Secretary of State Antony Blinken at press release (2022) hinted expressed, The post-Cold War era has concluded, and a vigorous competition is unfolding to influence the subsequent developments. He said, central to this competition is technology (US dept. of Commerce, 2022).

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[31] The FDRP rule is a US export control regulations that allows the re-export the US technology.

Followed by the Trump Administration's lead, Biden Administration continued the export controls, sanctions and restrictions on China. The landmark export controls imposed on People's Republic of China on 7 October 2022 by US Department of Commerce' BIS strangled the relations between USA and China curbing export controls on crucial semiconductors (BIS Report, 2022). The US Department of Commerce is implementing measures to restrict Chinese manufacturing of advanced computing chips, supercomputers, and semiconductors (BIS, 2023). These include new license requirements for items used in supercomputers and chip manufacturing equipment, aiming to limit their export to China (BIS, 2023). Biden signed the bipartisan CHIPS and Science Act on 9 August 2023 regulating investments from the US into the Chinese semiconductor industry, citing it as a 'state of emergency' (Mishra, 2022). The act aims to enhance American manufacturing, fortify supply chains, bolster national security, and allocate resources for research and development, science, technology, and future workforce development (WH. Gov, 2022). This strategic investment is designed to position the United States as a leader in emerging industries such as nanotechnology, clean energy, quantum computing, and artificial intelligence, ensuring competitiveness and success in the future and counter China in Semiconductor field (WH. Gov, 2022). White House (2022) announced Micron's $40 billion investment in memory chip manufacturing highlights a commitment to meeting the increasing demand for chips essential in computers and electronic devices. Additionally, Global Foundries' $4.2 billion partnership signals a substantial move to expand chip manufacturing capabilities at their upstate New York facility, contributing to the industry's growth and innovation (WH. Gov. 2022b). Following the plans Biden administration has decided to $5 billion in R&D to bolster chip design and manufacturing in US and counter

China's efforts to acquire advancement of the industry (Hawkins, 2024). Officials are aiming to prevent China from gaining advantages from research funded by the NSTC[32] (Nano Science and Technology Council), while also addressing gaps in the US research areas such as packaging and hardware said Dr. Laurie E. Locascio, Undersecretary for Standards and Technology, which are important due to the significant role electronic components play in the competition between the US and China (Hawkins, 2024). This investment plan aims to increase United States semiconductor manufacturing by 50 percent in next 5 years (WH.Gov, 2022). Calls from China to develop a self-reliant ecosystem for new technologies have prompted increased caution from the US (Mishra, 2022). In August 2023, President Biden's executive order aimed to restrict the US investments in Chinese entities across sectors like semiconductors, quantum information technologies, and certain artificial intelligence systems (WH.Gov, 2023). This marked a significant shift as the US began limiting not only exchanges of people and products but also capital. In a subsequent executive order in October of this year, the Biden administration further tightened control over technology and data, mandating new safety assessments, equity and civil rights guidelines, and research on AI's impact on the labour market (WH.Gov, 2023).

The United States and the Netherlands are set to increase restrictions on chipmaking equipment sales, particularly targeting ASML, a vital company in lithography processes (Cash, 2024). Additionally, the US is urging allies such as Japan and South Korea to limit the export of chip making machines (Cash, 2024). Nicolas (2023) asserts, U.S. Commerce Secretary Gina Raimondo on September 2023, announced new export controls on the Al

[32] The NSTC brings together leaders in Federal science and technology (S&T) and sets forth definitive national objectives for S&T policy and funding. It formulates R&D strategies that are harmonised among Federal entities to achieve various national goals. (WH. Gov, 2022b).

chips to China and these restrictions is designed to restrict China's from importing advanced semiconductors or equipment and keeping an edge in Military sphere (Nicholas, 2023). The tech rivalry involves direct actions against companies (Nicholas, 2023). America has blacklisted over 140 Chinese companies, limiting their access to the US-made components, causing crises for Chinese firms like Huawei (Nicholas, 2023).

China being a dominant economic and tech power, has taken significant countermeasures against the US actions. China has initiated a World Trade Organization (WTO) lawsuit against the US, alleging that its chip export controls constitute trade protectionism (Wang, 2023, December 13). On Monday, the Chinese Ministry of Commerce acknowledged the trade dispute and accused the U.S. of misusing export control measures, which it claims are hindering regular international chip trade (Kharpal, 2022, December 13). The Chinese state-owned companies are blocking deals for US firms like Cisco (Kynge, 2019). This could harm the US companies significantly, as they sell nine times more to American consumers than Chinese firms (Kynge, 2019). Qualcomm, a major US chip maker, has reported weaknesses in its China business, with 65 percent of its revenue coming from China according to 2021 data (Wheatley, 2019). Similarly, Beijing instructed Chinese firms dealing with critical information to cease buying goods from Micron Technology, a U.S.-based company producing memory chips for various electronics (Che, 2023) alleging that Micron posses poises serious network security risks[33] causing security risk to China's

[33] The Cybersecurity Review Office found serious network security risks in Micron's products sold in China, posing a threat to China's critical information infrastructure and national security. Consequently, in accordance with laws such as the Cybersecurity Law, operators of China's critical information infrastructure are advised to halt purchases of Micron products. This aims to prevent cyber security issues from compromising our national security and is part of China 's commitment to open markets while ensuring compliance with local regulations (CASC, 2023).

critical information (Che, 2023). Analysts see this as a response to the U.S. restrictions to limit China's access to advanced chips (Che, 2023).

China's dominance in supplying crucial semiconductor raw materials like gallium and germanium[34] (D'cruze, 2023) has led to export controls on June 3, 2023 in response to the US sanctions, causing prices to rise (MOFCOM, 2023). Analysts suggest Beijing's move serves as a warning to the US, but business confidence has eroded amidst the superpowers' crossfire (Montoya, 2023). Beijing asserts these measures protect China's national security without targeting third parties (Montoya, 2023). The export controls imposed on the US imports of gallium and germanium by China Ministry of Commerce likely to affect the US defence industry since these materials plays a crucial role in certain modern military systems such as advanced radar system, warships and ground installations (Holderness et. al., 2023). Its ability to handle high voltages at elevated temperatures makes it vital for high-energy radars like the AN/SPY-6 and AN/TPS 80 used by the US military (Holderness et. al., 2023). Despite its importance, the short- and long-term threat to the US Department of Defence (DOD) and defence industry is likely minimal (Holderness et. al., 2023). While costs may increase as demand outpaces supply, complete cut-off of access by China is improbable (Holderness et. al., 2023). These actions are retaliatory responses to export controls imposed by the U.S., Japan, and the Netherlands on semiconductor chips, manufacturing equipment, and other measures aimed at limiting China's access to high-end chips (Godek, 2023). Chinese companies are intensifying their focus on domestic supply chains and attracting significant investments from both Beijing and private

[34] China produces 94% of the world's gallium and 83% of germanium which makes it the dominant player in supply of the raw materials used in semiconductor manufacturing. (Gotek, S. 2023).

investors, despite the strict restrictions imposed by Washington seven months ago (Che & Lui, 2023).

In 2022, the Chinese government increased efforts on a national project called the "Information Innovation" initiative, also known as xinchuang, with the goal of replacing foreign providers in areas like semiconductor technology (Economist, 2024, February 13). It has been reported that several Chinese state entities, along with the People's Liberation Army (PLA), have invested more than $50 million in projects related to Reduce Instruction Set Computing (RISC-V) technology (TOI, 2024, February 5). These investments have led to significant advancements in RISC-V technology in China, which has enabled the development of self-driving car chips, AI accelerators, and data center processors (TOI, 2024, February 5). This highlights China's intent to reduce dependence on foreign technology and bolster its domestic semiconductor industry.

In the line of technological rivalry, Huawei is positioned to seize the opportunity in the Chinese AI chip market following Nvidia's limitations due to US restrictions. With the Ascend 910B processor[35] and its established AI chip product line (Tsai & Ke, 2024), Huawei is making significant strides in this sector (Kaur, D. 2023). Despite challenges such as slowed smartphone production, Huawei's Ascend chips remain competitive in China (Potkin & Zhu, 2024). Moreover, Nvidia acknowledges Huawei as a primary competitor in AI technology (Ika, 2024). Thus, Huawei's advancements highlight its

[35] The development of Huawei's Ascend 910B marks a significant advancement in their high-performance AI processor technology, positioning it competitively alongside Nvidia's H20 chip, particularly in the Chinese market. This underscores Huawei's growing presence and efforts in the semiconductor industry, not only in AI processors but also in smartphone chips and expanding chip manufacturing capabilities.

potential to fill the gap left by Nvidia's restrictions, signalling a promising future in the AI chip market.

China strongly opposes the U.S. manipulating export control issues and interfering in normal trade (Communication today, 2024). The Ministry of Commerce, People's Republic of China (MOFCOM) opposes the United States' Weaponisation of export controls. China's Commerce Minister Wang's discussion with Raimondo underscores Beijing's unease about the U.S. Department of Commerce investigation into how American companies are obtaining legacy chips for semiconductor manufacturing. This inquiry is part of the department's plan to allocate nearly $40 billion in subsidies. The survey, aiming to mitigate national security risks linked to China, will concentrate on the utilisation and sourcing of Chinese-made legacy chips in crucial U.S. industries. The dialogue also delved into navigating the fine line between national security interests and fostering trade and economic collaboration, as per China's commerce ministry (Cong, 2024).

3.3: New Front of openings in US-China Tech war 2024

President Joe Biden has implemented a bifurcated strategy aimed to constrain China's advancements in cutting-edge technology, encompassing the constriction of Beijing's access to state-of-the-art semiconductor chips and the fortification of semiconductor manufacturing within the United States (Lanhee, et. al., 2023). According to Jim McGregor, founder of technology analysts Tirias Research, packaging is the new pillar of the semiconductor industry where it can change drastically, he asserted that packaging has emerged as a pivotal aspect of the semiconductor industry, poised for significant transformation and additionally, it was highlighted that, unlike other areas, the United

States has not imposed restrictions on China in the field of packaging, suggesting that advancements in packaging could serve as a means for China to narrow the technological gap (Lanhee, et. al., 2023). The packaging was mainly outsourced to Asia with China being the prime beneficiary (Lanhee, et. al., 2023). Intel stated that, currently the US accounts only 3% of the packaging capacity. Intel is looking at advance packaging as the core of the US chip giant strategy to return to competitiveness, whereas for China it means building domestic semiconductor capacity meanwhile the United States is also shifting its own plans to self-sufficiency (Lanhee, et. al., 2023).

Samsung and Taiwan Semiconductor Manufacturing Company (TSMC), the top chip manufacturers in Korea and Taiwan respectively, are pouring billions into new production facilities in the United States. TSMC is seeking subsidies from the U.S. government for its Arizona factory as a part of de-risking the supply chains (Lanhee, et. al., 2023).

Several Chinese chip companies are finalising plans for public offerings this year, including Hua Hong Semiconductor, China's second-largest chip manufacturer, and a chip maker supported by Huawei. The ongoing technology disputes between the world's top two economies show no signs of easing. The Biden administration has drafted new rules aimed at restricting American venture capital investments in advanced chip firms in China (Che & Lui, 2023). Foreign investment in China's semiconductor sector this year has plummeted to $600 million, its lowest since 2020 (Che & Lui, 2023). Additionally, officials are considering stricter controls on technologies such as quantum computing and chip manufacturing equipment. Due to U.S. restrictions, Beijing has activated a state fund like the government's "Big Fund" injected around $1.9 billion into Yangtze Memory

Technologies Co., Ltd. (YMTC)[36] in February to strengthen its ability to deal with the U.S. restrictions. State media reports indicate that the fund has also recently invested in chip equipment and material suppliers. The new subsidies are intended to eliminate Western components from China's supply chains (Che & Lui, 2023).

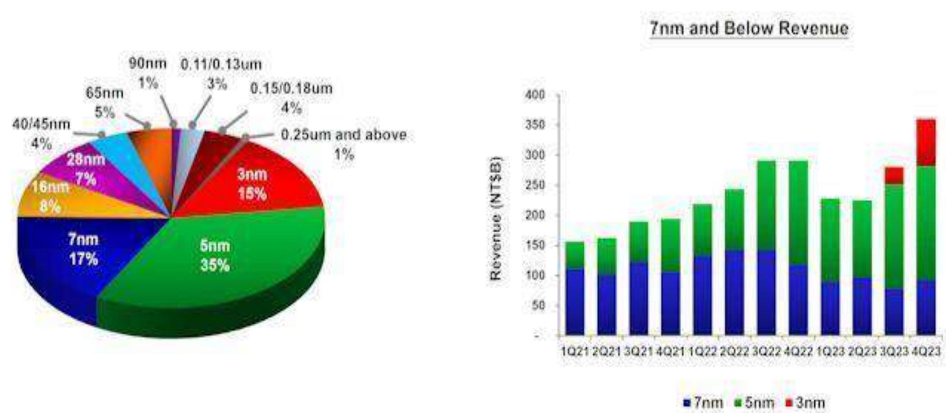
3.4: Decoding the Power: A Closer Look at How America Rules the Chip Industry

To comprehend the dynamics of the US-China technological conflict, an exploration of the United States' pre-eminence in semiconductor design and manufacturing becomes imperative. Central to the achievement of US dominance is the robust governmental endorsement of research and development initiatives within the semiconductor industry. During the earlier stages of the semiconductor industry, the United States government played a pivotal role in fostering research and development. Notably, the US Department of Defence made substantial investments in the creation of high-performance computer systems tailored for military applications (Lanhee, et. al., 2023). This strategic investment culminated in the breakthrough development of the first integrated circuit by Texas Instruments in 1958, fundamentally transforming the landscape of the electronics industry. At the same time, the establishment of the Advanced Research Projects Agency (ARPA) in 1958 marked a significant governmental initiative tasked with spearheading cutting-edge technologies for military applications. Among ARPA's notable achievements was the inception of the Advanced Research Projects Agency network (ARPANET), a precursor to the contemporary internet (Lanhee, et. al., 2023). With governmental support, the triumph

[36] Chinese flash memory chip giant based in Wuhan, China.

of the US semiconductor industry finds roots in the entrepreneurial ethos of American companies. Exemplary entities such as Intel, AMD, and Qualcomm exhibited a capacity for rapid innovation and technological development, enabling them to maintain a competitive edge. Intel, in particular, played a pivotal role in shaping the semiconductor industry by introducing the Intel 4004 microprocessor in 1971, a pioneering advancement that laid the foundation for the evolution of personal computers and other digital devices (Nicosia, 2023). Taiwan Semiconductor Manufacturing Corporation (TSMC) is the manufacturing hub for the cutting-edge chips designed in USA and outsourced to Taiwan is crucial for United States (Shilov, 2024). Currently, Taiwan is the only company able to manufacture cutting-edge technologies. Below illustrates the revenue of technologies manufactured by TSMC. Figure 3.2 depicts the TSMC'S cutting-edge technology by revenue

Figure 3.2: TSMCs Revenue by Technology



Source: AnandTech, TSMC (2023)

TSMCs 3nm chip technology accounts 15% of total wafer revenue, whereas 5nm and 7nm accounts 39% and 17 percent respectively. TSMC generated $2.943 billion from 3nm,

$6.867 billion from 5nm, and $3.3354 billion from 7nm, with advanced technologies (7nm, 5nm, 3nm) contributing to 67% of the company's total revenue. The broader category of FinFET (Fin Field-Effect)[37]-based process technologies represented 75% of TSMC's overall wafer revenue (Shilov, 2024).

3.5: Semiconductor Investment in the USA

The CHIPS and Science Act facilitates smart investments to empower Americans to excel and thrive in the future landscape of competition (WH. Gov, 2023). Additionally $50 billion investment is announced by companies in US semiconductor manufacturing which accounts total business investment if about $150 billion since presidency of Joe Biden (WH.Gov, 2023b). The Act is aimed at enhancing R&D in the semiconductors to ensure strategic edge in supply chain, secure national defence and critical sectors (WH. Gov, 2023). Qualcomm and Global Foundries have unveiled a ground-breaking collaboration, committing $4.2 billion to enhance chip manufacturing at Global Foundries' facility in upstate New York. As the foremost fabless semiconductor company globally, Qualcomm is set to bolster semiconductor production in the U.S. by as much as 50% within the next five years (WH.Gov, 2023). The administration announced in February 2024, its plan to grant $1.5 billion to chipmaker Global Foundries for upgrading and expanding facilities in New York and Vermont. These facilities produce chips for automakers and the defence sector (Swanson & Clark, 2024).

In September 2023, chip giant Intel convened officials at a site near Columbus, Ohio, announcing plans to invest a minimum of $20 billion in constructing two new

[37] FinFET is a 3D revolutionary transistor design that has transformed the semiconductor industry.

semiconductor factories (Swanson & Clark, 2023). Micron Technology commemorated the inauguration of a new manufacturing facility near Syracuse, New York, where the chip company projected to invest $20 billion by the end of the decade. Micron also announced its intention to allocate up to $100 billion over the next 20 years or longer for the construction of a massive computer chip factory (Lohr, 2022). The CHIPS and Science Act of 2022, enacted in August, allocates $52 billion in grants and subsidies to incentivise companies to construct and enhance computer chip factories within the country and shape the strategic industry (Swanson, 2022b). The fund encourages production of strategic semiconductors in United States encourage R&D un next-generation of chip technologies (Swanson, 2022) and investment is poised to reduce dependence on foreign supply chains. The decision to invest reshoring of facility is to bolster national security, rejuvenate American manufacturing, and invigorate innovation and research and development efforts said US Secretary of Commerce Gina Raimondo (Swanson, 2022). This is the most significant investment US made on last 50 years according to trade experts (Swanson, 2022b). TSMC plans to establish new factories in the Arizona and Kumamoto, Japan while MediaTek collaborated with Purdue University to launch a chip design center (Mozur., Lui., & Zhong, 2022). TSMC will investment $65 billion on the expansion of building three plants in Arizona, according to recent report (First Post, 2024, April 10). Earlier the TSMC investments accounted $40 billion. It is said that the first made in American chip would be out by 2026 and all three Arizona fabs will be operational by 2023 (First Post, 2024, April 10).

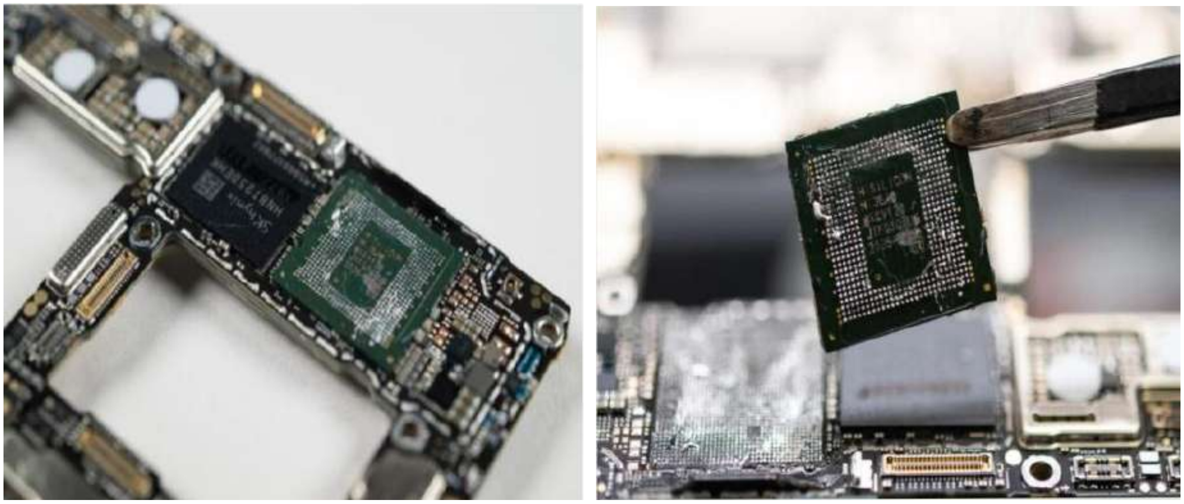
The United States currently leads the chip design but faces challenges in production capabilities particularly in advanced semiconductor chip manufacturing such as 3nm, 5nm, 7nm and 10nm. To address this gap Washington has led an ambitious plan to ramp up production and command a 20% market share by 2030. Collaborating with industry giants like TSMC and Samsung, the USA aims to boost its semiconductor manufacturing capabilities and strengthen its position in the global market. The semiconductor investments is both a strategic and financial investment for United States (First Post, 2024, April 10).

Since the world is worried for political future of Taiwan due to continuous efforts intervene the island which will halt the electronics supply chains specifically to high-end micro processors. Tech companies around the world are heavily dependent on cutting-edge chip manufactured by TSMC. During the visit of Taiwan, the US speaker Nancy Pelosi held discussions with TSMC's CEO Mark Liu and its esteemed founder Morris Chang (Mozur., Lui., & Zhong, 2022). Additionally, Senator Edward J. Markey led a separate delegation to meet with the company, focusing on investment opportunities and enhancing semiconductor supply chains (Mozur., Lui., & Zhong, 2022). The United States' reliance on similar expertise adds credibility to its military backing of Taiwan (Mozur., Lui., & Zhong, 2022).

3.6: China's Chip Breakthrough and Forging Ahead

In late 2020, Huawei faced a serious threat to its mobile phone business (Liu, 2023). The Trump administration's sanctions had cut off the company from the 5G technology and global semiconductor supplies by restriction access to the U.S technology to Huawei particularly in chips, chip design software and chip making equipment making it hard to produce advanced phones. To tackle this, China's telecom giant took a risky move, betting its $67 billion chip and mobile business on a deal with Semiconductor Manufacturing International Corporation (SMIC), a state-backed foundry aspiring to compete with top global chipmakers. Despite SMIC's promise to produce advanced chips using older equipment, the process would take longer, cost more, and success wasn't guaranteed (Liu, 2023). Huawei, desperate for a solution, approached SMIC to create a new smartphone chip which was codenamed as "Charlotte". In August 2023, a new Huawei smartphone was launched to the public: the Mate 60 series phone, powered by the Kirin 9000S chip (Liu, 2023). Huawei strategically launched the phone during US Commerce Secretary Gina Raimondo's visit to China, influenced in part by explicit encouragement from a high-ranking official within the government, reveals an anonymous source familiar with the situation, emphasizing the decision to demonstrate China's strength (Bloomberg News, 2023, December 1). Huawei was surprised by the unexpected request and originally planned a later release for the Mate 60 Pro shown in 3.3 (Bloomberg News, 2023, December 1). Despite meeting the adjusted launch date, the company had to skip the usual festivities due to time constraints. Huawei denies any government involvement in expediting the phone's introduction (Bloomberg News, 2023, December 1).

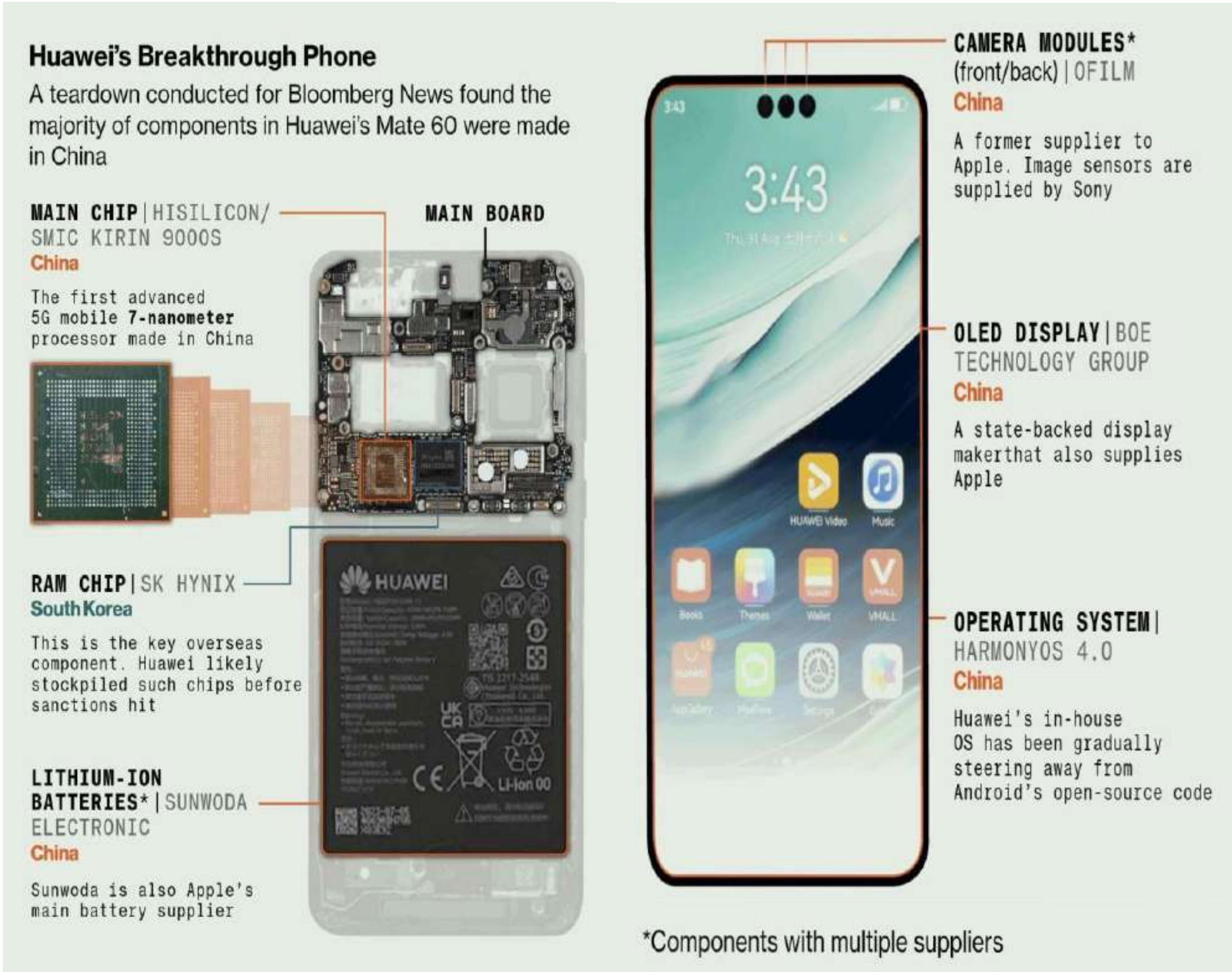
Figure 3.3: HISILICON SMIC KIRIN 9000S



Source: James Park, Bloomberg.

A week after the meet in California with its Chinese counterpart Xi Jinping in 10 November 2023, the US President Joe Biden told reporters “We’re in a competitive relationship, China and the USA.” Which is more clear in the high technology domain (Webb, 2023). Washington’s long efforts to limit Beijing acquiring advanced technologies particularly semiconductors appears to be falling apart amid the China's 7nm chip breakthrough in Huawei’s Mate 60 Pro smartphone (Webb, 2023). In August 2023, Huawei launched smartphone that exceeds capabilities the US authorities can ever thought possible for a domestic manufacturer like Huawei despite continuous US strict export controls (Webb, 2023). The TechInsights (2023), news disclosed that the device's chip was manufactured by China's SMIC China’s leading domestic chipmaker sparking inquiries into SMIC's capabilities and the efficacy of controls led by the United States. Huawei, China’s tech giant faced the US blacklisting since 2019 hence Ren Zhengfei, the founder and chief executive officer of Huawei shifted its move to redesign the circuit boards and software to function without American technology (Bloomberg News, 2023, December 1). Chinese state also showed support paving the way to today's independent relation and race to acquire self-sufficient semiconductor industry of which Huawei became a pivotal role stated by Kendra Schaefer, a partner at Beijing-based consultancy Trivium China (Bloomberg News, 2023, December 1). The directive to appoint Huawei as the leader in China's drive for a self-reliant chip industry comes directly from the highest levels of government, say anonymous sources familiar with the matter, citing the sensitivity of the topic (Bloomberg News, December 1, 2023). According to people familiar with the matter, The state and industry are now more closely aligned due to export controls, a phenomenon unprecedented in previous observations (Bloomberg News, 2023, December 1). SMIC's production of new chips using the advanced 7-nanometer (N+2 in SMIC process) technology has sparked concerns in U.S. national security circles (Allen, 2023). Questions arise regarding the efficacy of U.S. technology export controls on Huawei in light of these developments. China wanted to show the ineffectiveness of the US sanctions and that the extreme suppression has failed through its state-run media outlets (Allen, 2023). The development of the 7 nm chip powering the new Mate 60 smartphone represents a significant technological breakthrough for China, (shown in figure 3.4) showcasing its ability to make progress despite restrictions imposed by the U.S. and its allies (Allen, 2023).

Figure 3.4: Huawei's Breakthrough Smartphone



Source: TechInsights and Bloomberg reporting

(Bloomberg News, 2023, December 1) accords, the phone's significance lay in its substantial incorporation of advanced components manufactured in China, notably featuring a 7-nanometer processor from Shanghai's Semiconductor Manufacturing International Corp. Celebrated by state media as a patriotic achievement, it ignited intense discussions in the U.S. regarding the efficacy of its endeavours to impede China's technological progress.

While the Huawei phone itself is not a significant national security concern for the United States, the implications of the chip inside highlight the state of the Chinese semiconductor industry (Bloomberg News, 2023, December 1). The 7 nm chips in the new Huawei phone offer insights into the current and potential future state of China's semiconductor capabilities (Bloomberg News, 2023, December 1). In essence, China has not reached the global forefront in semiconductor manufacturing, but the gap between its technological level and the rest of the world has narrowed, despite U.S. government efforts to hinder SMIC (Bloomberg News, 2023, December 1). The advanced chip production capabilities are likely to be accessible to the Chinese military, raising challenging questions about the effectiveness of the current U.S. approach in light of Huawei and SMIC's breakthrough (Bloomberg News, 2023, December 1).

The Kirin 9000S chip was designed by HiSilicon[38] semiconductor subsidiary and manufactured by SMIC. In March 2023, China's government initiated a semiconductor self-reliance plan, designating Huawei, SMIC, Advanced Micro-Fabrication Equipment Inc. China (AMEC), and Naura as key players (Bloomberg News, December 1, 2023). Huawei holds a prominent role, influencing semiconductor policymaking within the government-backed team (Allen, 2023). The high end 7nm processor chips that power Apple's product and Tesla's semi-autonomous driving were both manufactured by TSMC using the advance EUV lithography tools to build these chips, while

SMIC used less efficient DUV lithography as per analyst and experts (Liu, 2023). Sources to Bloomberg articulate that the manufacturing equipment, including technology from

[38] HiSilicon is indeed a Chinese fabless semiconductor company located in Shenzhen, Guangdong, and is fully owned by Huawei. It specializes in designing and manufacturing integrated circuits, particularly for Huawei's devices like smartphones and networking equipment (HiSilicon.com).

Dutch manufacturer ASML and equipment from Lam and Applied Materials,[39] had foreign origins (Koc, & Hawkins, 2023). Bloomberg News reported in October 2023, that SMIC had utilized ASML equipment for the chip breakthrough (Koc, & Hawkins, 2023). According to anonymous sources of Bloomberg reporting, Shanghai-based SMIC utilised equipment from California-based Applied Materials Inc. and Lam Research Corp. to produce an advanced 7-nanometer chip for Huawei in 2023 but Applied Materials and the US Commerce Department's Bureau of Industry and Security, responsible for export controls, refused to provide information on the ongoing scenario of how Chi acquired the cutting-edge chip (Koc, & Hawkins, 2023). The state-owned semiconductor foundry in China, SMIC, commenced production of 14-nanometer chips in late 2019 (Shilov, 2023). Alibaba has developed artificial intelligence chips utilised in cloud computing applications (Shilov, 2023).

The launch of Huawei's recent laptop shocked the world which had 5nm chip technology embedded within. The teardown of the Qingyun L540 notebook laptop shows another Chinese breakthrough, it was discovered that the Kirin 9006C chip (5nm) was packaged and assembled by TSMC in 2020 running Huawei laptop, around this time the US sanctions hit the Chia's Huawei by cutting off the access to American tools and technology (South China Morning Post, 2024, April 23). Analysts believe that these 5nm Chips manufactured by TSMC was stockpiled by China when restrictions were put on Chinese companies (TechInsights, 2024). The latest cutting-edge node (nm) is the 3nm produced by TSMC

[39] Chinese chip equipment suppliers, such as Advanced Micro-Fabrication Equipment Inc. and Naura Technology Group Co., are striving to bridge the gap with their American counterparts, but their products currently lack the same level of comprehensiveness and sophistication. Shanghai Micro Electronics Equipment Group Co., China's top lithography system developer, still trails behind industry leader ASML by several generations in capabilities (Koc, C., & Hawkins, M).

and is prevalent in consumer electronics. For example one which is used in Apple products. The 5nm found in the laptop is two generation behind from the latest but one generation ahead of what China could have access (Bloomberg, 2024, January 6). These events raises debates on effectiveness of US sanctions (Savov & Wu, 2024). Exploring the 5nm realm would have marked significant progress for the Shenzhen conglomerate, forging it nearer to the cutting-edge processes, predominantly revolving around 3nm nodes. Prior to severing ties with Huawei, TSMC was providing chips as sophisticated as 5nm to the Chinese firms (Savov & Wu, 2024). How Huawei managed to manufacture the 7nm only a few years of processor node is unclear, though evidences suggest that Chinese firms were stockpiling the vital microchips amid US sanctions (Savov & Wu, 2024). The Biden administration was in the process of determining whether China's leading chip manufacturer, SMIC, had violated U.S. export regulations by supplying chips for Huawei's Mate 60 Pro smartphone (Alper & Freifeld, 2024). Alan Estevez, a senior official at the Commerce Department overseeing export controls, indicated a potential violation when queried (Alper & Freifeld, 2024). Additionally, the administration had not yet concluded whether Huawei had indeed released the phone powered by these chips were build by violating US restriction (Alper & Freifeld, 2024). Against the backdrop of ongoing efforts by Washington to impede China's capability in advanced semiconductor manufacturing, the Huawei Mate 60 Pro was perceived as a symbol of China's technological resurgence (Alper & Freifeld, 2024). Since the entity List 2019 was initiated TSMC terminated its acceptance of orders from Huawei in adherence to escalated trade regulations imposed by the United States (Savov & Wu, 2024). Huawei Technologies, along with secretive chip making partner in China, have submitted patents for a potentially effective method to produce advanced semiconductors, indicating China's potential to enhance chip manufacturing techniques despite US efforts to impede its progress (Yuan &Wu, 2024). The patents detail the development of technologies involving Self-Aligned Quadruple Patterning (SAQP)[40], which could enable the production of sophisticated chips without relying on ASML's EVU (Extreme Ultraviolet lithography machines) (Yuan &Wu, 2024). SiCarrier, a state supported chipmaker collaborating with Huawei, was granted a patent in late 2023 for SAQP technology using DUV chip making equipment, achieving similar technical aspects as 5nm chips (Yuan &Wu, 2024). This approach could bypass the need for EUV machines, thereby reducing manufacturing costs (Yuan &Wu, 2024). While China currently produces 7nm chips, advancing to 5nm would narrow the gap to just one generation behind the cutting-edge 3nm chips currently in commercial use (Yuan &Wu, 2024).

The geopolitical competition between the United States and China in the semiconductor industry has evolved into a multifaceted technological cold war, extending beyond trade disputes to encompass vital areas such as artificial intelligence, 5G, and advanced chip manufacturing. As the U.S. strives to maintain its historical supremacy in chip design and production, China has aggressively invested some $140 billions in initiatives like Made in China 2025 to achieve semiconductor self-sufficiency in both chip design and manufacturing and these investments will be spent over five years to extend subsidies to equipment and set up more fabrication plants in China (Sharma, 2024, April 10).

The US-China tech war has escalated through export controls, sanctions, and restrictions on crucial technologies, with a particular focus on limiting China's access to advanced

[40] Quadruple patterning involves etching lines on silicon wafers multiple times to boost transistor density and enhance performance (Yuan &Wu, 2024).

semiconductors. Notably, the breakthrough by China's Semiconductor Manufacturing International Corp. (SMIC) in producing a 7-nanometer chip for Huawei's Mate 60 Pro smartphone challenges the efficacy of the United States efforts to hinder China's technological progress. While the Huawei phone itself may not pose a direct national security threat, the technological advancements underscores China's narrowing gap in semiconductor capabilities, raising questions about the effectiveness of current U.S. strategies in the face of China's breakthroughs. The evolving dynamics, including the U.S. government's commitment to semiconductor manufacturing and China's strategic moves in packaging technology, indicate a new front opening In the US-China tech war, shaping the landscape of global technological leadership in the years to come.

In the pursuit of dominance in semiconductor industry, the United States is leveraging its alliances to restrict cutting-edge semiconductor technologies aiming to hinder China's progress in technological Arena which is perceived as threat by the US resulting in escalating security dilemma between the two nations. This strategy and its implications are extensively analysed in subsequent chapter.

CHAPTER IV

Security Dilemma Escalation And Geopolitical Alliance

The US and China are involved in the race for State-of-Art semiconductor chip supremacy. United States in order to maintain its leading edge in the semiconductor industry and boost its domestic semiconductor production had employed the US allies. This US strategy also aims to restrict access of advanced semiconductor technologies to China stating national security risk. The following chapter dwells into the strategy in detail and answers hypothesis stating that the US in collaboration with its allies is endeavouring to secure position in the semiconductor industry while imposing sanctions on China and this trajectory has sparked rivalry and heighten geopolitical tensions between the two economic giants.

4.1: Security Dilemma

The growing importance of semiconductors has led to increased geopolitical tension among nations. It is crucial to identify key strategic areas where advanced semiconductor technology can be utilised such as defence, which rely on semiconductors for cutting-edge military systems. The dynamics of the US-China chip war epitomises security dilemma[41],

[41] In anarchism, the security dilemma arises as individuals or groups, including their leaders, find themselves in a state where they must constantly worry about being attacked, dominated, or even annihilated by others (Herz,1950). To secure themselves from these threats, they are compelled to minimize their vulnerability to the power wielded by others states John Herz in 1950. The modern security dilemma describes a situation where states' efforts to enhance their security inadvertently escalate tensions and conflicts with other states. This concept, central to international relations, emphasizes how actions taken by one state to strengthen its security can be viewed as threats by others, prompting defensive reactions that heighten hostility. The security

wherein both nations perceive threats to their national security and technological supremacy, leading to escalating tensions and retaliatory measures. The security dilemma is aptly demonstrated in the diplomatic relations between the United States and China, especially within the escalating competition for dominance in microchip technology.

As elucidated by Robert Jervis (1978), security dilemma scenario highlights how actions taken by each nation to bolster their own security in the microchip sector inadvertently escalates tensions and fuelling a cycle of mistrust and competition between them. The 2022 US National Security Strategy states that People's Republic of China (PRC) as the sole competitor to the United States, possessing both the intent and progressively, the capability to alter the global order. Consequently, the 2022 National Defense Strategy designates the People's Republic of China (PRC) as the primary challenge for the Department of Defence and recognising China's ambition for "national rejuvenation[42]" by 2049 as a driving force behind its efforts to build a modern and formidable military (Office of the Secretary of Defence, 2023). Unites States has expressed worries regarding China's rapid progress in expansionism and military technology especially in advanced semiconductor development (Mark & Roberts, 2023). Semiconductors are pivotal in various tech sectors like cutting-

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dilemma arises due to the absence of a global authority, forcing states to prioritize their security independently. This often results in an arms race, where states continually build up military capabilities in response to perceived threats, perpetuating a cycle of insecurity and potential conflict. Addressing the security dilemma involves fostering trust, respecting the status quo, and improving communication to clarify intentions and prevent unnecessary conflicts (Tang, 2009).
Tang, S. (2009) The Security Dilemma: A Conceptual Analysis, Security Studies, 18:3, 587-623, DOI: 10.1080/09636410903133050

[42] Chinese Communist Party's General secretary defines national rejuvenation as the central mission of their Party Congress in 1987. President Xi Jinping describes national rejuvenation also known as Chinese Dream, is a strategic plan for achieving lasting greatness for the Chinese nation. The strategy focuses on achieving moderate prosperous society by eradicating poverty, and improving standard of living. Besides the plan also aims to transform China into a modern Socialist country that is prosperous, strong, democratic, civilised and harmonious by 2049 by encompassing political, social, economic and cultural dimensions. This dream is close approach of President Xi Jinping's political ideology and serves as inspiration for initiatives like Made in China 2025 (MIC2025) and Belt and Road Initiative (BRI).

edge computing, Al, biotech etc. China's military-civil fusion Strategy seeking to convert economic and technological gains into military strength further intensifies the situation (Mark & Roberts, 2023). Further, PLA continues to modernise its equipment and focus on becoming world class military (Office of the Secretary of Defence, 2023). To address this, the US government has imposed export controls on export of advanced semiconductor technology, potent supercomputers, and broader restrictions on Chinese firms alleging connection to Chinese military (Mark & Roberts, 2023). Chinese Communist Party (CCP) leaders perceive this as rise in global instability (Mark & Roberts, 2023). PLA continues to modernise its equipment and focus on becoming world class military (Office of the Secretary of Defence, 2023). This scenario highlights a broader security dilemma between United States and China in the chip conflict. There's competition between the US and China for dominance in microchip technology wherein China is trying to advance its semiconductor sector and US is formulating a leading force in the industry through its allies. Both nations are trying to secure their national security and technological supremacy, which has resulted in escalating tensions and retaliatory measures. This case scenario has led to mistrust and suspicion between them, potentially causing instability in their diplomatic relations. A prime example of this phenomenon is the US imposing export controls on semiconductor trade with China, prompting retaliatory measures such as restrictions on critical materials like gallium and germanium, key components in semiconductor manufacturing and China being the largest supplier (BIS, 2023 & Holderness, et al., 2023). It is vital for both nations to approach this issue with caution and find a way to address their security concerns without escalating the situation further. This intricate interplay between economic interests, technological rivalry, and military considerations highlights the delicate balance between safeguarding national interests and averting unintended escalation, with far-reaching implications for both nations and the broader global landscape.

The two biggest economies of the world, United States and China are involved in a competition to acquire state of Art semiconductor in global supply chains to secure their economic and national security. The world recognised the significance of semiconductors as strategic commodity during the covid-19 pandemic which resulted in chip shortages across the world which led to lasting impact (Sehgal, 2023). The automotive industry faced total losses of $61B in 2021 and the automotive semiconductor market suffered from reduced global automotive demand for and the transition to electric/hybrid vehicles, which require more semiconductors, exacerbating the downturn (Sehgal, 2023). The pandemic precipitated disruptions in production and supply chains, thereby impacting the broader semiconductor market. Due to supply chain disruptions during covid-19, nations realised that strategic technologies like semiconductors cannot be concentrated at one geographical location while referring to Taiwan's pivotal role in the semiconductor supply chains (Sehgal, 2023). Such vulnerabilities to semiconductor supply chains highlights the need to reduce dependency on Taiwan due to poised risk from Chinese invasion and diversification to ensure resilience in semiconductor supply chain (Banker, 2023).

The pandemic-driven chip shortage has had widespread implications, affecting 169 different consumer sectors, including leading tech giant Apple, which had to postpone the iPhone 12 launch by two months due to a shortage of processing chips and impact on consumer goods such as Smartphones, laptops and automobiles became a major concern for businesses worldwide (Sehgal, 2023).

The Security Dilemma between the US and China in the chip war originated from perceived economic aggression, sparking increased security competition and the potential for conflict. Realist anticipate heightened rivalry between the two nations, particularly in the semiconductor sector, as China's ascent continues. Some analyst in the field believe that the China's ambition of domestic semiconductor production, reducing the dependence of foreign chips and China's military aspirations have triggered the chip war (South China Morning Post, April 3, 2021 & Gregory, 2023).

China wants a stable supply of chips at a reasonable price to support its semiconductor industry's growth (Kim& Rho, 2024). Meanwhile, the US is restricting China's access to advanced semiconductor technology to increase the technology gap between the two countries in areas such as advanced nanometer technology, AI and telecommunications. The US has implemented strict controls on China's Application-Specific Integrated Circuit (ASIC) chips, crucial for advanced military weaponry, and imposed precise limitations on exporting AI chips to China (Kim& Rho, 2024). To curb China's access to advanced chip technology, the US has imposed sanctions along with its its allies and partners have staunchly supported US actions (BIS, 2023 & Cong, 2024). The CHIPS and Science Act of 2022 seeks to bolster domestic chip production through substantial investments (WH.Gov, 2022). The US government's initiative to invest in the domestic semiconductor to bolster chip manufacturing highlights the significant investment and time required for building new chip fabs, which demand specialized resources, clean rooms, and skilled labour (Thorbecke, 2022) wherein TSMC and United States are closely allied to achieve offshore TSMC fabrication plant in Texas and Arizona

In his speech outlining the Biden Administration's China policy, US Secretary of State Antony Blinken emphasised a strategy focused on investing in American strengths while forging alliances with allies and partners to effectively compete with China (Kim & Rho, 2024). As the national security tensions and competition between the two countries continues to intensify US is formulating plans and policies to restrict access the semiconductor technologies to China through partnered countries and its allies having expertise in semiconductor sector explained as follows. Such strategies aims to strengthen the US by fully integrating its economy and security (Kim & Rho, 2024).

The US is constantly assessing the evaluates the necessity of broadening export controls to prevent China from acquiring advanced semiconductor technologies that could bolster its military capabilities (AP, 2024, March 12).

4.2: Geopolitical Alliance

As geostrategic competition escalates between the United States and China, Washington is intensifying efforts to retain its technological edge over China, particularly in critical areas like semiconductors. In order to maintain this lead, America has adopted a dual approach, employing export controls to restrict China's access to cutting-edge semiconductor technology while simultaneously offering incentives through initiatives like the CHIPS and Science Act to promote investments in domestic production expansion (Stangarone, 2023).

The production of chips involves a complex process that spans the globe requires various specialised materials, equipment, design, software, testing, and packaging also labour costs matter during production (Lewis, 2022). To build advanced factories like those owned by TSMC cost over $12 billion (Chu & Hille, 2022). Leading chip-making countries include

Taiwan, South Korea, the United States, Japan, Singapore, and China (Pathak, 2023). The U.S. perceives China as a major threat to the semiconductor supply chain and is working with allies to secure the supply chain (WH. Gov, 2021) which led some companies like TSMC to push greater semiconductor production in the United States thereby trying to restore the semiconductor supply chain and de-risk potential vulnerabilities (Lewis, 2022). The U.S. and its allies are pursuing strategies like friend-shoring[43] to enhance supply chain resilience and minimise reliance on potentially vulnerable sources through relocating key production (APF, 2022).

ASML, a crucial maker of lithography equipment is based in the Netherlands is a U.S. ally (Koc et al., 2023) and is capable of making highly complex lithography machines needed to produce microchips. Besides Netherlands, Japan produces equipment used to fabricate chips (Allen, et al., 2023). Amidst the US restrictions on China, in January 2023, the United States, the Netherlands, and Japan purportedly struck a deal to implement export controls on advanced semiconductor equipment (Reuters, 2023 & Allen, et al., 2023). Subsequently, the Dutch and Japanese governments declared plans to enforce new export controls on various semiconductor technologies, likely encompassing China (government.nl, 2023 & Allen, et al., 2023). To mitigate potential Chinese backlash, neither country explicitly mentioned China as the target nor acknowledged any connection to the agreement with the United States (Allen, et al., 2023).

[43] Friendshoring essentially involves redirecting supply chains to countries considered politically and economically stable or low-risk, aiming to mitigate disruptions to business operations. “Friendshoring” is an emerging trade strategy emphasizing supply chain partnerships with countries considered political and economic allies. This trend aligns with other supply chain strategies like “nearshoring,” “reshoring,” and “onshoring.” Nonetheless, some experts express concerns that prioritising friendshoring could exacerbate geopolitical divisions and contribute to what is termed de-globalisation (Ellerbeck,2023).

Cash (2024) notes, the United States along with the Netherlands had planned to intensify restrictions on the sale of chip making equipment, including products from the Dutch company ASML, a key player in the crucial lithography process, as reported by Reuters Figure 4.1 illustrates the headquarter of ASML company in Veldhoven, Netherlands. Amid the US controls, China's Commerce Minister Wang Wentao raised concerns with the U.S. Commerce Secretary Gina Raimondo during a official communication expressing concerns about American restrictions impeding third countries from exporting lithography machines to China, as reported by his ministry. Washington employed export controls to restrict China's access to advanced chips and tools essential for AI breakthroughs and sophisticated military computers. Additionally, it has urged key suppliers among its allies to implement comparable restrictions. Cash (2024) further stated one such ally is Netherlands, on January 1, 2024 ASML reported that the Dutch government had revoked an export license, impacting the shipment of certain equipment to China, for example the most sophisticated Extreme Ultraviolet (EUV) lithography machines has never been exported to China and according to the new export controls by the United States the Deep Ultraviolet (DUV) lithography equipment, and old version of lithography machines was banned in October 2023. In the third quarter of 2023, China constituted ASML's largest market, accounting for 46% of the company's sales (Cash, 2023). It seems like there are serious concerns about the United States interfering with the export of lithography machines from Dutch companies to China, as expressed by Shu Jueting, a spokesperson from China's commerce ministry at MOFCOM press conference (Mofcom. Gov, 2024).

Figure 4.1: The ASML Holding NV headquarters and factory in Veldhoven, Netherlands

Source: Peter Boer, Bloomberg

The Commerce Minister of China, Wang Wentao, on march 27, 2024 was engaged in discussions with his Dutch counterpart, Geoffrey van Leeuwen, to dissuade the Netherlands from aligning with the United States' stance on certain trade issues (Mofcom. Gov, 2024). Specifically, the focus was on the export of lithography machines to China and fostering collaboration within the semiconductor industry (Mofcom. Gov, 2024). These discussions, held in Beijing, underscored the importance of maintaining normal trade relations, particularly in the context of lithography a crucial chipmaking process. ASML, a Dutch company holding a monopoly on advanced chipmaking equipment, remains active in China with 13 offices, highlighting the significance of the Chinese market in the semiconductor sector (Jennings, 2024). Given the critical role of chips in modern devices like smartphones, computers, and vehicles, both China and the Netherlands recognize the potential for mutually beneficial trade partnerships (Jennings, 2024). China's appeal to the Netherlands emphasizes the value of independent decision-making and cooperation, distinct from geopolitical pressures, to ensure the smooth conduct of lithography trade and broader economic relations between the two nations (Mofcom. Gov, 2024).

The United States has persuaded ASML to relocate its headquarters to Austin, Texas, as part of its friend-shoring initiative (Maire, 2024). This move is significant, particularly in light of Sam Altman's advocacy for allocating up to $7 trillion towards the semiconductor industry, with a focus on AI development (Maire, 2024). As part of the relocation package, the US Department of Commerce has pledged to ease export restrictions to China, addressing a longstanding concern for ASML (Maire, 2024). Moreover, ASML stands to benefit from substantial funding opportunities, including eligibility for billions of dollars in support from initiatives like the CHIPS and Science Act, given its new status as a US-based company (Maire, 2024).

Besides Netherlands, the US also urges allies like Japan, South Korea, to restrict export of chip-making machines (Cong, 2024). Washington urges Japanese companies to restrict the amount of certain important chemicals used in making computer chips that they sell to China. Japan has some top companies in this field, like Shin-Etsu Chemical Co. and Tokyo Ohka Kogyo Corporation (Baazil et al., 2024).

According to Pranay Kotasthane,[44] a geopolitics expert, the formation of alliances among countries with strong semiconductor industries, like the US, South Korea, Japan, and Taiwan, was primarily triggered by concerns over China's role in the semiconductor market (WION, 2022, September 24) and the collaboration emphasises the significance of chips for both economic and national security, while also indicating a collective effort by nations to counter China's progress in this pivotal technology sector (Kharpal, 2022b)

[44] Pranay Kotasthane is the Deputy Director at the Takshashila Institution, an independent think tank dedicated to research and education in public policy.

To effectively compete with China and implement the policies, the United States must leverage and collaborate its network of allies governments, foreign firms to enforce export controls abroad (Stangarone, 2023) by recognizing that collaboration is crucial in emerging and foundational technologies like semiconductors. Working closely with allies such as Taiwan, the Biden administration encourages the adoption of complementary controls within their domestic jurisdictions to strengthen the global semiconductor supply chain (Weinstein, 2023).

Like Taiwan and Japan, South Korea is a important ally of United Stated in global semiconductor supply chains. South Korea holds a significant position as a manufacturer for fabless semiconductor firms, boasting an 18% market share (Stangarone, 2023). Samsung Electronics, the country's flagship company, ranks as the world's second-largest manufacturer, closely following TSMC (Stangarone, 2023). Moreover, South Korean firms are known for their high level of technological advancement in the semiconductor industry (Stangarone, 2023). After Taiwan and Japan, South Korea produced the cutting-edge chip technology ranging from 10nm and below (Leswing, 2021 & Fritz, 2024). South Korea faces less risk from China than Taiwan. Japan, another major producer, is a key U.S. security partner and dominates the production of Semiconductor Manufacturing Equipment (SME) (Stangarone, 2023). Singapore though reliable US partner, prefer not to be caught in a battle between giants (Lewis, 2022). These global distribution of chip-making countries share democratic values and often have treaties with the U.S. in chip-making are friendly to the U.S. is an advantage (Lewis, 2022). Striving self-sufficiency in the United States will provide United States and key advantage over China.

United States has led export controls and Biden administration's implementation of these controls not only signifies a shift in its approach to technological competition with China but also broadens the scope of national security to encompass significant sectors of the Chinese economy, even when the primary focus may not be explicitly on the broader Chinese economy (Weinstein, 2023). Persuading key allies such as Japan, Taiwan, the Netherlands, and South Korea to adopt new semiconductor industry controls is imperative in maintaining the integrity of the U.S. semiconductor supply chain strategy. Without their cooperation, the U.S. risks significant disruptions and vulnerabilities within its semiconductor industry, potentially undermining its global competitiveness and strategic goals (Weinstein, 2023). Among all, Weinstein asserts that, TSMC is the key player in the semiconductor supply chains since it accounts ATP processes[45] and 50 percent of world's logic foundry market share is caught in the geopolitical realm since it poises a threat from China's claim as a renegade province and promised a "reunification" of the island with mainland China (Kharpal, 2022). This scenario presents a supply chain risk that raises concerns not only for the United States but also for the rest of the world.

When it comes to the export restrictions imposed by China on gallium and germanium, besides China Japan is the major player in gallium production in the world (Benson, 2023). Japanese companies import lower purity gallium and refine it, with many currently relying on China for primary gallium imports due to its cost-effectiveness (Holderness, et al., 2023). Despite Chinese export controls, Japan's ability to refine imported gallium remains intact, as China only accounts for 22 percent of Japan's gallium imports (Holderness, et

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[45] Taiwanese companies are integral players across the entire spectrum of semiconductor operations, spanning design, fabrication, manufacturing, and assembly, testing, and packaging (ATP) processes (Weinstein, 2023).

al., 2023). Additionally, Japan engages in gallium production through recycling globally available scrap, which may experience some slowdown but not a complete halt due to Chinese export controls (Holderness, et al., 2023). Furthermore, Japan has its own primary gallium production facilitated by the dowa Metals and Mining Company, utilizing by-products from zinc smelting imported from Mexico, which falls outside of Chinese influence (Holderness, et al., 2023). Other US allies like Germany's Ingal Stade GmbH[46] ceased primary gallium production in 2016 but plans to restart operations due to escalating global prices (Holderness, et al., 2023). Despite Australia's current lack of gallium production, its abundant zinc and bauxite resources, crucial for gallium manufacturing, could facilitate future production (Holderness, et al., 2023). As Chinese export controls limit affordable mineral availability and global demand surges, gallium prices are anticipated to increase (Holderness, et al., 2023). This scenario might encourage Australia to emulate Germany's initiative, re-establishing gallium production and bolstering the supply chain with assistance from reliable U.S. allies (Holderness, et al., 2023).

The recent surge In AI development has prompted the US to forge partnerships with prominent AI entities such as G42[47], prioritising the implementation of globally recognised standards for ensuring the safety, trustworthiness, and responsibility of AI technologies (Gregg & Zakrzewski, 2024, April 16). In negotiations with the US government, G42 has committed to removing Chinese equipment from its operations, addressing apprehensions surrounding the use of Huawei gear (Gregg & Zakrzewski, 2024, April 16). This move reflects the US's proactive approach to mitigating security risks while fostering

[46] Ingal Stade GmbH is Germany's sole producer of primary gallium and the biggest outside China.
[47] G42 is an Emirati AI development holding company headquartered in Abu Dhabi established in 2018. The company is specialised in AI advancements spanning multiple sectors.

collaboration with other nations (Gregg & Zakrzewski, 2024, April 16). The Commerce Department's spokesperson Brittany, highlights the ongoing effort to expand opportunities for US businesses while carefully balancing national security interests (Gregg & Zakrzewski, 2024, April 16). This includes engaging with technology leaders like the UAE, renowned for its advancements in cutting-edge technologies (Gregg & Zakrzewski, 2024, April 16). Together, these efforts aim to establish verifiable commitments regarding the safe development, protection, and deployment of emerging technologies on a global scale (Gregg & Zakrzewski, 2024, April 16).

4.3: Building an Alliance Excluding China

Countries have increasingly sought chip partnerships due to the complex nature of the semiconductor industry, recognising that collaboration is essential for excellence in all aspects of chip production (Kharpal, 2022b). Recent developments highlight this trend, with notable interactions between key players. President Biden visited Samsung's semiconductor plant in Pyeongtaek, South Korea, (depicted in figure 4.2) emphasizing the importance of international cooperation and Samsung has invested $17 billion to build a fabrication plant in Taylor, Texas followed by the United States initiative to revitalise its semiconductor industry through bipartisan CHIPS Act (WH. Gov, 2022, Kim., et al., 2022., Hunnicutt & Smith, 2022). Additionally, US Secretary of Commerce Gina Raimondo met her Japanese counterpart in Tokyo to discuss collaboration in semiconductors and export controls (commerce.gov, 2023). The meeting aimed to bolster collaboration between the US and Japan in advanced chip research, AI, and quantum technology, emphasizing efforts to expand chip manufacturing and ensure access to crucial components for economic growth (Pollard, 2023). This partnership, part of a broader trend involving countries like

Japan, the US, and the Netherlands, aims to address concerns regarding China's chip ambitions and technology development by aligning on export controls and limiting chip-making tool sales to China (Pollard, 2023).

Taiwan's President Tsai Ing-wen expressed interest in producing "democracy chips"[48] with the US during a state visit to Arizona, highlighting the significance of semiconductor cooperation among democracies (Reuters, 2022, September 1). Furthermore, the US has proposed a "Chip 4"[49] alliance with Taiwan, South Korea, and Japan to strengthen the semiconductor supply chain (Kharpal, 2022b). These interactions underscore the growing emphasis on strategic partnerships to advance semiconductor technology and production capabilities globally.

Figure 4.2: President Biden at Samsung Electronics Co. in Pyeongtaek, South Korea

Source: Jonathan Ernst, May 21, 2022. Reuters.

[48] Democracy chips are semiconductors produced to safeguard democratic interests and enhance cooperation among democratic nations in the tech industry. Taiwan, in collaboration with the United States, aims to ensure a stable and resilient supply chain for critical technologies like semiconductors. These chips symbolize a strategic effort to promote technological independence, strengthen alliances, and counter pressures from non-democratic regimes, emphasizing the importance of secure supply chains in high-tech industries amidst authoritarian threats and geopolitical tensions (Reuters, 2022, September 1 & nbcnews, 2022).

[49] The "Chip 4" alliance, also known as the "Fab 4" alliance, consists of the United States, Japan, Taiwan, and South Korea. The goal of this alliance is to improve cooperation in semiconductor production and to strengthen the resilience of the supply chain. The alliance was formed to diversify manufacturing bases, protect intellectual property, and regulate advanced technology (Reuters, 2023, February 25).

4.4: Tension in the Alliances

Though Washington has formed a strong strategic alliance in the semiconductor domain against China to curtail its advancement in chip technology there appears some cracks appearing bet some partnered countries.

China's Foreign Minister Wang Yi strongly criticized the United States for its extensive trade restrictions imposed on China, condemning the tactics as unjust and reaching unprecedented levels of absurdity. Wang Yi warned that the US's persistent efforts to suppress China could ultimately backfire and have negative consequences for the US itself (Baazil, et al., 2024). In an interview with the Financial Times, Ahn Duk-geun, South Korea's trade minister, highlighted the differences between Seoul and Washington regarding the ongoing export control restrictions on semiconductor tools to China (Kharpal, 2022b). China, being the world's largest importer of chips, is a crucial market for chip companies globally, ranging from US giants like Qualcomm to South Korea's Samsung (Kharpal, 2022). As politics and business intertwine, tensions between nations within these high-tech alliances could escalate. Not all US allies are eager to join these alliances or enforce stricter export controls on technology to China, as they have significant investments in manufacturing in China and rely on the Chinese market for sales and many are cautious not to antagonise Beijing on these matters (Kharpal, 2022b).

United States of America introduced rigorous export restrictions on China and blocked the access to advanced technologies in semiconductor sector. For Example: the United States' Bureau of Industry and Security (BIS) introduced comprehensive restrictions on exporting advanced semiconductor manufacturing equipment to China on October 7, 2022 and urged its allied partners to restrict the sale chip making technology to Beijing (Allen, et al., 2023). The effectiveness of the policy's long-term success relied on the United States gaining cooperation from Dutch and Japanese counterparts to regulate semiconductor equipment types not produced by U.S. companies (Allen, et al., 2023). It also aimed to prevent Dutch and Japanese firms from filling the void left by technologies the U.S. refrains from selling to China (Allen, et al., 2023).

At the core of US-China semiconductor race lies Taiwan being the largest supplier of cutting edge chips. However Taiwan faces a persistent existential threat from China which claims Taiwan as a renegade province and aspires for reunification with the mainland China by any means. Thus the world ensue disruption of semiconductor supply chains resulting in chip shortages. This scenario is analysed succeeding chapter by looking into the future of semiconductor industry.

CHAPTER V

Future Projections and Scenarios

The previous chapter discusses strategic importance of semiconductor alliances among countries like the US, Japan, South Korea, and Taiwan to counter China's growing influence in the semiconductor industry. It highlights efforts to strengthen collaboration, implement export controls, and promote self-sufficiency in semiconductor production. However, tensions with the allies such as Taiwan are on rise in recent years as China aims to acquire semiconductor technology from TSMC during the poised Taiwan invasion impacting the electronic consumer production and use of microchips in advanced military systems specifically to the United States. Chapter five comprehensively assess the China-Taiwan conflict and impact on semiconductor industry amidst poised Chinese invasion on Taiwan.

5.1: The Future of Semiconductor Industry Amidst China-Taiwan Poised Conflict

The United States and China are engaged in a technological competition, often referred to as a cold tech war or chip war and other terminologies used by experts in field, where the victor could shape the future of the twenty-first century (Chang, 2020). A decade ago, Beijing wasn't considered as a major player in technology due to its dependence on west for the technology, but now some consider it a frontrunner. The U.S. is already lagging behind in crucial areas which is now trying to catch up with recent plans and investment (Chang, 2020). This emerging competition between the two superpowers is predicated as

New cold war that differs from the US-Soviet confrontation by experts (Carlson, 2023)[50]. The competition began with the Trade and tariff imposed on China by Trump Administration resulting in process of decoupling.

The process of decoupling was spurred by various factors, including concerns over China's economic practices during the Trump administration, leading to a trade war and tariffs on Chinese imports (Murray & Al-Rikabi, 2023). However, its origins can be traced back to China's entry into the World Trade Organisation in 2001, the 2008 financial crisis, and President Xi Jinping's assertive global stance (Murray & Al-Rikabi, 2023). Tensions escalated under President Biden, who maintained a tough approach on Beijing, implementing measures to restrict US investments in Chinese tech companies and prioritising the reshoring of high-tech production to reduce China's market influence (Murray & Al-Rikabi, 2023b).

This dynamic of decoupling between the United States and China has transitioned from decoupling during the Trump administration to a new strategy termed de-risking[51] under President Biden (Mishra, 2022b). Initially, both administrations recognised the need to reduce reliance on Chinese products and supply chains for economic and national security reasons (Mishra, 2022b). Trump's response was a trade war with China, marked by tariff increases and efforts towards economic decoupling (Mishra, 2022b). Biden has maintained

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[50] Grano, S. & Huang, D. (2023). China-US Competition. Palgrave MacMillan.

[51] In the landscape of US-China relations, the concept of de-risking entails a strategic approach to address and minimize vulnerabilities arising from extensive economic interdependence between the two nations. Unlike the notion of "decoupling," which implies a radical disconnection, de-risking seeks to preserve economic connections while proactively managing associated risks. This strategy aims to fortify the United States' position as a global leader in technology by constraining China's access to cutting-edge US innovations. Specifically targeting critical sectors such as technology, de-risking to uphold US technological primacy and hinder Chinese entities from leveraging American knowledge for their innovation pursuits (Xue,2023).

some of these policies, including tariffs and investing in domestic production to decrease dependency on Chinese imports (Mishra, 2022b). However, Biden’s approach has shifted towards de-risking, prioritising resilient supply chains to mitigate vulnerability to coercion from any nation, especially in critical areas of national security and industrial competence (Anand, 2023). This strategic shift aims to mitigate the impacts of economic interdependence with China while preserving longstanding economic ties (Anand, 2023). Biden’s strategy involves a balanced approach of cooperation and competition with China, with a focus on building alliances in the Indo-Pacific region while also maintaining a firm stance on issues such as Taiwan (Anand, 2023). Biden's approach combines elements of cooperation and competition with China, prioritising alliances in the Indo-Pacific region while upholding a firm stance on sensitive issues like Taiwan (Anand, 2023). The shift from decoupling to de-risking demonstrates a nuanced strategy aimed at navigating the intricate dynamics of the U.S.-China relationship within the contemporary geopolitical context (Anand, 2023). The process of US-China decoupling gained significant attention in 2017, with much of the focus cantered on trade issues and the controversy surrounding Huawei, a major Chinese global technology firm in the 5G sector (Nicosia, 2023). In September 2022, the US government imposed sanctions on Semiconductor Manufacturing International Corporation (SMIC), China’s largest state-owned chip manufacturer, citing concerns about the involvement of its advanced semiconductors in military applications within China which sparked chip rivalry between the USA and China (Nicosia, 2023). Later in October 2020, China delivered its 14th Five-year plan in an attempt to boost its domestic semiconductor industry (Nicosia, 2023). Although closing the semiconductor innovation gap is a top priority for Beijing, significant obstacles still persist (Nicosia, 2023).

In the context of U.S.-China-Taiwan triangular relationship tensions have surged, marked by increased U.S. backing for Taiwan in the face of Chinese aggressive assertiveness (Castro, 2024). This escalation has been accompanied by a bolstering of military assistance to Taiwan, exacerbating friction with China, which maintains its claim over Taiwan (Castro, 2024). Such developments highlight the intricate geopolitical dynamics within the Indo-Pacific region, where the interactions among the United States-China, and Taiwan are shaped by strategic rivalry and security imperatives (Jue, 2016).

Taiwan, officially known as the Republic of China (ROC), is an island situated across the Taiwan Strait approximately 130km (80 miles) from mainland China shown in figure 5.1 (Maizland, 2023). Since 1949, it has operated autonomously from mainland China, despite the People's Republic of China (PRC) claiming it as a renegade province and aspiring for reunification (Maizland, 2023). With a population of twenty-three million, Taiwan is democratically governed, and its political leaders hold differing perspectives on its status and relationship with the mainland (Maizland, 2023).

Figure 5.1: Taiwan's Strategic Location and Bolsters U.S. Allies in Indo-Pacific

Source: Council on Foreign Relations (2023).

People's Republic of China' (PRC) ascent to global prominence across political, economic, and military spheres raises concerns among other nations in South China Sea. Recently, China's stance on Taiwan has shifted from emphasizing peaceful reunification to a more assertive approach, omitting the term "peaceful" in official statements (Reuters, March 5, 2024). This suggests a potential hardening of China's stance towards Taiwan, indicating a willingness to use force to achieve reunification (Reuters, March 5, 2024). The situation is particularly tense regarding Taiwan's security, with potential disruptions to trade routes, economic growth, and even military actions looming (Easton, 2017). There are fears of political instability, including the possibility of targeted assassinations and threats to democratic institutions (Easton, 2017). The Chinese government, under the leadership of the Chinese Communist Party (CCP), is actively investing substantial resources into enhancing its military capabilities such as increase in defence spending by 7.2% , with the stated goal of achieving national reunification (Easton, 2017 & Reuters, March 5, 2024). The core objective of the People's Liberation Army (PLA), the armed wing of the CCP, centers on the potential invasion of Taiwan (Easton, 2017). This strategic focus underscores the PLA's role in safeguarding China's territorial integrity and national interests. China asserts One-China Principle[52] and Taiwan as part of it. Taiwan is gradually solidifying its de facto independence and is considering formally declaring national autonomy (Russell, 2001). According to Chinese propaganda, Taiwan is portrayed as a renegade province, and its de facto independence and democratic system are depicted as posing an existential threat to the Chinese Communist Party's (CCP) authority to govern China (Easton, 2017 & China Embacy.gov, 2024) as a result, the interests of the Chinese regime is to take over Taiwan and end the de facto independent status (Easton, 2017). The United States has affirmed that any military aggression against Taiwan would pose a significant threat to American interests (Russell, 2001). In April 2001, President Bush

[52] The concept of One China is a geopolitical principle concerning the recognition of a singular Chinese government. This policy maintains that there exists only one sovereign state, recognized as China, regardless of competing claims by other entities claiming to represent China. The One China principle is a cornerstone of the People's Republic of China's (PRC) foreign policy, affirming the PRC as the sole legitimate authority representing all of China, including Taiwan. It guides China's stance on cross-strait relations and reunification efforts, prioritizing peaceful negotiations but not excluding the possibility of force if required. (Xue, 2024).

publicly stated that the United States would take whatever measures necessary to defend Taiwan in the event of an attack by China (Russell, 2001). Since the election of former Taiwanese President Tsai Ing-wen in 2016 (Maizland, 2023) and following the 2024 Taiwan elections, Lai Ching-te of the Democratic Progressive Party (DPP) secured the presidential seat with 40.1% of the total votes, succeeding President Tsai Ing-wen (Tan, 2024). However, the DPP lost its majority in the Legislative Yuan to the Kuomintang (KMT), which emerged as the largest party with 52 seats (Tan, 2024 & Bush, et. al., 2024). This political shift increased tensions in the Taiwan Strait, with China expressing dissatisfaction with Lai's victory (Tan, 2024). Furthermore, China escalated military pressure on Taiwan by deploying balloons over the island and unilaterally altering flight paths, exacerbating cross-Strait tensions (Tan, 2024 & Bush, et. al., 2024).

Prior, analysts held the view that the likelihood of significant Chinese military action against Taiwan was minimal, since PLA lacked the capability to invade Taiwan, particularly after the U.S.-ROC alliance strengthened (Russell, 2001 & Easton, 2017). Throughout the period from 1979 to the 2000s, the PLA remained significantly underpowered to make such an operation militarily viable and China did not possess the military capabilities to launch an amphibious attack and seize control of Taiwan for at least a decade (Russell, 2001). This assessment resulted in the United States maintaining its strategic ambiguity[53] stance and downplaying the possibility of a military conflict in the Taiwan Strait that could lead to direct combat between American and Chinese forces (Russell, 2001 & Easton, 2017). But this situations seems to be changing as Beijing's

[53] Strategic ambiguity is a tactic utilised across various domains, such as business, politics, and marketing, where intentionally vague language is employed to achieve organizational objectives. While it offers adaptability in navigating shifts, it can also result in internal confusion. However, it empowers stakeholders by allowing for multiple interpretations.

actions, such as flying fighter jets near the island, have grown more aggressive (Maizland, 2023). The frequency of close encounters between Chinese and Taiwanese military forces surged by 30% to 100% or even more from 2019 to 2020, highlighting the escalating tension in the region (O'Hanlon, 2022). Besides, in September 2020, People's Liberation Army aircraft violated the longstanding median line in the Taiwan Strait, erasing a de facto buffer zone that had maintained peace in the region for decades (Ellis, 2020). China initiated new military exercises in the Taiwan Strait, which notably included a rare breach of the median line, while a prominent U.S. diplomat, Keith Krach, US Undersecretary of State for Economic Growth, Energy and the Environment showed growing American backing for Taiwan by visiting Taipei and Nancy Pelosi's visit to Taiwan in August 2022 helped unify Congress in taking a firm stance against China. (Bloomberg, 2020 & Mishra, 2022). This trend persists, evident in China's unprecedented number of military aircraft sorties into Taiwan's self-declared Air Defence Identification Zone in 2021 (O'Hanlon, 2022). In the past, the answer to whether China would engage militarily with Taiwan was a straightforward no, however, today, with China's extensive military modernizations, the situation has become much more complex (O'Hanlon, 2022).There are concerns among analysts that a potential Chinese attack on Taiwan could lead to a conflict involving the United States and China (Maizland, 2023). Chinese President Xi Jinping seems determined to achieve the reunification of Taiwan with China during his tenure, aiming to accomplish this goal sooner rather than later (O'Hanlon, 2022). During his visit to the United States in November 2023, Xi Jinping stressed the preference for peaceful reunification but also mentioned the potential use of force if needed. Biden, in turn, reassured Xi that Washington is resolute in maintaining peace in the region (Reuters, 2023, November 16 & mfa.gov, 2023).

The development of Taiwanese national Identity has seen a notable trend towards a unique Taiwanese identity, distinct from mainland China (Horst,2016). Survey findings demonstrate a substantial rise in the proportion of Taiwan residents identifying as Taiwanese, particularly among the youth, while a minority continue to identify as Chinese i.e the older generation still feels a connection to mainland China, aligns with the evolving sentiments in Taiwan regarding their identity and relationship with China (Muyard, 2024). This shift in identity within Taiwan's population, especially among the younger generation, poses a challenge to China's goal of reunification. The divergence in perceptions between generations in Taiwan underscores the complexity of the reunification issue and the need for China to navigate these changing dynamics to achieve its reunification objectives

5.2: In what ways can China Attack Taiwan

The One China Principle underlines two systems, one approach entails the ROC government in Taiwan relinquishing sovereignty to the PRC, leading to the transformation of the island into an occupied, authoritarian territory similar to Hong Kong (Easton, 2017). Alternatively, China could exert its force over Taiwan to reunify the island with the mainland (Easton, 2017). The legitimacy contest across the Taiwan Strait is often described as a zero-sum game, where the success of one side implies the defeat of the other, leaving little room for mutual recognition or compromise (Easton, 2017).

In June 2021, while the world was preoccupied with responding to the pandemic, China seized control of Hong Kong and enacted Hong Kong National Security Law, exploiting the global distraction (Toru, 2021). This event underscores concerns that China might employ a similar tactic to invade Taiwan.

PLA writings suggest a formal plan for wartime operations delineates the role of Chinese military and civilian units before, during, and after a potential invasion of Taiwan (Easton, 2017). The objectives of the plan include rapidly capturing Taipei, destroying the government, seizing other major cities, clearing out surviving defenders, and ultimately occupying the entire country (Easton, 2017). To achieve these goals, the plan involves overwhelming the ROC military’s coastal defences and securing surrender before the United States can deploy adequate forces to the region (Easton, 2017). PLA writings suggest that China has also developed contingency plans to counter potential American and coalition intervention in the Pacific to prevent assistance in defending Taiwan (Easton, 2017). The conceptual plan, known internally within the PLA as the Joint Island Attack Campaign, is characterized by a high level of centralization and regular updates informed by current intelligence, advancements in weapons production, and insights gained from exercises and training (Easton, 2017). This plan is highly classified, likely comprising a series of documents, but unfortunately, these are not accessible to the public (Easton, 2017).

China’s strategy necessitates coordinated joint operations across multiple domains, including land, sea, air, outer space, electromagnetic spectrum, and cyberspace. (Easton, 2017) Various military branches such as army groups, naval fleets, air force divisions, and missile brigades would all have vital roles in executing the plan (Easton, 2017). Any shortcomings in performance by any of these units could significantly affect the success of the entire campaign (Easton, 2017).

Initially, electronic jamming, cyber attacks, and missile strikes would be employed to isolate the island from external communication and support networks (Easton, 2017). Active jamming measures would be complemented by passive jamming techniques, where transport planes would release significant amounts of chaff into the air to generate electronic smokescreens (Easton, 2017). Simultaneously, intelligence-gathering aircraft would remain in the vicinity of the Strait, gathering electronic data samples to evaluate radar performance and identify vulnerabilities (Easton, 2017). China's electronic warfare units would likely target American strategic warning satellites positioned high above the Pacific. By jamming or degrading these space assets, both Taipei and Washington would receive less advanced notice of Chinese ballistic missile launches. Additionally, the PLA would employ aircraft, ships, and trucks to emit dummy radio chatter, mimicking large-scale troop and ship movements along the mainland coast (Easton, 2017). These electronic decoys are intended to deceive Taiwan into believing that enemy forces are gathering in areas where they are not, along lines of approach that are not intended for attack (Easton, 2017). The objective is to mislead military commanders into deploying troops to incorrect locations while keeping Taiwan's leadership confused and off balance (Easton, 2017).

The analyst specifically examines the possibility of a Chinese blockade against Taiwan in the 2020s, utilising existing or emerging technologies (O'Hanlon, 2022). The objective of such a blockade would be to apply pressure on Taipei, potentially leading to some form of submission to Beijing's authority, aiming at forced reunification (O'Hanlon, 2022). Executing an effective sea blockade is nearly impossible for any military without at least localized control over the air (Easton, 2017). This challenge is particularly pronounced in the Taiwan Strait, where Chinese naval assets are susceptible to Taiwanese jets, torpedocarrying patrol planes, and submarine-hunting helicopters (Easton, 2017). Consequently, PLA writings underscore the importance of first gaining air superiority in the region (Easton, 2017).

Under international law, this blockade would constitute an act of war (O'Hanlon, 2022). However, Beijing might argue it as an internal matter, disregarding criticisms based on diplomatic norms (O'Hanlon, 2022). In response, the United States and Taiwan, possibly with assistance from Japan and other nations, would seek to counter the blockade (O'Hanlon, 2022). Their aim would be to sustain Taiwan's economy and ensure the well-being of its populace until China is compelled to cease the blockade due to the attrition of its military forces (O'Hanlon, 2022). This form of blockade represents the most probable significant military threat to Taiwan (O'Hanlon, 2022). In another scenario, China's attempt to impose a blockade on Taiwan may face challenges due to the potential need for bombardment, while Taiwan might be unable to be bombarded until a blockade is established (Murray & Easton, 2019). To neutralize the ROC Air Force, Chinese forces would target airbase runways, aircraft shelters, air traffic control towers, and communications stations (Easton, 2017). Missile strikes would likely target surface-to-air missile batteries, command posts, and supply depots (Easton, 2017). To diminish Taiwan's capability to breach the maritime blockade, it is anticipated that fighter jets would sink ships attempting to approach or depart from Taiwan's major ports, while bombers would target transportation lines linking port cities with the mainland. Alongside harbour infrastructure, bombing operations are expected to target major rail yards, bridges, tunnels, and highway roads for destruction (Easton, 2017).

Bloomberg Economics has conducted modelling on two potential scenarios: one involving a Chinese invasion potentially involving the US in a localised conflict, and another focused on a blockade isolating Taiwan from global trade (Bloomberg, 2024, January 16). In a comprehensive scenario, to reduce China's vulnerabilities and limit Taiwan's immediate response options, PLA attack submarines could serve as the primary assets deployed, rather than surface ships or aircraft (O'Hanlon, 2022). Cyberattacks would likely complement the physical operations (O'Hanlon, 2022). The PLA has been assigned the mission of preparing for a potential assault on the island, which is considered its primary war planning scenario (Easton, 2017). This comprehensive strategy, known in restricted-access Chinese military literature as the joint island Attack Campaign, encompasses various domains including air, land, sea, space, and cyberspace also media outlets may be targeted as part of this strategy (Easton, 2017). Alternatively, Beijing might escalate to the use of land-based missiles and aircraft, depending on the initial outcomes (O'Hanlon, 2022). China does not need to halt all ships voyages rather stop ships into and out of Taiwan through which Taiwanese economy will suffer badly (O'Hanlon, 2022) and only allow passage to ships carrying key medicines. This will ensure a weak Taiwan rather than Strong Taiwan which is in favour of China.

Beijing before launching an invasion, the cyber and electronic warfare units would likely target Taiwan's financial system, critical infrastructure, and U.S. satellites to minimize detection of impending ballistic missile strikes (Ellis, 2020). Subsequently, airstrikes would swiftly target top political and military figures in Taiwan, as well as neutralize local defences (Ellis, 2020). One potential strategy for China could involve launching massive missile barrages targeting critical areas in Taiwan where civilians and military leaders are located (Russell, 2001). This could include government facilities, military headquarters, and residential areas. By aiming to disrupt Taiwan's leadership and defence capabilities, China could seek to weaken Taiwan's ability to resist (Russell, 2001). Chinese military exercises, described as decapitation drills[54], have been observed to include full-scale replicas of targets such as the Presidential Office Building and airstrikes aims to kills top Taiwanese diplomats indicating thorough preparation for such operations (Ellis, 2020). The Presidential Office Building would likely be among the first targets in Taipei, reportedly slated for attack with cruise missiles and ballistic missiles during the initial stages of hostilities, aiming to obliterate a significant symbol of political sovereignty (Easton, 2017). Other targets in the heart of Taipei would likely include key political and economic institutions such as the cabinet building (Executive Yuan), parliament (Legislative Yuan), Ministry of Foreign Affairs, Ministry of Economic Affairs, and others (Easton, 2017). The only aspect of Taiwan's power grid that may not be targeted is the country's nuclear power plants. The Chinese PLA officers warns against bombing nuclear power plants, as the radioactive fallout could escalate the political situation and provoke global condemnation against China (Easton, 2017).

Following the initial cyber and electronic warfare operations, an invasion would commence, with People's Liberation Army (PLA) warships and submarines navigating the Taiwan Strait, covering approximately 130 kilometres (80 miles) (Ellis, 2020). Peripheral islands like Kinmen and Pratas could swiftly fall under Chinese control, setting the stage

[54] Decapitation drills are military exercises aimed at neutralizing the leadership of a hostile entity, as seen in recent South Korean drills targeting North Korea's Kim Jong Un. These drills involve training special forces in precise manoeuvres to remove enemy leaders, disrupting their command structure and hindering their ability to wield power effectively. By prioritising the elimination of leadership, these exercises aim to disrupt the enemy's command and control capabilities, forming part of a strategy to deter or swiftly resolve conflicts with precision and efficiency (Panda, 2022 & Oliveira, 2023).

for a potential conflict over the Penghu archipelago[55], strategically positioned just 50 kilometres from Taiwan (Ellis, 2020). A PLA victory here would grant them a crucial foothold for further advancement. Meanwhile, thousands of paratroopers would descend upon Taiwan's coastlines, aiming to breach defences, seize key structures, and establish beachheads[56] for the arrival of tens of thousands of additional soldiers, paving the way for a decisive triumph (Ellis, 2020). Despite the aggressive rhetoric, both China and Taiwan have strong incentives to avoid a war that could result in significant casualties, economic devastation, and the risk of nuclear escalation involving the U.S. and its allies (Ellis, 2020). The prevailing view is that Beijing will persist in seeking to assert control over Taiwan through a combination of military intimidation, diplomatic isolation, and economic incentives (Ellis, 2020).

The possible intervention of the U.S. remains a critical variable while accessing the Taiwan invasion scenario (Ellis, 2020). Historically, American naval strength has served as a deterrent against Chinese aggression, despite the U.S. nullifying its mutual Defence treaty with Taiwan in 1979 to establish diplomatic relations with Beijing (Ellis, 2020). However, the Taiwan Relations Act[57] (TRA) permits the sale of American weaponry to Taiwan to ensure it maintains a credible self-defence capability (Ellis, 2020). The United States is

[55] The Penghu Archipelago, also referred to as the Pescadores Islands, comprises 90 islands and islets situated in the Taiwan Strait, approximately 50 km west of Taiwan's main island. With a total area spanning 141 square kilometres, it constitutes Penghu County in Taiwan.

[56] A defended position on a beach reclaimed from the enemy by landing forces, serving as a strategic launch point for subsequent attacks.

[57] Enacted in 1979, the Taiwan Relations Act aims to bolster peace and stability in the Western Pacific by fostering relations between the U.S., Taiwan, and China. It enables the U.S. to provide defensive arms to Taiwan, supports human rights, and facilitates Taiwan's participation in international agreements. Additionally, it established the American Institute in Taiwan to maintain relations post-diplomatic shifts. Despite common misconceptions, the Act does not mandate arms sales to Taiwan but expresses intentions to support its security. Serving as a cornerstone for U.S.-Taiwan relations, it emphasizes collaboration and stability in the region (Congress. Gov, 1979).

committed to supporting its democratic ally in Taiwan in the face of potential threats such as blockades, bombings, or invasion by China

Conventional thinking suggests that a Chinese invasion of Taiwan would be seen as irrational due to the time needed to acquire and deploy advanced weaponry (Russell, 2001). However, the likelihood of conflict depends on both the actual risks of war and how they are perceived by those involved (Russell, 2001).While China may lack the capability for a US-style amphibious assault on Taiwan, Chinese leaders might fear China will never have enough time to develop such capabilities (Russell, 2001). Despite claims of increased military transparency, what is known about China's military may just be the surface. China might be more willing than Western powers to use weapons of mass destruction to enhance the psychological impact of their attack (Russell, 2001). They might reason that using such weapons in an internal conflict would not lead to significant international consequences (Russell, 2001). Ballistic missiles could also be armed with various agents to incapacitate Taiwan's air defence forces, allowing China to gain air superiority (Russell, 2001). While a Chinese invasion of Taiwan may seem irrational on the surface, factors such as perceptions of threat and military strategy could make it a possibility (Russell, 2001). Taiwan's ability to deter or withstand Chinese use of force is heavily contingent on the effectiveness of Chinese long-range precision strikes, making this vulnerability a critical factor in Taiwan's defence strategy (Murray & Easton, 2019).

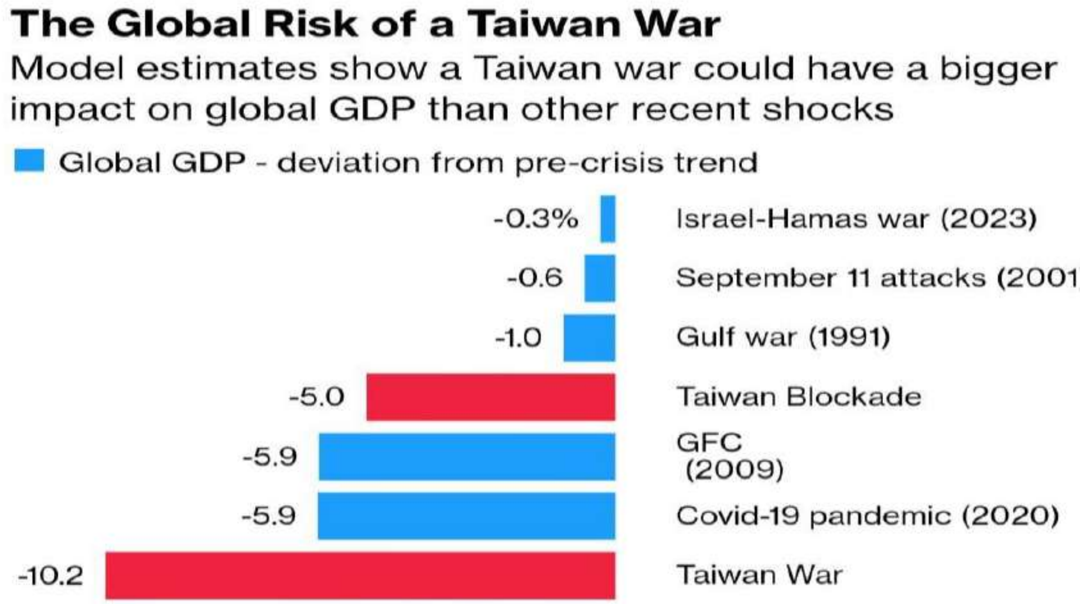
5.3: The Impact on Semiconductor Supply Chain Amidst a Potential China-Taiwan Conflict

The increased military drills around the Taiwan Strait in last few years depicts poised China-Taiwan in the region. Analysts across various sectors are strategising responses to potential Chinese actions ranging from a maritime blockade of Taiwan to the seizure of its outlying islands, and even a full-scale invasion, underscoring the gravity of the regional security landscape (Bloomberg, September 18, 2020). The Taiwan Strait conflict poses a significant threat to the global semiconductor supply chain, as disruptions in production from key players like TSMC could lead to shortages of high-end chips crucial for consumer electronics such as laptops, tablets, and smartphones, highlighting the vulnerability of consumer production to geopolitical tensions in the region (Bloomberg, September 18 2020). The war in Taiwan will have global consequences since global supply chains and economies would suffer greatly due to Taiwan’s pivotal role as the leading supplier of semiconductors, providing 92% of the world’s advanced microchips (Resilinc Editorial Team, 2023). In the event of a conflict between China and Taiwan, Taiwan's economy would face severe devastation, with Bloomberg Economics estimating a significant 40% decline in Gross Domestic Product (GDP), reflecting trends seen in comparable recent conflicts (Scott, 2024 & Bloomberg, 2024, January 9). The concentrated population and industrial base along the coast would exacerbate both the human and economic loss (Scott, 2024., Tsoi et. al., 2024 & Ellis, 2020). Additionally, with major trade partners cutting off relations and no access to advanced semiconductors, China's GDP would suffer a substantial 16.7% blow (Scott, 2024 & Tsoi et. al., 2024 & Ellis, 2020). The United States, although further removed from the conflict, would still experience significant repercussions, with a 6.7% decrease in GDP due to dependencies on the Asian electronics supply chain, exemplified by Apple. Globally, the impact would be widespread, with a projected 10.2% decrease in GDP, with economies in East Asia, particularly South Korea and Japan, bearing the brunt of the consequences (Welch et. al., 2024 & Tsoi et. al., 2024). Under such circumstances, the United States would likely mobilize allies to impose coordinated and severe economic sanctions against China (Welch et. Al., 2024 & Tsoi et. al., 2024). The diminished impact compared to the scenario of war arises from the fact that although the global economy loses access to all of Taiwan's chips, other shocks such as tariffs between the US and its allies and China, disruptions to Asian shipping, and fallout in financial markets are mitigated to a certain extent (Welch et. al., 2024 & Tsoi et. al., 2024).

Amidst efforts by the United States to halt China's progress in semiconductor technology, TSMC has found itself in a challenging position. In 2020, TSMC ceased taking orders from Huawei, a significant customer, due to its reliance on American technology, as explained by Mr. Liu, company has no say in this context (Lui& Mozur, 2023b).

The leader of the Chinese Communist Party (CCP), Xi Jinping, has threatened potential changes to the status quo across the Taiwan Strait depicted in figure 5.2, the risk of China's amphibious attack on Taiwan (AEI, 2024). The People's Liberation Army's (PLA) modernization efforts and increased military activities suggest a part of effort to integrate Taiwan with People's Republic of China (PRC), possibly through coercive means, while asserting regional dominance (AEI, 2024).Top US official, Gen. Mark Milley, Chairman of the Joint Chief staff said that conflict over Taiwan will be a bad choice for China as reaffirmed Washington commitment to provide military aid to Taiwan through training and provisions for weapons (Fredly, 2022). Restricting Huawei's access to TSMC could potentially escalate tensions, leading to geopolitical shifts that increase the likelihood of a Chinese takeover of Taiwan (Shattuck, 2020). The takeover of Taiwan will be just the beginning of war between China and Taiwan. This potential conflict between could escalate into a broader international crisis, potentially involving the United States (Shattuck, 2020). To prevent TSMC from falling into Beijing's control, the option of obstructing a Chinese takeover by any means necessary, including destroying TSMC's factories, may be considered by United States thereby securing its national interest (Shattuck, 2020). Both United States, its allies and the entire world cannot afford to lose TSMC in the hands of Beijing. American policymakers and military leaders are preparing for potential scenarios, including an invasion of Taiwan (AEI, 2024). Urgent strategic planning is necessary to counter Chinese coercive actions, as failure to do so could embolden China to pursue alternative methods to achieve its objectives short of direct military invasion (AEI, 2024). Safeguarding Taiwan demands a nuanced understanding of Chinese grand strategy and decision-making regarding the use of force (AEI, 2024).

Figure 5.2: Strategic Perspective of Taiwan's Imminent War Risk



Source: Bloomberg Economics, IMF, Note: Israel-Hamas war, Taiwan blockade, and Taiwan war are Bloomberg Economics estimates.

Amid escalating concerns over potential conflict between China and Taiwan, the global semiconductor supply chain faces increased vulnerabilities (Asia Financial, 2022, February 21). In response, Taiwan Semiconductor Manufacturing Corp. (TSMC) is strategically redistributing some of its chip production facilities to the US and Japan (Asia Financial, 2022, February 21). This strategic adjustment aims to counterbalance the risks associated with geopolitical tensions that could disrupt operations in Taiwan potentially due to China-Taiwan conflict (Kuo, 2023). TSMC's ambitious plan to construct foundries in the US and Japan, backed by substantial investments, holds paramount importance in diversifying its supply chain, bolstering proximity to major markets, and diminishing exposure to potential disruptions in Taiwan (Asia Financial, 2022, February 21). This proactive reallocation of TSMC's chip production facilities serves as a preemptive measure to fortify the global semiconductor supply chain against potential adversities stemming from geopolitical tensions, notably the looming spectre of conflict between China and Taiwan (Kuo, 2023). The fate of the future hinges on the smaller node processors, with the rivalry between the U.S. and China poised to center on the supremacy of the tiny microchips that power virtually every aspect of modern technology.

5.4: TSMC's Survival Amidst Potential Amphibious Threat from China

In the hypothetical scenario of an amphibious incursion targeting Taiwan, the Taiwan Semiconductor Manufacturing Company (TSMC) confronts substantial risks, with plausible prospects of survival with US strategies like blow up TSMC during the Taiwan invasion according to the IS Congressman Seth Moulton(McKinsey, 2023 & Dangwal, 2023). Taiwan's defence minister Chiu Kuo-cheng and officials strongly opposed the proposal, emphasizing Taiwan's zero tolerance for any threat to TSMC's facilities (McKinsey, 2023, & Asia Financial, 2023). Instead, Taiwan reaffirms its commitment to collaborating with the U.S. and its allies to counteract China's military aggression (McKinsey, 2023).

The envisaged invasion poses the potential for severe economic ramifications, with the interruption of chip fabrication globally due to Taiwan's pivotal role in semiconductor production. TSMC's endurance is contingent upon a multifaceted array of factors, encompassing its capacity to withstand initial assaults, sustain operational continuity amidst the conflict, and mitigate disruptions to its intricate supply chains and infrastructural networks. Leveraging Taiwan's strategic geographical advantages, characterized by rugged terrain and climatic adversities unfavourable to invaders, may fortify the protection of critical assets, including TSMC (Collins & Erickson, 2023). Furthermore, Taiwan’s strategic defensive doctrines, investments in cutting-edge anti-drone technologies, and resilient critical infrastructure serve to bolster the prospects of TSMC’s survivability. Despite the inherent perils associated with a potential Chinese military offensive, the continued viability of TSMC assumes paramount significance not only for the sovereign entity of Taiwan but also for the global semiconductor industry (McKinsey, 2023).

5.5: Future of Semiconductor Fabs Amid US-China Conflict

TSMC, the key maker of the chip manufacturing announced to spend $40 billion in first major US hub for semiconductor production (Clark & Browning, 2022). The investment includes two fabs, one is Arizona (figure 5.3 shows US President Biden vising the fab) to be functional by 2025 with 4nm chip production which are one or two years behind the cutting-edge (Lee & Wu, 2024). The company marked global expansion with facilities in US, Japan and Germany (Lui& Mozur, 2023). Sony Group Corp. and Denso Corp. are also investing in the factory, with support from the Japanese government (Kyodo News, 2023).

Recently, TSMC delayed the start of manufacturing at its Arizona factory to 2025, attributing the setback to a lack of expertise among local workers in installing certain advanced equipment. Additionally, the company recently announced that its second plant will not commence chip production until 2027 or 2028, instead of the initially projected 2026, citing uncertainties surrounding technology decisions and federal funding (Clark & Swanson, 2024). Another reason being TSMC is not finding enough skilled workers to complete its facility, reflecting a broader issue in America’s semiconductor industry, which anticipates a shortfall of 67,000 technicians, engineers, and computer scientists by 2030 (Mann, 2023). These professionals are essential for constructing and staffing multi-billion-dollar factories, such as those promised by Intel and TSMC, and for designing crucial components (Mann, 2023). Efforts like the US CHIPS and Science Act, unlocking $39 billion in subsidies, tax breaks, and incentives, are poised to generate nearly 115,000 jobs in the semiconductor sector, according to the SIA (Mann, 2023). However, the SIA also estimates that the U.S. needs to train 26,400 new technicians, 27,300 engineers, and 13,400 computer scientists by the end of the decade to address the potential shortage, based on current enrollment in relevant programs (Mann, 2023).

Figure 5.3: Building Semiconductor Fab[58] in USA

Mr. Liu and President Biden joined Aaron Butler, president of the Arizona Building and Construction Trades Council, at the TSMC plant in Arizona. **Source:** T.J. Kirkpatrick, New York Times 2023.

[58] Foundry, facility, and fabs are interchangeable terms referring to the manufacturing facilities responsible for producing semiconductors.

Intel, Microchip Technology, and several other companies have also revised their production timelines due to a decline in chip sales across various sectors, prompting them to carefully control spending on new infrastructure. Establishing new chip factories is an immensely complex process, requiring the coordination of thousands of construction workers, extended construction periods, and significant investments in machinery amounting to billions of dollars (Clark & Swanson, 2024). Mark Lui, Chairman of TSMC says, “It would be difficult to replicate what the company has build in Taiwan.” He emphasized that swiftly developing and manufacturing the company’s most advanced chips demands a substantial endeavour, involving up to 3,000 research scientists for each generation of the technology and this could not put somewhere else according to TSMC Chairman (Lui & Mozur, 2023). Cultural disparities have led to internal tensions between TSMC and American employees (Lui & Mozur, 2023).

Japan is investing in billions to mass produce state-of-art 2nm logic chips in 2027 through home-grown venture Rapidus Corporation. Amid the US-China tensions over chip making expertise and equipment access, Japan’s government perceives a chance to reassert its dominance in a field it once dominated, capitalising on Washington’s supply chain security concerns (Nohara, 2024) since advanced chips serve as a foundation for critical technologies like AI, weapons system and electrical vehicles. Japan’s new chip strategy focuses on two key elements, enticing major foreign chip manufacturers to set up fabs in Japan with substantial subsidies such as $7 billion to TSMC, (Sharma, April 10, 2024) and launching the ambitious Rapidus project in Hokkaido to regain prominence in cutting-edge silicon-chip technology (Nohara, 2024). As part of the Rapidus project, IBM Corp. is training approximately 100 experienced Japanese engineers in Albany, New York, to equip them with advanced US chip expertise (Nohara, 2024). Prime Minister Fumio Kishida ambitious $27 billion investment to revive Japan's semiconductor industry and also to reorient positive growth of the economy (Nohara, 2024b). The fab is part of Japan's Rapidus plan to make a giant leap in chip technology and established Japan at the forefront of the semiconductor expertise. The government's chip strategy aims to triple domestic chip sales to approximately ¥15 trillion by 2030, aiming to regain market share lost to competitors from Taiwan and South Korea (Nohara, 2024b). This initiative has already attracted foreign investment, including Taiwan Semiconductor Manufacturing Co. (TSMC), which is undertaking two factory projects in Kumamoto with potential for further expansion. Prime Minister Kishida has emphasised the positive impact on local communities, as TSMC plans to offer starting salaries 20% above the national Japanese average, leading to significant economic growth and job creation (Nohara, 2024b). The first TSMC foundry is projected to generate an economic impact of ¥7 trillion and create over 10,000 jobs, with expectations of even greater benefits from future expansions. Japan visions Hokkaido to replicate Silicon Valley, fostering innovation and economic prosperity (Nohara, 2024b).

TSMC, a major chip manufacturer with clients like Apple and Nvidia, dominates half of the global chip production, serving various industries from smartphones to satellites and AI technology. However, pressure from customers and governments concerned about chip supplies has led to calls for TSMC to expand its production beyond Taiwan (AFP, 2024). The establishment of a new plant in Japan represents a significant international investment for TSMC, strengthening political ties between Taiwan and Japan. Chris Miller emphasised that this move also reinforces Taiwan's strategic alliances amid increasing pressure from

China (AFP, 2024). Understanding this fundamental aspect the subsequent chapter culminates the entire study consolidating the relevant findings to draw comprehensive conclusion.

CHAPTER VI

CONCLUSION

6.1: Fallouts of the Chip Race

The history of semiconductor industry can be traced back to the theorisation, innovative thinking perseverance of Dr. William Shockley which eventually led to the invention of transistors breakthrough that revolutionised electronics and providing foundation to today's digital era. As the semiconductor industry progresses from the transistor's invention to the creation of cutting-edge microprocessors, flash memory, and digital signal processors, it relentlessly expands the horizons of technological possibilities and remains at the forefront of technological innovation. This relentless pursuit of innovation across diverse sectors, enhancing our lives in countless ways. This invention led the foundation for modern computing, transportation, communication networks, and also in military technology and warfare. This persistent pursuit of progress catalyses innovation across a wide range of industries, profoundly impacting and enhancing our daily lives. The industry marks a remarkable achievement and remains forefront in driving innovations across the various sectors as advancements in semiconductor technology continues. The technology used today for building semiconductor was invented in America and hence dominated the design and manufacturing in 1960s but due to the increased cost of production in the United States saw rapid decline in 1990 from 40% to 11% in semiconductor production by 2019 (Miller, 2023). Still it continues to dominate in the chip design. Besides the US semiconductor manufacturers faced competitiveness with companies such as Sony and

Japan became the largest producer and consumer of in-house manufactured microchips driven by growth in computers, automotive electronics, and telecommunications. But Japan's semiconductor industry was largely affected due to the Asian financial crisis in 1997. Meanwhile TSMC in Taiwan was emerging as a key player in the semiconductor sector with decades of R&D and collaboration with American governments. Today, only handful of companies play a pivotal role in the semiconductor sector namely TSMC based in Taiwan, Samsung Electronics co. in South Korea and Intel, Qualcomm, Nvidia and Micron Technology based in United States of America including China's SMIC and Huawei growing intensively in recent years.

The United States and People's Republic of China (PRC) China are fiercely competing over the critical semiconductor technologies which power the modern warfare system and global economy which commenced since late 2017 due to the imposition of huge tariffs on Chinese imports from America by the Trump administration and still being continued by Biden Administration. The series of export controls and restrictions impeded on China as it advances in its domestic semiconductor production of cutting-edge chips through Chinese government initiatives like 14th Five-year plan and Made in China policy. Despite the continued US sanctions and restrictions laid down on China, Chinese tech company Huawei developed the 7nm state of art semiconductor chips embedded in the Huawei's Mate 60 Pro 5G-capable smartphone in 2023. In amongst the most significant advancement that shocked the United States, brought doubts in the analysis on chip and effectiveness of US restrictions on China. The United States fear that PRC has been using the 7nm chip in its military advancement resulting in the security dilemma between US-China. While some

US official statements suggests that China lacks the capabilities of mass producing such semiconductors.

Having seen such advancement by Chinese companies United Stated in collaboration with its allies, ASML company, headquartered in Netherlands is cutting off China’s access to chip making equipment, a highly advanced lithography machines used to build microchips. Recent updates suggest that United States conveyed ASML to move its headquarters to Texas to enhance domestic production of semiconductors on the US soil by the Biden Administration with the incentives plans like CHIPS and Science Act to ensuring supply chain resilience. Besides TSMC stopped supply of semiconductors to China on US request along with South Korea’s Samsung Electronics and Japan’s semiconductor manufacturer. In order to de-risk the supply avoid potential disruptions of semiconductor supply chain due to China-Taiwan conflict, TSMC started offshoring of its fabrication facility in Texas, Arizona, and 2 foundries in Kumamoto Japan.

PRC’s claim over Taiwan as renegade province and aspiring to reunification with mainland China poises an existential threat to Taiwan’s self governing democracy. The leaders of CCP are determined to reunify Taiwan with the use of force if necessary. Tensions in the Taiwan Strait have escalated recently, marked by increased U.S. support for Taiwan and China’s more assertive stance towards reunification amid the building rivarly between the two economic giants. The growing divergence in Taiwanese identity, particularly among the younger generation, poses a challenge to China’s reunification aspirations, adding another layer of complexity to the situation. The possibility of a military conflict between China and Taiwan, potentially involving the United States, looms large amidst China’s military modernisation efforts and aggressive actions in the region. While both Xi Jinping and Biden stress the preference for peaceful resolution, the situation remains precarious, requiring careful navigation to maintain stability.

The first hypothesis of the study suggests that the United States in collaboration with its allies such as Japan, South Korea and Taiwan is endeavouring to secure a dominant position in the semiconductor industry while imposing sanctions on China. This trajectory has sparked a semiconductor rivalry and heightened geopolitical tensions between the two economic giants. From the studies of chapter 4, it is clear that America in alliance with allied partners are trying to create an competition with China.

China is percieved as a threat to the resilience of semiconductor supply chain and US by citing national security concerns is working with its allies to secure this supply chain. As a result the United States in collaboration with its allies such as Taiwan which hold largest chip production through TSMC is building fabrication plants in Arizona to boost it domestic production of semiconductor chips and trying to restore the semiconductor supply chain. Through the concept like friend-shoring TSMC is starting two of its manufacturing units in Kumamoto, Japan. United States persuaded ASML to lay down export controls on China as a result ASML has revoked an export license impacting the shipment of Extreme Ultraviolet (EUV) lithography machines and also banned the access to old version Deep Ultraviolet (DUV) lithography to China. Besides, United States along persuaded ASML to relocate its headquarters to Austin, Texas as part of friend-shoring according to recent reports. United States also urges allies like Japan and South to restrict export of chipmaking machines. US urges Japan to restrict the sale of certain critical chemicals used in making computer chips.

Global partnerships, including the US, Japan, and others, aim to counter China's chip ambitions by controlling exports and limiting chip-making tool sales. Taiwan's President expressed interest in producing democracy chips with the US. The US proposed a Chip 4 alliance with Taiwan, South Korea, and Japan to strengthen the semiconductor supply chain. These partnerships emphasise the growing importance of collaboration in advancing semiconductor technology globally. These facts demonstrate that the United States has forged a strong alliance to assert a leading role and maintain longstanding dominance in strategic commodities like semiconductors, showcasing its power on the global stage that checks the hypothesis affirmatively

The second hypothesis states, through the utilisation of the cutting-edge technology and government subsidies, SMIC has manufactured a most advanced chip in closing the gap of tech race for silicon supremacy circumventing the sanctions brought by the US is yet to be answered since China is trying hard to reduce the gap but it is not able to completely meet the challenge as yet. Despite unclear methods, Huawei managed to produce 7nm processors, possibly through stockpiling amid US sanctions. The Biden administration investigated whether SMIC violated export regulations by supplying chips for Huawei's Mate 60 Pro but the administration had not confirmed if Huawei released the phone using chips that potentially violated US restrictions. Alan Estevez hinted at a potential violation. The Mate 60 Pro was seen as a symbol of China's tech resurgence amidst US efforts to hinder its semiconductor capabilities.

The potential for conflict between China and Taiwan poses significant threats to global security and to the semiconductor supply chain. China's military strategies include various options, such as cyberattacks, missile strikes, and even a full-scale invasion, to assert control over Taiwan. Tensions are heightened by Taiwan's strategic importance in semiconductor production, with disruptions potentially leading to economic devastation globally. While Taiwan and the US are preparing to defend against potential Chinese aggression, the fate of TSMC, a critical player in the semiconductor industry, remains uncertain in the event of a conflict. However, Taiwan's commitment to collaboration with the US and its allies suggests a determination to resist Chinese military aggression and safeguard its vital industries. Overall, the intertwined relationships between the United States, China, and Taiwan highlights the intricate geopolitics of the Indo-Pacific region and the delicate balance between cooperation and competition in shaping its future.

6.2: Seizing the Moment: US-China chip Conflict is an Opportunity for India

Semiconductor chips, play a pivotal role in powering the network devices that have become ubiquitous in our daily lives. Their technology drives progress in computing, transportation, communication, and myriad other appliances. Programmed with software that fuels virtually every electronic device we use today, from cars and laptops to smartphones, washing machines, modern manufacturing plants, defence equipment and weaponry semiconductors are indispensable. Realising the importance semiconductor technology in the digital world, the Indian government is poised to investing in its domestic semiconductor industry and aspires to become a reliant partner in the semiconductor supply chain. The government of India's policies are on attention to befriend companies such as Foxconn, TSMC, Applied Materials, Micron, Nvidia and Intel and other major players to create electronic manufacturing in the country. The semiconductor sector in India which is currently in its rapid expansion, driven by initiatives such as the India Semiconductor Mission, which aims to position the nation as a prominent player in global electronics manufacturing and design. Meanwhile Semiconductor Industry Association (SIA) advocates for transparent, predictable, and market-based incentives aligned with international trade regulations, complemented by favourable investment, regulatory, and trade policies to drive the growth of India's semiconductor industry (SIA, 2023). The Indian semiconductor sector is welcoming three manufacturing units (Rao, 2024) laying the foundation of significant player in the supply chain. According to reports, India's semiconductor consumption market in 2021 was valued at $27.2 billion and it is expected to reach $64 billion 2026 (WION, 2024, March 1). But non of these microchips are manufactured in India.

December 15, 2021 India announced an ambitious new Incentive scheme worth $10.2 billion to boost semiconductor ecosystem showing government policies are investing to create electronic manufacturing hubs in the country (Meity.gov, 2022). "We are preparing a package of Incentives to become a key manufacturer of semiconductors" Prime Minister Narendra Modi (Langa, 2023). PM Modi urges the industry to make India a global hub for semiconductors (Langa, 2023).

On February 24, 2023, the Centre for Development of Advanced Computing (CDAC) of India unveiled the ChipIN Center, a pioneering initiative aimed at empowering students and start-ups nationwide in the field of chip design (Singh, 2024). This pivotal platform seeks to bolster capacity and readiness in chip design within the country(Singh, 2024).

6.3: Government Investments & New Semiconductor Fabs

India’s first landmark deal in the semiconductor sector was laid down by Foxconn and Vedanta joint venture in Gujarat. In a statement released on July 10, Taiwan-based Hon Hai Technology Group, commonly known as Foxconn, announced its withdrawal from the joint venture with the Vedanta Group of India likely to invest $19.5 billion together and meant manufacture 28nm semiconductor technology (The Hindu, 2023, July 10). But soon Foxconn declared withdrawal from the joint venture (Nandi, 2023).

The joint venture between Foxconn and Vedanta in Gujarat, India, faced multiple challenges leading to its failure. Foxconn withdrew from the $19.5 billion semiconductor project with Vedanta due to concerns about Vedanta’s financial stability, delays in government incentive approvals, and cultural differences between the companies (Barik, 2023). The deadlock in negotiations with European chipmaker STMicroelectronics, the project’s technology partner, significantly contributed to the venture’s failure (Vengattil et. al., 2023) along with slow progress, and difficulties in pacing the project also contributed to its downfall (Gupta, 2023 & Telecom lead, 2023). Additionally, Vedanta’s debt load hampered its ability to acquire essential chipmaking technology, further influencing Foxconn’s decision to exit the partnership (Kharpal, 2023). Despite efforts to find alternative partners, Foxconn’s withdrawal significantly impacted the project’s advancement and its prospects for continuation (Kharpal, 2023). This setback underscores the intricate nature of large-scale joint ventures and semiconductor manufacturing sector. The Indian entrepreneurship minister pointed out Vedanta Ltd lack prior experience in semiconductor technology as a contributing factor to the project's challenges (Razdan, 2023). Both parties acknowledged that the project faced sluggish progress and encountered challenging obstacles that were difficult to overcome smoothly, along with external issues unrelated to the project (Nandi, 2023). Constructing fabrication facilities from scratch in a new location presents significant challenges (Nandi, 2023).

Under the initiative "Development of Semiconductors and Display Manufacturing Ecosystems in India," the Cabinet has approved the establishment of three new semiconductor manufacturing units, signalling a notable advancement for the Indian semiconductor sector (Rao, 2024). The semiconductor fabrication facility is slated to be set up in Dholera, Gujarat, through a collaboration between Tata Electronics Private Limited (TEPL) and Taiwan's Powerchip Semiconductor Manufacturing Corporation commonly knows as PSMC (IANS, 2024). Operating with 28nm technology, the facility will specialize in producing power management chips tailored for electric vehicles (EVs), telecom, defence, automotive, consumer electronics, display, power electronics, and other sectors. It is expected to achieve a monthly production capacity of 50,000 wafer starts (Rao, 2024). Ahead of the Dholera fab US-based firm, Applied Materials is poised to supply equipment to India's first semiconductor fabrication plant[59] (FE Bureau, 2024).

Followed by another Semiconductor ATMP[60] (Assembly, Test, Marking, and Packaging) facility will be established in Morigaon, Assam, contributing to the region's semiconductor industry infrastructure by Tata Groups with an investment of INR 2700 million or

[59] The India Validation Centre stands as a testament to our commitment and success in bolstering India's chip manufacturing resilience, with Applied Materials serving as a trusted partner in realizing the Indian semiconductor vision. Demonstrating the ability to process 300-mm wafers within the IVC marks a significant milestone, representing a pioneering achievement for the private industry in India (FE Bureau, 2024).

[60] Tata Semiconductor Assembly and Test Pvt Ltd The facility will focus on developing advanced semiconductor packaging technologies such as flip chip and ISIP (integrated system in package), aiming to establish indigenous capabilities. With a daily capacity of 48 million units, it will serve various sectors including automotive, electric vehicles, consumer electronics, telecom, and mobile phones (Rao, 2024).

US$325.99 million (Rao, 2024). Tata Semiconductor Assembly and Test Pvt Ltd The facility will focus on developing advanced semiconductor packaging technologies such as flip chip and ISIP (integrated system in package), aiming to establish indigenous capabilities. With a daily capacity of 48 million units, it will serve various sectors including automotive, electric vehicles, consumer electronics, telecom, and mobile phones (Rao, 2024). Tata Group has submitted a proposal to set up a semiconductor processing plant in Assam with an investment of ₹40,000 crore. The plant will be established in partnership with the Assam government and will be located in Jagiroad for assembly and packaging (Kalita, 2024). The region boasts abundant high-quality water resources, ideal for producing ultrapure water (UPW) necessary for semiconductor sites (Singal, 2024). Furthermore, Assam offers a pollution-free environment, making it appealing for expatriate workers essential for the initial stages of semiconductor greenfield projects, addressing the scarcity of such talent within India (Singal, 2024). Tata Group has assured employment to 1000 youths from Assam (Purkayastha, 2023).

The most recent semiconductor fab announced is the Semiconductor ATMP unit for specialised chips at Sanand, Gujarat (Rao, 2024). The CG Power, in collaboration with Renesas Electronics Corporation of Japan and Stars Microelectronics of Thailand, will inaugurate a semiconductor unit in Sanand, Gujarat, with a substantial investment of INR 760 million and US$91.63 million in dollars (Rao, 2024). According to reports, government of India has allotted 188arces of land to Tata Group's CG (Crompton Greaves Limited) power for Gujarat's chip drive in country (Moneycontrol, 2024). Following Prime Minister Narendra Modi's state visit to the United States, Micron, a semiconductor giant from the USA, has announced investment plans in India (Singal, 2024). President Biden and Prime Minister Modi praised the signing of an MoU on Semiconductor Supply Chain and Innovation Partnership as a significant milestone in coordinating semiconductor incentive programs between the USA and India (WH. Gov, 2023c). This collaboration aims to bolster commercial opportunities, research, and talent development within the semiconductor industry (WH. Gov, 2023c). The leaders also commended Micron Technology, Inc., for its plan to invest up to $825 million in constructing a new semiconductor assembly and test facility in India, supported by the Indian government (WH. Gov, 2023c). This combined investment of $2.75 billion is projected to generate around 5,000 direct jobs and 15,000 community job opportunities over the next five years (WH. Gov, 2023c). Additionally, they welcomed Lab Research's initiative to train 60,000 Indian engineers through its Semiverse Solution virtual fabrication platform, contributing to India's semiconductor education and workforce development objectives (WH. Gov, 2023c). Furthermore, they appreciated Applied Materials, Inc., for its commitment to invest $400 million in establishing a collaborative engineering center in India (WH. Gov, 2023).

The India AI mission[61], approved by Union Cabinet on March 7, 2024 advocates for governmental backing in the advancement of AI chips, through a collaboration between the public and private sectors (MeitY, 2024). It aims to establish an ecosystem inclusive of AI computing infrastructure featuring 10,000 or more GPUs (Moneycontrol News, 2024b). Nvidia has pledged its support for India's newly launched IndiaAI mission to bolster

[61] The genesis of the IndiaAI initiative can be attributed to the early months of 2023, when the government established seven expert committees tasked with formulating a comprehensive roadmap for policy advancements in AI. Drawing from the insights of these working groups, the government subsequently published a 180-page report that mirrors many of the initiatives now endorsed within the India AI mission (Moneycontrol News, 2024).

artificial intelligence computing capacity within the nation, as highlighted by Union Minister Ashwini Vaishnaw in an exclusive interview (Srikant & Sur, 2024). India is also looking forward to foster an educational framework within the semiconductor and telecom sectors by endorsing curricula such as BTech, MTech, and PhD programs focusing on cutting-edge AI technologies (Srikant & Sur, 2024). Similarly, government of India's Ministry of Tribal Affairs in collaboration with the Indian Institute of Science (IISc) in Bengaluru to provide semiconductor technology training to tribal students (PTI, 2024b). This initiative comes as part of the India Semiconductor Mission (ISM), which aims to boost job opportunities in the semiconductor industry (PTI, 2024b). The tribal affairs ministry, in partnership with IISc, will establish a training fab unit offering courses on semiconductor technology to tribal students (PTI, 2024c).

The Indian government's commitment to developing a cutting-edge supercomputer dedicated to AI underscores India's emergence as a significant contender in the global AI race with a substantial investment of ₹10,300 Crore (approximately $1.24 billion USD), India is poised to fortify its technological infrastructure and develop its presence evolving field of AI in decades ahead (Editorial Team Techovedas, 2024). This strategic move builds upon India's remarkable progress in the computing sector, garnering attention from leading industry players such as Apple and NVIDIA[62] (Editorial Team Techovedas, 2024). At the heart of this initiative lies the construction of an advanced supercomputer equipped with an impressive array of 10,000 GPUs, reflecting India's ambition to leverage advanced computing power for transformative AI applications (Editorial Team Techovedas, 2024).

[62] While specific details about the hardware for India's state-of-the-art supercomputer dedicated to AI remain undisclosed, speculation indicates that NVIDIA, a prominent provider of AI GPUs, could play a crucial role in supplying the necessary technology (Editorial Team Techovedas, 2024).

Recent developments suggest a potential collaboration, as evidenced by a significant order of AI GPUs worth over $500 million USD following a meeting between NVIDIA CEO Jensen Huang and Indian Prime Minister Narendra Modi (government of India, 2023). This underscores the possibility of Nvidia's involvement in equipping India's supercomputer with cutting-edge AI capabilities asserted by Editorial Team Techovedas (2024), further solidifying India's position in the global AI race. As part of Viksit Bharat 2047 initiative Power Renesas Powerchip semiconductor manufacturing corp. announced assembly and test unit at Sanand, Gujarat and (Outsourced Assembly and Test) OSAT unit in Assam (ET Online, 2024)[63]. Besides laying the foundation of fabs in India, the recently inaugurated Qualcomm's new semiconductor design center in Chennai by Information Technology (IT) Minister Ashwini Vaishnaw, marked a significant investment of ₹177.27 crores (Xavier, 2024). This expansion is set to create up to 1,600 tech jobs, with a specific focus on wireless connectivity solutions and Wi-Fi technologies (Xavier, 2024). The center will play a pivotal role in supporting San Deigo, California-based Qualcomm's global research and development efforts in advancing 5G cellular technology (Xavier, 2024).

India had dreamed of becoming a semiconductor hub for long but they have been fruitful (Singal, 2024). India missed the opportunities in past to establish a fab in country, since way back in 1960s and 1970s the Co-founder of Intel, Robert Noyce showed interest and visited India to start a manufacturing facility but as it could only produce limited chips due to the government's mandate it was impossible for him to proceed with establishing the fab

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[63] The Indian government, under the leadership of Prime Minister Modi, has recently intensified its efforts to establish India as a prominent destination for semiconductor design, manufacturing, and technology advancement (ET Online, 2024). This initiative is exemplified by the announcement of the Programme for Development of Semiconductors and Display Manufacturing Ecosystem in India on December 21, 2021, which has been allocated a substantial budget of Rs. 76,000 crore (MeitY, 2021).

facility (Singal, 2024). Intel gave another try and attempted to start with packaging unit in 2005 but it also result in another failure (Singal, 2024b). Once the ecosystem is established, particularly with the setup of Micron's ATMP plant costing $2.7 billion, experts and officials from MeitY (Ministry of Electronics and Information Technology) anticipate a significant influx of opportunities and growth within the industry (Singal, 2024b). The development of Made in India and Designed in India chips can propel India's progress in 4^{th} Industrial revolution, overcoming past limitations (ET Online, 2024). By fostering indigenous chip manufacturing and design, India can reduce dependency on imports of critical technology of chips, boost its economy, create jobs, and establish itself as reliant partner in the semiconductor industry.

India's semiconductor industry is experiencing a significant new field of developments in semiconductor technology, propelled by government support, strategic partnerships, and substantial investments. India is closely monitoring developments in the semiconductor industry (Kshitij, 2024). In the semiconductor industry there exist a high stakes game interms of its market share was packed at $600billion in 2021 by Mc Kinsey and projected to grow to 1 trillion by 2030 wherein United States, Europe, Japan, South Korea, and also India wants to have a share (Kshitij, 2024)

The collaboration between domestic and international players, such as Tata Electronics, Semiconductor Manufacturing Corporation, Renesas Electronics, and Micron Technology, through the establishment of new manufacturing units, signifies a pivotal shift in India's semiconductor landscape. These initiatives will not only address the country's growing semiconductor demand but also position India as a key player in the global supply chain. To bolster India's semiconductor landscape, the government is likely to introduce a scheme aimed at incentivising semiconductor ancillary firms (PTI, 2024d). This initiative would not only address existing challenges but also facilitate the establishment of supply chain players in India (PTI, 2024d). Recognising the importance of addressing disability issues within the semiconductor industry, the government may integrate provisions within the scheme to support this aspect (PTI, 2024d). Such measures could significantly contribute to the growth and robustness of India's semiconductor ecosystem.

While there is evident growth in India's semiconductor sector, it is crucial to recognise the industry's extensive requirements for R&D, processing capabilities, and skilled talent to achieve mass production and market entry. Despite ambitious plans, India's investments in the semiconductor sector have struggled to match the scale needed to establish a robust semiconductor ecosystem. The gap between India's aspirations and its current investment levels highlights significant challenges in achieving its semiconductor goals effectively and emphasising the need for further investment plans where companies like Nvidia is investing $30 billion in its new unit in San Francisco for AI expansion compared to India's investments are fairly less. With continued dedication, strategic planning, and collective efforts, India is poised to lead the way in driving technological advancement, economic growth, and innovation in the semiconductor industry, however, it is just the beginning, and there will be many obstacles to overcome in the future for India to build an robust semiconductor ecosystem and become a giant in the semiconductor industry.

The semiconductor industry is currently experiencing a renaissance, attracting significant investments from government's world wide. The countries are actively seeking to expand their semiconductor capabilities by allocating substantial financial resources. Such investments showcases how semiconductor chips have become a new strategic asset.

REFERENCES

Primary Sources

US Dept. of Commerce. (2022, October 17). Antony J. Blinker Stanford University. [Press Release]. U.S. Dept of State. https://www.state.gov/secretary-antony-blinken-remarks-to-the-press-3/.

BIS. (August 2020). *Commerce Department Further Restricts Huawei Access to U.S. Technology and Adds Another 38 Affiliates to the Entity List.* US dept. of Commerce.

BIS Report. (2022). *Commerce Implements New Export Controls on Advanced Computing and Semiconductor Manufacturing Items to the People's Republic of China (PRC).* BIS.gov. www.bis.doc.gov.

BIS (2023, October 17). *Commerce Strengthens Restrictions on Advanced Computing Semiconductors, Semiconductor Manufacturing Equipment, and Supercomputing Items to Countries of Concern Updates to Modify and Reinforce Restrictions Initially Released on October 7, 2022, to Address National Security Concerns Posed by PRC Military Modernization. Bureau of Industry and Security.* https://bis.doc.gov.

Commerce.gov. (2023, January 5). Readout of Secretary Raimondo's Meeting with Japan's Minister of Economy, Trade and Industry Yasutoshi Nishimura. U.S. Department of Commerce. https://www.commerce.gov/news/press-releases/2023/01/readout-secretary-raimondos-meeting-japans-minister-economy-trade-and.

China, Embacy.gov. (2024, March 7) *Wang Yi: All People of Chinese Descent Should Jointly Oppose "Taiwan Independence" and Support Peaceful Reunification*. China Embacy.gov.cn. http://za.china-embassy.gov.cn/eng/zgyw/202403/t20240308_11256422.htm.

Congress. Gov. (1979). Taiwan Relations Act, 96th Congress (1979-1980). Congress. Gov.bill. https://www.congress.gov/bill/96th-congress/house-bill/2479.

Government.nl. (2023). *Letter to Parliament on additional export control measures concerning advanced semiconductor manufacturing equipment. Government of Netherland.* https://www.government.nl/documents/parliamentary-documents/2023/03/10/letter-to-parliament-on-additional-export-control-measures-concerning-advanced-semiconductor-manufacturing-equipment.

Government of India. (2023, September 4). Mr. Jensen Huang, the CEO of Nvidia meets PM. [Press Release]. Pmindia.gov. https://www.pmindia.gov.in/en/news_updates/mr-jensen-huang-the-ceo-of-nvidia-meets-pm/.

Meity.gov. *Modified Programme for Semiconductors and Display Fab Ecosystem*. https://www.meity.gov.in/esdm/Semiconductors-and-Display-Fab-Ecosystem.

Ministry of Electronics & IT (2024, Match 7). Cabinet Approves Over Rs 10,300 Crore for IndiaAI Mission, will Empower AI Startups and Expand Compute Infrastructure Access. [Press Release]. Pib.gov.in. https://pib.gov.in/PressReleasePage.aspx?PRID=2012375.

MOFCOM (2023, July 7). MOFCOM Regular Press Conference. Mofcom.gov. http://english.mofcom.gov.cn/article/newsrelease/press/202307/20230703421747.shtml.

Mofcom, Gov. (2024, March 28). *Minister Wang Wentao met with Dutch Trade Minister Geoffrey van Leeuwen. Ministry of Commerce People's Republic of China.* http://english.mofcom.gov.cn/article/newsrelease/significantnews/202403/20240303486718.shtml.

Ministry of Foreign Affairs of the People's Republic of China. (2023, November 15) *Xi Jinping Arrives in San Francisco for China-U.S. Summit Meeting and the 30th APEC Economic Leaders' Meeting.* Mfa.gov. https://www.mfa.gov.cn/eng/topics_665678/xjpfmgjxzmyshwtscxapec/202311/t20231115_11180650.html#:~:text=On%20the%20afternoon%20of%20November,of%20U.S.%20President%20Joe%20Biden.

Office of the Secretary of Defence (2023). *Military and Security developments involving People's Republic of China- Annual report to Congress.* US Department of Defence (.gov).

PRC State Council. (2019) *Made in China 2025.* CSET.

US Dept. of Commerce. (2019, May 16). Department of Commerce Announces the Addition of Huawei Technologies Co. Ltd. To the Entity List. Commerce.gov. https://2017-2021.commerce.gov/news/press-releases/2019/05/department-commerce-announces-addition-huawei-technologies-co-ltd.html.

WH. Gov. (2021, February 24) *Executive Order on America's Supply Chains.* White House. https://www.whitehouse.gov/briefing-room/presidential-actions/2021/02/24/executive-order-on-americas-supply-chains/.

WH. Gov. (2022, August 9). *FACT SHEET: CHIPS and Science Act Will Lower Costs, Create Jobs, Strengthen Supply Chains, and Counter China.* Whitehouse.

https://www.whitehouse.gov/briefing-room/statements releases/2022/08/09/fact-sheet-chips-and-science-act-will-lower-costs-create-jobs-strengthen-supply-chains-and-counter-china/.

WH. Gov. (2022b, May 20). Remarks by President Biden After Touring Samsung Electronics Pyeongtaek Campus. [Press Release]. White House. https://www.whitehouse.gov/briefing-room/speeches-remarks/2022/05/20/remarks-by-president-biden-after-touring-samsung-electronics-pyeongtaek-campus/.

WH. Gov. (2023, August 9). *FACT SHEET: One Year after the CHIPS and Science Act, Biden-Harris Administration Marks Historic Progress in Bringing Semiconductor Supply Chains Home, Supporting Innovation, and Protecting National Security.* Whitehouse. https://www.whitehouse.gov/briefing-room/statements-releases/2023/08/09/fact-sheet-one-year-after-the-chips-and-science-act-biden-harris-administration-marks-historic-progress-in-bringing-semiconductor-supply-chains-home-supporting-innovation-and-protecting-nationals/#:~:text=Semiconductors%20were%20invented%20in%20the,peak%20of%20the%20space%20race.

WH. Gov. (2023b, October 30). *Executive Order on Addressing United States Investments in Certain National Security Technologies and Products in Countries of Concern.* Whitehouse. https://www.whitehouse.gov/briefing-room/presidential-actions/2023/10/30/executive-order-on-the-safe-secure-and-trustworthy-development-and-use-of-artificial-intelligence/.

WH.Gov. (2023c, June 22). Joint Statement from the United States and India. [Press Release]. Whitehouse. https://www.whitehouse.gov/briefing-room/statements-releases/2023/06/22/joint-statement-from-the-united-states-and-india/.

WH.Gov. (2024). *Office of Science and Technology Policy NSTC.* White House. https://trumpwhitehouse.archives.gov/ostp/nstc/#:~:text=The%20NSTC%20convenes%20Federal%20S%26T,at%20accomplishing%20multiple%20national%20goals.

Secondary Sources

Alsop, T. (January 10, 2024). *Top Semiconductor Companies by Market Cap2024. Statista*. https://www.statista.com/statistics/283359/top-20-semiconductorcompanies/#:~:text=Leading%20semiconductor%20companies%20worldwide%202023%2C%20by%20market%20cap&text=As%20of%20November%202023%2C%20Nvidia,Broadcom%2C%20Samsung%2C%20and%20ASML. Accesses on January 12, 2024.

Arcuri et al. Shivkumar (2022, October 18). Moore's law and its practical implications .*CSIS*. https://www.csis.org/analysis/moores-law-and-its-practical-implications accessed on: December 12, 2023.

Athanasia, G. (2022, February 10). The Lessons of Silicon Valley: A World-Renowned Technology Hub. *CSIS*. https://www.csis.org/blogs/perspectives-innovation/lessons-silicon-valley-world-renowned-technology-hub.

Allen, G. (2023, October 6). In Chip Race, China Gives Huawei the Steering Wheel: Huawei's New Smartphone and the Future of Semiconductor Export Controls. *CSIS*.

https://www.csis.org/analysis/chip-race-china-gives-huawei-steering-wheel-huaweis-new-smartphone-and-future.

APF. (2022, July 21). US Allies agree to work to Improve Supply Chains. The Economic Times. https://m.economictimes.com/small-biz/trade/exports/insights/us-allies-agree-to-work-to-improve-supply-chains/articleshow/93018593.cms.

Allen, G., Benson, E., & Putnam, Margot. (2023, April 10). Japan and the Netherlands Announce Plans for New Export Controls on Semiconductor Equipment. *CSIS*. https://www.csis.org/analysis/japan-and-netherlands-announce-plans-new-export-controls-semiconductor-equipment.

Alper, A. and Freifeld, K. (2024, March 22). US still assessing if China's SMIC broke US rules to make Huawei chip. The Economic Times. https://telecom.economictimes.indiatimes.com/news/devices/us-still-assessing-if-chinas-smic-broke-us-rules-to-make-huawei-chip/108691979.

AFP (2024, February 24). Chip giant TSMC shifts away from hotspot Taiwan with Japan plant. The Economic Times. https://m.economictimes.com/tech/technology/chip-giant-tsmc-shifts-away-from-hotspot-taiwan-with-japan-plant/amp_articleshow/107960943.cms. Accessed on February 25, 2024.

AEI. (2024). *Coalition Defence of Taiwan*. The American Enterprise Institute. https://www.aei.org/coalition-defense-of-taiwan/.

Anand, V. (2023, May). Why is the U.S. shifting its approach to China from decoupling to de-risking?. The Hindu. https://www.thehindu.com/news/international/explained-why-is-the-us-shifting-its-approach-to-china-from-decoupling-to-de-risking/article66913286.ece.

Asia Financial. (2022, February 21). China War Risk Sees Taiwan's TSMC Moving Fabs to US, Japan. Asia Financial. https://www.asiafinancial.com/china-risk-sees-taiwans-tsmc-moving-chip-fabs-overseas.

AP. (2024, March 12). US is Constantly assessing expansion of export controls on chip that could boost China's military. The Economic Times. https://m.economictimes.com/news/defence/us-is-constantly-assessing-expansion-of-export-controls-on-chips-that-could-boost-chinas-military/articleshow/108427937.cms.

Gregg, A. & Zakrzewski, C. (2024, April 16). Microsoft invests in Arabic AI firm as US Tries to limit China's away. The Washington Post. https://www.washingtonpost.com/business/2024/04/16/microsoft-g42-artificial-intelligence-cloud/.

Asia Financial. (2023, May 10). Taiwan Will Not Let US Blow up TSMC if China Invades – TN. Asia Financial. https://www.asiafinancial.com/taiwan-will-not-let-us-blow-up-tsmc-if-china-invades-tn

Bloomberg News. (2020, September 18). China Launches aggressive military exercises in Taiwan Strait amid US envoy's visit. The Print. https://theprint.in/diplomacy/china-launches-aggressive-military-exercises-in-taiwan-strait-amid-us-envoys-visit/505553/?_gl=1*czxs2f*_ga*NnhjcmRyamc4UlZldm5oN2lZWGpJNng3dnpwSkExWnNOSUpnWl93M0UyWU52anZPVVRCM3Y5YjVNRnpGOC1Fdg..*_ga_RY6PTZYBSH*MTcxMTcwOTg4NC4yLjEuMTcxMTcxMDM1OC4wLjAuMA.

Bloomberg News. (2023, December 1). China Secretly Transforms Huawei Into Most Powerful Chip War Weapon. Bloomberg.https://www.bloomberg.com/graphics/2023-china-huawei-semiconductor/?utm_medium=deeplink.

Bloomberg News. (2024, January 6). Huawei Teardown Shows 5nm Chip Made in Taiwan, Not China. Bloomberg News. https://www.bloomberg.com/news/videos/2024-01-05/huawei-teardown-shows-5nm-chip-made-in-taiwan-not-china-video. Accessed on January 7, 2024.

Bloomberg, (2024, January 9). If China Invades Taiwan, It Would Cost World Economy $10 Trillion. The Times of India. https://timesofindia.indiatimes.com/world/china/if-china-invades-taiwan-it-would-cost-world-economy-10-trillion/articleshow/106664628.cms.

Bloomberg (2024, January 16). Here's what Could Happen if there's a war over Taiwan. https://www.bloomberg.com/news/articles/2024-01-16/here-s-what-could-happen-if-there-s-a-war-over-taiwan.

Brain, M. (2001, April 23). "*How Semiconductors Work*". *HowStuffWorks.com*. https://electronics.howstuffworks.com/diode.htm. 10 April 2024.

Bhandari, K. (2023). The Geopolitics of the Semiconductor Industry and India's Place in It. *Carnegie Endowment for International Peace*. http://www.jstor.org/stable/resrep51801.

Barik, S. (2023, July 11). The unmaking of Vedanta-Foxconn's chip dream: What went wrong?. Indianexpress. https://indianexpress.com/article/explained/explained-sci-tech/the-unmaking-of-vedanta-foxconns-chip-dream-what-went-wrong-8825070/.

Bhatiya, S. (2022). *Chip Nanometer Technology explained and Why the smaller the better.* Pocketnow. https://pocketnow.com/chip-nanometer-technology-explained/.

Baazil, D., Koc, C., Hawkins, M., & Nienaber, M. (2024, March 6). US Urges Allies to Squeeze China Further on Chip Technology. Bloomberg. https://www.bloomberg.com/news/articles/2024-03-06/us-urges-allies-to-further-squeeze-china-on-chip-technology.

Benson, E. (2023, October 18). Updated October 7 Semiconductor Export Controls. *CSIS*. https://www.csis.org/analysis/updated-october-7-semiconductor-export-controls.

Banker, S. (2023, February 17). The World's Most Vulnerable Supply Chain Impacts All Supply Chains. Forbes. https://www.forbes.com/sites/stevebanker/2023/02/17/the-worlds-most-vulnerable-supply-chain-impacts-all-supply-chains/?sh=40d974bb4cd6.

Chu, A., Hille, K. (2022, October 6) TSMC in Phoenix: $12bn fab eases US microchip supply fears. Financial Times. https://www.ft.com/content/d0fe3dda-7ea4-4d37-9564-71a129b9002f.

Cash, J. (2024, January 11). China raises concerns with US over chip-making export controls, sanctions. Reuters. https://www.reuters.com/technology/china-raises-concerns-with-us-over-chip-making-export-controls-sanctions-2024-01-11/. Accessed January 22, 2024.

Cong, W., Fan F. (2024, January 11).China raises 'serious concerns' over US restrictions, crackdowns as commerce chiefs talk. Globaltimes. https://www.globaltimes.cn/page/202401/1305192.shtml. Accessed on January 22, 2024.

CRS Report (2021, April 20), China's New Semiconductor Policies: Issues for congress. CRS. Pp 4.

CRS Report (2023, March 10), Made in China: Industrial Policies, Issues for congress. CRS. Pp. 1-2.

Champion, M. (2019, May 17). How US-China Tech War rivalry Looks like a Digital Cold War. Bloomberg., https://www.bloomberg.com/view/quicktake/how-u-s-china-tech-rivalry-looks-like-a-digital-cold-war.

Communications Today. (2024, January 12).China raises Concerns with US over Chip making export controls and Sanctions. Communicationtoday. https://www.communicationstoday.co.in/china-raises-concerns-with-us-over-chip-making-export-controls-sanctions/.

Cash, J. (2024, January 11). China raises concerns with US over chip-making export controls, sanctions. Reuters. https://www.reuters.com/technology/china-raises-concerns-with-us-over-chip-making-export-controls-sanctions-2024-01-11/.

Capri, A. Semiconductors at the Heart of US-China Tech War. Hinrich Foundation. January 2020.

Che, C., Lui, J. (2023, May 11). 'De-Americanize': How China Is Remaking Its Chip Business. New York Times. https://www.nytimes.com/2023/05/11/technology/china-us-chip-controls.html.

Che, C. (2023, May 21). China Bans Some Sales of Chips From U.S. Company Micron. The New York Times. https://www.nytimes.com/2023/05/21/business/china-ban-microchips-micron.html.

Clark, D., Browning, K. (2022, December 6). In Phoenix, a Taiwanese Chip Giant Builds a Hedge Against China. The New York Times. https://www.nytimes.com/2022/12/06/technology/tsmc-chips-factory-phoenix.html.

Clark, D., Swanson, A. (2024, February 12). Plants to Expands U.S. Chip Manufacturing Are Running into Obstacles. The New York Times. https://www.nytimes.com/2024/02/19/technology/semiconductor-chip-factories-delays.html.

Chang, G. (2020). *The Great US-China Tech War.* Encounter Books.

Collins, G, & Erickson, A. (2023, September 27). Silicon Hegemon: Could China Takeover Taiwan's Semiconductor Industry without Invading?. *Baker Institute*. https://www.bakerinstitute.org/research/silicon-hegemon-could-china-take-over-taiwans-semiconductor-industry-without-invading.

Cio, E. (2023, June 2). AI chips are hot. Here's what they are, what they're for and why investors see gold. ETCIO.com.https://cio.economictimes.indiatimes.com/news/next-gen-technologies/ai-chips-are-hot-heres-what-they-are-what-theyre-for-and-why-investors-see-gold/100698190.

Das Gupta, S. (2023, July 11) Foxconn in talks for 2 fab plants as the Vedanta joint venture fails. Business Standards. https://www.business-standard.com/industry/news/foxconn-in-talks-for-2-fab-plants-as-vedanta-joint-venture-fails-123071101103_1.html.

DiPippo, G., Mazzocco, I., Kennedy, S., Goodman, M. (2024, January 11).Estimating Chinese Industrial Policy Spending in Comparative Perspective. CSIS.

D'Cruze, D. (2023, June 10). What are 'germanium' and 'gallium' and why is China trying to restrict its export. Business Today. https://www.businesstoday.in/technology/news/story/explainer-what-are-germanium-and-gallium-and-why-is-china-trying-to-restrict-its-export-388280-2023-07-10.

Dangwal, A. (2023, May 11). US Threatens To 'Blow Up' Taiwan's Semiconductor Manufacturing Firm If China Invades The Island; Taipei Unhappy. The Eurasian Times. https://www.eurasiantimes.com/us-threatens-to-blow-up-taiwans-semiconductor-manufacturing/amp/.

De Vera, D. (2024, March 13). Strategic Ambiguity – Definition, importance, examples, and FAQs. Accounting Professor.org. https://accountingprofessor.org/strategic-ambiguity-definition-importance-examples-and-faqs/.

Ellis, S. (2020, October 8). Here's what could happen if China invaded Taiwan. The Print. https://theprint.in/world/heres-what-could-happen-if-china-invaded-taiwan/519324/.

Easton, I, (2017). The Chinese Invasion Threat: Taiwan's Defence and American Strategy in Asia. Camphor Press.

Editorial Team, Techovedas. (2024, March 9). India Enters Global AI Race, With Plans Of Developing Mega-Supercomputer Featuring 10,000 AI GPUs. Techovedas. https://techovedas.com/india-enters-global-ai-race-with-plans-of-developing-mega-supercomputer-featuring-10000-ai-gpus/.

ET Online. (2024, March 13). India Plans 10,000 GPU Sovereign AI Supercomputer. The Economic Times. https://m.economictimes.com/news/india/pm-modi-lays-foundation-stone-of-indias-first-commercial-semiconductor-fabrication-facility/articleshow/108453700.cms.

Eurasia Group. (2020). The Geopolitics of Semiconductors. *Eurasia*. 3-7. https://www.eurasiagroup.net/live-post/geopolitics-semiconductors.

Ernst, J. (2022). First stop Samsung: Biden touts South Korean role in securing global supply chains. Reuters. https://www.reuters.com/world/asia-pacific/biden-south-koreas-yoon-meet-amid-worries-about-north-korea-2022-05-19/.

Esaki, L. (1981). Highlights in Semiconductor Device Development. Ncbi. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6753011/ accessed on: December 25,2023.

Ellerbeck, S. (2023, February 20). *What's the difference between 'friendshoring' and other global trade buzzwords?*. World Economic Forum. https://www.weforum.org/agenda/2023/02/friendshoring-global-trade-buzzwords/#:~:text=Essentially%20friendshoring%20refers%20to%20the,to%20the%20flow%20of%20business.

FE Bureau. (2024, March 10). Applied Materials looks to sell equipments to India's first semiconductor fab. FinancialExpress. https://www.financialexpress.com/business/industry-applied-materials-looks-to-sell-equipments-to-indias-first-semiconductor-fab-

3420165/#amp_tf=From%20%251%24s&aoh=17100914364621&csi=0&referrer=https%3A%2F%2Fwww.google.com.

Federal Register. (2020, August 20). Addition of Huawei Non-U.S. Affiliates to the Entity List, the Removal of Temporary General License, and Amendments to General Prohibition Three (Foreign-Produced Direct Product Rule). Federal registrar. https://www.federalregister.gov/documents/2020/08/20/2020-18213/addition-of-huawei-non-us-affiliates-to-the-entity-list-the-removal-of-temporary-general-license-and.

Fritz, M. (2024, January 24). South Korea invests big in becoming a global chip leader. Dw. https://www.dw.com/en/south-korea-invests-big-in-becoming-a-global-chip-leader/a-68073870#.

Firstpost. (2024, April 10). Live: Pakistan Raises Kashmir in Saudi Arabia; Snubbed by Riyadh/ Vantage with Palki Sharma. https://www.youtube.com/live/DcFiTJirVuk?si=kxpR-GWM9k79abg1.

Fredly A. (2022, November 11).Top US General Warns China That Conflict Over Taiwan Will Be 'Bad Choice'. The Epoch Times. https://www.theepochtimes.com/china/top-us-general-warns-china-that-conflict-over-taiwan-will-be-bad-choice-4856949.

Godek, S. (2023, July 19). *Why China's Export Controls on Germanium and Gallium May Not Be Effective*. Stinson. https://www.stimson.org/2023/why-chinas-export-controls-on-germanium-and-gallium-may-not-be-effective/.

Gregory, A. (2023, May 3). China's New Strategy for Waging the Microchip Tech War. *CSIS*. https://www.csis.org/analysis/chinas-new-strategy-waging-microchip-tech-war.

Gargeyas A. (2022). The Role of Semiconductors in Military and Defence Technology. *Defence and Diplomacy*. 11(2). 44-50.

Horst, L. (2016, June 10). The Evolution of Taiwanese Identity. The diplomat. https://thediplomat.com/2016/06/the-evolution-of-taiwanese-identity/.

Holderness, A., Velazquez , N., Henry C. H. & Cook, C. (2023, July 7). Understanding China's Gallium Sanctions. *CSIS*. https://www.csis.org/analysis/understanding-chinas-gallium-sanctions.

Holderness, A., Velazquez, N., Carroll, H., and Cook, C. (2023, July 7). Understanding China's Gallium Sanctions. *CSIS*. https://www.csis.org/analysis/understanding-chinas-gallium-sanctions.

Herz, J. H. (1950). Idealist Internationalism and the Security Dilemma. *World Politics*. 2(2), 157–180. https://doi.org/10.2307/2009187.

Hoeren. T., Guadagno. F., Wunsch-Vincent. S. (2015). Breakthrough technologies- Semiconductor, innovation and intellectual property. *WIPO*. vol.(),8.https://www.wipo.int/edocs/pubdocs/en/wipo_pub_econstat_wp_27.pdf.

Hawkins, M. (2024, February 9). US to Launch $5 Billion Research Hub in China Chips Race. Bloomberg. https://www.bloomberg.com/news/articles/2024-02-09/us-to-launch-5-billion-research-hub-to-stay-ahead-in-chip-race.

Hisilicon. (2024). What is Hisilicon. https://www.hisilicon.com/en/aboutus/company.

Hunnicutt, T & Smith, J. (2022, May 21). First stop Samsung: Biden touts South Korean role in securing global supply chains. Reuters. https://www.reuters.com/world/asia-pacific/biden-south-koreas-yoon-meet-amid-worries-about-north-korea-2022-05-19/.

IANS. (2024, March 6). India's chip manufacturing progress under PM Modi begins to jolt China's dominance. investing. https://in.investing.com/news/indias-chip-manufacturing-progress-under-pm-modi-begins-to-jolt-chinas-dominance-4052683.

Ika, N. (2024, February 23). In A First For Huawei, *Nvidia Acknowledges Huawei As Primary Competitor In Official Filing; Nvidia VS Huawei, Who Will Win The AI Game?*. Inventiva. https://www.inventiva.co.in/trends/in-a-first-for-huawei-nvidia-acknowledges-huawei-as-primary-competitor-in-official-filing-nvidia-vs-huawei-who-will-win-the-ai-game/.

India as chipmaker for world: Govt approves semiconductor plant investments worth $15bn. (2024, March 1). WION. https://www.wionews.com/business-economy/india-approves-over-15-billion-worth-of-investments-in-semiconductor-fabrication-plants-695331#amp_tf=From%20%251%24s&aoh=17138515361724&referrer=https%3A%2F%2Fwww.google.com&share=https%3A%2F%2Fwww.wionews.com%2Fbusiness-economy%2Findia-approves-over-15-billion-worth-of-investments-in-semiconductor-fabrication-plants-695331.

Jervis, R. (1978). Cooperation Under the Security Dilemma. *World Politics.* 30(2), 167–214. https://doi.org/10.2307/2009958.

Jennings, R. (2024, March 28). China asks Netherlands, exporter of world's top chipmaking equipment, to avoid decoupling. SCMP.

https://www.scmp.com/economy/global-economy/article/3257118/china-asks-netherlands-exporter-worlds-top-chipmaking-equipment-avoid-decoupling.

Jue, S. (2016). Triangular Relations between U.S., China and Taiwan. *American Journal of Chinese Studies*. 23(2), v–ix. http://www.jstor.org/stable/44289152.

Ji, K. & Nauta, L. (2023, 14 June, 14). *Mapping Global Supply Chains – The Case of Semiconductors*. Rabobank. https://www.rabobank.com/knowledge/d011371771-mapping-global-supply-chains-the-case-of-semiconductors.

Kalita, P. (2023, December 9). Tata Eyes 40,000 crores Semiconductor Plant in Assam. TOI. https://timesofindia.indiatimes.com/city/guwahati/tata-eyes-rs-40000-crore-semiconductor-plant-in-assam/articleshow/105852066.cms.

Kshitij A. (2024, March 8). Semiconductor Space Looks Attractive; defence stocks likely to Produce Many Multibaggers in the Future: Rakesh Pujara. Economic Times. https://m.economictimes.com/markets/expert-view/semiconductor-space-looks-attractive-defence-stocks-likely-to-produce-many-multibaggers-in-the-future-rakesh-pujara/articleshow/108333088.cms.

Khairnar, B. (2021). *Whitebook on Semiconductor Industry.*

Kharpal, A. (2023, July 23). Apple supplier Foxconn's failed India chip venture shows how tough it is for new players. cnbc. https://www.cnbc.com/2023/07/24/foxconn-failed-india-chip-effort-shows-how-hard-it-is-for-new-players.html.

Kharpal, A. (2022, December 13). China brings WTO case against US and its Sweeping Chip Control Curbs as tech tensions escalate. CNBC.

https://www.cnbc.com/2022/12/13/china-brings-wto-case-against-us-chip-export-restrictions.html.

Kharpal, A. (2022b, September 21). The US and Allies are joining forces on Chips that could Stop China reaching the next level. CNBC. https://www.cnbc.com/2022/09/22/semiconductor-alliances-between-us-and-asia-could-hold-back-china.html.

Kim, S., Jacobs, J., & Lee, J. (2022, May 20). Biden Hails US-South Korea Alliance on Tour of Samsung plant. Bloomberg. https://www.bloomberg.com/news/articles/2022-05-20/biden-heads-to-asia-with-semiconductors-and-security-in-mind.

Kim, Y. & Rho, S. (2024, January 17). The US-China Chip War, economy-Security Nexus and Asia. Springer. https://doi.org/10.1007/s11366-024-09881-7.

King, L., Bergan, Mark., et., al. Brody, B., (2019, May 20). Top US Tech Companies Begin to Cut off Vital Huawei Supplies. Bloomberg. https://www.bloomberg.com/news/articles/2019-05-19/google-to-end-some-huawei-business-ties-after-trump-crackdown.

Kynge, J. (2019, August 23). Why the US has a lot to lose in a Tech War with China. Financial Times. https://youtu.be/5e3At_qhr_o?si=sXVmpGRRyci5Kj5p.

Koc, C., & Hawkins, M. (2024, March 8). Huawei Chip Breakthrough Used Tech from Two US Gear Suppliers. Bloomberg. https://www.bloomberg.com/news/articles/2024-03-08/huawei-chip-breakthrough-used-tech-from-two-us-gear-suppliers.

Koc, K., King, L., Deutsch, J. (2023, April 26). ASML, Europe's Most Valuable Tech Firm, Is at the Heart of the US-China Chip War. https://www.bnnbloomberg.ca/asml-europe-s-most-valuable-tech-firm-is-at-the-heart-of-the-us-china-chip-war-1.1912742.

Kaur, D. (2023, November 8). Huawei is poised to take up Nvidia's position in China's AI chip market. Techhq. https://techhq.com/2023/11/how-is-huawei-poised-to-take-up-nvidias-position-in-chinas-ai-chip-market/.

Kohli, V. (2023, September 13). Introduction to semiconductor manufacturing. Power and beyond. https://www.power-and-beyond.com/semiconductor-manufacturing-steps-explained-a-ebfb8f22238e055c7f98329eed1af49e/.

Kyodo, News. (2023, June 6). TSMC considering 2nd chip plant in Japan's Kumamoto: report. Kyoto News. https://english.kyodonews.net/news/2023/06/5281df6f9d4a-tsmc-considering-2nd-chip-plant-in-japans-kumamoto-report.html.

Kuo, M. A. (2023, August 7). *US and Taiwan: Semiconductor Supply Chain Partnership.* The diplomat. https://thediplomat.com/2023/08/us-and-taiwan-semiconductor-supply-chain-partnership/.

Liu, Q. (2023, November 30). How Huawei surprised the US with a cutting-edge chip made in China. FinancialTimes.https://www.ft.com/content/327414d2-fe13-438e-9767-333cdb94c7e1.

Liu, J., Mozur, P. (2023, August 4). Why TSMC Will Keep Its Roots in Taiwan, Even as It Goes Global. The New York Times. https://www.nytimes.com/2023/08/04/technology/tsmc-mark-liu.html.

Liu, J., Mozur, P (2023b, Feb 22). Inside Taiwanese Chip Giant, a U.S. Expansion Stokes Tensions. The New York Times. https://www.nytimes.com/2023/02/22/technology/tsmc-arizona-factory-tensions.html.

Lee Lanhee, J., el. Al, King, L., et. Al, Hawkins, M., et. Al. Deutsch, J. (2023, November 21). A New Front is Opening Up in the US-China Conflict over Chips. Bloomberg. https://www.bloomberg.com/news/features/2023-11-21tech-war-us-china-competition-moves-into-advanced-chip-packaging.

Langa, M. (2023, July 28). PM Modi wants India to become a hub of semiconductor industry. The Hindu. https://www.thehindu.com/business/Industry/50-financial-assistance-to-firms-setting-up-semiconductor-manufacturing-unit-in-india-prime-minister-modi/article67130911.ece.

Lualy, LI., Cheng Ting-Fang, C., Nikkei Staff. (2020, May 28). Huawei builds up 2-year reserve of 'most important' US chips. Nikkei. https://asia.nikkei.com/Spotlight/Huawei-crackdown/Huawei-builds-up-2-year-reserve-of-most-important-US-chips.

Lohr, S. (2023, October 4). Micron Pledges Up to $100 Billion for Semiconductor Factory in New York. New York Times. https://www.nytimes.com/2022/10/04/technology/micron-chip-clay-syracuse.html.

Lewis, J. (2022). Strengthening a Transnational semiconductor Industry. CSIS. Jstore.

Leswing, K. (2021, March 23). Intel is spending $20 billion to Building two new Chip Plants in Arizona. CNBC. https://www.cnbc.com/2021/03/23/intel-is-spending-20-billion-to-build-two-new-chip-plants-in-arizona.html.

Miller, C. (2022). *Chip War: Fight for the World's Most Critical Technology.* Simons &Schuster UK Ltd.

Miller, E. (2023). Why Washington Must invest in Domestic Compound Semiconductor Production. *Elsevier* .

Morris. P. (1990). *A History of World Semi-Conductor Industry.* Institution of Engineering and Technology.

Maire, R. (2024, April 4). *ASML moving to U.S.- Nvidia to change name to AISi & acquire PSI Quantum*. SemiWiki. https://semiwiki.com/semiconductor-services/semiconductor-advisors/343631-asml-moving-to-u-s-nvidia-to-change-name-to-aisi-acquire-psi-quantum/.

Moneycontrol (2024, March 8). *Gujarat's chip drive: Tata Group, CG Power get 188 acres for semiconductor plants, says report.* Moneycontrol. https://www.moneycontrol.com/news/business/gujarats-chip-drive-tata-group-cg-power-get-188-acres-for-semiconductor-plants-12422691.html.

Moneycontrol News. (2024b, March 8). *Decoding IndiaAI: Inside India's Rs 10,372-crore plan to boost AI infrastructure.* Moneycontrol. https://www.moneycontrol.com/news/business/decoding-indiaai-inside-indias-rs-10372-crore-plan-to-boost-ai-infrastructure-12423821.html.

Mishra, V. (2022). The 'chip war' is now embedded in US-China techno-economic rivalry. *ORF*. https://www.orfonline.org/expert-speak/the-chip-war-is-now-embedded-in-us-china-techno-economic-rivalry.

Mishra, V. (2022b). From Trump to Biden, Continuity and Change in the US's China Policy. *ORF*. https://www.orfonline.org/research/from-trump-to-biden-continuity-and-change-in-the-us-s-china-policy.

Mozur, P., Lui, J., & Zhong, R. (2022, August 29). The Eye of the Storm: Taiwan Is Caught in a Great Game Over Microchips. The New York Times. https://www.nytimes.com/2022/08/29/technology/taiwan-chips.html.

Montoya, M. (2023, August 5). *Chip War: Is there end to tit-for-tat China-US trade Restrictions*?[Youtube] AI Jazeera. https://youtu.be/vJWliXmSaAs?si=wtKZ_euZ1V28oOed.

Maizland, L. (2023, February 8). Why China-Taiwan Relations Are So Tense. *Council on Foreign Relations*. https://www.cfr.org/backgrounder/china-taiwan-relations-tension-us-policy-biden.

Murray, B & Al-Rikabi. (2023, June 22). Why Prospect of US-China 'Decoupling' Is Getting Serious. Bloomberg. https://www.bloomberg.com/news/articles/2023-06-22/what-is-us-china-decoupling-and-how-is-it-happening?embedded-checkout=true.

Murray, B & Al-Rikabi. (2023, August 11b). Why Prospect of US-China 'Decoupling' Is Getting Serious. Washington Post. https://www.washingtonpost.com/business/2023/08/11/what-is-us-china-decoupling-and-how-is-it-happening/e33f195c-3867-11ee-ac4e-e707870e43db_story.html.

Murray, W. S. and Easton, I. (2019) "The Chinese Invasion Threat: Taiwan's Defense and American Strategy in Asia," *Naval War College Review:* Vol. 72 : No. 1 , Article 10. https://digital-commons.usnwc.edu/nwc-review/vol72/iss1/10.

Muyard, F. (2024). The Formation of Taiwan's New National Identity Since the End of the 1980s – Scientific Figure on *ResearchGate*. https://www.researchgate.net/figure/Taiwanese-Chinese-Identity-1990s-2000s-various-surveys_tbl2_261557344.

McKinsey, J. M. (2023, June 2). TSMC's fate will indeed be at stake if China attacks Taiwan. Nikkiasia. https://asia.nikkei.com/Opinion/TSMC-s-fate-will-indeed-be-at-stake-if-China-attacks-Taiwan.

Mann, T. (2023, July 26). One Problem with America's Chip Ambitions: Not Quite Enough staff. The Register. https://www.theregister.com/2023/07/26/us_semiconductor_skill_shortage/.

Maire, R. (2024, April 4). ASML moving to US- Nvidia to Change name to AISi & acquire PSI Quantum. SemiWiki. https://semiwiki.com/semiconductor-services/semiconductor-advisors/343631-asml-moving-to-u-s-nvidia-to-change-name-to-aisi-acquire-psi-quantum/#:~:text=News%20report%20on%20operation%20Beethoven&text=The%20target%20location%20in%20the,not%20far%20from%20Tesla%27s%20headquarters.

Mark, J. & Roberts, D. T. (March 2023). United States-China Semiconductor Standoff: A Supply Chain Under Stress. *Atlantic Council*.

Nicholas, H. (2023, October 17) *Biden administration announces new restrictions on exporting AI chips to China*. Axios. https://www.axios.com/2023/10/17/biden-export-restrictions-ai-chips-china.

Nicosia, J. (2023). *The Ultimate Chip War: The Battle for Tech Supremacy, Exploring the History, Science and High Stakes Battle for Dominance in the Global Chip*

Industry.[ebook] Amazon Asia-Pacific Holdings Private Limited. https://www.amazon.in/ULTIMATE-CHIP-WAR-Supremacy-High-Stakes-ebook/dp/B0C1F6YZ8M?dplnkId=0db4b6c7-03ab-4c7d-899d-5c4cd95ca6f5.

Network, China. (2023, May 21). Micron Products Sold in China failed Cybersecurity Review. CAC. https://mp.weixin.qq.com/s/1ZxmaJsjqaorOfD37KiBmg

Nandi, T. (2023, July 11). Foxconn issues list of FAQs on why it parted ways with Vedanta and its future plans for India. Livemint. https://www.livemint.com/companies/news/foxconn-shares-a-list-of-faqs-when-why-it-parted-with-vedanta-for-make-in-india-semiconductor-plan-11689068618388.html.

Nohara, Y. (2024, February 21). Japan Bets $67 Billion to Become a Global Chip Powerhouse once Again. Bloomberg. https://www.bloomberg.com/news/features/2024-02-20/japan-s-67-billion-bet-to-regain-title-of-global-chip-powerhouse.

Nohara, Y. (2024b, February 21). Japan's chip spree aims to kick economy into high gear. The Japan Times. https://www.japantimes.co.jp/business/2024/02/21/tech/chip-spree-helps-japanese-economy/.

Nathaniel Garcia, J. (2023). Chip race: the political economy of semiconductors. *ResearchGate*. https://www.researchgate.net/publication/367433370.

O'Hanlon, M. E. (2022). Can China Take Taiwan? Why No one Really knows. Foreign Policy at Brookings.

Online, E. (2024, March 13). PM Modi lays foundation stone of India's first commercial semiconductor fabrication facility. The Economic Times.

https://m.economictimes.com/news/india/pm-modi-lays-foundation-stone-of-indias-first-commercial-semiconductor-fabrication-facility/articleshow/108453700.cms.

Oliveira, A. (2023, December 31). South Korea staging "decapitation drills" for possible assassination of Kim Jong Un. New York Post. https://nypost.com/2023/12/31/news/south-korea-training-for-assassination-of-kim-jong-un/.

Purkayastha Kalyan, B. (2023, December 10). Tata to invest ₹40,000 cr in Assam to set up semiconductor processing plant: CM. Hindustan Times. https://www.hindustantimes.com/cities/others/tata-to-invest-40-000-cr-in-assam-to-set-up-semiconductor-processing-plant-cm-101702192055759.html.

PTI. (2024, March 7). *Govt to train tribal students in semiconductor technology: Arjun Munda.* Moneycontrol. https://www.moneycontrol.com/news/business/govt-to-train-tribal-students-in-semiconductor-technology-arjun-munda-12420601.html.

PTI. (2024b, March 7). Government to train tribal students in semiconductor technology: Arjun Munda. Press Trust of India. https://www.ptinews.com/story/national/govt-to-train-tribal-students-in-semiconductor-technology-arjun-munda/1341151.

PTI (2024c, March 7). Govt to train tribal students in semiconductor technology. The Economic Times. https://m.economictimes.com/news/india/govt-to-train-tribal-students-in-semiconductor-technology-arjun-munda/articleshow/108298571.cms.

PTI (2024d, March 13). Govt is likely to come up with policy to incentivise semiconductor ancillary firms. Rajeev Chandrasekhar. The Economic Times. https://m.economictimes.com/industry/cons-products/electronics/govt-likely-to-come-up-with-policy-to-incentivise-semiconductor-ancillary-firms-rajeev-chandrasekhar/articleshow/108472248.cms.

Palmisano, Sam. US Semiconductor Race with China. Interview. Bloomberg. August 22, 2023.

Potkin, F & Zhu, J. (2024, February 5). Al Chip Demand Forces Huawei to Slow Smartphones Production. https://www.reuters.com/technology/ai-chip-demand-forces-huawei-slow-smartphone-production-sources-2024-02-05/.

Pathak, T. (2023, August, 27). *WION, India's Semiconductor Dream, A Reality Check.* [Youtube]. Wion. https://youtu.be/RqY0EoTj2DA?si=1vVGf6qs7EAQKY3V.

Pollard, J.(2023, May 26).Japan and US Agree to Cooperate on Advanced Technology. Asia Financial. https://www.asiafinancial.com/japan-and-us-agree-to-cooperate-on-advanced-technology.

Panda, A. (2022, August 15). South Korea's "Decapitation" strategy against North Korea has more risks than benefits. *Carnegie Endowment for International Peace.* https://carnegieendowment.org/2022/08/15/south-korea-s-decapitation-strategy-against-north-korea-has-more-risks-than-benefits-pub-87672.

Reuters. (2022, September 1). Taiwan president says she looks Forward to Producing 'democracy Chips' with US. Reuters. https://www.reuters.com/technology/taiwan-president-says-looks-forward-producing-democracy-chips-with-us-2022-09-01/.

Reuters. (2023, May 27). Washington and Tokyo Vow closer chip Corporation. The Print. https://theprint.in/tech/washington-and-tokyo-vow-closer-chip-cooperation/1597253/.

Reuters. (2023b, November 16). Xi told Biden Taiwan biggest, most Dangerous issue in Bilateral ties: US official. The Economic Times. https://m.economictimes.com/news/international/world-news/xi-told-biden-taiwan-is-biggest-most-dangerous-issue-in-bilateral-ties-us-official/articleshow/105247428.cms.

Rao, A. (2024, March 1). *India's Semiconductor Sector Welcomes Three New Manufacturing Units*. India-briefing. https://www.india-briefing.com/news/indias-semiconductor-sector-welcomes-three-new-manufacturing-units-31434.html/.

Reuters. (2024b, March 5). *China drops 'peaceful reunification' reference to Taiwan; raises defence spending by 7.2%.* Business Today. https://www.businesstoday.in/latest/world/story/china-drops-peaceful-reunification-reference-to-taiwan-raises-defence-spending-by-72-420078-2024-03-05.

Razdan, K. (2023, July 11). Foxconn exits US$20 billion Indian semiconductor joint venture, slowing country's global chip hub march. Scmp. https://www.scmp.com/news/asia/south-asia/article/3227238/foxconn-exits-us20-billion-indian-semiconductor-joint-venture-slowing-countrys-global-chip-hub-march.

Riordan, M., Hoddeson L. (1998). *Crystal Fire: The Invention of the Transistor and the Birth of Information Age.* [ebook]. W. W. Norton & company New York London.

Richard C. Bush, R. C., Hass, R., Kim, P. M., Liff, A. P., Melanie W., Lin, S. S., & Thornton, S. S. (January 17, 2024). He impact of Taiwan's election in 2024 and beyond. *Brookings*. https://www.brookings.edu/articles/the-impact-of-taiwans-election-in-2024-and-beyond/.

Russell, R. L. (2001, August 17). What if …"China Attacks Taiwan!". *Army war college.* Vol(31), no. 3 doi:10.55540/0031-1723.2055.

Resilinc Editorial Team. (2023, January 17). What would happen if China invaded Taiwan?. Resilinc. https://www.resilinc.com/blog/what-would-happen-if-china-invaded-taiwan/.

Reuters. (2023, February 25). Taiwan says 'Fab 4' chip group held first senior officials meeting. Reuters. https://www.reuters.com/technology/taiwan-says-fab-4-chip-group-held-first-senior-officials-meeting-2023-02-25/.

Roberts J. M. & Westad O. A. (2013). *The History of the World. Oxford University Press.*

Stangarone, T. (2023, April 13). The Role of South Korea in the U.S. Semiconductor Supply Chain Strategy. *Nbr*. https://www.nbr.org/publication/the-role-of-south-korea-in-the-u-s-semiconductor-supply-chain-strategy/.

Sehgal, A. (2023). Geopolitics of Semiconductor Supply Chains: The Case of TSMC, US-China-Taiwan Relations, and the COVID-19 Crisis. *Digital collection.* digitalcollections@sit.edu.

South China Morning Post. (2021, April 23). Scmp. US-China tech war: Everything you need to know about the US-China tech war and its impact. https://www.scmp.com/tech/tech-war/article/3130587/us-china-tech-war-everything-you-need-know-about-us-china-tech-war.

Shilov, A. (2024, January 19). *TSMC Posts Q4'23 Earnings: 3nm Revenue Share Jumps to 15%, 5nm Overtakes 7nm For 2023.* AnandTech.

https://www.anandtech.com/show/21239/tsmc-q4-2023-earnings-3nm-revenue-share-jumps-5nm-overtakes-7nm.

Shilov, A. (2023, May 16). *SMIC Removes Mentions of 14nm Node: US Sanctions at Work?*. Tomshardware. https://www.tomshardware.com/news/smic-removes-mentions-of-14nm-node.

Shattuck, T. J. (2020, November). Stuck in the Middle: Taiwan's Semiconductor Industry, the U.S.-China Tech Fight, and Cross-Strait Stability. *Foreign Policy Research Institute by Elsevier*. Doi: 10.1016/j.orbis.2020.11.005

Scott, M. (2024, January 9). War Over Taiwan Is a $10 Trillion Risk. Bloomberg. https://www.bloomberg.com/news/newsletters/2024-01-09/economy-risks-latest-taiwan-war-would-cost-world-10-trillion.

Shu, C. (2019, May 20). *Several chip companies, including Qualcomm and Intel, have reportedly stopped supplying Huawei after blacklist.* TC. https://techcrunch.com/2019/05/20/several-chip-companies-including-qualcomm-and-intel-have-reportedly-stopped-supplying-huawei-after-blacklist/.

South China Morning Post. (2021, April 23). *Scmp. US-China tech war: Everything you need to know about the US-China tech war and its impact.* https://www.scmp.com/tech/tech-war/article/3130587/us-china-tech-war-everything-you-need-know-about-us-china-tech-war.

Savov, V., Wu, D., (2024, January 5). Huawei Teardown Shows 5nm Chip Made in Taiwan, Not in China. Bloomberg. Huawei Teardown Shows 5nm Chip Made in Taiwan, Not China https://www.bloomberg.com/news/articles/2024-01-05/huawei-qingyun-l540-laptop-teardown-reveals-5nm-chip-by-tsmc-not-china-s-smic.

Swanson, A. (2022, September 6). Biden Administration Releases Plan for $50 Billion Investment in Chips. The New York Times. https://www.nytimes.com/2022/09/06/business/economy/biden-tech-chips.html.

Swanson, A. (2022b, August 3). Congress Is Giving Billions to the Chip Industry. Strings Are Attached. New York Times. https://www.nytimes.com/2022/08/03/business/economy/chip-industry-congress.html.

Swanson, A., Clark, D. (2024, February 19). U.S. Awards $1.5 Billion to Chipmaker GlobalFoundries. The New York Times. https://www.nytimes.com/2024/02/19/business/economy/biden-administration-1-5-billion-chipmaker-globalfoundries.html.

Singal, N. (2024, February 15). Why Assam makes sense for Tata's semiconductor packaging plant. Business Today. https://www.businesstoday.in/technology/story/why-assam-makes-sense-for-tatas-semiconductor-packaging-plant-417712-2024-02-15.

Singal, N. (2024b, February 4). India's semiconductor manufacturing: Has a strong foundation been laid?. BussinessToday. https://www.businesstoday.in/magazine/deep-dive/story/indias-semiconductor-manufacturing-has-a-strong-foundation-been-laid-416123-2024-02-04.

SIA, Report. (2023). INDIA SEMICONDUCTOR SECTOR: Increasing India's Role within the Global Semiconductor Value Chain. *Semiconductor Industry Association.*

Singh, H. (2024, March 8). *What is ChipIN : C-DAC's Secret Weapon to Train over 85,000 Chip Designers in India.* Techovedas. https://techovedas.com/what-is-chipin-c-dacs-secret-weapon-to-train-over-85000-chip-designers-in-india/.

Srikant, A., Sur, A. (2024, March 9). *Nvidia committed to supporting IndiaAI Mission, says Ashwini Vaishnaw*. Moneycontrol. https://www.moneycontrol.com/news/technology/nvidia-committed-to-supporting-indiaai-mission-says-ashwini-vaishnaw-12428941.html.

South China Morning Post. (2021, June 8). US-China tech war: Everything you need to know about the US-China tech war and its impact. South China Morning Post. https://www.scmp.com/tech/tech-war/article/3130587/us-china-tech-war-everything-you-need-know-about-us-china-tech-war.

SMIC-*About SMIC.* (2024). https://www.smics.com/en/site/about_summary.

The Hindu Bureau. (2023, July 10). Foxconn withdraws from India's semiconductor joint venture with Vedanta. The Hindu. https://www.thehindu.com/business/Industry/foxconn-withdraws-from-indias-semiconductor-jv-with-vedanta/article67064177.ece.

Telecom lead. (2023, July 10).Why Foxconn drops $19.5 bn semiconductor JV with Vedanta?.https://www.telecomlead.com/semiconductor/why-foxconn-drops-19-5-bn-semiconductor-jv-with-vedanta-111180 .

Thomas, C. (2021, January 7). Lagging but motivated: The State of China's Semiconductor Industry. *Brookings*. https://www.brookings.edu/articles/lagging-but-motivated-the-state-of-chinas-semiconductor-industry/.

Thadani, A., Allen, G. (2023, May 30). Mapping the Semiconductor Supply Chain: The Critical of the lndo-Pacific Region. *CSIS*. https://www.csis.org/analysis/mapping-semiconductor-supply-chain-critical-role-indo-pacific-region. Accessed on January 11, 2024.

The Economist (2024, February 13). China is quietly reducing its reliance on foreign chip technology. The Economist. https://www.economist.com/business/2024/02/13/china-is-quietly-reducing-its-reliance-on-foreign-chip-technology. Accessed on February 15, 2024.

Times of India (2024, February 5). How This Open-Source Technology May Help China Reduce US Dependence For AI Chips. TOI. https://timesofindia.indiatimes.com/gadgets-news/how-this-open-source-technology-may-help-china-reduce-us-dependence-for-ai chips/articleshow/107433069.cms#amp_tf=From%20%251%24s&aoh=17079765674207 &referrer=https%3A%2F%2Fwww.google.com&ampshare=https%3A%2F%2Ftimesofin dia.indiatimes.com%2Fgadgets-news%2Fhow-this-open-source-technology-may-help-china-reduce-us-dependence-for-ai-chips%2Farticleshow%2F107433069.cms. Accessed on February 15, 2024.

Tsai, M. & Ke, W. (2024, March 5). *Can Huawei Fill the Gap in the Chinese AI Market left by Nvidia amid US restrictions*. Digitimes. https://www.digitimes.com/news/a20240305PD202/huawei-ai-chip-china-nvidia.html.

TechInsights. (2023, November 17). *When Huawei Shocked America With a Smartphone*. https://www.bloomberg.com/news/videos/2023-11-16/when-huawei-shocked-america-with-a-smartphone-video.

Tang, S. (2009) The Security Dilemma: A Conceptual Analysis, Security Studies. *Taylor & Francis Online. Springer.* 18:3, 587-623, DOI: 10.1080/09636410903133050

Thorbecke, C. (2023, October 18). The US is spending billions to boost chip manufacturing. Will it be enough?. CNN Business. https://semiwiki.com/semiconductor-services/semiconductor-advisors/343631-asml-moving-to-u-s-nvidia-to-change-name-to-aisi-acquire-psi-quantum/.

Tan, O. (2024, March 1). ASEAN sighs with relief after Taiwan's election. *East Asia Forum*.

Tsoi, T., Alloway, T, & Weisenthal, J. (2024, January 17). Here's What Could Happen If There's a War Over Taiwan. Bloomberg. https://www.bloomberg.com/news/articles/2024-01-16/here-is-what-could-happen-if-there-s-a-war-over-taiwan.

Toru, K. (2021, September 22). Hong Kong's National Security Law: An Attack on Civil Society. Nippon. https://www.nippon.com/en/in-depth/d00746/.

The Transistor- Linda Hall Library. (2022, December 16). The Linda Hall Library. https://www.lindahall.org/about/news/scientist-of-the-day/the-transistor/.

Taiwan. (2024). https://ai.stanford.edu/~latombe/mountain/photo/taiwan/penghu.htm.

Vengattil, M., Karla, A., Lee, J. (2023, June 1). Modi's chip making plan flounders as firms struggle to find tech partners. Reuters. https://www.reuters.com/world/india/india-chip-plan-stalls-after-tower-intel-deal-setback-modi-2023-05-31/.

VerWey, J. (2019). Chinese Semiconductor Industries Policy: Past and Present. *Journal of International Commerce and Economics*.

Vyrian. (2022). *What nm stands for in a processor? And why it is important?*. Your world integrated. https://www.vyrian.com/what-nm-stands-for-in-a-processor-and-why-it-is-important/ accessed on January 6, 2023.

WION. (2023) *TOP 10 Semiconductor Manufacturing countries in the World.* https://www.wionews.com/web-stories/trending/top-10-semiconductor-manufacturing-countries-world-1684252921932.

Weinstein, E. (2023, January 21). The Role of Taiwan in the U.S. Semiconductor Supply Chain Strategy. *Nbr*. https://www.nbr.org/publication/the-role-of-taiwan-in-the-u-s-semiconductor-supply-chain-strategy/.

Webb, A. (2023, November 17). When Huawei Shocked America With a Smartphone. Bloomberg. https://www.bloomberg.com/news/articles/2023-11-16/when-huawei-shocked-america-with-the-mate-60-pro-smartphone.

Wang, O. (2023, December 13). China files WTO suit against US over chip export controls, saying policy is 'trade protectionism' | South China Morning Post https://www.scmp.com/news/china/article/3203066/china-files-wto-suit-against-us-over-chip-export-controls-saying-policy-trade-protectionism.

Wheatley, M. (2019, July 13). *Qualcomm suffers as Huawei ban and 5G transition hurt sales*. Siliconangle. https://siliconangle.com/2019/07/31/qualcomm-suffers-huawei-ban-5g-transition-impact-sales/.

Welch, J., Leonard, J., Cousin, M., DiPippo, G., & Orlik, T. (2024, January 8). Xi, Biden and the $10 Trillion Cost of War Over Taiwan. Bloomberg.

https://www.bloomberg.com/news/features/2024-01-09/if-china-invades-taiwan-it-would-cost-world-economy-10-trillion.

WION (2022, September 24). US and allies join forces on semiconductor supply to stop China's advancement. Wion. https://www.wionews.com/world/us-and-allies-join-forces-on-semiconductor-supply-to-stop-chinas-advancement-519309#amp_tf=From%20%251%24s&aoh=17106520474374&referrer=https%3A%2F%2Fwww.google.com&ampshare=https%3A%2F%2Fwww.wionews.com%2Fworld%2Fus-and-allies-join-forces-on-semiconductor-supply-to-stop-chinas-advancement-519309.

Google Cloud. *What is artificial intelligence (AI)?,* (2024). Google Cloud. https://cloud.google.com/learn/what-is-artificial-intelligence.

5G FAQ. (2024). *What is 5G?, Everything You Need to Know.* Qualcomm. https://www.qualcomm.com/5g/what-is-5g.

Xavier, J. (2024, March 14). Qualcomm expands its chip design facility in Chennai with a focus on developing next gen WiFi technologies. The Hindu. https://www.thehindu.com/sci-tech/technology/qualcomm-expands-its-chip-design-facility-in-chennai-with-a-focus-on-developing-next-gen-wifi-technologies/article67950527.ece.

Xue, M. (2023, July 26). *De-risking Comes With New Risks.* China US Focus. https://www.chinausfocus.com/foreign-policy/de-risking-comes-with-new-risks.

Yuan, G. & Wu, D. (2024, March 22). Huawei Tests Brute-Force Method for Making More Advanced Chips. Bloomberg. https://www.bloomberg.com/news/articles/2024-03-22/huawei-tests-brute-force-method-for-making-more-advanced-chips.

ZEISS Group. (2024). *About Zeiss*. https://www.zeiss.com/corporate/en/home.html.