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# Semiconductors and Artificial Intelligence: An Analysis of Global Power, Security, and Strategic Competition

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***Abstract-*** ***AI Infrastructure is a critical component of our modern lives, defining the backbone of innovation and aiding in the transition from traditional systems to those powered by AI.AI Infrastructure is the backbone of innovation and a vital part of our modern lives that is helping to bridge the gap between traditional systems and those driven by AI.Production of microelectronics is one of the old-fashioned macro-geopolitical and macro-economic issues. Twenty-first-century paradigms. In this doctoral thesis, an attempt is made to the detailed and An in-depth study of this complexity of the technical crossing, in a critical way, assessment of the strategic position of the existing and new economic powers –Within an increasingly globalized world—this is an essential element of the 1970s revolution in world politics.This is a vital part of the 1970s revolution in world politics, in an increasingly globalized world.A fragmented and fragmented semiconductor market.A fragmented and decentralized semiconductor market. Comprehensive solutions are available for the use of a large compendium. official technology policy, quantitative industrial analytics, and institutional literature,The systemic competitive dynamics, supply chain and customer dynamics are revealed in this investigation.deficiencies, processes and collaborations with various stakeholders involved.The development of the modern Microchip industry. The experimental data indicate that the world microelectronics industry exhibited the following characteristics. Revenue in FY 2025 was $791.7 billion, the largest amount yet. Based on mathematical projections, there are severe structural imbalances on the horizon that will reach the $1 trillion mark by 2026.continue to endure. In that place, the quality of the manufacturing capability remains high throughout a geographical area. All of these are located in specialized companies and nodes in specific regions. Ultimately, this the clear strategic guidance for private, institutional architects is identified by dissertation. The stakeholders were targeted for engineering resilient, balanced and technologically sovereign. A technological structure that would be able to support an equitable global technological development. The term artificial intelligence, semiconductors, geopolitical competition and supply chain are used. Furthermore, there is potential for various emerging technologies to influence.***

***Key Words:*** ***Resilience, Semiconductor Governance, India's Semiconductor Mission, Export Controls, Policy and Technology.***

## I. INTRODUCTION

1.1 The strategic landscape of AI and semiconductors is evolving rapidly

AI and semiconductors are changing quickly. With the middle of the previous century, the solid-state transistor was invented.Leading a technological paradigm shift which was epochal and affecting the whole world economic landscape.Redrafted national defence ideas and concepts, and reorganized the sphere of human influence. civilisation. Microelectronic semiconductors are microscopic electronic structures that are engineered to have developed a connection between electrical signals and can do complex digital processing— (Charles D. Grier and John C. Riddley (1992) refer to themselves as the physical understructure of modern institutions. These architectures are integrated in a wide range of essential technologies,From everyday consumer microelectronics to sophisticated imaging systems and state-of-the-art medical equipment. From everyday consumer microelectronics to the latest medical equipment and elaborate imaging systems.intelligence technology for the military field and for the foundations of cutting-edge artificial intelligence technology.Intelligence models (Maksakova, 2025). This is because computational models have been getting larger over the years and they became more and more.

Over the past decade, there has been a strategic need for advanced microchips that power. These

calculations have been increasing this year. This fact has now set off very aggressiveThe development of the national system is contested by nation-states, corporate monopolies and multilateral bodies of governance. The national system is subject to competition from nation-states, corporate monopolies and multilateral governance bodies.to have sovereign influence in the global semiconductor value network and supply chain.The institutionalisation of architectures of ML as a systemically.An economy and a state security based on a technology that changes the life is a basic part of life.The rules on purchasing industrial hardware. Unlike, as opposed to.classical consumer technology industries that are based on well-known product cycles,The demand based on machine learning, linear adoption metrics and structured obsolescence curves is structurally distinct. It is one of the domains with tremendous growth in raw computing power.Extreme workloads, special hardware configurations and management focus.Interdependencies between the chip architecture design, physical foundry fabrication and physical layout design that determines performance and creating the frameworks for deployment of ultimate downstream in 2025. Highly specialized silicon.The most noticeable accelerators are the accelerated graphics processing units (GPUs), some of the new releases of which include the massively parallel graphics processing units (GPUs).

AI and semiconductors:
The strategic landscape of the fourth part.Strategic landscape of AI and semiconductors 4. The experts that are helping to drive the markets they're in, like Nvidia (and other players) are essential and indispensable. Breaking the boundaries of deep neural network training, natural language processing, sophisticated speech recognition and other cutting-edge technologies.

Advanced autonomous systems, complex machine vision systems. Consequently, regular and the access to the latest generation of semiconductor foundries, the most advanced, has been raised to a new level of importance.For the national security of the country it is crucial (Maksakova, 2025). Such as integrating the use of industrial process with Nvidia's H100 part hardware accelerator provides thousands of specially designed processing cores that are optimised for this. Deliver enormous power in a parallel computer, which was believed to be unachievable.This .A new breakthrough in hardware allows institutions to accomplish complicated deep model preparing.Normally, models can't be mathematically demonstrated, in limited timelines. unfeasible.This close integration of the execution of machine learning with microelectronics poses a special challenge.The inevitable geopolitical tension that has been emerging from manufacturing. The landmark policy.Unilateral restrictions in the form of an implementation by the United States government in October 2022, of wide purview.Additionally, export controls will continue to limit the movement of frontier computing logic and of advanced lithographic technology.At the same time the transfer of frontier computing logic and advanced lithographic technology will remain limited by export controls.

A decisive moment in the major shift in the balance of power in the world, in favor of the People's Republic of China.Paving the way to tech-related commerce securitisation. This was a change in regulation from a rule, so it was a new thing. Make the technology environment for commerce and transactions a domain of geopolitics and statecraft.Turn the business-tech environment into a geopolitics and statecraft arena. Make the tech environment of transactions and business a geopolitical, statecraft environment. economic containment (Yee, 2025; Gomes, 2025). These unwelcome moves in the legislature have had Went on for a prolonged period; became a stimulant to macroeconomics. These have been responsible for a vigorous reaction with the product and are known as structural reactions.strategies in a number of independent countries (India, Republic of Korea, Japan and the EU member countries to dole out State funds to the domestic economies. We welcome the Japanese government and the members of the European Union (EU) to invest in the domestic economies. Fabrication plants create local assembly ecosystems and purposely insulate themselves.From very concentrated and high risk foreign manufacturing centers.

1.2 The rationale and importance of the research

The new challenges facing macroeconomic and strategic analysis from modern artificial
A dozen or more intelligence development and hardware foundry paths.Limitations of the software- and computing engineering fields. There are serious sliding logistics.The COVID-19 pandemic (2020-2021) disruptions around the world and the fragility of the very highly globalised industrial business models had been evident from 2022. These upset created a short-term deficit in different areas such as industrial, commercial, residential and public-private. It demonstrates the potential dangers of uncertainly in industries ranging from car-making to high-tech medical equipment.It gives an example of the uncertainty of risks, whether in the automotive industry or in the complex medical technology platforms. This is connected to the high concentration of geographies for advanced microchip production (PwC, 2024).

As machine learning models will be technically scaled up and operationally proliferated across Institutional economy, critical questions of the sovereign entities that dominate, construct and manage. The importance of these special chips to carry out these procedures to the state level is gigantic. The three elements of national independence, military strength and competitiveness. The last forecast that has not proven correct is that microelectronics industry will become a huge $1 industry. This will be an industry of the trillion by 2030 – an extraordinary size economically technological frontier. The very cyclical nature of the supply and demand of the sector, Consistent with the importance of the use of rigorous, empirically grounded technology, structural imbalances are made evident. policy assessments. While there are academic scholarships and policy assessments on this issue at the institutional level, these responses are limited.Limited academic answers and institutional policy evaluations on this issue also exist.While there has been a marked expansion of topic, there is still a major analytic constraint. The vast With the exception of the very fine grained, most modern research is still limited to engineering difficulties of creating sub-nanometer nodes, the binary zero-sum geopolitical rivalry playing out between Washington and Beijing. In this dissertation, an intentional step is taken to fill this gap in analysis. In this study, a complete academic system is followed, Knows and interprets new industrial policies in new markets and looks at the multilateral approaches to international policies. courses the future of manufacturing.governance mechanisms, and evaluates the structural manufacturing constraints of the future that are very harsh.Capital expenditures for silicon in regions. For this reason, this research will attempt to give a more systematic, correct and complete knowledge of the complex macrostructural Currents are shaping the world paradigm of artificial intelligence and semiconductors.

### 1.3 Research Questions

To offer a well-structured and disciplined structure to this research, the research Trajectory is structured according to four major questions:

1. How has the number of machines grown exponentially in actual structural forms? Learning architectures changed the economic value models and national security in a fundamental manner.
2. What could be the implications of a global manufacturing of semiconductors?
3. What are the most accurate industrial strategies, and public incentive frameworks which are primary national in Five countries—actually the United States, China, South Korea, India and the United Kingdom—account for more than half of the world's actors?
4. Do you have any ongoing efforts in place for dealing with supply chain risks or geographic vulnerabilities?
5. What are the particular structural cost, friction and manufacturing realities that Limit investments in advanced semiconductors in the West?
   In an industrial setting, in what ways, and to what extent, are these limitations being dealt with, and what strategies are being developed to counter them?
6. How are international governance organizations organized internationally and regional states trying to control new computing power and particular the volatile

Are the advanced hardware battles threatening the geopolitical situation?

1.4 The Dissertation should have the following structure:

The structure of the intellectual process of realization of this study is organized in six logical chapters so that it can be used as a guide in the study process.

- Systematic exploration Chapter 1 sets up the wide-ranging introduction, clarifying The research value and the questions to guide enquiries.
- Chapter 2 explains a profound The analysis of the current academic/institutional writing and thinking was carried out analytically and traced back to its sources and the need for architecture to serve modern computing needs, Institutional context of global tech-governance.
- The academic is presented in Chapter 3 Explanation of the methodology, including the qualitative research methodology, scientific selection of secondary data.The data and the theoretical frameworks used for interpreting the data.
- Chapter 4 presents some fundamental empirical The results of the study are presented in an orderly manner, on each of the six analytical pillars.
- Chapter 5 A critical interpretative analysis of these findings, and an interpretation of the direct implications for the purposes of this study, is provided and the emerging state economies, multilateral regulatory institutions and the global technology stakeholders.
- Finally, the main results of the dissertation are presented in Chapter 6, which is followed by a formulation of the dissertation's own specific influences on technological policy research, and sets clear guidelines for future.
- academic research.

## II. LITERATURE REVIEW

### 2.1 The Birth of Silicon Valley

The evolution of semiconductors from a theoretical, one-lab industry to a mass-market one, has been shaped by the following factors.The following factors have influenced the evolution from a one-lab, theoretical semiconductor industry to a mass-market one. curiosity during the late 1940s into the vital infrastructure of the globalized macroeconomy has the ongoing pursuit of micro-economic optimisation, the huge amounts of capital, and the automation of work enabled by technology have been the defining features of this condition. Pools and extreme industrialization. During Fiscal Years (FY) 2000 to 2019,The industry worldwide saw an historic growth in aggregate economic profit. climbing from some $38 billion to an extraordinary $450 billion, largely due to the back-to-back rises.There are waves of digitization in place, from cellular telephony, consumer personal computers, and there are wide-spread enterprise server deployments (Mahindroo, 2025). This is a historic trajectory that has been created by this and the basis of modern mathematical models that predict the total industry revenues, which are scaled up to an By 2040, that will grow to be immense $2.4 trillion,This forecast takes into account the all pervasive fusion and One day, silicon processing units would be incorporated into commonplace devices, and the enormous economic value of such integration would be ensnared.For next generation, hyper advanced computing logic architectures. One of the most fundamental facts in today's semiconductor business is the extreme fragmentation,A very unequal distribution of the profit from the market. Rigorous corporate performance analytics reveal that a small, elite tier of the top 5% of the world's performance. Silicon companies – and more specifically hyper-specialist companies such as Nvidia, TSMC, Samsung. The entire positive economic value of the sector was dominated by electronics, Intel and AMD. During calendar year 2024, the Company made a profit. In contrast, the other ninety-five percent of the world's population was the remaining ninety-five percent.

During corporate distribution, the economic value creation was either flat or declining (Mahindroo,2025). This extreme Capitalization profile is a good example of just the many, many benefits These benefits have been enjoyed by the first-mover frontier firms. These benefits are seen as staggering capital scale, multi billion-dollar yearly R&D outlay, deep IP barriers, and an array of other

factors are also playing a role.locked-in long-term client relationships, forming almost insurmountable barriers to entry for external corporate competitors. At the same time, the traditional operating model of Moore's law which was traditionally based on a “double every 18 months” rule, where the count of transistors on a chip would double predictably every 18 months.The silicon has started to crack about once every 24 months. This physical barrier has pushed the industry into a very complicated engineering environment with all the potpourri of diversity. Advanced silicon integration, multi-layered 3-D design topologies, and hyper-complex advanced material costs.packaging methodologies that further intensify required upfront capital expenditure and raw material costs. manufacturing complexity (Begue, 2025). Those organizations that are not able to keep up this pace of the market shares of frontier technical capital deployment have been quickly eroded. The graphic is an example of the winner-take-most nature of today's microelectronic commerce.

2.2 Artificial Intelligence as a Promoter of Transformational Innovation

The wide use of deep learning networks in various industrial fields is even accelerating. Verticals have produced patterns of semiconductor component demand which are quite distinct,Not from the cyclical fluctuations that have been seen typically in classical consumer goods markets. High-distribute end machine learning processing workloads—most notably, the heavy workload of machine learning training. Readers can also expect to learn about the massive large language models (LLMs) and multi-modal generative inference, which is currently live.Software platforms require terrific amounts of ongoing parallelised computation. These routines require tremendous high memory architecture bandwidths and customized hardware layouts optimised for sophisticated neural layer operations and matrix-tensor multiplication, rendering Advanced computing has been taken over by mostly classical sequential x86 general purpose central processing units. workloads (Futuriom, 2024). This change in the structural architecture has had a major impact on highly parallelized graphics processing units and customized silicon accelerators—including specialized neural to the absolute processing units (NPUs) and field-programmable gate arrays (FPGAs).

Heart of the world's microelectronic purchasing pipeline.

The continuous development shift to more sophisticated agentic machine learning platforms —systems that can be used to make highly autonomous decisions depending on the context, manage long-term multi-A significant frontier is the ability to step through logic paths, and to interact with “real world” environments in real time. software engineering that is sure to increase the structural need for highly resilientsilicon accelerators (Gomes, 2025).

Municipalities are widely using public firms and public bodies to achieve their goals.Public corporations and state institutions are being widely used to deliver on the government's agenda.These standalone digital agents can automate very complex operational workflows throughout the world. Markets for finance, heavy industry, international supply chain logistics, and healthcare diagnostics. The overall compute demands of the local server infrastructure will continue to scale up in production.

Exponentially as a result, the specialized artificial intelligence silicon market was the expected $56.42 billion in trade of these products and services in the 2024 fiscal year can be quantitatively calculated as.The total amount is expected to reach an enormous $232.85 billion by the year 2034, a compound annual growth rate of 2.3 percent. significant advances in the growth rate with the structural integration of deep learning architectures and their corresponding frameworks.significant advances in the growth rate with the structural integration of deep learning architectures and their corresponding frameworks. Consumer and industrial electronics are expected to be the primary application areas for edge computing (Precedence Research, 2024). Beyond the physical components of these programs or processes that are used to run the computations, also known as raw computational components; hyperscale server centers, distributed cloud compute architectures, and very capable consumer.edge devices—has turned into

an active hub of vast capitalization. Institutional tracking suggested that the total amount of money being invested by the big global cloud service giants in the cloud would reach.The number of workers in the sector is projected to rise by an impressive 36 percent in 2024, which will be driven by the growth in construction. specialized artificial intelligence data centers, and global GPUs' procurement targets are forecasted to Supply grows by 200 percent by 2026, thanks to the increasing importance of machine learning models in daily business software (Bain, 2024).

The addition of local hardware-accelerated processing power:
The expected response of an aggressive replacement cycle from features in consumer hardware is expected to drive the mobile device market.The mobile device market is expected to be driven by features in the consumer device market. for personal computers and cellular smartphones, the sales growth is anticipated to be 31 percent and 15 per cent, respectively, between 2023 and 2026 (Bain, 2024).

2.3 The importance of high-performance microchips
The importance of high-performance microchips couldn't be more critical and so they have been taken out of the equation for good to make them active and dynamic agents rather than 'neutral' and commercial products. The instruments of State strength and geopolitical competition. The wide-spreading unilateral application of drugs is not recommended. The export containment policies of the United States Bureau of Industry and Security (BIS) were established in 2022.deliberately attacked the flow of frontier computing logic and sub-nanometer lithographic to promote the equipment in China. This change of structure to the intervention was for a reason.The reason for this change of structure to the intervention was a change. Explicitly integrated national defense priorities of technology trade. They have gone into business (Yee, 2025). The BIS has adopted a confrontational attitude in this regard in the following four quarters. Updatable regulatory guidance on specific high performance domestic integrated circuit. Made in China – specifically Ascend 910B, 910C and 910D silicon processors by Huawei that is Being active targets of export denial regime. These types of rules enact warnings concerning severe. Direct criminal prosecutions and sanctions, prosecutions and sanctions, and indirect consequences like international legal ramifications when a company is not complying with the regulations prosecution, financial penalties of millions of dollars against the company, and even cancelation of the company's license.The west's export privileges (BIS, 2025).

The Chinese state has been strengthening its own strategy, which is to accelerate domestic.Self-sufficiency in semiconductors with a particular focus on coordinated investments, while relying heavily on government capital investment. The National Integrated Circuit Industry Investment Fund (ICIIF) or popularly known as the Big Fund has directed its funds.Significant investment of money in the development of small electronic components in the country, and Institutional targeting to raise the percentage of domestic production to 50% in all.The demand for silicon is expected to reach 38.37 MT in 2025 (Economics Observatory 2024). Although domestic champions like SMIC have made excellent advances in manufacturing in proven legacy manufacturing environments.An emerging business model nodes and downstream assembly, testing and packaging (ATP) was successfully captured by China.The conventional capacity utilisation is about 75 per cent, which is very critical.Some structural engineering bottle necks remain. Most importantly the overall ban on buying state-of-the-art advanced EUV lithography machines from niche European companies.Despite how much effort the Chinese foundries have expended on these efforts, the companies with monopolistic power (such as ASML) make it impossible for them to produce sub- reliable.

Introducing five nanometer silicon configurations at commercial scale, thus setting a cap on them.Able to provide computing frontiers (Economics observatory, 2024). Consequently, China is still a big net importer of advanced processing logic. It was too big, however, and it expanded into a tremendous expansion of its sort.There is a challenge to the economy because of the current mid-tier legacy node manufacturing capacity.Farmers from all over

Taiwan, South Korea and Japan. This wide-fetched concept of technological a sovereign nation or region that thinks in terms of 'nationalism' is one that imagines, tries to attain and defends a national interest.The development of critical digital technologies, away from risky foreign influences—has proliferated. Much further than the U.S.-China axis. It is a philosophy that is pushing the multi-billion dollar silicon industry.It's a philosophy that's actively shaping the multi-billion dollar silicon industry.In all four, EU, India, Japan and South Korea have adopted policies of industrial policy.European Union, Japan and South Korea have had industrial policy programs in place and in India, it was adopted for the last one year (Shamaei, 2024).

2.4 The modern revolution of the microelectronics industry

Digital transformation is not something new, it's been around since the early 2000s.The modern revolution of the microelectronics industry is closely connected to the invention of the microcomputer.Microcomputers and the modern revolution of microelectronics are intimately related,Within a broader structural digitalisation of a larger macroeconomy. Long-term demographic percentage of people with access to and use of technology in the world will be around 75 percent by 2030.People will be hooked on the Web and linked up to a huge ecosystem of over 50 billion.interconnected digital devices. This super-connected experience will create unprecedented quantities of Data that will require very complex computing logic, In the future, high-bandwidth networking microchips (Linden,2024). Within the modern-day economic analysis, information has come to be a key strategic instrument.value that fuels economic growth and development in the world.Raw commodity like oil, it's the value that is essential and needed as the base of economic growth and development in the world.The data needed to train complex machine learning architectures and establish sustainable.Commercial differentiation is seen in every aspect of an enterprise today (Linden, 2024). This structural digital transformation, or the complete restructuring of business processes, is a growing trend across industries.The trend of digital transformation —also known as the reorganization of business processes—is becoming widespread in the industry has established a new standard in operational business models and in positioning the business in the market through digital technologies. The electronic access - from a classic logistics point of view to an integral requirement of baseline industrial survival.In the world of small and medium businesses, and large multinational companies, the global. Alibaba and Shopify are just two of the scaled digital infrastructure platforms that have taken over. Re-wrote Micro-economics Concepts related to International trade. These internet portals make it possible to an easy-to-navigate market, and lower costs of historical transactions and intermediaries towards technology in International business (2025). Computing systems is expected to grow as well.At the same time, the practical scale of cloud computing systems is anticipated to rise.The key technologies are the Internet of Things (IoT), decentralized cryptographic ledgers, and architectures, the industrial Internet of Things (IoT), and decentralized cryptographic ledgers.There are a lot of optimization possibilities with automated business analytics. However, these systems at the same time create an increasing need for the so-specialized microchips that enable such remote architectures. The development of the modern semiconductor industry has been like a flower.

Semiconductors are an expanding industry and this became a very complex, nonlinear circuit. It's not just some reaction to the present and this industry is driven by the trends in electronics consumption and engineering innovations in machines mainly driven by electronic consumer spending trends, engineering breakthroughs within machine.The next generation of learning and are being shaped by high performance server architectures. Industrial technology development lifecycles (PwC, 2024).

2.5 International governance and regulatory structures

The world oversight of advanced computing technologies and vast microelectronic.

For them, the supporting infrastructure is a space that is now highly Polarized and competitive: international diplomacy. As a result of the creation of

multilateral institutions like the United Nations, UNESCO, High level ethical guidance and norms have been developed by OECD and other Organizations to ensure safe implementation of AI. Unlike the regional legislative units (such as the European Union). Regulatory mechanisms are highly restrictive, legally binding regulatory processes that Union have decided to implement (UNDP,2025). The U.N. High Level Advisory Body on Artificial Intelligence was established in 2023, and its website is currently being taken down.The U.N. High Level Advisory Body on Artificial Intelligence was established in 2023 and its website is now being taken down and made authoritative warnings of significant structural mismatch between exponential and the development curve of frontier computing software coupled with the highly reactive and unresponsive oversight.The regulatory power of today's regulatory authorities. This analysis examined the ‘pandemic peril' Although this is not a new trend in cinema, it has never been more blatant.This is not something that's novel in the movie industry, but it's more obvious than ever before. A large volume of sophisticated software capabilities in a few powerful states (UNDP, 2025).There's a huge difference in sovereign regulatory methods. The United States is still dependent on Mostly the innovation model applied is market driven, and increasingly a market driven guidance. Safety testing and risk assessment for frontier models – strict regulation.

The Chinese government has basically adopted a very centralised and government-centric regulatory system:

Artificial intelligence engineering into the national industrial program completely incorporates the technology. This framework sets high standards for the explainability, transparency and State data localization - comprehensive, (UNDP, 2025). In the meantime, the EU's groundbreaking AI Act is definitely the law with the most legal complexities and structure. A worldwide regulatory structure put in place. It gives a high level categorization of risk.liveness, and safety.Structural algorithmic transparency, liveness and safety requirements are hard-coded in a system. accountability, continuous, human-in-the-loop monitoring across a wide variety of computational applications. This is a very keen regulatory rivalry among different countries.The new frameworks add a huge amount of operational legal complexity to multinationals in the technology sector.civilian structure for the United Nations is needed to handle overlapping authorities and to determine if there must be a unified, civilian organization at the United Nations to coordinate overlapping powers.It is hard to believe that a functional global governance regime for advanced computing architectures is ever going to become a reality achieved (UNDP, 2025; ICLE, 2024).

## III. METHODOLOGY

### 3.1 Research Design

In this dissertation, qualitative, interpretive research design that is based on systematic document analysis. The interdisciplinary approach of the research questions which are about:

- An alternative paradigm of economics, political science and tech-policy, qualitative Study of the complexity, contingency and contextual specificity of the approach is well suited to capturing the process of the phenomena under investigation. The study was not designed to test or validate a hypothesis, it was merely an attempt to demonstrate that one can test the proposed hypothesis. Gives a theoretically informed and empirically grounded explanation of the strategic, economic, cultural and political aspects of AI-semiconductor competition in the and governance aspects.
- This was secondary research methodology as the phenomenon of ‘learning through play’ and ‘play as learning’ was available here. It is an area of geopolitical strategy, industrial policy and governance by regulation that interests us from our side the most. There is extensive evidence of its existence and is reflected in official documentation including policy documents, institutional reports, quality documentation.
- Instead of collecting primary information, analytical literature. In view of the changes taking place in this sphere, Also, the qualitative synthesis approach enables the incorporation of a range of sources of data

such as Using quantitative market data in conjunction with a qualitative policy analysis and commentaries in a manner that is conducive to business.The use of a combination of quantitative data and qualitative policy analysis, and expert commentaries, in a way that is helpful for businesses and complete an analytical account.

3.2 Data Sources & Selection Criteria

This study uses empirical data including the purposive selection of secondary data.

The data are from four main categories. First up, industry reports from the top research and advisory companies and industry voices. They include consultants like McKinsey and Company, PwC, Bain and Company, Futuriom and Precedence.Research gives quantitative data on the market and analysis of the sector. Second, messages that are official from government organisations like the National Institutes of Standards and Technology (NIST) and the U.S. Bureau of Industry and Trade.The AI and semiconductor game is changing.The AI and semiconductors strategic landscape is changing the Information Technology, together with others, announced the new EITI system.EITI system was an initiative of the Security, the Semiconductor Industry Association and the Ministry of Electronics and Information Technology of India. Information Technology — and other multilateral organizations, like the United Nations — have frequently been called upon for support.Multilateral organizations, including Information Technology, have been frequently asked to assist.

Reports on regulatory and strategic issues are provided by Development Programme and OECD.

developments. Thirdly, Academic works and studies at Master's level (Master's thesis). Analysts with expertise in semiconductor geopolitics and AI governance, like researchers from the DAMAC Channel and the AI Institute for Governance and Ethics, are on the agenda.But at the top of its agenda will be discussions on semiconductor geopolitics and AI governance, adding much needed analytical rigor.Theoretical grounding. Finally, some great niche, local news from:

Other news coverage included by semiconductor engineering, CNBC, the Korea times, the guardian and Computer Weekly.

Gives up-to-date updates on industry news and sources selected were appropriate based on relevance and timeliness of data to the research questions.Time sensitive field, preference publications 2023-26, in the case of time sensitive field where changes have occurred at a rapid pace during this time sensitive field. The trustworthiness of the publishing body (domain) and the trustworthiness of the publishing body in general. Where possible,The primary data was preferred over secondary data. The most (maximum) were used as a criterion for evaluating the sources' statements and inconsistent information.

authoritative available evidence.

3.3 Analytical Framework

Two complementary frameworks are used for the analysis. Sector analysis — covers the concept of market structure, competition, value chain set up and supply. chain risk — to have an insight into the economic structure of semiconductors.Comparative institutional analysis of the impact of different national and multilateral institutions on the environment of innovation and the success of the innovation process. governance mechanisms are evolving to deal with the competitive threat from AI versus semiconductors.In the sector analysis, aspects of the theory of oligopolistic competition are introduced, such as the Cournot model.Models of quantity competition, price competition (Bertrand) and models of Stackelberg competition.Heuristic applications of models of sequential strategic interaction are used to shed light on the competitive dynamics.How Semiconductor foundry and AI chip business functions and the whole semiconductor value chain is analyzed during important stages of its design and intellectual property, its manufacturing and assembly, further the testing and packaging as carried out in the industry(McKinsey, 2024).

3.4 Limitations

The study has a number of limitations. It is a secondary research design and as such it is dependent.Do not have access to good sources and

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can't document developments that So far, there haven't been any public reports of these happening. AI-semiconductors markets are characterized by rapid changes and polarization.AI-Semiconductors markets are polarized and dynamic.

Note:

- Quantitative data may be added to in the future, as additional data becomes available in the. timeframe of writing. Although the geographic area was fairly large for most of the literature, it was not as great as desired.
- Some such experiences may be found in the literature, but there is a lack of representation of the experience of less developed or smaller economies.
- Documented players in the semiconductor value chain across the world. Despite these limitations, the Materials used are clear and varied – offers good empirical basis for analysis, the analytical framework adopted offers flexibilities which allow for some interpretation of the results.Lack of confidence and shifts in evidence base.

## IV. FINDINGS

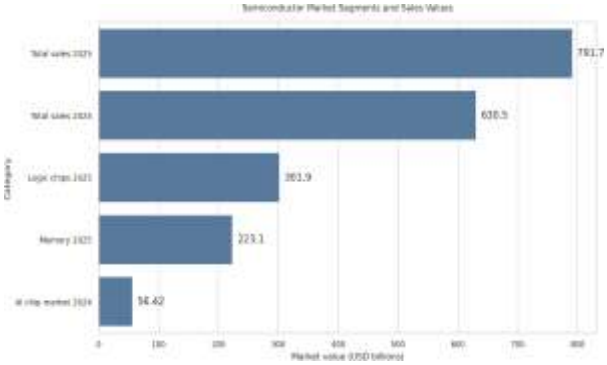
### 4.1 The global semiconductor market dynamics and AI-enabled growth

The global semiconductor market dynamics and AI-enabled growth are discussed in this section.Here, the global semiconductor market dynamics and the growth driven by AI are discussed.

In 2025, the global semiconductor industry began to grow at record pace and the total annual sales for the Semiconductor Industry Association (SIA) is $791.7 billion, up 25.6 percent increase on the $630.5 billion recorded in 2024 (SIA, 2025). Fourth-quarter 2025 revenues the total value of goods and services transactions for the month was at $236.6 billion, up 37.1 per cent compared with December 2024.The combined monthly revenue of alone was $78.9 billion. The market was dominated by logic chips, bringing in all, $301.9 billion in annual sales, a gain of 39.9 percent, and memory goods rose 34.8 percent.percent to $223.1 billion (SIA, 2025). SIA President and CEO John Neuffer characterized 2025 Revenue was expected to reach its best levels in industry history and industrywide semiconductor sales were expected to hit a new record was Driven by AI, the Internet of Things, and other applications, the value of the transactions handled by this industry would reach over $1 trillion in 2026.

Figure 1- Semiconductors Market Segments and Sales Values

- In 2025, total semiconductor sales hit a record $791.7 billion, marking a 25.6% increase from 2024's total of $630.5 billion and an unprecedented surge in demand.
- By far the biggest product category is logic, which will generate $301.9 billion in sales in 2025, accounting for about 38% of total sales.
- Logic chips, along with the memory chips, accounted for about two-thirds of the total market, illustrating the combined power of compute and storage to power the industry, which ranked second at $223.1 billion.




- While the AI chip market is still a relatively small part of the market today, with estimated growth of over a trillion dollars by 2026, it is one of the fastest-growing segments of the overall market.
- That's a $161.2 billion difference between 2024 and 2025 total sales, which represents a higher year-over-year increase than the total AI chip sales for 2024.

6G Telecommunications and Autonomous systems

Asia-Pacific region led the global sales with 45.0 percent share, and the Americas region was the next largest volume with 39.9 percent in turn with the Americas at 30.5 cent, China at 17.3 cent, Europe at 6.3 cent, and Japan.The only major market to show

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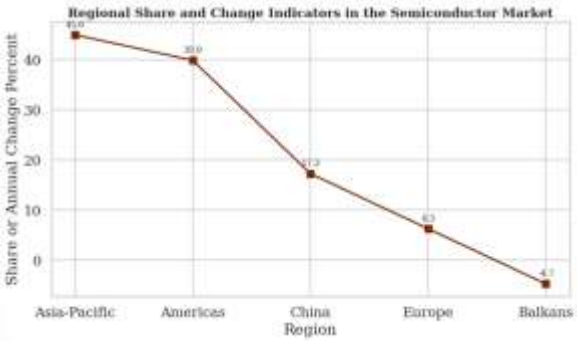
annual decrease was the Balkans market with a negative -4.7 per cent (SIA, 2025).The following distributions are combined by electronics manufacturing concentration in East Asia and by the logic of each logic processor.The following distributions are combined by electronics manufacturing concentration in East Asia and by the logic of each logic processor.The emerging end-markets for high-end chips, such as cloud and AI infrastructure, in North American In particular, the AI semiconductor market, which was estimated to be worth $56.42 billion in 2024,The value of mobile networks is estimated to hit about $232.85 billion by 2034 with a CAGR of the number of deep learning systems, edge computing, and AI accelerators deployed is on the rise, pushing up the share of 15.23 percent. AI that is integrated into industrial and consumer gadgets (Precedence Research, 2024).One of the key characteristics of the existing system is the high level of concentration in the market.

Economic returns in a small group of frontier firms Nvidia — who was a market Artificial Intelligence & Semiconductors.

Figure 2- Regional Share and Change Indicators in the Semiconductors Market




- Asia-Pacific is the largest semiconductor market in the world with a share of 45% of global semiconductor sales due to the large electronics manufacturing base in East Asia, which makes it the undisputed center of the global chip supply chain.
- The Americas are also doing well, with 39.9% of the value, largely from North American demand for high-end chips in cloud infrastructure, AI data centres and logic processors, where the largest chip consumers are, despite the focus for manufacturing elsewhere.
- The remainder of the world, with China and Europe at the extreme ends at 17.3% and 6.3%, respectively, is either less engaged with the high value chip sector or is constrained by supply/geopolitical issues that do not permit the same amount of participation.
- The Balkans remains the only region to suffer negative annual growth (-4.7%) while marking the only market with negative growth year-on-year, reflecting a structural imbalance between frontier semiconductor markets and those that haven't established strong careers in chip design, manufacturing and AI infrastructure.

In 2024, valuation stands at $2.6 trillion, which represents the incredible value creation that can be achieved by companies that managed to get to the AI chip front, and TSMC's 68 percent stake in the market, are the best bets for taking a stake in the industry.The two most promising are that that successfully place themselves at the AI chip frontier, and that TSMC's 68 percent stake in the market.The global pure play foundry market held 92 percent of the advanced chip manufacturing below 10. Nanometers are used to demonstrate the appropriate concentration in fabrication.

(Maksakova, 2025). The top 5% of semiconductor companies accounted for all of the
The rest of the 95 per cent of industry's economic profit declined in 2024. economic value — a distribution that exhibits winner takes most in technological Markets with high fixed costs and network effects and cumulative learning benefits(Mahindroo, 2025). This trend continues as a result of the long-term demand shift taking place in the industry.

Growth in AI related segments such as AI accelerators and high bandwidth communication. Conventional consumer electronics growth is expected to be significantly outstripped by growth in memory and situations, and we saw a rise in the number of firms that already implement AI.Businesses with AI-specific capabilities are more

likely to be rewarded than traditional situations, and we observed a growing number of businesses that already use AI markets.

4.2 U.S. A -China-South Korea Geopolitical Rivalry

Involving the United States, China and South Korea, this competition is marked by geopolitical rivalry.This competition is defined by a geopolitical rivalry involving the United States, China and South Korea. The competitive struggle for semiconductor supremacy has been singled out in The growing competition between the US and China. The US has been following a two-track strategy.The US has been taking a two-track approach.The strategy of massive investment in domestic semiconductors — the CHIPS and the data center — has been underway for a long time.The approach of investing in semiconductors locally – CHIPS and the data center – has been a long time in the making ,further Science Act and related programmes — which have fully-fledged export control mechanisms to prevent.

China's ability to gain access to frontier chips and manufacturing equipment for making competitive AI. capabilities (Yee, 2025). The Bureau of Industry and Security has issued back-to-back advisory documents that contain information related to the use, aggregation or transfer of advanced integrated circuits —Anything that involves devices made by Huawei or similar devices, may be in violation of the Export Administration Regulations that its consequences were to be so serious that criminal prosecution, large fines, and suspension of export activities were threatened.Players that do not comply are granted privileges (BIS, 2025).

The US 'technology access' approach has been organised around a tiered structure. Under the Biden administration's AI Diffusion Rule, effective early 2025. Nations fully Based on the United Kingdom, Canada, Japan and other countries' technology oversight requirements.The top tier and highest access to advanced AI chip is shared by and Australia. Strategic rivals, such as China and Russia, are in a limited tier, while technologies are sorted.Technologies are sorted while strategic competitors such as China and Russia are in a limited tier(BIS, 2025). In this architecture of technological statecraft, it is aimed at preserving the United States and its national image. deprive, build coalitions of technologically aligned partners, and competitive advantages in AI. The adversary to the semiconductor infrastructure required to build the front-line of AI. This framework has been further refined with BIS guidance from May 2025, which has been consistently.

Strengthening the stance on technology regulations on China.

The Chinese strategic response has been focused on speeding up China's semiconductor self-sufficiency. Sufficiency by State-directed investment. The National IC Industry Investment Fund has allocated significant funds to semiconductor research, development and production,The target for the domestic production of chips is 50 percent by 2025, stated (Economics Observatory,2024). There has been a lot of progress made in the fabrication of mature nodes, especially at SMIC— and assembly and testing, about 75 per cent of which in China. ATP capacity across the globe. Chinese tech companies such as Huawei have persisted in their efforts and successful development of top-of-the-line AI chips despite the export ban, raising new questions about the US controls, completeness and enforceability. However, China is still facing critical structural constraints: EUV lithography equipment is not available in China.chipmakers who produce chips at less than 5 nanometres, quite a restriction on.AI Competitiveness at the forefront of the revolution (Economics Observatory, 2024). China continues to be a net importer, despite its rising share of traditional chip sales, advanced semiconductors is threatened by its dominance of these markets.

Competitive pressure for long-established producers in Taiwan, South Korea and Japan.

South Korea's strategic role in the global semiconductor industry is reflected by Samsung Electronics and SK Hynix, both subsidiaries of Samsung Corp., possess world-leading technology for the manufacture of memory chips.Samsung Corp.'s memory chip unit Samsung Electronics and SK Hynix have the world-leading technology for producing memory chips.IHynix — alongside the rise

of the ambitions of the AI chip designers and advanced packaging. The announcement of a one trillion won (around USD 687.8 million) by the Korean government.Fostering national development of AI semiconductors via the National Programme for on-device AI semiconductor development. There has been a shift toward domestic production of the Alliance in order to lessen reliance on foreign supplies.Strategic decision to manufacture AX Alliance — reflects a shift toward domestic production of the Alliance to lessen reliance on foreign supplies.AI chip suppliers are expanding Korean fabless companies' access to cutting-edge foundry services.AI chip suppliers are expanding Korean fabless companies' access to cutting-edge foundry services(Korea Times, 2026). The M.AX Alliance, formed in September 2024, consists of Around 1,000 companies and research institutes such as Samsung, Hyundai, LG Electronics and so on. The and Rainbow Robotics is a holistic public-private model for AI-powered

The shift from automotive to smart home to humanoid robotics to communications, and beyond applications. A complementary government investment fund will help fabless enterprises develop.The Minister will be on hand to sign a memorandum of understanding with the company for the supply of mid-technology chips to the automotive, communications and Defense industries.The seminar revealed that semiconductors play a pivotal role in South Korea's technological advancement, as Kim Jung-kwan made clear about the importance of semiconductors in the country's technological development, sovereignty and national security.However, South Korea's close economic links to both China and Japan complicate its strategic location and interdependencies with China, which is a big customer for Korea's semiconductors, and Which controls a large portion of Korean chips production and selling. US pressure to the business and the government, leading to growing scepticism on both sides.Such a tension exists between the business and government sides, as a result of reducing business contacts with Chinese partners, and increasing the scepticism on both sides. personal pledges and business interests — which is typical of the challenges many face. In the present context, the economies of the technology exporting countries are aligned with the USA (IACIS, 2025). Despite,In the face of these limitations, India and South Korea are deepening their collaboration in semiconductors and AI.Despite these limitations, India and South Korea are strengthening their ties in the semiconductor and AI sectors.India's design capabilities and South Korea's manufacturing prowess could be a game-changer, providing a viable avenue to launch the product.providing both nations with access to new markets and Establishing new bilateral relationships.

4.3 Emerging Market Strategies: India and the United Kingdom

India's semiconductor strategy is based on India Semiconductor Mission (ISM).The programme, called 'Bhavnagar Urban Transport', was started in December 2021 with incentives worth ₹76,000 crore, while its follow-up scheme, ISM, was worth ₹47,000 crore.The government has revealed plans to increase the 2.0 figure by an extra ₹1,000 crore as part of the 2026-27 Union Budget.The production linked incentives (PLI) are estimated at ₹ and 8,000 crore, respectively (ET Edge Insights, 2026). In total, there are 10 approved, with the government's support of 1.6 trillion rupees (USD 18.2 billion). semiconductor projects such as two semiconductor manufacturing plants, numerous assembly, testing and design development centers, and a few research and development centers and Packaging units, a sign of the desire to build up an end-to-end domestic semiconductor supply. chain (CNBC, 2025). The biggest ongoing project is a 910 billion (USD 11 billion) ₹ investment in the railways.Tata Electronics developed the fabrication plant in collaboration with Taiwan’s. Powerchip Semiconductor Manufacturing Corporation, which aims at power management and computing chip applications.

ISM 2.0 has set high goals as a medium-term target: 70–75 per cent of the domestic market. Upgrading semiconductor needs from 28 to advanced nanometres by 2029.The 7 nanometre technology nodes and the ability to be one of the three world leading semiconductors.

By 2035, the number of manufacturers will drop to 700 by ET Edge Insights (2026). The Design Linked Incentive (DLI) Scheme is intended to support at

least 50 fabless businesses, fostering growth across AI, telecommunications, and other high-value application areas. ISM 1.0 has already trained 67,000 semiconductor.The engineers and helped 315 educational institutions provide advanced chip design tools .A starting point for future stages of the programme (IndianExpress, 2026). India has a talent pool of some 20 semiconductor design experts.This percentage of the world's talent represents a major comparative advantage and the nation's US Ambassador Sergio Gor's designation as a reliable and secure supply chain partner is a reflection of his.India's strategic semiconductor role is gaining recognition internationally (Outlook Business,2026).Despite these objectives, India has serious structural problems.The Galwan India's technological dependence on China was brought into sharp focus during the confrontation of 2020 when the country relied on Chinese technology. Around 62 percent of India's imports of electronic components and regulation of critical mineral. Material supply chains are vital to semiconductor production (ORF, 2024). China's predominance in assembling, and Testing, and packaging — plus its growing legacy chip-making capacity and facilities — have helped drive up prices.Testing, and packaging, plus its growing legacy chip-making capacity and facilities, have helped to push up prices is a competitive position that cannot be quickly caught up by India. McKinsey analysis has pointed out the capital-intensive nature and long lead times of semiconductor manufacturing.Structural constraints involving implementation of a long-term, sequenced approach to ecosystem for India.

The idea is not to copy the entire value chain at the same time, but to start developing it (McKinsey, 2024). A 20-year semiconductor roadmap is being developed to give strategic continuity Over the course of various government administrations and periods of investment (Indian Express, 2026).The UK has a blueprint for semiconductor strategy that it has followed a mix of strong IP and weak manufacturing. The UK's contribution to the
The market share of semiconductors has fallen from about 20 percent to less than 10 percent in the global economy.The contribution of manufacturing to total employment in recent decades has been less than one per cent (Weekly, 2025). However, companies based in the UK, such as Arm Holdings, whose, are home to the major players.More than 90% of the global smartphone and tablet population has got architectural designs embedded in them — Control key areas of the world chip IP business, as specialist companies Pragmatic Semiconductor, Graphcore, Imagination Technologies, Salience Labs and Cambridge GaN Devices have proven the UK's continued ability to manufacture semiconductors.

The University of Cambridge has been driving innovation in AI processors, compound semiconductors and photonic chips, according to UK Tech News (UKTN).
2025). The UK National Semiconductor Strategy receives £1bn of government investment. Accompanied by £500m in quantum tech investment – specifically recognises that
It would be neither possible nor advisable to compete with the leaders of the established foundry companies. (Computer Weekly, 2025). Rather, it has a niche market focus on chip design, AI, and other areas that Comprehending the strategic landscape of AI and semiconductors.Understanding the strategic landscape of AI and semiconductors. Everything from robotics to factory automation, medical devices to autonomous vehicles .The advantages of UK engineering excellence and proximity to end-markets can be realised in applications and competitive advantage. The market for AI chips is set to grow to £700 billion by 2033, and analysts forecast that the technology will be used to power 96% of the world's computers and supercomputers by 2030 and to estimate that under a targeted approach the UK could secure as much as five per cent of this market, generating tens of thousands of high-paying jobs and billions of dollars in income (Guardian,2025).Key strategic recommendations include a 12,000 increase in the UK workforce of chip designers over 10 years.Through specific investments in the education and training of electrical engineering and computer science students, and investing in sovereign AI investment instruments, strengthening technology cooperation with US. The ability to offer the newest design and process capabilities to chip makers.

4.4 Global Supply Chain Vulnerabilities and Manufacturing Obstacles

The semiconductor supply chain has structural characteristics that give rise to both

Systemic risk and important constraints on geographic diversification. A typical semiconductor supply chain is sourced from around 25 countries, critical materials being sourced from around 20 countries and parts that could travel over 25,000 miles and pass through over 70 international borders to get to where they are needed. Connecting to end consumers (McKinsey, 2024). With the help of cutting-edge chip processing technology, approximately 300 Very special equipment and a few operators were used to generate a few very distinct critical inputs. A handful of worldwide vendors, notably ASML, which makes EUV lithography machines. Essential for the manufacturing of chips smaller than the seven nanometres. One of the major weaknesses in the supply chain is the concentration on raw materials. Three of the most important minerals that are necessary are being dominated by China. Makes semiconductors like: gallium, germanium and tungsten.shown readiness to use export restrictions as geopolitical "tools" with regard to these materials(McKinsey, 2024). Where there are more than 70 percent of the markets for key materials in some countries,The significant risks are associated with the chipmakers and device manufacturers in the value chain. Supply interruption caused by geopolitical factors. This is compounded by the increasing number of people who are of age to be concerned about them. It seems that AI and semiconductors are becoming a strategic partnership. The strategic partnership between AI and semiconductors is emerging. Transistors on a chip: About 110 transistors fit on a chip that is 3 nanometres in size.The number of layers in the mask has dropped by over an order of magnitude from the 65-nanometre device, and has also lowered mask material consumption. The growth rates for the U.S. and Europe should be 60 and 65 percent until 2030 (McKinsey, 2024). The better price premium of semiconductors in the Western economies as compared to the rest of the world. One of the major constraints to trade is the establishment of Asian manufacturing centers. geographic diversification efforts.

The challenge was to create a fully functional logic fabrication lab in the United. The state's cost is as much as 10 per cent higher than that of a similar facility in Taiwan and its operating cost is higher per year. The costs are approximately 35 per cent higher, primarily because of substantially higher labor expenses, and extended working hours.The time of construction is lengthy, the price of economies is low (McKinsey, 2024). Germany faces similar and they will be faced with cost disadvantages, relative to the competitors from East Asia. The current analysis by McKinsey shows that the number of cases has risen by almost 177% since the beginning of 2019. Financing and support, including from the EU CHIPS Act and the US CHIPS Act – may not be enough to offset long-term operational cost differences, creating questions,On commercial viability of Western investments in semiconductor manufacturing beyond time. The assembly, testing and packaging (ATP) part of the value chain is one of the mostGeographically concentrated, as approximately 75 per cent of the world's supply is from mainland China.In the USA and Europe, only 5% of the

capacity is in conventional ATP(McKinsey, 2024). The use of advanced packaging is becoming more and more vital in reaching the goal of achieving it.The bulk of the performance boost coming with end-of-the-year transistor scaling reduction is focused on Taiwan (more than 70%).More than 85 per cent of the high bandwidth memory (ATP) remain unmet. There are gaps left in South Korea for more than 85 per cent logic ATP and more than 85 per cent high bandwidth memory ATP capacity. It will take a lot of effort to create comparable ATP in western economies. The implementation of specialized equipment, training of the workforce and the associated industrial support.Ecosystems that are not easily put together. The US National Advanced Packaging and the CHIPS programme (funded via the CHIPS Act) is a first step in

To fill this gap, but the scale for it is typically considered low.

4.5 Network Infrastructure, Network Configurations, and Network Design Innovation.

Upon completion of this course, students will be able to explain network infrastructure, network configurations, and network design innovation. AI workloads have seen a tremendous change in infrastructure architecture.The challenges with evolution have increased as the size and complexity of AI models have increased. As the size and complexity of the AI models have grown, so have the challenges in evolution. The data centres were operated on a hyperscale basis. Hyperscale data centres. Today, the likes of Nvidia, Amazon Web Services, Google and Microsoft are among the players that represent the primary environment for frontier scale AI training and inference, which requires networking, Computing and storage architectures that are very different from the traditional data centre architecture (Futuriom, 2024). The variety of hardware and software components of AI systems. Different hardware and software set-up of AI systems.

System orchestration with combination of CPUs, parallel computing with GPUs and dedicated AI accelerators. computation — require high memory bandwidth, high latency of memory connections, and Continuing innovation in power management with new chip architecture, packaging and cooling.With its gradual integration as a network standard, Ethernet is quickly emerging as the backbone of AI networking. A viable option to proprietary interconnect solutions such as InfiniBand and NVLink. The formation of the Ultra Ethernet Consortium (which is working on open Ethernet specs) A more general industry trend towards optimising for AI and high-performance computing workloads — Advancements towards interoperable networking architectures, multi-vendor deployments and to reduce reliance on any proprietary ecosystems (Futuriom, 2024). New entrants including The networking giants are on their nerves as Arrcus, Aviz Networks, DriveNets and Hedgehog test them and to help provide a more competitive and innovative infrastructure, with AI-specific platforms market.

The design process is also undergoing a transformation thanks to AI. Electronic design automation The EDA platforms that have been created by companies like Cadence Design Systems now include Use of reinforcement learning, generative AI techniques for placement, routeing and configuration to reduce congestion. Utilizing reinforcement learning and generative AI for placement, routeing and configuring to minimize congestion. Check their designs, think about design (configuration) spaces at once and design chips for optimisation. The performance, area, and power considerations (Cadence, 2024). These AI-driven tools are making strides fast automobiles. It's also been useful in managing the complexity of modern cars, and has contributed to shortened development times.

The AI and semiconductors strategic landscape for 2023.semiconductor designs — complexity that would otherwise take up a too large design Increased time and staff. At the operational level, AI-powered facilities are being put in place.The semiconductor manufacturing management platform has been reduced by 75%. Increased maintenance response times by 90 per cent, data accuracy improved by 90 per cent and the cost of maintaining data quality cut by 50 per cent.

During unforeseen downtime, achieving returns to the investor of over 5 times the investment by 2025 (JLL, 2025). Another area of application is semiconductor test analytics, which is now being tackled by AI. operational transformation, but one with a fair amount of implementation difficulties.The developed models may not be reliable under natural or real world conditions and usually fail to be so under controlled or idealized conditions. Faced with the physical variations and noise that are present in the world, equipment drift, and equipment noise. degradation (Haley, 2025). The successful implementation of the AI-based test analytics is based on data collection and analysis.

Let's discuss Data Collection and Data Analysis. Data reliability and quality — underlying data reliability and quality; predictions. models trained on corrupted or incomplete data — predictions made by models with corrupted or incomplete data.Lack of well-defined data leads to less reliable results, which can have a major impact on the product.Quality and yield of manufacturing. As discussed in the practitioner

experiences, industry sentiment, rewards the important role of human knowledge in the supervision, verification and the semiconductor sector, the key to effectively incorporating insights generated by AI is to contextualize data. Contextualizing AI-generated insights is a key aspect of effective AI integration in semiconductor manufacturing. Hybrid models are required in environments where there are also experienced engineers, but they have different skills to contribute. This is getting phased out with AI systems (Haley, 2025).

4.6 : Global Regulation and Governance Structures

Our governance of AI and semiconductor technologies is now a priority agenda topic.We are now making AI and semiconductor technologies a priority governance agenda item.National and international levels, each operating within its own set of frameworks and methodologies.multiple, overlapping frameworks at both national and international levels, operating simultaneously in their different frameworks and methodologies. At multi-regional and bilateral levels. The UN High-Level Advisory Body on Artificial Intelligence is a coalition of 39 independent experts across a range of professions, founded in 2023. backgrounds, published a flagship report — Governing AI for Humanity — that identified a critical. The regulation has failed to keep up with the development of AI and this report covers the sectors of AI and semiconductors.frameworks (UNDP, 2025). The report's four-pillar strategic roadmap — encompassing shared the term covers risks of understanding, policy consultation which is inclusive, access to AI which is equitable and dedicated UN. governance infrastructure — offers a normative blueprint for global AI governance, albeit its design is still in its infancy. There is still work to do translating into effective institutional mechanisms. At the Summit of the Future (2024), two historic governance documents were created Both Global Digital Compact (GDC) and the Pact for the Future have been endorsed by all 193 UN member states. The GDC lays out guidelines on inclusive cooperation in the digital sphere, data rights and data protection. equitable AI governance is introduced as are institutional innovations with the Pact for the Future. With an Independent International Scientific Panel on AI and a Global Dialogue on AI.

Governance, and expresses an ethical responsibility towards current and future generations under the UNDP Declaration on Future Generations (2025). These instruments are combinations of the event also included a number of key multilateral pledges on human-centred AI governance and embedding responsible AI principles. A development within the framework of the global norm system of Multilateralism. The Global Partnership on Artificial Intelligence (GPAI) is part of the OECD. On July 2024, the UN's normativeness complements was complemented by a practitioner-oriented alternative in the form of the framework governance agenda. The four working groups are responsible for the development of the recommendations.The recommendations are developed through four working groups they are Responsible AI, Data Governance, Data Security, and Data Quality. Mentored by expert centres in the fields of the Future of Work, and Innovation and Commercialization — GPAI is a policy laboratory based on voluntary collaboration in Paris, Montreal and Tokyo,Knowledge sharing and exchange; peer learning (UNDP, 2025). India is the Chair of the GPAI in 2024.proved their ability to set global governance of AI, and the expansion of the organization's geographical goals was demonstrated by Serbia's 2025 chairmanship. The GPAI, however, has a key drawback in its still voluntary, non-binding nature, especially, where there is limited regulatory capacity.Specially, the governance of generative AI is a very challenging regulatory issue.

A 2023 Stanford University study revealed that 10 of the 10 key generative applications examined were inaccurate when it came to capturing the meaning of the text. compliance standards outlined in the EU AI Act, as well as the potential for innovation to drive future growth.Showing the difference between what frontier AI can achieve and the compliance criteria laid out in the EU AI Act, and how innovation will further develop the field. Regulatory frameworks to control them (ICLE, 2024). The effective regulation of generative AI will ask regulators to create detailed

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technical knowledge about their specific architectures, few such as the authors are equipped to handle.The regulatory agencies now have in their possession. The case of one large e-commerce company that was compelled to Concrete examples of economic and social impacts of reduction in operation because of algorithmic design flaws are given by scale back operations. Regulatory failures in this area can have costs that may need to be addressed (ICLE, 2024).

## V. DISCUSSION

### 5.1 Synthesis: Danger, Competition and Vulnerability in the Sahara.

The findings from this dissertation give an overall depiction of the AI-semiconductor market in the global context. characterised by unprecedented commercial growth, deepening structural concentration, They deepened geopolitical competition, and developed but underdeveloped governance reactions. The record amounts of revenues that have been recorded in 2025 and the projected $1 trillion in 2026 illustrate the extraordinary business life of AI-driven semiconductors. Yet this growth are not uniform across firms, geographies and value chain segments make strong implications about economic equity, technological sovereignty and strategic stability. The clustering of advanced semiconductor manufacturing companies within a small number of companies. The severity is emphasised by the world's most critical vulnerability and geographies — Taiwan most notably through Taiwan's chipmaking giant, TSMC.The pandemic has shown what happened in the supply chain during its outbreak, and it was proven that it rippled through. According to PwC (2024), the automotive and electronics and healthcare sectors worldwide are among the hardest hit. The semiconductor Industry's structural inelasticity is caused by the long lead times and capital needed in the industry. The robustness of the fabrications plant construction — would be exacerbated if it were triggered. Long lasting and very strong, causing losses far greater than the crop's worth. missing components. The rivalry between US and China has introduced some instability in the form of a new rivalry. Commercial semiconductor relationships are being pushed now into a new geopolitically charged environment, thereby increasing compliance. Multinational companies' issues and potential partial technological decoupling between competing blocs.The findings reveal the amazing versatility of value added in semiconductors chains and the various strategic reactions of big economies to shared vulnerabilities. The EU's Chips Act, the CHIPS and Science Act in the USA and the Indian Semiconductor Mission.EU Chips Act, CHIPS and Science Act, and India's Semiconductor Mission.

In South Korea, M. will fulfill its mission.For the first time in almost 20 years, there are two distinct strategies for the United Kingdom: AX Alliance, and the UK National Semiconductor Strategy each stand in for unique solutions to structural problems, and are unique to the specific Comparative advantages, political economies and strategic cultures of the two countries' economies. A variety of strategic responses may result in a more dispersed and dampened response. global semiconductor ecosystem, over time — as long as the promise of investing. The technical problems are addressed and cooperation processes are built with other countries, continuously Having a sufficient depth and coherence.

### 5.3 The International Economics of Energy.

India's ambitions for semiconductors are realistic but need to overcome significant challenges frank assessment. The nation's skills in electronics and innovative design.

Manufacturing industry is one of the main drivers of the economy with value of USD 48 billion in 2017 is expected to grow to USD 101 billion by 2023.As a trusted partner of the diversification of supply chains by the West, –Opportunities for value chain integration (ORF, 2024). However, the competitive advantages China has seen over the years in its ecosystems due to the investments of the state —This includes assembly and testing capabilities, critical mineral supply chains, manufacturing scale, etc. But the high cost and difficulty of reproducing increasingly competitive chip designs — can't be reproduced quickly. India's experience with Make in India electronics promotion is a good example of the paradox that with electronics assembly growth in the downstream the components manufacturing is

decreasing in the upstream. unintentionally add to the reliance on imports of upstream components although the Programme has been Between 2006 and 2014, China's imports of electronic components increased by 19.23 percent CAGR between FY2019 and FY2023 (ORF, 2024). Identifying opportunities in the short term is India's pragmatic approach and short-term strategy. In some areas, there are actual comparative advantages, including with respect to chip design and AI software. Design, test and assemble legacy chips for automotive applications and legacy packaging.

Greater investment in the consumer electronics business – and slowly acquired advanced fabrication skills. Using established industry partners of the foundry. The ISM has already been a success and has already trained tens of thousands.This view is supplemented by thousands of semiconductor engineers.India, being the second biggest smartphone manufacturing country in the world, has tremendous potential in the market. The possibilities of aggregating demands (ORF, 2024). The key to success is to know how to be patient. So what does India have to do to make its semiconductor roadmap work for a 15–20-year planning period?What will be the roadmap for India if its semiconductor roadmap is to be on 15–20 year planning horizon? To achieve the level of development of the ecosystem needed for real technological sovereignty(Indian Express, 2026).The UK has a niche market leadership policy in AI specific chip design, which is ushering in a revolution in the field of artificial intelligence.Niche market leadership in the design of chips and AI-specific in the UK is sparking a revolution in AI.A more direct competitive path is to go to the top of hardware, than trying to go to the top of advanced.
fabrication. The fact is that Arm's global reach—its architectures are in more than 90 percent of — has been rewarded proving that the creation of value in semiconductors does requires no manufacturing, but design excellence and IP protection is required.There is high support for frameworks (Guardian, 2025). The UK's existing regulatory and financial framework. AI startup hubs, such as the new 2.5-acre AI innovation hub in San Francisco built by the founders of OpenAI and others that will have separate innovation, research, and production areas, and the bilateral technology relations are good with the United States, which offers good opportunities for. The design investment in semiconductors is also attracting here. Taking on the skills shortage in chip-making. The best way to do this is through engineering
— education investments and focused immigration policy is the most effective way to a serious short-term impediment to realizing this potential.

The role of governance as a strategic resource.The governance as a strategic resource. One of the important learnings from the findings is that governance frameworks work AI-semiconductors' advancement.not only as constraints in AI-semiconductors' growth but as sources of their advancement. Strategic influence and a competitive edge. Countries and territories that achieve success in Establishing valid, technically advanced and internationally accepted governance structures for AIs can shape global technology standards, and define their relevance to responsible AI.All of which equates to real economic benefits — can be achieved through these strategies.These strategies can enable investment, increase public trust in AI systems, and finally, reap clear economic advantages. AI Segments and Application Areas and geopolitical benefits: The Brussels Effect refers to the fact that EU regulations are, through this effect, drafted according to the highest standards.Transitions that gradually unfolded in the implementation of an inter-jurisdictional multi-sectoral approach by international organizations spread over different jurisdictions — demonstrates exposure to the products, does not justify their influence on policy decisions.The authority agenda-setting power can wield for governance leaders, even when they have no direct involvement in manufacturing the products, does not warrant their influence in policy-making.technological capabilities are limited But, the key in effective governance structures is technical knowledge. Adequate to the regulated systems. The Stanford research revealed that the perception of the impact of the huge breakthrough in generative AI has evolved.

The EU AI Act demands a lot from frontier AI.This is reflected in the limited number of EU AI Act compliant applications available. Knowledge of capabilities and frameworks to respond to and

manage their risk (ICLE, 2024). Bridging this gap will require ongoing investment on RT capacity, in adaptive governance mechanisms that can scale with new architectures of AI, and have meaning.To prevent the different levels of governance from having different standards.The micro example is helpful, consider the domain of AI-semiconductors and Effective Governance of AI in high-stakes manufacturing environments should be a blend of human and AI models where veteran engineers verify and put AI-facilitated insights into perspective — However, in addition to this, Haley mentions a broader design principle in Organisations that can be applied to AI governance (Haley, 2020).

5.4 Policy and industry recommendations for better ocean health

From the above analysis, some strategic recommendations are identified Policymakers and industry stakeholders. R&D will increase to a small scale.First, the government's semiconductor R&D expenses will be raised to moderate levels. Western economies should use a similar approach in terms of their manufacturing capacity, alongside equivalent attention paid to) other sectors.These supply chains for critical raw materials, specialised gases and advanced chemicals are particularly relevant to upstream supply chains because they do not have a clear path for supply or demand.Upstream supply chains are particularly relevant, especially for critical raw materials, specialised gases and advanced chemicals, because of the ambiguous supply and demand chain.Nowadays, investment may be made in the downstream fabrication process but not in the upstream production process, which is a risk. The inputs required for sustainable operation of it. Secondly, workforce development at all levels from to competent manufacturing technicians, via PhD research, to be treated as long term strategic.

An investment that cannot be considered a typical investment and requires collaboration among the Government, schools and industry,The intersection of AI and semiconductors, strategic landscape Intersection of AI and semiconductors Increasing participation, and especially diversifying participation from under-represented groups to attract talent. The development of third, and fourth, elements of multilateral coordination should also be a key priority of AI governance. set up mutual standards of technology and audit procedures for compliance Improved outcomes, reduced compliance costs for multinational companies and effective compliance. oversight. Fourth, strategic selectivity is important for emerging economies, namely by concentrating on: advantage is claimed.Investments in the semiconductor value chain in a few targeted segments of comparative advantage. There are opportunities here — not to copy and paste all the things that have been done in manufacturing. ecosystems — will yield a greater quantity of public investments. Fifth, the semiconductor Proactively invest in the hybrid human-AI workflows, data quality infrastructure and tools required to enhance data quality for industry.Industry needs to invest proactively in the hybrid human-AI workflows, data quality infrastructure, and data quality tools to improve data quality.A mission that is powered by AI to maximize the potential of AI sensor characterization.The manufacturing optimization approach is recommended, rather than considering AI adoption as a “one-size-fits-all” solution.

## VI. CONCLUSION

The report identifies the main problem areas and findings of the inspections.

This dissertation has explored the strategic, economic and governance aspects of the analyze the global AI-semiconductor landscape based on a comprehensive analysis of secondary literature, industry reports, and policy documents. The research has shown that the area of the crossing was related to one of the main lines of development of the learning program is the artificial intelligence and semiconductor technology.AI and semiconductor technology is one of the backbone of the learning Programme. The 2020s brings geopolitical tensions nd competition and a host of economic interests that will bring unparalleled levels of rivalry to the table. Investment, policy innovations and regulations in the major economies. Global semiconductor revenues hit a record high of $791.7 billion in 2025, and are expected to surpass $1 trillion. It is an estimated

trillion in growth by 2026, but this growth is fuelled by structural inequalities in its distribution.

value and capability: vast share of economic profit goes to frontier firms and geographies, and the growth pace is corroborated by the proportion of value creating firms.

The concentration of the supply chain in a geographical location presents a vulnerability with systemic risk in that area.Consequences that spread throughout the economy around the globe. Semiconductor was a commercial field that has been transformed by the US-China competition into a realm of technology-based diplomacy, vast influences on commerce traffic,National and international standards of technology, and investment decisions. Newly rich nations such as India and South Korea are charting this course through innovation of their own national semiconductor. The strategies that they can exploit their respective comparative advantages – India for design talent and skills, and China for manufacturing capacity. All these factors are positive: strategic positioning, South Korea's contribution to the memory business, its involvement with AI chip development. Everything said so far is good: strategic positioning, South Korea as a leader in the manufacture of memories, in the development of AI chips. Aiming to minimize the risk from localised supply chains. The United Kingdom of Great Britain and Ireland is Following a niche design and IP leadership strategy to address its assets Issues of global semiconductor value chains. The regulation of AI-semiconductor technologies has become an increasingly

It is an important region in multilateral policy in which the UN, the EU, the OECD and the GPAI fulfil their respective roles in this. Changing norms and rules and much progress has been achieved to Explain ethical frameworks and principles, and turn them into technically A sophisticated, global and well-coordinated regulatory practice and enforcement is still limited.One of the core issues is — one that the fast changing of Generative AI and autonomous systems poses — and that is the challenge of integrating them seamlessly. As semiconductor manufacturing becomes more complex, it is becoming more complicated.Manufacturing semiconductors is increasingly complicated; it's getting more complicated.

6.2 Contributions to Knowledge

The dissertation is several times a contribution to the existing body of literature. It provides a the AI-semiconductor strategic landscape, a wide variety of concepts and technologies, is reviewed in detail, but from an empirical perspective.framework.brings brings together geopolitical, economic, governance and technical aspects in one analytical framework. The framework of the depth of integration is not found as much in the existing literature. challenge demands. Analyzes the economy in a broader context than typical existing studies: India, South Korea, the United Kingdom as well as the US-China

The bilateral axis that is embedded in academia and policy. It conceptualises governance Stones and sticks are becoming tools rather than barriers. providing a more detailed understanding of the relationship between institutional capacity and design of policy and technology competition. And it documents and analyses the structural manufacturing barriers and supply chain Geographic diversification risks that will impact this strategy for semiconductorsOver the long-term (2020s and beyond).

6.3 Research directions for the future

There are a number of directions for further research that can be taken from this study. First, the effectiveness of US Restriction of Chinese access to frontier AI chip capabilities in the form of and allied export controls is an Empirically contested question which requires more fine-grained assessment as Evaluate the strategic developments in the field of AI and semiconductors.Analyse the strategic trends in AI and semiconductors.Implementation data accumulates. Secondly, the long term commercial viability of the new Westward. The investments made in semiconductor fabrications warrants systematic monitoring, especially considering the cost,In this study, the risk of demand cyclicality as well as documented differentials are considered. Third, the governance potential implications of more independent AI systems in semiconductors will be

covered.The implications will be discussed of increasingly independent AI systems in semiconductor manufacturing, such as: AI-driven design, predictive maintenance, and quality control — pose new questions regarding Present accountability, responsibility and the appropriate realm of human control. There is a lack of frameworks that can effectively tackle. Fourth, the new India-South Korea

technology, is another key factor.Another key factor is the new India-South Korea technology. The cooperation between the two countries could be a case study in partnership between two middle income countries with complementary features.The capability can create new supply chain relationships which exclude involvement by the incumbent US-China-Taiwan axis. The semiconductor industry has been gradually shifting into more complex, and more diffused, directions, the report will not be addressed.The report does not address the strategic, economic and governance challenges that will be addressed through and AI-integrated architectures. The number of such work is more likely to increase than to decrease and the importance of ongoing research on this topic is increasing domain required and in time.

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