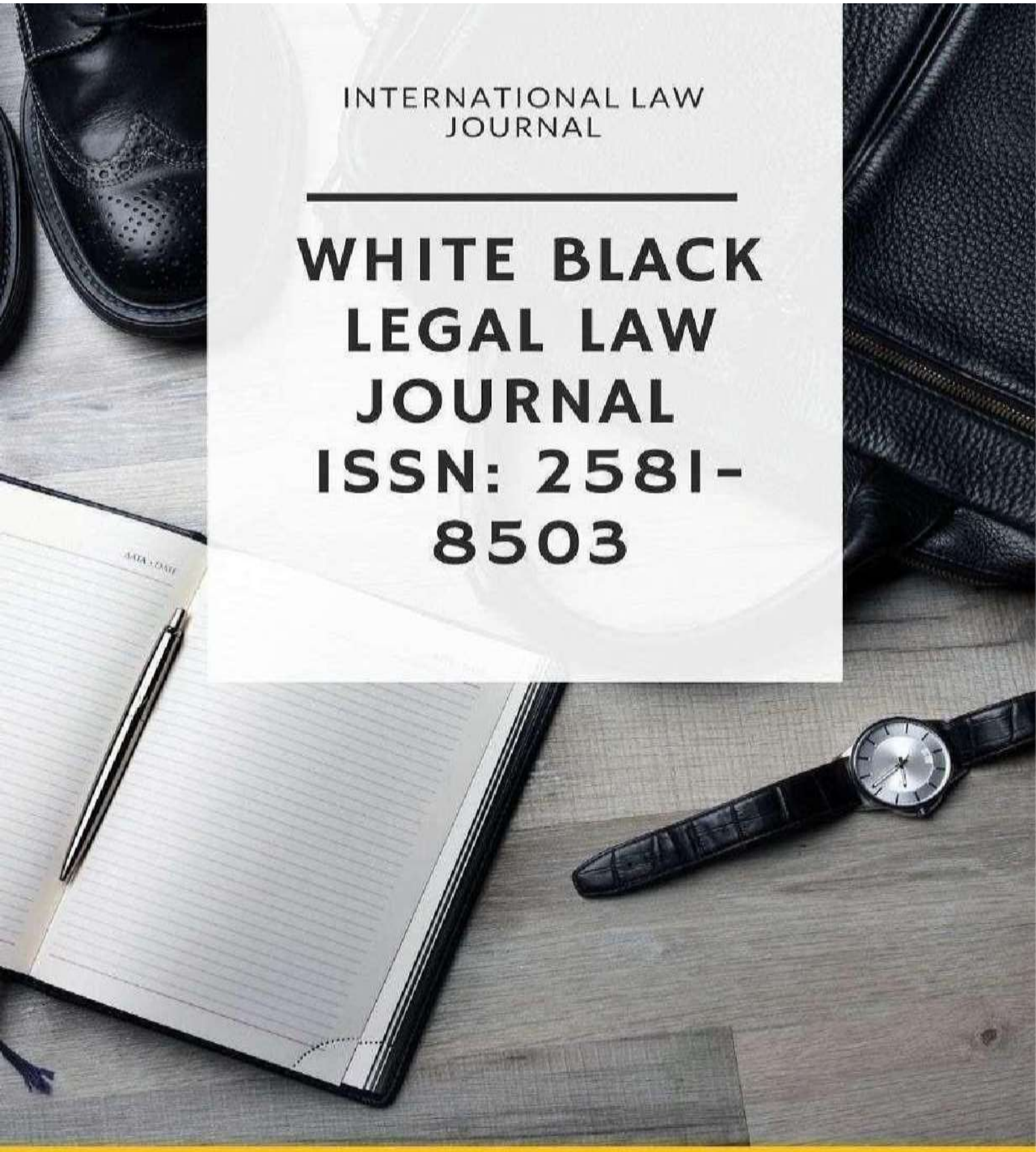

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WHITE BLACK LEGAL is an open access, peer-reviewed and refereed journal providededicated to express views on topical legal issues, thereby generating a cross current of ideas on emerging matters. This platform shall also ignite the initiative and desire of young law students to contribute in the field of law. The erudite response of legal luminaries shall be solicited to enable readers to explore challenges that lie before law makers, lawyers and the society at large, in the event of the ever changing social, economic and technological scenario.

With this thought, we hereby present to you

ANALYSIS OF SEMICONDUCTOR MANUFACTURING IN INDIA THROUGH THE LENS OF INTERNATIONAL TRADE RELATIONS.

AUTHORED BY: DHRITI ROHATGI

Institution: School of law Christ Deemed to be University Bangalore

Abstract

On March 10, 2023, bilateral initiatives signed between India and the United States regarding high-technology cooperation have spurred examination of the potential supply chain of critical technology. As India strives to establish a competitive foothold in the semiconductor industry, it faces multifaceted challenges and opportunities, including technological expertise, capital investment, environmental considerations, and research and development limitations. Moreover, India's recalibration of customs duties under the World Trade Organizations's purview prompts scrutiny of legal ramifications and potential trade agreement repercussions. This paper delves into the interplay between India's developmental aspirations and trade relations vis-à-vis environmental preservation, particularly concerning resource acquisition for sustainable technologies. Analysing semiconductor manufacturing's implications, it evaluates India's pursuit of self-reliance and collaborative efforts with other nations, notably excluding China, thus influencing global relations and supply chain diversification. Integrating schemes like PLI, DLI, and Make in India alongside fostering startup innovation and intellectual property growth, the paper assesses existing capabilities and potential sectoral benefits for industry growth. Furthermore, it underscores the symbiotic relationship between defence, automotive, MSME, technology, AI, and telecom industries with semiconductor technology, elucidating pathways for synergistic growth and indigenisation of semiconductor production. Initiatives like Innovation Bridges and regulatory barrier mitigations between India and the United States, bolstered by research collaborations and quantum technology coordination mechanisms, underscore concerted efforts towards technological advancement and resilient supply chains. A memorandum of understanding signifies joint commitments to semiconductor research and development, emphasising collaborative efforts to fortify technology value chains. India's strategic alignment with global semiconductor industry trends, fortified by collaborative initiatives and

indigenous manufacturing incentives, offers a transformative pathway towards technological leadership and economic resilience. India's reliance on hardware technology imports, coupled with a dearth of critical minerals like germanium, underscores the necessity for fostering "Friendshoring" to augment India's capabilities. By integrating goals with other nations and focusing on strengths and gradual diversification, India can enhance the global supply chain in environmental sustainability and critical technology, essential for the growth of developing countries.

Keywords: Semiconductors, Friendshoring, Critical Technology, Information Technology, Development, Self-reliance

Introduction

This research paper delves into critical issues at the intersection of technology, trade, and resources, as they pertain to India's strategic positioning in the global landscape. In an era where technological innovation and sustainable resource management are paramount, India faces multifaceted challenges and opportunities. India's aspiration to establish a competitive presence in the semiconductor industry prompts us to investigate potential avenues while considering the specialised knowledge requirements, high capital expenditure, environmental implications, and limitations in research and development (R&D) and subsidies. India's reevaluation of imposing customs duties on products covered by the World Trade Organizations's (WTO) declaration raises questions about the legal implications and potential consequences for international trade agreements The alignment or conflict between India's development goals and trade relations with environmental preservation concerns in resource acquisition for green and sustainable technologies is examined in-depth. It assess the implications and potential consequence of semiconductor manufacturing while fostering self-reliance and India's approach to integrated goals with other countries in the semiconductor industry, particularly the exclusion of China, raises questions about its impact on international relations and global supply chain diversification. It assesses the development of India's existing strength, along with an sectoral transfer of benefits for the growth of the industry. The same is sought to be done through the integration of various sectors, schemes, including PLI, DLI, Make in India, and incentives for start-ups and intellectual property growth.

Research Questions

1. What are the potential avenues for India to establish a competitive presence in the semiconductor industry, considering the specialised knowledge requirements, high capital expenditure, environmental implications, and limitations in R&D and subsidies, Additionally, how can India address the absence of mineral production and its implications on semiconductor manufacturing
2. In light of India's reconsideration of its moratorium on imposing customs duties on products covered by the WTO's declaration, what are the legal implications and potential consequences for international trade agreements
3. Is it legally feasible for India to establish policies that involve the licensing of production-grade technologies for the extraction and processing of critical minerals
4. How do India's development goals and trade relations align with or conflict with environmental preservation concerns when it comes to obtaining resources necessary for the production of green and environmentally sustainable technologies
5. How is India's approach to integrated goals with other countries in the semiconductor industry affecting its relations with the United States, particularly in the context of excluding China, and what implications does this perspective hold for international relations and global supply chain diversification

Research Methodology

The Research methodology adopted is a mixed methodology using experimental and correlational approach on Secondary quantitative data. For qualitative data using grounded theory approach and content analysis. The primary source of data is secondary research, encompassing academic literature, reports, government documents, trade agreements, and industry publications.

Philosophical and Economic Background

Utilitarianism, a well-established moral theory, underlines that the morally right action should maximise overall good, taking into account the well-being of all. It's rooted in the idea that pleasure and pain guide human behaviour. Jeremy Bentham first articulated this, highlighting that these forces shape our thoughts and actions. John Stuart Mill further developed utilitarianism[1], emphasising happiness as humanity's ultimate goal and the importance of general happiness for the collective well-

[1] Mill, John Stuart. "Utilitarianism." 1863.

being. Applied to international relations, this theory supports countries aligning based on strengths, as seen in semiconductor manufacturing. India, despite lacking technical expertise, can contribute through collaboration, knowledge sharing, and exploration rights, fostering efficiency and economic growth.[2] This approach promotes mutual interdependence among nations while discouraging monopolies and excessive competition, in line with the principle of shared benefits. Critics argue that interpretations of moral rights may vary, especially in the context of geopolitical trade relations with China. Nevertheless, diverse perspectives should be considered, ensuring shared benefits remain the central focus.[3] In the realm of economics, Donald E. Campbell and Jerry S. Kelly underscore the concept of trade-offs, recognising that decision-makers and societies must balance desires.[4] Dr. Jairam Ramesh stresses the need to balance growth and the environment, particularly in rare earth mining, where economic gains must be weighed against environmental and health risks.[5] Mining also transforms landscapes and threatens local environments, posing a trade-off between economic benefits and ecological consequences. Pollution accumulation from mining creates long-term challenges, emphasising the need to evaluate Resource and Environmental Carrying Capacity for sustainable development. Learning from China's green mining practices can provide valuable insights for India.[6] Regarding economic externalities, mining generates both positive and negative external effects. Positive externalities include job creation, economic growth, and technological advancements.[7] Negative externalities arise from environmental degradation, health risks, and resource depletion, affecting communities beyond the mining industry.[8] These negative externalities can lead to deadweight loss, where environmental harm outweighs the benefits. A comprehensive approach involving all affected parties is essential to address these environmental challenges effectively.

[2] Gare, Arran. "Utilitarianism in the Age of the Anthropocene: From the Utilitarian's Dilemma to the Ethical Designer's Dilemma." Journal of Business Ethics, 2015.
[3] Bentham, Jeremy. "An Introduction to the Principles of Morals and Legislation." 1789.
[4] Campbell, Donald E., and Jerry S. Kelly. "Trade-Offs in Economics." American Economic Review 67.1 (1977): 178-183.
[5] Ramesh, Jairam. "Green Signals: Ecology, Growth, and Democracy in India." 2015.
[6] Resource and Environmental Carrying Capacity (RECC): A Concept Paper." Ministry of Environment and Forests, Government of India, 2004.
[7] World Trade Organisation (WTO). "Understanding the WTO: The Agreements - Information Technology Agreement (ITA)." Accessed on January 25, 2022.
[8] Das, D. (2019). "Critical Minerals and India's Pursuit of Secure Supplies." Strategic Analysis, 43(5), 360-372

Current Challenges and Opportunities in the Industry

1. Tensions in Trade Relationship: Addressing the challenges arising from trade tensions with various countries, which can impact the flow of critical technology components, such as semiconductors.
2. Striving for Self-Sufficiency with Import-Export Restrictions: Balancing the goal of achieving self-sufficiency in semiconductor production with the potential consequences of import-export restrictions on global trade and economic partnerships.
3. Shortage of Semiconductors: Understanding the root causes of the semiconductor shortage, including supply chain vulnerabilities, and finding effective solutions to mitigate these issues.
4. Spillover Effects of China-US Economic Decoupling: Managing the spillover effects of the economic decoupling between China and the United States, which can have ripple effects on global supply chains and technology access.
5. India's Position and Partnerships: Defining India's position in the global semiconductor
6. industry and exploring potential partnerships, particularly with the United States, to strengthen its semiconductor capabilities.9
7. Enhancing Semiconductor Policy Effectiveness: Identifying strategies to enhance the
8. effectiveness of semiconductor policies in India, such as incentives for domestic manufacturing and research and development.
9. No Loan Guarantees: The absence of loan guarantees can impact the ability of start-ups and semiconductor firms to access financing for research and production.
10. No Upfront Money for Start-ups: Addressing the lack of upfront financial support for start-ups in the semiconductor industry and finding alternative ways to encourage innovation.
11. Focus on Delivering at Home Before Leading Abroad: Acknowledging the need for India to establish a strong domestic semiconductor industry before becoming a global leader and ensuring that policies align with this goal.
12. Continued Dependence on Hardware Imports: Acknowledging the challenge of India's substantial reliance on hardware technology imports and the long-term nature of developing self- sufficiency in hard-tech innovation.
13. Lack of Skilled Workforce: India does have the engineers and human resources for a specific section of the supply chain. However, most of them add value to other countries revealing an

[9] Complement to Succeed: A Case for India-Taiwan Collaboration on Semiconductors, The Takshashila Institution, https://takshashila.org.in/research/a-case-for-india-taiwan-collaboration-on-semiconductors

immense brain drain.

14. Scarcity of Raw Materials: India lacks critical minerals for semiconductor manufacturing such as Silicon, Germanium and gallium arsenide, and Silicon carbide. India would need to either import these critical materials or invest in its mining industry. India holds over 6 per cent of the world's rare earth reserves. However, expanding this industry would require considerable time and financial investment to keep up with the demand from the electronics industry.

Integration with other Sectors

Defence: The defence industry relies significantly on semiconductor technology to develop cutting-edge military equipment. Wireless sensors, a crucial product of semiconductor technology. are gaining prominence in both aerospace and military applications.[10] In the aerospace sector, wireless sensors play a vital role in aircraft construction and fuel cost reduction. Presently, India's primary military entity produces semiconductors for military use, but a significant portion is imported for indigenous equipment. The demand for semiconductor chips in the military sector is contingent upon India's military decisions and strategic plans. If the country opts for non-contact methods of warfare, such as cyber and electronic warfare, the demand for capabilities increases substantially. Additionally, there is a pressing need for innovation in military technology. Historically, defence requirements have been a low priority for the semiconductor industry. The military's inclination to assert its presence can drive semiconductor manufacturers to adopt a more aggressive approach, developing specialised chips for military applications. Military innovation encompasses various needs, including image sensors, communication chips, amplifiers, and microcontrollers. The node size of these components ranges from 40 to 180 nm, aligning somewhat with the automotive sector. However, the semiconductor industry faces challenges, as its major customers are mobile manufacturers with a preference for advanced chips whose profit margins are way higher. Balancing the production of legacy chips for defence and automotive industries, utilising older technology, versus meeting the demand for advanced chips with higher profit margins poses a dilemma for

[10] Milica Pejanović Đurišić, Zhilbert Tafa, Goran Dimić and Veljko Milutinović, "A survey of military applications of wireless sensor networks", in 2012 Mediterranean conference on embedded computing (Meco), pp. 196-99, ieee, 2012, https://www.researchgate. net/profile/Zhilbert Tafa/publication/261267386_A_Survey_of_Military_Applications_of_Wireless_Sensor_Networks/links/5d738caaa6fdcc9961b58fb5/A- Survey-of-Military-applications-of-Wireless-Sensor-Networ

semiconductor manufacturers.[11] In the realm of defence innovation, the unique knowledge of technology among defence personnel necessitates special translators. This creates a demand for additional personnel well-versed in defence technology. As technological advancements unfold, the Indian military explores unmanned ground vehicles, mirroring developments in the private sector's driverless cars. There is an overlap between the two in terms of sensors, connectivity, data analysis, storage, and communication. The heightened demand for semiconductors, coupled with the establishment of large data centres and protocols mandating data localisation, further complicates the landscape.[12]

Automobile: The importance of semiconductors in the automobile sector owes to infotainment systems, engine management and safety features of vehicles. As the vehicle gets more advanced, the need for semiconductors increases. Further, delays or disruption in the supply chain of semiconductors has a direct relationship with production delays and backlog of orders in the automobile industry directly impacting its market share and growth. An indigenous system of semiconductor manufacturing impacts the parts which are used to make automobiles. India has taken the lead in several climate change mitigation policies and at the COP 26 global summit on climate change - 5 goals of the Indian Government - which included India's fossil-related energy consumption below 500 GW by 2030 and achieving NET ZERO by 2070. A step towards this is the shift to electric vehicles which run on lithium batteries which may change to a more efficient means of power generation and consumption shortly. Continued availability of chips is essential for this. EV shift seems logical, however, EV uses at least 10,000 times as much lithium as a single smartphone. Brewing competition among smartphone and automotive manufacturers. Additionally, EVs require at least 6 times the number of Integrated Circuits than a conventional fossil fuel-based car. With the growing demand for chips for Integrated Circuits, the conversion of automobiles as a means of conveyance to service - that is the emerging field of mobility as service, until the production of chips is not indigenised, it will create bottlenecks for automotive manufacturers in the medium to long term. MSME: The chip shortage and dependence on imports of semiconductors have a direct impact on the MSME sector. Whenever there is a non-availability of chips, the waiting period for cars is high. So

[11] Akshat Upadhyay, Role of Semiconductors in India's National Security (Manohar Parrikar Institute for Defence Studies and Analyses, Occasional Paper No. 61, 2022), https://www.idsa.in/occasionalpapers/op-61-Role-of-Semiconductors-in-India

[12] Arjun Gargeyas, "The Role of Conductors in Military and Defence technology", Defence and Diplomacy Journal Vol. 11 No. 2 2022

MSME sectors that supply goods like gear, and seat covers suffer for no fault of theirs. MSMEs related to industries will benefit from the supply chain once India starts indigenizing its production.[13] Technology and AI: The semiconductor industry has saturated most of its consumers being mobile phones and computers due to its ever-increasing demands. However, the shift in strategy for semiconductors to focus on other sectors like autonomous vehicles, industrial robots, and drones, most of which require semiconductors in embedded Al for face recognition, speech-to-text, personal assistant, navigation and search. Most of the applications which use Al rely on hardware as a core enabler of innovation. Al, semiconductors and quantum are said to change the future of India providing immense opportunity for our education system, start-up and innovation ecosystem. The intersection is integral to India's growth as a digital economy. Al and technology have an interplay with industries like automobiles as well where the automotive industry has delivered countless innovations with different technology. The Internet of Things, cloud computing and artificial intelligence and wireless communication are also on the go. The past few decades have seen India's growth in the services and software industry. However, India has a strong position to take up semiconductor manufacturing.[14]

Telecom: Semiconductors have become an integral backbone of digital infrastructure and communication. Semiconductor has played a huge role in the evolution of wireless communication and enables communication over long distances. Radio frequencies of mobile phones, the development of the internet, routers and modems are dependent on semiconductors. They have also enabled the development of technologies like 4G and 5G to transmit and receive data at high speeds. Influence is not only on the hardware aspect, but also cloud computing which transformed the telecommunication industry by enabling digital service over the internet.

iCET Initiatives

The United States and India are actively pursuing a comprehensive collaboration strategy to advance critical and emerging technologies, deepen connectivity across innovation ecosystems, and address key issues related to regulatory barriers and talent mobility. This multifaceted approach includes multiple initiatives and partnerships to foster innovation, promote resilience in semiconductor supply

[13] Lack of indigenous chips hurt Indian defence industry, FINANCIAL EXPRESS (Jul. 28, 2023), https://www.financialexpress.com/business/defence-lack-of-indigenous-chips-hurt-indian-defence-industry-3191377/

[14] John A. Mathews & Dong-Sung Cho, Tiger Chips: The Rise of East Asia in the Global Semiconductor Industry, in Tiger Technology: The Creation of a Semiconductor Industry in East Asia 29–70 (2000).

chains, and develop a skilled workforce.[15]

Innovation Bridges - The U.S. and India recognise the importance of establishing "innovation bridges" in key sectors. These bridges are designed to promote cooperation in areas such as biotechnology, advanced materials, and rare earth processing technology. Various activities, including expos, hackathons, and pitch sessions, will facilitate knowledge exchange and technological advancements.

Regulatory Barriers - Both nations are committed to addressing regulatory barriers and business and talent mobility issues through a standing mechanism under the "International Centre for Entrepreneurship and Technology" (iCET). This commitment signifies a shared interest in removing obstacles to international business and talent movement.

Research Collaboration - A new Implementation Arrangement for a Research Agency Partnership between the National Science Foundation (NSF) and Indian science agencies has been signed. This arrangement aims to expand collaboration in various areas, including artificial intelligence, quantum technologies, and advanced wireless technologies, to foster a robust innovation ecosystem.

Quantum Coordination - The establishment of a joint Indo-U.S. Quantum Coordination Mechanism, involving industry, academia, and government, is designed to facilitate research and industry collaboration in quantum technologies. This mechanism recognises the transformative potential of quantum technologies.

AI Standards- Collaboration in developing consensus, multi-stakeholder standards for trustworthy artificial intelligence is emphasised. The goal is to ensure that these standards align with democratic values, promoting responsible and ethical AI development.

High Performance Computing - Both countries intend to promote collaboration on High Performance Computing (HPC). This includes efforts to lower barriers to U.S. exports of HPC technology and source code to India. This collaboration will enhance the capabilities and accessibility of HPC

[15] United States-India Joint Statement, The White House, 2023.

resources.

Semiconductor Supply Chains - Bilateral collaboration on resilient semiconductor supply chains is a priority. The objective is to develop a semiconductor design, manufacturing, and fabrication ecosystem in India. This includes fostering a skilled workforce that supports global semiconductor supply chains.[16]

A task force organised by the U.S. Semiconductor Industry Association (SIA) and the India Electronics Semiconductor Association (IESA) is working to assess the readiness of India's semiconductor ecosystem. It will identify opportunities, challenges, and strategies for India's involvement in the global semiconductor value chain. These initiatives reflect a commitment to strengthening technology cooperation, fostering innovation, and building resilient semiconductor supply chains.The collaborative efforts span multiple sectors, from emerging technologies to semiconductor manufacturing, with the aim of enhancing economic growth and technological progress.[17]

MOU between United States and India

In a joint statement dated September 8, 2023[18], issued by India and the United States, the leaders emphasised their commitment to establishing robust global semiconductor supply chains. They highlighted the investments made by Microchip Technology, Inc., and Advanced Micro Devices in India, totalling approximately US$300 million and US$400 million over several years, respectively, aimed at expanding research and development activities. Furthermore, the leaders expressed contentment with the progress in implementing previous commitments made in June 2023 by U.S. companies like Micron, LAM Research, and Applied Materials. The statement also underlined the significance of an Implementation Arrangement between the U.S. National Science Foundation (NSF) and India's Department of Biotechnology. This arrangement paves the way for scientific and technological research collaborations, particularly in the field of biotechnology and biomanufacturing innovations. Additionally, they acknowledged the release of proposals by NSF and India's Ministry

[16] White Paper on India Semiconductor Sector: Increasing India's Role within the Global Semiconductor Value Chain, SIA and APCO Worldwide, 2023.
[17] Konark Bhandari, The Geopolitics of the Semiconductor Industry and India's Place in It, Carnegie India, https://carnegieindia.org/2023/06/30/geopolitics-of-semiconductor-industry-and-india-s-place-in-it-pub-90054
[18] Joint Statement - India-U.S. Summit, Prime Minister of India.

of Electronics and Information Technology, fostering collaborative endeavours in various sectors such as semiconductor research, next-generation communication systems, cybersecurity, sustainability, green technologies, and intelligent transportation systems. The leaders reaffirmed their commitment to building resilient technology value chains and strengthening defence industrial ecosystems. They pledged to facilitate greater technology sharing, co-development, and co-production between industry, government, and academic institutions in both India and the United States. The strategic trade dialogue, initiated in June 2023, will continue to serve as a platform for ongoing engagement and collaboration.

Furthermore, the leaders celebrated the signing of a Memorandum of Understanding (MoU) between Indian universities, represented by the Council of Indian Institutes of Technology (IIT Council), and the Association of American Universities (AAU). This MoU established the India-U.S. Global Challenges Institute, with an initial combined commitment of at least US$10 million. The institute's objective is to unite prominent research and higher-education institutions from both countries, extending beyond AAU and IIT memberships, to advance frontiers in science and technology. This collaboration will encompass various domains, including sustainable energy and agriculture, health and pandemic preparedness, semiconductor technology, advanced materials, telecommunications, artificial intelligence, and quantum science. Finally, the leaders commended the resolution of the seventh and last outstanding World Trade Organisation (WTO) dispute between India and the United States. This achievement followed the unprecedented settlement of six bilateral trade disputes within the WTO in June 2023, signifying a positive step in trade relations between the two nations.

Information Technology Agreement

The impact of the Information Technology Agreement (ITA) on India's electronics manufacturing sector displayed a twofold outcome. Firstly, India's Information Technology (IT) services flourished significantly owing to government initiatives and the Industrial Policy Statement of 1991.[19] However, India's accession to the ITA in 1997 had adverse consequences as it led to a decline in domestic hardware production due to alterations in tariff structures and a surge in imports.[20] Consequently, while market-oriented reforms boosted the IT services, the revenue generated from exporting

[19] The Information and Communication Technology Sector in India:Performance, Growth and Key Challenges, at 9–10. Cf. Kallummal (2012, pp. 12, 39–40)
[20] Marwaha (2012)

hardware only witnessed a modest growth of $3.2 billion from 2004 to 2007, primarily because the sector heavily relied on imported components.[21]Advocates of globalisation expressed concerns regarding India's heavy dependence on imported inputs, particularly in the realm of technological products.[22] During the ITA-I period, India experienced a significant erosion in domestic manufacturing, resulting in a trade deficit of 69.26%. This deficit might not have been a significant issue had it been complemented by policies aimed at bolstering domestic manufacturing and integrating into global value chains.[23] However, India focused on stimulating demand for IT products without simultaneously fortifying domestic policies. This led to a surge in imports, with covered products escalating from $1 billion to $16.7 billion between 1996 and 2010, while exports grew at a slower pace, from $0.5 billion to $4.3 billion. Consequently, 65% of the demand for these products relied on imports. Despite liberalisation and India's participation in the ITA, domestic value addition in IT products remained low, accounting for only 1.31% of global production, and India's share in IT product exports represented a mere 0.3% of the world trade in this sector. India's participation in the ITA led to imbalanced growth, resulting in a decline in domestic electronic component manufacturing to 20-22%.[24]Arguments suggesting that low tariffs in the Information and Communication Technology (ICT) sector would spur economic growth and reduce input costs had limited relevance in India, as they failed to enhance domestic value addition.[25] While the Industrial Policy Statements did liberalize trade in the ICT sector, they failed to establish favourable conditions for sustaining the sector in a zero-tariff environment. The decline of India's electronics sector can be partially attributed to deficiencies in the investment climate and early membership in the ITA.[26] Recognising that skill development was a crucial challenge for India's manufacturing capabilities and the reason for its absence from global value chains, the government chose to address these issues before completely eliminating tariffs in the ICT sector. This decision was made in light of the fact that past industrial policies had predominantly favoured the IT services segment.

[21] Id. 11
[22] The Information and Communication Technology Sector in India: Performance,Growth and Key Challenges, OECD Digital Economy Papers
[23] Information Technology and Economic Performance: A Critical Review of the Empirical Evidence, 35(1) ACM Computing Surveys
[24] Id. 14
[25] Ernst and Young (2009) and Frost and Sullivan (2013).
[26] WTO (2012, pp. 54–55)

Product linked Incentive Scheme

Sanctioning of 76,000 crore under the PLI scheme so as to boost the domestic manufacturing of semiconductors within India through financial aid, reduction of production costs, reducing reliance on imports, reducing the cost of capital, providing subsidies and increasing job creation. Apart from subsidies, there should be focus given to the ease of doing business influenced by the quality of institutions, there should be an environment that is conducive to promoting and attracting investments. There must be adequate measures to establish the right institutions. There must be requisite measures in order to allocate the necessary amount of funds for the necessitated objectives and evaluate the unused funds to be used for other goals. There must be encouragement in bilateral trade, CEPA between India and other foreign countries like Korea to increase investment while also taking into consideration indigenous companies and providing incentives for other sectors as well. Domestic value addition is not only to be contributed by a few large multinational companies but also by MSME companies. The sector must be as free as possible to satisfy consumer desires and reduce the burden of unnecessary regulations. There must be parameters and objective rules that define the eligibility criteria for the subsidies and no discretion in the interpretation and implementation of the rules The subsidies shouldn't have to bear the burden of the subsidies that might reduce their incentive to work as taxes on them rise, no misallocation of resources, it should be dictated by the want and demand of the consumers moreover those that reside in India not merely due their monopolisation. There must be clear navigation in boosting aggregate demand. There needs to be uniformity and non-discrimination as to which sector or company that receives the subsidies. The focus of the policy is to increase the maximum participation of Indigenous companies. Demand needs to be considered when we are aiming to incentivise the private sector and these schemes will not succeed. There should be a reduction in inequalities and an improvement in mass consumption. Employment, inadequacy of research and development by reducing the risk of investment are critical to building our technology and internal strength. The PLI scheme is an incentive given only to those companies that have made the necessary output and it encourages promotion facilitation and incentivization of investment that needs political accountability. There should be a distinction between a general subsidy that is through the economy giving importance to employment and living conditions and a specific subsidy based on the decisions taken by the government that needs a fair and equitable system sans discrimination. The critical focus should be on first having the technology and capacity to supply goods in the market on their own and indirect taxes should be supported by subsidies and living wages. There should also be allocation under the PLI scheme for IT hardware in order to boost manufacturing of computers, tablets

and servers.[27]

Design linked Incentive Scheme

The aim of this scheme is to provide financial and infrastructural support in setting up fab units by providing fiscal support of costs, and capital expenditure. It would also provide incentives on net sales for 5 years of semiconductor design including IP cores. This however should not be limited to companies that can achieve a turnover of more than 1500 crore but also to take necessary measures to incentivise the MSME sector. There should be a robust measure to promote and reduce the scarcity of chips for other sectors. The scheme should reduce the dependency on a few countries and companies even within the territory of India indirectly improving the supply chain and encouraging innovation. The focus should be to reduce the expenditure of IP rights, design, software, development, testing and deployment not only for global players but also for indigenous players. Fabrication units should not only be limited to defence and space applications but also for other sectors and should also expand their location areas. There should be a proper analysis of fund allocation for the setting up of fabs with clear and appropriate rules and regulations, other alternatives must also be considered like OSAT, ATMP etc. Consideration should also be made to navigate connectivity and resource accumulation. The scheme should be broad and reconsider the restrictive cap on disincentivizing start-ups that apply. It should support multiple MSMEs and start-ups involved in the field of semiconductor design, covering intellectual property filing, registration and licensing fees. There should be re-consideration of anti-dumping policies that might help Imports. Second-hand tools are used for designing, ranging in thermal and sensor simulation tools and other licensed tools that will help in reducing the financial burden on MSMEs and start-ups to provide for the licenses of these tools. Design should not be treated as an extension and must be made Central. There should be promotion of home-grown intellectual property, ensuring domestic design development.

Make in India

Protection measures should be made in order to improve and focus on national markets for protecting employment and incomes in the domestic market. As opposed to protecting large-scale industries, this policy aims to boost the micro sector, leading to improvements in employment to generate enough

[27] Under the PLI Scheme, India is Paying Manufacturers to Bring Work: Raghuram Rajan, THE WIRE, https://thewire.in/economy/pli-scheme-india-manufacturing-raghuram-rajan-karan-thapar

demand in the economy. The focus should be on the unorganised sector and not the organised sector. There should not be any marginalisation and this policy should aim to deal with the shortage of demand and economic slowdown. There should be a reduction in sectors that have high externalities by investing and developing the core sectors. There should be proper targeting to incentivise industries, promoting sustainable technology in order to facilitate the global sustainable development goals, green industries, net-zero goals, and subsidies should be granted in such sectors. We are meeting the problem of demand by way of imports that should be catered through local production. Indigenous and local demand is to be exploited for industries within the country and for the remaining there should be a Demand stimulus. Small medium electronic component makers need encouragement under the PLI scheme.[28]

Incentives for Start-ups and growth of IP

Evidence suggests that for developing countries strengthening intellectual property doesn't have an overall effect on growth, there should be promotion of domestic innovation and technology diffusion through foreign patenting and international trade. The impact of IPR protection is to a certain extent offsetting the growth-enhancing benefits that should be discouraged. The IPR protection should facilitate the TRIPS standard and promote domestic companies in promotion and other activities with enhancing technology impact. There should be rapid publication of patent applications with full disclosure of the technical process that is involved in the inventions that shall be used for commercial use. This will maximise the integration of local and domestic companies that would facilitate innovation through the available knowledge.

Mines and Minerals Amendment Act 2021

The Mines and Minerals (Development and Regulation) Amendment Act, 2021 is a significant legislative change enacted by the Ministry of Mines in India. This amendment is aimed at enhancing mineral production, simplifying the regulatory framework, and promoting the ease of doing business in the country. It also seeks to boost the contribution of mineral production to the Gross Domestic Product (GDP). The amendment Act brings about several noteworthy changes to the existing Mines and Minerals (Development and Regulation) Act of 1957. One of the key provisions of this

[28] Chip wars: How India plans to trot out its old war horse, feeding it $2 billion – The Economic Times, https://economictimes.indiatimes.com/industry/cons-products/electronics/chip-wars-how-india-plans-to-trot-out-its-old-war-horse-feeding-it-2-billion/articleshow/103955208.cms

amendment Act pertains to the removal of restrictions on the end-use of minerals. Under the original Act, the central government had the authority to reserve certain mines, excluding coal, lignite, and atomic minerals, for specific end-uses, like reserving an iron ore mine for a steel plant. These reserved mines were referred to as captive mines.[29] However, the Amendment Act eliminates the provision allowing the reservation of mines for particular end-uses. Another crucial aspect of the amendment Act relates to the sale of minerals by captive mines. Captive mines, with the exception of atomic minerals, can now sell up to 50% of their annual mineral production in the open market after fulfilling their own requirements. The central government may raise this threshold through a notification, and lessees must pay additional charges for minerals sold in the open market. Additionally, the Act empowers the central government to conduct auctions for mineral concessions, such as mining leases and prospecting licenses, in cases where state governments are unable to complete the auction process within a specified time frame. This provides a mechanism for the central government to step in when needed. The transfer of statutory clearances is also addressed in the amendment Act.[30] Instead of requiring new lessees to obtain fresh clearances within two years of taking over a mine, the amendment Act stipulates that transferred statutory clearances will be valid throughout the lease period of the new lessee, reducing bureaucratic hurdles. The amendment Act introduces provisions for the allocation of mines with expired leases to government companies in specific situations. These allocations can occur if the auction process for a new lease is incomplete or if a new lease is terminated within a year of the auction. The state government may grant a lease for up to 10 years or until the selection of a new lessee, whichever is earlier, to a government company in such cases. The rights of certain existing concession holders are also affected by this amendment. While previous amendments in 2015 granted rights to existing concession holders, the 2021 Amendment Act nullifies these rights, leading to the reimbursement of any expenses incurred by these holders. The amendment Act further addresses the extension of mining leases to government companies and conditions for the lapse of mining leases. It introduces the possibility of extending government company leases and outlines circumstances under which mining leases may lapse. Lastly, the amendment Act eliminates the provision for non-exclusive reconnaissance permits, which were previously available for preliminary prospecting of minerals other than coal, lignite, and atomic minerals. . It removes certain restrictions, streamlines the auction process, and updates various provisions to encourage mineral production, ease of doing business, and economic growth. The Amendment Act of 2021, specifically Section 10(1)

[29] Mines and Minerals (Development and Regulation) Amendment Act, 2021.
[30] Central Government Gazette Notification, 28 March 2021.

and Section 14(3), has raised concerns about potential violations of state rights, the role of the NITI Aayog, the Ministry of Finance, ambiguity in the consultation process, and its impact on the public sector. Section 10(1) of the Amendment Act may be seen as encroaching upon the rights of individual states. This section empowers the central government to specify a time frame for the auction of mineral concessions, allowing them to conduct auctions if state governments fail to meet this deadline. This provision may undermine the autonomy of states in regulating their mineral resources, potentially violating the principle of federalism. The involvement of NITI Aayog and the Ministry of Finance in the consultation process under Section 14(3) has raised questions about their roles in the mining sector. This section requires consultations between the central government and state governments, but the engagement of these bodies, which are primarily responsible for economic and policy matters, has caused ambiguity regarding their influence and decision-making powers in the mining sector. Section 14(3) mandates consultations between the central and state governments for matters related to mineral concessions. The lack of clarity in defining the scope and specifics of these consultations has led to uncertainty in the industry. Stakeholders are concerned that the vague language in this section may lead to disputes and inefficiencies in the decision-making process. The Amendment Act's provisions, such as the potential allocation of mines with expired leases to government companies, have raised concerns about the future of the public sector's role in mineral resource management. It may lead to the weakening of the public sector's presence in the mining industry, which could have broader economic and social implications.

Conclusion

In India's quest to bolster its presence in the semiconductor industry and grapple with the intricate dimensions of international trade agreements, it becomes paramount for the Government of India (GOI) to adopt fundamental principles and best practices that are instrumental in securing success. This conclusion highlights the essential elements that should serve as guiding pillars for India's policies and investments in this dynamic sector. India's pursuit of nurturing a robust semiconductor ecosystem must be anchored in market-driven incentive schemes. A core tenet of this approach is that the competitiveness of companies and their product offerings should be the primary driver of industrial prosperity, with minimal government interference. Public backing for the semiconductor manufacturing sector should harmonise with real-world market demand and the capability of firms or projects to thrive on the global stage. While there may be a legitimate need for government support in certain instances, particularly for national defence applications, incentives should predominantly

be geared towards promoting both new and existing projects. India should exhibit a keen awareness of the global demand for expanded capacity and ensure that its incentives align with market dynamics. India's strategy for public investments in the semiconductor domain should adhere to a well-defined and pragmatic approach. This entails channeling resources towards areas where India holds a competitive edge and addressing vulnerabilities that directly impact supply chain resilience. India possesses a substantial workforce skilled in chip design and should leverage this asset by further enhancing its capabilities in semiconductor research and design. Rather than concentrating solely on chip manufacturing, India should commit resources to advancing its expertise in chip design through workforce development and research and development (R&D). With targeted government support, India has the potential to cultivate a competitive fabless chip design industry ecosystem. As India contemplates significant public investments to establish a domestic semiconductor manufacturing ecosystem, the government should focus its efforts on segments that synergies with its strengths and align with prevailing market demands. For instance, India's strong demand for consumer electronics and communications, coupled with growing downstream assembly activities, presents an opportunity to invest in the design, fabrication, and assembly of semiconductors associated with these sectors. Furthermore, it should seriously consider substantial investments in science and engineering education to nurture highly skilled talent in the semiconductor sector. The semiconductor industry thrives on innovation driven by specialised expertise, making a rigorous focus on education imperative.