A Compute Agenda for India

EV.:.M LAW & POLICY

July 2024

A Compute Agenda for India

EVAM
LAW & POLICY

Evam Law and Policy is a New Delhi-based boutique tech policy research and advisory firm. It specialises in emerging technologies, and guides stakeholders through a rapidly evolving regulatory landscape.

For more information, see: www.evamlp.com

Author

Jai Vipra

CyberBRICS Fellow, FGV Direito Rio

Contents

1. Background

There are three interrelated ingredients of an AI system: algorithms, data, and computational power, or compute. Algorithms comprise structured sets of instructions that make up the architecture of an AI system. Data, for large language models, includes vast quantities of unlabelled and labelled data.

Compute can mean different things depending on the context. It can refer to the chips used, such as Graphics Processing Units (GPUs) or Application-Specific Integrated Circuits (ASICs), or the software used to communicate with these chips, or the arrangement of these chips in large clusters, called compute infrastructure.[1] In this report, we refer to all these aspects of compute because we are analysing its supply chain. Some parts of this supply chain are more concentrated than others, and thus call for more attention.

Compute is important to AI models because it can often be a differentiator in quality between models. Large models perform better overall on various benchmarks, especially in the generality of their application. Even when a firm possesses large amounts of data, it needs a proportional amount of compute to train a model on that data. Leading AI firms, including OpenAI, Google DeepMind, and Anthropic, have so far built their market positions based on their preferential access to compute.

From a national perspective, AI compute is important for both economic and strategic reasons.

1.1 The economic importance of AI compute

A country's compute power is commercially relevant because AI itself could be a driver of the economy. Compared to 2022 – where AI contributed somewhere around 136 billion USD to the global economy – AI is estimated by some analysts to contribute up to USD 15 trillion to the global economy by 2030, whilst growing at a mean annual growth rate of 37 percent between 2023 and 2030.[2] According to some estimates, AI is also expected to contribute up to USD 500 billion to India's GDP by 2025, and the addition of USD 967 billion to India's economy by 2035.[3] It is also estimated that around 70 percent of companies globally will adopt at least one type of AI technology by 2030.[4] Such projections are not watertight, could be entirely wrong, and we will elaborate on their drawbacks in a later section. However, it is worth taking the possible economic impact of AI seriously.

AI is already transforming many business contexts, automating processes in programming, customer service, advertising, and likely even manufacturing. Compute is an indispensable part of AI, and currently the largest cost driver. The hardware acquisition cost for Google's Gemini Ultra is estimated to be around USD 670 million.[5] Given these high costs and the wide-ranging applications of AI, AI compute is of utmost commercial importance for businesses in all sectors.

1 https://ainowinstitute.org/publication/policy/compute-and-ai

2 https://business.teamleasedigital.com/artificial-intelligence-forces-shaping-the-future-of-technology/

3 https://indianexpress.com/article/business/economy/artificial-intelligence-expected-to-add-500-bn-to-india-gdp-by-2025-8507775/

4 https://www.mckinsey.com/capabilities/quantumblack/our-insights/the-state-of-ai-in-2023-generative-ais-breakout-year

5 https://epochai.org/trends

1.2 The strategic importance of AI compute

AI is strategically important for two reasons: one, because of its potential use in national security and defence systems, and two, because of its possible comprehensive global economic impact.

The use of AI in weapons systems has been growing rapidly (see Box 1).

Box 1

In the last few years, automation has taken root in different capabilities of weapons systems. Russia's S-350 Vityaz air defence system is reported to have shot down a Ukrainian aircraft in "automatic mode" implemented using AI.[6] In the West Bank, Israel is reported to be already using its AI-powered robot guns, which are quicker than humans in selecting targets and firing.[7] In June 2022, Israel's largest arms company, Elbit Systems, showcased its new system of a swarm of killer robots called Legion-X, labelling it "AI-driven."[8] The IDF is also reported to be using an AI recommendation system which uses data about military-approved targets to calculate ammunition loads, prioritise, and assign thousands of targets to aircrafts and drones. It reportedly also proposes a schedule. [9]

The UK is also increasingly interested in looking into the use of autonomous weapons, per the AI Defence Strategy 2022, a document that describes how the UK plans to work closely with the private sector to use AI to revolutionise the capabilities of its armed forces.[10] The Chinese armed forces' Strategic Support Force (SSF) established back in 2015 is reported to be rapidly developing AI-based autonomous machinery military strategies.[11] The United States Air Force is also developing a new generation of AI drones at a target cost of 3 million US dollars each[12] - including 'XQ-58A Valkyrie' - an AI-powered combat aircraft capable of autonomously chasing and destroying targets, with human pilots merely acting as its 'wingmen'. While Valkyrie has been successfully tested on its flight capabilities, it is yet to be tested on its combat capabilities.

The Indian Army has also begun exploring AI as an enabler in a number of domains. For example, the Army is reportedly using AI-enabled surveillance systems including high-resolution cameras, sensors, and unmanned aerial vehicles for threat detection and border security.[13] Further, it is reported that AGNI-D, an AI-enabled surveillance software, is currently being tested at India's northern borders of Ladakh.[14] The Indian Government has also taken a number of steps to further AI research and development for defence use. In 2018, the Indian Government launched the Innovations for Defence Excellence (iDEX) initiative aimed at fostering indigenous technological innovation and development in India's defence and aerospace sector. To this end, a budgetary allocation of ₹498.78 crores was approved to provide financial support to 300 startups, MSMEs, and individual incubators along with 20 partner incubators.[15]

---

6 "1st Kill By 'Artificial Intelligence'! Russia Confirms Its S-350 Vityaz System 'Shot Down' Ukrainian Aircraft In Auto Mode." Accessed October 19, 2023. https://www.eurasiantimes.com/1st-kill-by-artificial-intelligence-russia-says-its-s-350-vityaz-system/.

7 Euronews. "AI-Powered Guns Being Deployed by the Israeli Army in the West Bank." October 17, 2022. https://www.euronews.com/next/2022/10/17/israel-deploys-ai-powered-robot-guns-that-can-track-targets-in-the-west-bank.

8 "Israel Is Already Weaponizing AI — But Not in the Ways It Claims to Be | Truthout." Accessed October 19, 2023. https://truthout.org/articles/israel-is-already-weaponizing-ai-but-not-in-the-ways-it-claims-to-be/.

9 "Israel Is Already Weaponizing AI — But Not in the Ways It Claims to Be | Truthout." Accessed October 19, 2023. https://truthout.org/articles/israel-is-already-weaponizing-ai-but-not-in-the-ways-it-claims-to-be/.

10 ComputerWeekly.com. "Lords Committee to Investigate Use of AI-Powered Weapons Systems | Computer Weekly." Accessed October 19, 2023. https://www.computerweekly.com/news/365532024/Lords-Committee-to-investigate-use-of-AI-powered-weapons-systems.

11 Brookings. "The PLA's Strategic Support Force and AI Innovation." Accessed October 19, 2023. https://www.brookings.edu/articles/the-plas-strategic-support-force-and-ai-innovation-china-military-tech/.

12 https://economictimes.indiatimes.com/news/defence/us-military-set-to-deploy-xq-58a-valkyrie-ai-drones-to-counter-chinas-strength/articleshow/103178598.cms

13 https://indiaai.gov.in/news/the-army-deploys-140-ai-based-surveillance-systems-to-enhance-border-security

14 https://timesofindia.indiatimes.com/city/bengaluru/army-officer-develops-ai-based-software/articleshow/97995723.cms

15 https://www.ddpmod.gov.in/sites/default/files/iDEX%20scheme%20Final3.pdf

8
Evam Law & Policy

Other measures include setting up the Defence AI Council (DAIC)[16] and two AI-research dedicated labs under the Defence Research & Development Organisation (DRDO), as well as launching the DRDO Industry Academia Center of Excellence (CoE) at the Indian Institute of Technology, Hyderabad.[17] Additionally, the Government has also finalised an AI roadmap under which 70 defence-specific AI projects have been identified for development.[18]

The examples above do not necessarily suggest that India must be uninhibited in the development of AI capabilities in all weapons systems. Mistakes made by autonomous weapons can be costly, both for armed forces and often for civilians. Automating decision-making on the battlefield can have unexpected and spiralling consequences, highlighting the need to have humans in the loop. Autonomous weapons may also not demonstrate necessary human judgement, core components of which are discernment and proportionality, both of which must be maintained especially in the context of war. Autonomous weapons systems can encourage the commission of internationally prohibited war crimes if they allow military officials to evade liability.[19] The UK Parliament's Artificial Intelligence in Weapon Systems Committee has accordingly warned that public confidence and democratic endorsement are essential for the use of AI in weapons systems.[20]

With all these caveats in mind, and to the limited extent that AI is likely and desirable to be used in India's defence capabilities, such AI (and its infrastructure) must be domestically controlled. If compute or AI models for defence uses are procured from foreign sources, these might include deliberate and inadvertent vulnerabilities. Information made public by Edward Snowden has already revealed that the United States – currently the leader in AI development – installs backdoors in exported technology, even when it is produced by private companies.[21] Such backdoors are possible in AI compute as well, and can enable remote monitoring and the manipulation of activity. This monitoring can include tracking the level of activity of a device, the type of use, as well as possibly remote shutdown mechanisms. There is currently a push to develop and include such "security features" in AI chips produced with US technology (which includes all advanced AI chips, even those produced in Taiwan).[22] This push would represent an escalation of the US government's compute export controls that aim to degrade China's AI capabilities.[23] Perhaps as a reflection of the United States' own efforts in this vein, some US government officials believe that chips produced in China could one day contain cyber-vulnerabilities that could cripple the infrastructure in which these chips are embedded.[24] These fears demonstrate that regardless of its geopolitical situation, India has an interest in developing some chips domestically.

1.3 The strategic dimensions of the economic impact of AI

AI could potentially lead to the re-evaluation or entrenchment of global economic relations, thereby accruing economic power to the countries that lead in its development. Much of India's economic prowess today derives from its potential to become a global manufacturing hub; with increasing automation, this advantage is significantly diminished. The export of services is an important pillar of the Indian economy, but it is not one that can replace the

16 https://pib.gov.in/PressReleasePage.aspx?PRID=1810442

17 https://newsonair.gov.in/News?title=DRDO-Industry-Academia-Centre-of-Excellence-inaugurated-at-IIT-Hyderabad&id=459447

18 https://www.pib.gov.in/PressReleasePage.aspx?PRID=1846937

19 https://www.972mag.com/lavender-ai-israeli-army-gaza/

20 https://committees.parliament.uk/committee/646/ai-in-weapon-systems-committee/news/198762/government-warned-to-proceed-with-caution-on-ai-in-autonomous-weapons/

21 https://www.theguardian.com/books/2014/may/12/glenn-greenwald-nsa-tampers-us-internet-routers-snowden

22 https://www.openphilanthropy.org/research/12-tentative-ideas-for-us-ai-policy/ and https://www.cnas.org/publications/reports/secure-governable-chips

23 https://www.csis.org/analysis/chinas-new-strategy-waging-microchip-tech-war

24 https://archive.is/yLqAX

extensive employment that is created through a strong domestic manufacturing base, as the US is now beginning to recognise.

In rural India, the proposed wholesale AI-driven automation and consequent consolidation of agriculture[25] – without commensurate job creation in urban India, and in the absence of redistribution of gains – can potentially lead to unemployment and destabilisation, not to mention mass poverty and suffering.[26] Domestic control of AI compute provides a chance for India to carry out automation in a carefully managed manner with appropriate safeguards in place.

If AI compute is controlled by a foreign country, irrespective of whether it is currently friendly to India or otherwise, India would witness a deterioration of economic autonomy. Consequently, strategic autonomy also moves in consonance with economic autonomy.

Thus, for reasons of defence, strategic autonomy, and economic development, India needs to develop self-reliance in AI compute in particular. This goal is in line with the Government of India's goal to develop self-reliance in semiconductors in general.[27] The additional imperative clarified through this analysis is that this self-reliance needs to be directed towards the particular goals of strategic and economic autonomy in an AI era.

Other governments have already started considering these issues. The US government has recently started viewing compute policy through a predominantly strategic lens. Its export controls, which expand regularly to involve not only chips but likely[28] AI models themselves, are a manifestation of this perspective.[29] The government of China seems to be thinking in a similar direction, as evidenced from a meeting of the National Security Commission of the ruling party.[30] In March 2023, the UK government announced a plan to invest GBP 900 million in a frontier supercomputer to build a national AI model nicknamed "BritGPT".[31] The UK's decision to invest in national AI compute was also driven by national security considerations.[32]

25 https://www.weforum.org/agenda/2023/11/indias-farmers-are-on-the-cusp-of-a-technological-revolution-agristack/

26 https://www.omfif.org/bulletin23_autumn_vipra/

27 https://auto.economictimes.indiatimes.com/news/auto-components/pm-modi-pitches-for-self-reliance-in-semiconductor-make-in-india/89970753

28 https://www.theatlantic.com/technology/archive/2023/10/technology-exports-ai-programs-regulations-china/675605/

29 https://www.theatlantic.com/technology/archive/2023/10/technology-exports-ai-programs-regulations-china/675605/

30 https://www.pbs.org/newshour/world/china-warns-of-artificial-intelligence-risks-calls-for-increased-national-security-measures

31 https://www.theguardian.com/technology/2023/mar/15/uk-to-invest-900m-in-supercomputer-in-bid-to-build-own-britgpt

32 https://www.theguardian.com/technology/2023/mar/15/uk-to-invest-900m-in-supercomputer-in-bid-to-build-own-britgpt

10
Evam Law & Policy

2. Recommendations for India's Compute Strategy and Policy

Achieving self-reliance in AI compute will require a multi-pronged approach. Not only will India need to focus on the production of advanced chips, but it will also need to continue to make simultaneous investments in other, often lower-value, parts of the value chain. It will also need to promote international compute and AI governance efforts. In addition, India needs thoughtful strategic direction in the development of AI products and services that are truly useful and do not follow short-term "hype cycles," such that high investments in compute are linked to actual economically beneficial outcomes. This multi-pronged strategy is necessary because, as we go on to explain, no single tactic has a high likelihood of succeeding by itself. Therefore, efforts towards the domestic production of AI chips (the primary goal) need to be hedged by efforts in the other aforementioned areas. Indian policymakers will also need to ensure that these different tactics coalesce towards self-reliance in sum.

The production of compute involves designing chips, making equipment for manufacturing chips, the actual manufacturing (known as fabrication) of the chips themselves, their assembly, testing, and packaging, and the clustering of these chips in servers housed in large data centres, also known as compute clusters. Large compute clusters are known as supercomputers. It is this last step in which India has made substantial progress.

India's fastest supercomputer, 'Airawat', has been ranked the world's 75th fastest supercomputer and consists of 640 GPUs. The government is considering investing in setting up a supercomputer with 25,000 GPUs, which is much more significant.[33] However, this is still dwarfed by some private supercomputers used for AI.[34] In addition, the new IndiaAI Mission plans to gather 10,000 GPUs – it is unclear if this new plan is a step down from the earlier plan for 25,000 GPUs, or if it is a separate plan.[35]

2.1 Investment in advanced chip production

India should not lose sight of the bottlenecks along the entire supply chain of compute. US export controls in AI focus on chip design and on semiconductor manufacturing equipment. Trade rules (or at least certain interpretations of them) allow the US to control the export of several components of this supply chain, because nearly every entity uses US intellectual property.[36] Its friendly relationship with the US notwithstanding, India must in its own interests be prepared for sudden export controls that can limit the supply of GPUs into India. As mentioned earlier, India should also plan for potential remote monitoring mechanisms within GPUs that are easier than export controls to deploy

33 https://indbiz.gov.in/govt-considering-proposal-to-set-up-25k-gpus/

34 See for instance: https://andromeda.ai/

35 https://www.pmindia.gov.in/en/news_updates/cabinet-approves-ambitious-indiaai-mission-to-strengthen-the-ai-innovation-ecosystem/

36 https://www.stairjournal.com/oped/2024/5/9/the-threat-of-on-chip-ai-hardware-controls

against geopolitical friends.[37]

The ideal outcome for India would be to produce AI chips domestically. This affords sovereign control over the production of strategically and economically important compute. “Production” includes design and fabrication.

Currently, India falls far behind leading countries in the design and fabrication of AI chips. Its most notable feat in carrying out indigenous chip design so far has been the development of general purpose microprocessors designed using RISC-V, an open-source design architecture.[38] Indian Institute of Technology (IIT) Madras has successfully designed a family of general purpose 180 nm node microprocessors called SHAKTI, produced at the Semi-Conductor Laboratory (SCL) in Punjab.[39]

General purpose chips such as SHAKTI are used in all computer systems. However, they have limited use for training today’s AI models. While GPUs are optimised for processes that require parallel computations (such as training deep learning models), and ASICs are hardwired to perform a narrow set of specific functions with great performance (such as AI-specific processes), general purpose chips perform tasks serially, and are not optimised for any specific functions.

Apart from these efforts, India’s design ecosystem is largely dominated by the presence of R&D and captive design centres set up by foreign MNCs and design firms including Intel,[40] Texas Instruments,[41] ARM, and Mediatek.[42] This offshoring has led to employment opportunities for the country’s design talent pool. Today, India is home to 20 percent of the global workforce employed in chip design.[43] This has also provided an impetus for additional investment in setting up design and R&D centres on Indian soil (See Box 2).

∴ Box 2

In recent years, foreign MNCs leading chip design globally have announced notable investments in India. For example, chip developer AMD has announced its plans to invest USD 400 million over the next 5 years towards the development of a design campus in Bengaluru, which will act as a centre of excellence for high-performing CPUs and other chips including SoCs, and FPGAs, and will employ 3,000 engineers focused on 3-D stacking, AI, and ML.[44] Further, Qualcomm has revealed its plan to invest ₹177 crore to set up a new design facility in Chennai, which will specialise in wireless connectivity solutions and innovation, and also generate 1,600 skilled jobs.[45] Construction conglomerate Larsen & Toubro (L&T) has also announced its plans to invest ₹830 crore (USD 99 billion) in India, towards setting up chip design and product ownership focused on automotive and industrial chip design.[46]

IBM has inked three Memoranda of Understanding (MoU) with the Government of India to set up a national AI innovation platform that will focus on AI skilling, ecosystem development, and integrating advanced foundation models.[47] Nvidia and India’s Reliance Industries have partnered to co-create an LLM that will be

37 https://www.stairjournal.com/oped/2024/5/9/the-threat-of-on-chip-ai-hardware-controls

38 https://pib.gov.in/PressReleseDetailm.aspx?PRID=1913995

39 https://pib.gov.in/PressReleseDetailm.aspx?PRID=1913995

40 https://www.livemint.com/companies/news/intel-india-opens-new-design-and-engineering-centre-in-bengaluru-11656065255511.html

41 https://analyticsindiamag.com/indias-rd-prowess-not-enough-to-become-china1-in-chip-game/

42 https://economictimes.indiatimes.com/tech/hardware/arms-india-design-centre-to-be-worlds-second-largest/articleshow/2863014.cms

43 https://www.pib.gov.in/PressReleasePage.aspx?PRID=1814029

44 The Times of India. “AMD Opens Its Largest Design Centre in Bengaluru.” November 29, 2023. https://timesofindia.indiatimes.com/city/bengaluru/amd-largest-design-centre-india/articleshow/105577037.cms.

45 The Economic Times. “Qualcomm India Invests Rs 177 Crore in New Design Centre in Chennai.” January 7, 2024. https://economictimes.indiatimes.com/tech/technology/qualcomm-india-invests-rs-177-crore-in-new-design-centre-in-chennai/articleshow/106608665.cms?from=mdr.

46 Techcircle. “L&T to Invest ₹830 Cr for Fabless Chip Design.” November 1, 2023. https://www.techcircle.in/2023/11/01/l-t-to-invest-830-cr-for-fabless-chip-design.

47 Moneycontrol. “IBM to Boost India’s R&D and Skill Development in AI, Chips, Quantum Computing.” October 18, 2023. https://www.moneycontrol.com/news/business/ibm-to-boost-indias-rd-and-skill-development-in-ai-chips-quantum-computing-11556661.html.

12
Evam Law & Policy

trained on Indic languages, and will reportedly be owned by Reliance.[48]

At the same time, such foreign presence in India has not led to self-reliance for two main reasons. Firstly, although aspects of chip design have been offshored to India, foreign MNCs retain the intellectual property (IP) rights underlying the chip designs.[49] Secondly, domestic firms have hesitated to develop in-house IP because they have to depend on fabrication giants like TSMC to ultimately produce the chips they design. Indian companies have thus been choosing instead to provide design services to foreign MNCs.[50]

Chip fabrication in India is primarily carried out at the SCL, an autonomous research facility under the Ministry of Electronics and Information Technology (MeitY).[51] SCL is equipped to carry out the design, fabrication, assembly, testing, packaging, and sale of chips at the 180 nm node obtained from the Israel-based company, Tower Semiconductors, in 2010.[52]

SCL holds immense strategic importance for India's defence and space sector. SCL-produced chips have been used in India's Mars Orbiter Mission.[53] However, SCL operates with older technology on a very small scale, with only 2 wafer fabrication lines.[54] Given India's high demand for indigenous chips in the defence sector alone,[55] the SCL's monthly output of 750 Wafer Starts Per Month (WSPM)[56] falls short of other countries including China whose domestically-owned corporations can collectively produce up to 4.4 lakh WSPM.[57]

In sum, India is in a nascent stage in the production of AI chips. The absence of a chip fabrication ecosystem has positioned India several decades behind other countries in the production of less specialised chips, which has led to slow progress in the production of more specialised chips. Despite foreign presence, India does not own the critical intellectual property needed to be self-reliant in chip design.

2.1.1 Existing policy measures

The Government of India has been actively framing policy to reach the goal of domestic production of AI chips. Its general push has three main components:

- Incentive schemes along different aspects of the supply chain,[58]
- A call for proposals to modernise and commercialise SCL,[59] and
- A commitment to building stronger R&D in India with help from global industry experts, under the India Semiconductor Mission.[60]

In 2021, the Government officially approved a budget of ₹76,000 crore (approximately USD 10 billion) under a production-linked incentive

48 US Chipmaker Nvidia to Partner Reliance, Tata to Boost AI in India." The Economic Times, September 9, 2023. https://economictimes.indiatimes.com/tech/technology/us-chipmaker-nvidia-to-partner-reliance-tata-to-boost-ai-in-india/articleshow/103518856.cms.

49 https://carnegieindia.org/2023/05/23/is-india-ready-for-semiconductor-manufacturing-pub-89814

50 https://www.hindustantimes.com/opinion/indias-semiconductor-push-should-focus-on-revamping-the-dli-scheme-101657959377978.html

51 Note: India also has two research units, namely, STARC, Bangalore, and GAETEC, Hyderabad, that undertake semiconductor fabrication and development for DRDO's strategic purposes.
https://www.drdo.gov.in/labs-establishment/about-us/society-integrated-circuit-technology-and-applied-research-sitar

52 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

53 https://www.pib.gov.in/PressReleseDetailm.aspx?PRID=1898080

54 https://www.meity.gov.in/writereaddata/files/EoI-SCL%20Modernization.pdf

55 https://www.financialexpress.com/business/defence-lack-of-indigenous-chips-hurt-indian-defence-industry-3191377/

56 WSPM is a measure used to denote the output of a semiconductor wafer plant.

57 https://www.lightreading.com/semiconductors/china-eyes-40-billion-fund-to-build-up-domestic-chip-production.

58 https://pib.gov.in/PressReleasePage.aspx?PRID=1781723

59 https://www.meity.gov.in/writereaddata/files/EoI-SCL%20Modernization.pdf

60 https://pib.gov.in/PressReleasePage.aspx?PRID=1781723

scheme ("PLIS") to promote a semiconductor ecosystem in India.[61] The PLIS[62] and the design-linked incentive scheme ("DLIS")[63] both extend financial incentives of 50 percent cost reimbursement with varying eligibility criteria and restrictions. The goal is to incentivise business entities to set up their fabrication units and carry out chip design on Indian soil. So far, this goal has run into problems.

While the PLIS received initial traction, the scheme has not seemed to gain momentum due to issues surrounding the transfer of technology. In order to avail the incentive, applicants must meet a minimum investment threshold of ₹20,000 crore (USD 2.5 billion). They must also "own or possess production-grade licensed technology for the proposed technology process."[64] While originally the 50 percent incentive was only applicable to those carrying out fabrication at 28 nm nodes or lower, the Government subsequently thought it prudent to make the incentive uniform along legacy nodes as well.[65] An Expenditure Finance Committee has been empowered to determine the structure and quantum of financial support granted under the PLIS. In lieu of such support, the Government's share is not to exceed 49 percent of the total project equity.[66]

Initially, the PLIS received applications from IGSS,[67] ISMC,[68] and the joint venture between Foxconn and Vedanta.[69] Shortly after, IGSS dropped out.[70] ISMC did not proceed with its application since its technology partner, Tower Semiconductors, was unable to sign a binding agreement during its ongoing takeover by Intel.[71]

Most notably, the joint-venture between Taiwan's Foxconn and India's Vedanta did not follow through with its application since its Europe-based technology partner, STMicroelectronics, was unwilling to invest in an equity partnership under the PLIS as was desired by the Government.[72] This caused the planned USD 19.5 billion investment in setting up a chip fabrication facility in Gujarat to fall through. It was reported that STMicroelectronics was unwilling to have more "skin in the game" at that stage, and instead wished to wait for the Indian market to mature further.[73]

At present, there is only one application under the PLI that has received governmental approval — a fabrication facility worth INR 91,000 crore (USD 10.9 billion) proposed to be set up by India's Tata Electronics Private Ltd. (TEPL) at Dholera, Gujarat, along with Taiwan's PSMC acting as its technology partner.[74]

In comparison, the DLIS has garnered more response. While it aims at promoting 100 chip design companies, as of July 2023, only 5 applications stood approved under the scheme.[75]

The DLIS recognises that despite the presence of foreign design centres on Indian soil, a miniscule portion of the IP generated domesti-

61 https://pib.gov.in/PressReleasePage.aspx?PRID=1781723

62 https://www.meity.gov.in/esdm/Semiconductors-and-Display-Fab-Ecosystem

63 https://chips-dli.gov.in/

64 https://www.meity.gov.in/writereaddata/files/Notification%20Modified%20Scheme%20for%20Semiconductor%20Fabs.pdf - Also make sure we've defined legacy nodes somewhere before I think I kind of have.

65 https://pib.gov.in/PressReleasePage.aspx?PRID=1861129

66 https://www.meity.gov.in/writereaddata/files/Notification%20Modified%20Scheme%20for%20Semiconductor%20Fabs.pdf

67 https://economictimes.indiatimes.com/tech/technology/india-should-decide-on-semiconductor-sops-by-october-igss-ventures/articleshow/94062636.cms?from=mdr

68 https://www.financialexpress.com/industry/ismc-to-invest-3-billion-in-karnataka-to-set-up-indias-first-chip-making-plant/2509657/

69 https://economictimes.indiatimes.com/news/india/vedanta-clarifies-semiconductor-manufacturing-to-be-done-by-ultimate-holding-company-volcan/articleshow/94226964.cms

70 https://www.reuters.com/world/india/india-chip-plan-stalls-after-tower-intel-deal-setback-modi-2023-05-31/

71 https://swarajyamag.com/technology/chip-manufacturing-in-india-intel-tower-deal-stalls-ismcs-3-billion-semiconductor-facility-plan

72 https://www.reuters.com/world/india/india-chip-plan-stalls-after-tower-intel-deal-setback-modi-2023-05-31/

73 https://www.reuters.com/world/india/india-chip-plan-stalls-after-tower-intel-deal-setback-modi-2023-05-31/

74 https://www.tata.com/newsroom/business/first-indian-fab-semiconductor-dholera

75 https://www.cnbctv18.com/india/india-semiconductor-push-5-applicants-approved-under-design-linked-incentive-scheme-17104801.htm .

cally belongs to India.[76] The scheme also refers to India's large talent pool of engineers trained in chip design, and cites a yearly output of one thousand chips designed by Indian engineers.[77] The Government considers existing chip design activities being carried out in India as the country's "biggest advantage."[78]

However, primary research carried out within the industry indicates that the design work that was historically carried out by Indian engineers at foreign centres set up on Indian soil pertained more to peripheral aspects of design, while core-design activities were offshored to countries like Israel.[79] Higher-end activities within the design flow (such as specification and architecture) are typically restricted to the global headquarters of such foreign design companies. The high-end design (architecture and RTL implementation) of a device is a core differentiating aspect in the industry.[80]

Recommendation 1:
Policy efforts should be more specifically targeted towards the exact aspects of chip design that do not currently take place in India. A micro-level assessment of the design ecosystem in India would be a good starting point. Currently, policymaking in this domain relies on macro-level data on incoming investment, patent registration and employment.

2.1.2 Open source efforts

Open source efforts can go a long way in achieving self-reliance in chip design in an environment of export controls. An important example of such an effort is RISC-V, which is an open source Instruction Set Architecture (ISA). ISAs are used by chip designers as the interface between hardware and software. It refers to the total set of available commands for a processor, which would allow it to carry out program instructions. Most chips are built using closed ISAs created, for instance, by Arm or Intel. Using closed ISAs means paying licensing fees to the ISA developer, which can be quite costly.

India, China, and the EU all consider RISC-V as a way to achieve compute sovereignty. India's SHAKTI chips are based on RISC-V, and the government has run a competition to encourage developers to build devices based on RISC-V chips.[81] The EU has allocated EUR 270 million (USD 294 million) to funding a project to build high-performance computers based on RISC-V, as to avoid relying on Arm, Intel and others.[82] China's strategy to build chip technology despite US export controls relies heavily on the use of RISC-V.[83]

Unsurprisingly, RISC-V is being discussed by a US House Select Committee in relation to national security.[84] However, controlling the export of RISC-V – an internationally developed offering that is already open source – is impractical and therefore unlikely. In this sense, building an ecosystem around RISC-V seems like a good bet for India.

There are various parts of the RISC-V ecosystem that need to be strengthened before it can be used for designing chips suited for AI development. For instance, any ISA needs to be verified in its implementation. Verification refers to testing the quality and accuracy of the function-

76 Background, Point 1.3 of the DLI scheme https://chips-dli.gov.in/DLI/AbstractFilePathCoded?FileType=RQ==&FileName=R2F6ZXR0ZU5vdGlmaWNhdGlvbl9ETElTY2hlbWUucGRm&PathKey=RE9DVU1FTlRfVEVNUExBVEU=

77 https://chips-dli.gov.in/DLI/AbstractFilePathCoded?FileType=RQ==&FileName=R2F6ZXR0ZU5vdGlmaWNhdGlvbl9ETElTY2hlbWUucGRm&PathKey=RE9DVU1FTlRfVEVNUExBVEU=

78 https://www.businesstoday.in/latest/economy/story/govts-roadmap-to-make-india-hub-of-semiconductor-manufacturing-315701-2021-12-15

79 D. Ernst, A New Geography of Knowledge in the Electronics Industry? Asia's role in global innovation networks, Policy Studies, no. 54, (Honolulu East-West Center, 2009), p -21
https://www.files.ethz.ch/isn/104328/ps054_2.pdf
This is consistent with this author's research on Intel Bangalore's IC-design projects.

80 https://sci-hub.se/https://doi.org/10.1016/j.techfore.2017.03.032

81 https://www.theregister.com/2020/08/19/india_microprocessor_challenge_risc_v/

82 https://www.hpcwire.com/2022/12/16/europe-to-dish-out-e270-million-to-build-risc-v-hardware-and-software/

83 https://archive.is/yLqAX

84 https://archive.is/yLqAX

ing of the ISA. For RISC-V, this is still a developing area. The interconnects between compute and memory, as well as between different chips, are still in the process of being optimised for RISC-V chips.[85] In terms of economics, while in theory RISC-V allows smaller companies to design and fabricate chips, for chips that are more general purpose, larger companies can achieve economies of scale and provide more competitive prices.[86]

However, RISC-V has a great deal of potential to be used to design AI chips. It allows for flexibility, which can be useful for the application-specific nature of AI chips. While RISC-V itself is free to use, designs based on RISC-V can be open, closed, or have specific licences, allowing for a variety of incentives for developers. Because the chip design market is so concentrated, many companies have now started investing in the RISC-V ecosystem.[87]

Software ecosystems around specific parts of the compute value chain are extremely important: the more people contribute to this ecosystem, the more compelling it becomes for others to use it, and so on.[88] It appears now that there is considerable momentum towards building an ecosystem around RISC-V.

Recommendation 2:
The government should carry out or commission a study of the parts of the RISC-V ecosystem that can benefit the most from policy support. Indicatively, these might include investments in verification, supporting startups that use RISC-V to design chips, and incentivising participation in RISC-V's Special Interest Group on High Performance Computing.[89]

The DLIS also recognises the need to support India's nascent semiconductor design ecosystem by reducing entry barriers to design startups. To this end, it extends financial incentives to domestically-owned companies, startups, and MSMEs engaged in chip design across different semiconductor products. The Government has also introduced a chip-to-startup scheme that aims to train 85,000 engineers in specific aspects of fabless (without fabrication) design by inculcating a culture of such studies across the undergraduate to research level of education.[90]

A firm applying for the DLIS must be registered in India and more than 50 percent of its capital must be owned by an Indian resident or entity. This geographic limitation on raising capital has been critiqued.[91]

Recommendation 3:
The government may consider removing domestic capital requirements from the DLIS, as long as overall control rests with Indian nationals. The presence of a wide range of design activities in India can itself help foster a growth in domestic design talent and ownership.

One significant barrier to entry for domestic design firms today is the lack of access to capital. Chip design is inherently a capital-intensive activity with a long gestation period. The design cost of a single leading-edge 5 nm chip is estimated to be around USD 540 million.[92] Domestic startups struggle to find seed capital to carry out sustained operations, and Government-provided incentives can only act as secondary support systems in comparison to primary funding.

85 https://semiengineering.com/is-risc-v-ready-for-supercomputing/

86 https://www.moneycontrol.com/news/business/inside-iit-madras-big-industry-prefers-chinese-chips-over-indian-10267591.html

87 See for instance: https://www.qualcomm.com/news/onq/2023/09/what-is-risc-v-and-why-were-unlocking-its-potential

88 https://ainowinstitute.org/publication/policy/compute-and-ai

89 https://semiengineering.com/is-risc-v-ready-for-supercomputing/ and https://lists.riscv.org/g/sig-hpc

90 https://c2s.gov.in/

91 https://www.hindustantimes.com/opinion/indias-semiconductor-push-should-focus-on-revamping-the-dli-scheme-101657959377978.html

92 https://www.mckinsey.com/industries/industrials-and-electronics/our-insights/semiconductor-design-and-manufacturing-achieving-leading-edge-capabilities

16
Evam Law & Policy

Recommendation 4:
Since the investment horizon for designing chips is significant (at least three years) and fabrication even longer, the government can build in a system of guaranteed purchase contracts that creates certainty for market participants. Careful policy design can help ameliorate the need to "pick winners" in this market, perhaps by guaranteeing purchase for any chips that fulfil high performance and quality standards.

Despite these policy efforts, we must reckon with the high likelihood that India cannot achieve self-reliance in the production of AI chips in the next decade. Enormous capital investments are required for fabricating AI chips, and progress in chip technology is rapid. India has already experienced the trickiness of technology transfers in this domain. Intellectual property in chip production is guarded so strongly that it drives geopolitical conflict and accusations of luring or reportedly even the planned abduction of scientists (although this is denied by the governments involved).[93]

Even China – which is several years ahead of India in domestic production of semiconductor technology – has found it exceedingly challenging to achieve self-reliance in the most advanced chips, with existing US restrictions. Its recent progress in this area has been driven by massive investments, retaliatory manoeuvres, and even reverse-engineering.[94] As an illustration, a single memory chip Chinese startup raised USD 5.4 billion from government-backed investors in November 2023.[95]

While part of India's strategy is to take advantage of the US's shift away from China, one should note that other countries have found it difficult to do the same. For instance, Intel recently cancelled its expansion plan in Vietnam as an alternative to China, reportedly due to issues of power capacity and bureaucracy.[96] Building a broad semiconductor base requires fundamental change in production structures and governance.

India is starting from a disadvantageous position, and while it continues to make investments in AI chip production, it must supplement this strategy with other investments and actions.

2.2 Investment in other parts of the AI value chain

There are three reasons why investing in the lower end of the value chain is likely to further India's strategic interests with respect to AI and compute. One, that successful investments in the lower end can make investments in the higher end more attractive by reducing logistics costs and demonstrating the maturity of the market. Two, that any measure of self-reliance in any part of the compute value chain is desirable inasmuch as it reduces dependence. Three, to some extent, control over any part of this value chain can be used as strategic leverage.

This lower end of the value chain, consisting of assembly, testing, marking, and packaging (ATMP), is the penultimate stage in the value chain before chips are finally distributed and sold to customers. ATMP processes are undertaken to protect fabricated chips from physical damage caused by dust, moisture, temperature, or vibrations, while also allowing them to be connected to other devices.

Traditionally, the ATMP process involves inspecting silicon wafers produced at fabrication facilities, dicing wafers into individual integrated-circuits (ICs) or chips, testing such chips to identify the functional ones, encasing such chips in protective packaging, and finally testing such encased chips at extreme temperatures and voltages.

When carried out at a captive facility set up to serve a single company, the process is simply

93 https://www.scmp.com/news/china/military/article/3195682/taiwan-denies-us-has-plan-evacuate-chip-engineers-and-destroy

94 https://www.csis.org/analysis/chinas-new-strategy-waging-microchip-tech-war and https://www.semianalysis.com/p/wafer-wars-deciphering-latest-restrictions

95 https://www.scmp.com/business/banking-finance/article/3240490/china-invests-us54-billion-two-year-old-memory-chip-maker-self-sufficiency-drive-picks

96 https://www.scmp.com/tech/tech-war/article/3240719/intel-calls-planned-chip-operation-expansion-vietnam-which-positions-itself-china-alternative-source

referred to as ATMP, whereas when carried out at a facility set up to service a wide range of customers, it is referred to as Outsourced Semiconductor Assembly and Testing (OSAT).

Presently, more than 60 percent of global ATMP capacity is concentrated in OSAT facilities located in Asian countries such as China, Taiwan, and Japan, thus making this stage of the value chain a chokepoint for the US.[97] The US has made significant efforts towards onshoring chip packaging on US soil, and boosting innovation in packaging technologies via the US CHIPS and Science Act. OSAT/ATMP firms are also starting to diversify their global footprint, and are building capacity in regions such as Malaysia and Mexico.

Relative to other parts of the value chain, foraying into ATMP presents fewer challenges for India. Firstly, it is generally understood that ATMP is a labour-intensive process. Secondly, as a lower value-added stage of the supply chain, ATMP also presents lower barriers to entry. For example, the annual capital expenditure of fabrication companies is typically around 35 percent of their revenues, and the total cost for building and operating an advanced fabrication facility now exceeds USD 20 billion. In comparison, for firms specialising in OSAT, the annual capital expenditure is approximately 13 percent of revenue.[98] Additionally, unlike wafers, the output of ATMP units can be directly consumed by electronic product companies.[99]

ATMP is increasingly being seen as an opportunity to advance the leading edge of semiconductor technology, specifically via what are collectively called advanced packaging technologies. Advanced packaging technologies are an assortment of approaches for packaging chips in a manner that boosts their computational capabilities while lowering power consumption and cost. Two such technologies are fan-out wafer-level packaging and 3-D packaging. The advanced packaging industry is predicted to rise at a 6.6 percent CAGR from USD 32 billion in 2024 to USD 45 billion by 2029.[100] The US CHIPS Act authorised USD 2.5 billion in the financial year of 2022 alone for a newly established National Advanced Packaging Manufacturing Program.[101] Although the industry is gaining momentum, it is still in its nascent stages. India could use the industry transition as an opportunity to carve out a role for itself by potentially participating in setting global standards for advanced packaging.

Presently, India's capacity in ATMP is highly limited. The sector consists of only a handful of Indian companies, most notably SPEL Semiconductors based out of Tamil Nadu. Financial incentives under the PLIS, however, have the potential to attract more interest in the sector.

The PLIS includes a scheme which provides incentives for setting up chip ATMP or OSAT facilities in India ("ATMP Scheme").[102] Under this scheme, approved applicants can be given financial support of 50 percent on the capital expenditure incurred by them.[103] The scheme also earmarks 2.5 percent of its financial outlay for the R&D and training costs involved. Further, ATMP and OSAT units set up under the scheme will be supported through purchase preference in procurement of electronic products by the Government under the Public Procurement (Preference to Make in India) Order 2017.

To be eligible under the ATMP scheme, applicants are required to invest a minimum sum of ₹50 crore (USD 5.9 million) and either own/operate a commercial packaging unit, or own/possess the licensed technology for the proposed packaging unit as well as demonstrate the roadmap to advanced packaging technologies through licensing or development.

97 https://www.stiftung-nv.de/sites/default/files/chinas_rise_in_semiconductors_and_europe.pdf

98 https://apcoworldwide.com/wp-content/uploads/2023/02/White-Paper-Indias-Semicon-Sector.pdf

99 https://www.financialexpress.com/business/industry-cg-power-files-application-with-meity-to-establish-semiconductor-assembly-test-facility-3314008/

100 https://www.mordorintelligence.com/industry-reports/advanced-packaging-market#:~:text=Advanced%20Packaging%20Market%20Analysis,period%20(2024%2D2029).

101 https://www.csis.org/analysis/advanced-packaging-and-future-moores-law#:~:text=Advanced%20packaging%20offers%20higher%20profit%20margins%2C%20thereby%20making%20large%2Dscale,investment%20in%20the%20United%20States.

102 https://d2p5j06zete1i7.cloudfront.net/Cms/2022/Oct/07/1665120229_Notification_Modified_Scheme_for_Compound_Semiconductor_ATMP.pdf

103 https://d2p5j06zete1i7.cloudfront.net/Cms/2022/Oct/07/1665120229_Notification_Modified_Scheme_for_Compound_Semiconductor_ATMP.pdf

So far, the ATMP scheme has secured an investment from US chip manufacturer Micron Technology.[104] Micron has partnered with the Government of India and the State Government of Gujarat to set up an ATMP unit in Sanand, Gujarat. While the total project investment is a sum of USD 2.75 billion, Micron will invest 30 percent (USD 825 million) of this sum over the course of seven years.

A few Indian players have also proposed to set up ATMP facilities. For example, India's railway manufacturer CG Power and Industrial Solutions has proposed to set up an ATMP facility worth INR 7600 crore (USD 909 million) at Sanand, Gujarat, in a joint venture with Japan's Renesas Electronics Corporation, and Thailand's Stars Microelectronics. Additionally, TPEL has proposed to set up an ATMP facility worth INR 27,000 crore (USD 3.26 billion) at Jagiroad, Assam.[105]

Recommendation 5:
The government should continue to support ATMP activities in India. In addition, the government may aid universities in specific actions such as attracting foreign faculty with industry experience, or facilitating industry training for Indian faculty to develop ATMP talent. It may also consider further subsidising educational programs related to ATMP.[106]

National influence in AI can go beyond investments in production, especially when such investments are large and risky. In the next subsection, we explore the role India can play in international AI governance to secure its own interests.

2.3 Internationalisation of AI governance

Apart from efforts to strengthen the commercial ecosystem in India – through promoting investment in chip design, fabrication, assembly and ancillary activities – the Indian government ought to also consider international governance mechanisms as a central part of its strategy.

The effects of AI are global and not limited to the countries that develop advanced AI. Internationalising the governance of AI, including AI compute, is beneficial for India as it limits unilateral decision-making by countries that have advanced AI capabilities. It ensures that India, and other countries in a similar position, have a say in the development and deployment of AI despite not leading its production.

Recommendation 6:
It would be useful for India to build upon Global South alliances forged at different multilateral institutions, including the UN and the WTO, to push for more inclusive international decision-making on AI. It can explore BRICS and other regional agreements to co-create common compute governance frameworks.

Current efforts at international agreements are led by the Global North or China; take for instance the G7 Japan's proposal for an AI code of conduct for the G7 group of countries, an interoperable AI governance framework between the US and Singapore, the UK's AI Safety Summit, AI safety summits hosted by France and South Korea, and the Cyberspace Administration of China's proposed AI governance initiative.

Recommendation 7:
India should leverage its position as Lead Chair (2024) of the Global Partnership on Artificial Intelligence (GPAI) initiative. India should underscore the Delhi Declaration, signed by GPAI members at the GPAI Summit 2023, to secure more concrete collaborations with countries such as the US, Japan, and Australia. In particular, India should leverage those commitments in the Declaration which pertain to the promotion of equitable access of resources critical for AI compute, and to the development of the skill, infrastructure and governance mecha-

104 https://cxotoday.com/press-release/micron-announces-new-semiconductor-assembly-and-test-facility-in-india/

105 https://pib.gov.in/PressReleaseIframePage.aspx?PRID=2010132#:~:text=Semiconductor%20ATMP%20unit%20for%20specialized,7%2C600%20crore.

106 https://www.businesstoday.in/technology/news/story/heres-how-india-can-fill-the-semiconductor-talent-gap-for-the-world-391665-2023-07-28

nisms needed to effectively leverage AI in low and middle income countries.[107] India should also build on discussions that took place at the GPAI Summit 2023 emphasising the need for increased involvement of the Global South in AI governance processes.[108]

Recommendation 8:
If India is to have a significant voice in the international governance of AI, it needs to take an independent stance based on inclusivity and public welfare. India should build upon its work on internationalising its digital public infrastructure (DPI) innovations. Studies on the relationship between advanced AI and DPI would clarify the positive proposals that India can bring to the world stage. India should further its views – especially suggested positions on compute neutrality – at the 2024 G20 forum in Brazil.

2.4 Preparing for future compute paradigms

Advances in semiconductor technology are rapid. However, it is not always advisable to depend upon rapid, linear advances in a technological area. GPUs, for instance, do not represent linear advances over CPUs, and today's advanced AI models depend on GPUs for scaling while older models used CPUs. Had India invested in GPU technology early on, it would have played a leading role in current AI governance.

It is worthwhile to ask questions about future computing arrangements that can reduce dependence on centralised, large scale computing. For instance, decentralised computing – training AI models on computational power in different locations, even on thousands of individual phones – can in principle reduce the compute barrier to entry. However, decentralised computing today faces practical issues related to security, memory requirements, and communication costs.[109]

We must also look at investing in future computing paradigms that would make today's GPUs redundant. Quantum and optical computing are examples of such paradigms, and breakthroughs in these technologies would mean a significantly reduced reliance on the semiconductor supply chain. Neuromorphic technology is another paradigm that could result in breakthroughs, but it is more reliant on the semiconductor supply chain. This is why countries including the US, UK, and China have been making large investments in quantum computing research. While it is difficult to predict the time frame along which research in these technologies can bear fruit, the expected benefits are large enough that investments today might be warranted in any case.

Recommendation 9:
With a view to its long-term strategic interests, India can invest in research aimed towards solving tractable issues in decentralised computing, neuromorphic computing, quantum technology, optical computing, and other paradigms.

The National Quantum Mission supports research in, and development of, quantum technology applications. However, while it includes support for novel research including in semiconductor structures, true quantum computing breakthroughs might require an element of fundamental research.

Strengthening fundamental scientific research is a large and complicated undertaking. However, we must remember that artificial intelligence research was initially largely carried out within universities or non-profit laboratories, with its commercial importance being realised later. Such commercial importance also led to the drain of AI talent from universities to commercial entities, in particular to Big Tech. About 8 percent of top-tier AI researchers come from India, and 20 percent from the US. In comparison, 59 percent of the top-tier AI researchers work in the US, while the same number in India is negligible.[110] 11 percent of top-tier AI researchers that work in the US come from In-

107 Points 7 and 8 of the Declaration, https://gpai.ai/2023-GPAI-Ministerial-Declaration.pdf

108 https://indiaai.gov.in/article/forging-a-global-path-navigating-the-opportunities-and-challenges-of-ai-governance-for-a-shared-future

109 https://ainowinstitute.org/publication/policy/compute-and-ai

110 https://macropolo.org/digital-projects/the-global-ai-talent-tracker/

dia, many through the postgraduate studies pipeline.[111] 70 percent of Indian AI researchers pursue postgraduate education in the US.[112] This drain – along with the high price of compute – has contributed to the lack of public oversight in the development of AI. Such dynamics can be prevented from occurring in the domain of quantum technology (Big Tech companies already have thriving quantum research teams) through large investments in such research in universities, where an attractive and open research culture must be allowed to thrive.

Recommendation 10:
India should direct some resources towards research in theoretical physics. This strategy would have high risks but also has chances of delivering great economic rewards. The strengthening of institutions of scientific learning, with increased global linkages as well as robust, open and free development within such institutions will be necessary to carry this strategy out.

2.5 Designing data policy to achieve strategic goals

Data is as necessary as compute, and when compute is scarce, data serves as the differentiator of quality. The compute supply chain today is not arranged in India's favour, but data produced in India is still valuable. The government must recognise that this data has strategic value in addition to being subject to people's own rights over it. In addition, cross-border data flows can face various security challenges, particularly for sensitive applications including defence.[113]

India must not find itself in a situation where the supply of compute is concentrated and unilaterally controlled by other governments, and conversely data flows freely. Provisions in trade agreements, including the IPEF and some FTAs, would result in such a situation. Besides, if India aims to build internationally competitive DPIs, data policy must be considered carefully such that it does not lead to the wholesale export without compensation or consent of Indian people's data.

Recommendation 11:
Enabling provisions for data localisation or conditions on cross-border data flows are in India's strategic interests. Ceding ground on them, at multilateral or bilateral forums, is detrimental to self-reliance in AI. In other words, it is critical that the government continue maintaining its negotiating position of rejecting mandatory free data flows in e-commerce and other agreements.

111 https://macropolo.org/digital-projects/the-global-ai-talent-tracker/

112 https://macropolo.org/digital-projects/the-global-ai-talent-tracker/

113 https://assets.iqt.org/pdfs/Workshop-Report_Data-Centers_Nov-2023.pdf/web/viewer.html

3. Caveats

It is possible that today's advanced AI models do not after all lead to significant economic change. They face significant issues of accuracy or "hallucination", and it is possible that new capabilities are not found even as the compute used to train models increases. Compute is expensive, and for large AI models to be used extensively, they will have to demonstrate economic returns that justify compute costs. We are yet to see convincing evidence of such returns.

However, for military and similar uses, being self-reliant in advanced compute might still be important. Narrower models for such applications might still require advanced semiconductors.

It is also important to not further a global race towards reckless AI development and use. Such a race can lead to the use of AI in sensitive contexts, where inaccuracies can cause significant harm. It can also redirect resources from more socially useful pursuits to the creation of ever larger AI models, with their attendant environmental and energy costs, without substantial documented benefits of such investments.

Recommendation 12:
It is important to think of strategic self-reliance in AI in the larger context of public welfare, and not precipitate the over-use of, or over-reliance on, AI through strategic investments. It is also important to not perpetrate over-reliance on large AI models: it is advisable to invest in the development of less general and more application-specific models that are more tailored and less risky to use for those applications. There is a link between compute development and AI capabilities, but there is no clear link between domination over the most advanced compute and proficiency in useful and widely transformative AI applications.

A Compute Agenda for India

EVAM
LAW & POLICY

July 2024

604, Tower 7,
Commonwealth Games Village
Delhi - 110092