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Law and the political economy of AI production

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ABSTRACT

The governance of artificial intelligence (AI) is at a historical juncture. Legislative acts, global treaties, export controls, and technical standards are now dominating the discourse over what used to be a predominantly market-driven space. Amidst all this frenzy, this paper explains why none of these projects will achieve 'alignment' of AI with the prospect of a sustainable model of production authentically committed to the rights and freedoms of people and communities. By reflecting on the role of law in consolidating the visions and logics of few multinationals in the global value chains of AI, it warns against the peril of regulating AI without looking at the methods and logistics of its material production. Following a detailed overview of the various (techno-)legal ways through which law enables the flow of materials, capital, and power from Global South to Global North, and from small players to lead firms, the paper concludes with some preliminary thoughts on a transformative agenda for the transnational regulation of infocomputational production.

KEYWORDS: law and technology; artificial intelligence; digital infrastructures; political economy; global value chains; technology regulation.

INTRODUCTION

Things are changing in the way we talk (and think) about the regulation of artificial intelligence (AI). 'AI ethics' is now 'AI governance', and 'AI principles' are gradually transforming into 'AI standards'. The safety of the 'human race' has somehow become policy priority, and meanwhile, calls for the regulation of AI are mushrooming. From legal frameworks that determine what is allowed and what is not when building and deploying AI systems to investment-friendly trade legislation and restrictions on semiconductor (or chips) trade, countries of the Global North are in a race to control what AI systems will be built, by whom, and to what ends.

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At the same time, various narratives for a Global Governance of AI are being thrown around.[1] From the Council of Europe's 'AI Treaty' and the 'Bletchley Declaration' to the recent calls by the President of the European Commission for AI 'guardrails', people and institutions have been squeezing their minds and resources to compile a set of internationally agreed general principles for the future development of AI.[2] The inherent consensus-driven generality and self-affirming value of these initiatives endows them with a gravitational force that stakeholders and policymakers find hard to resist. Who would disagree with the goal of '[sustaining] an inclusive global dialogue that engages existing international fora and other relevant initiatives […] and [ensuring] that the benefits of the technology can be harnessed responsibly for good and for all'.[3]

But the issues that seem to capture the mind, attention, and imagination of policymakers and lawyers stand in stark contrast to the material reality of AI production. Orchestrated by multinational corporations (MNCs) with the capital resources and infrastructural power to control the ends and means of computational technologies (from chips design blueprints to hyperscale data centres and troves of data for machine learning), AI development is a very mature line of production strategically consolidated -primarily through private law—around specific modes of operation, organizational structures, and geographies. Throughout this value chain, normatively significant path dependencies and levers of infrastructural control are lost in an ocean of techno-legal micro-structures whose interlinkages make up the infrastructural *whole* that sustains the political economy of global AI production. Challenging—through law and/or social action—the production logics and visions of these infrastructures seem unthinkable for mainstream legal analysis and its normative toolkits.[4]

Meanwhile, as institutions and policymakers were busy drafting ethical guidelines for the deployment of AI systems, the political economy of the semiconductor industry has been undergoing a historic transformation due to a complex blend of physics, geopolitics, natural disasters, and a pandemic. For over 30 years, technological advancement in transistor design, following the so-called Moore's law, allowed steady and linear progress that saw a decrease in the transistor size (which means an increase in chip efficiency) from 250 nm in 1997 to 4 nm in 2022. However, the industrially inscribed Moore's law came to an end as we approached the limits of known physics, and today, the industry is rapidly consolidating among those few factories with the manufacturing capacity to build chips in the so-called 'leading node' (roughly below 14 nm). Indicatively, the number of foundries with leading-edge production capabilities fell from 25 in 2002 to only 4 in 2017.[5] Today, at the time of writing, only Samsung and the Taiwanese Semiconductor Manufacturing Company (TSMC) have moved/are moving towards 3 nm production.

As sources become limited, tensions are growing. The USA has dragged the semiconductor trade (especially for high-performance chips that are built in the leading nodes and used for AI systems) in its conflicts with China and as a consequence, a transnational value chain gradually fragments. Natural disasters in the key areas of the value chains (from winter storms in Austin, Texas, to earthquakes in Japan) coupled with skyrocketing demand and supply constraints due to the COVID-19 pandemic led to an unprecedented shortage of semiconductors. Eventually,

[1] For an overview see Michael Veale, Kira Matus and Robert Gorwa, 'AI and Global Governance: Modalities, Rationales, Tensions' (2023) 19 Ann. Rev. L. & Soc. 255.

[2] 'Council of Europe AI Treaty' (*Center for AI and Digital Policy*) <https://www.caidp.org/resources/coe-ai-treaty/> accessed 13 November 2023; 'The Bletchley Declaration' (*AI Safety Summit*, 1 November 2023) <https://www.gov.uk/government/publications/ai-safety-summit-2023-the-bletchley-declaration/the-bletchley-declaration-by-countries-attending-the-ai-safety-summit-1-2-november-2023> accessed 13 November 2023.

[3] 'The Bletchley Declaration' (n 2).

[4] Kevin B Sobel-Read, 'Reimagining the Unimaginable: Law and the Ongoing Transformation of Global Value Chains into Integrated Legal Entities' (2020) 16 Eur Rev Contract Law 160.

[5] Neil Thompson and Svenja Spanuth, 'The Decline of Computers as a General Purpose Technology: Why Deep Learning and the End of Moore's Law Are Fragmenting Computing (SSRN Preprint)' (20 November 2018) 34.

driven by mandates of national security and supply chain resilience, governments reshaped their strategies and revisited their role(s) in the semiconductor industry. In so doing, they affected the dialectics of the field, meaning the way we talk about semiconductors and, consequently, the way we understand the problem that law is supposed to solve.

Inevitably, the pathway for the development of AI systems ended up a value chain of deeply consolidated trade flows, path dependencies, and strong lock-in effects.[6] Companies that design AI chips (i.e. Apple or Nvidia) cannot simply switch manufacturers (from TSMC to Samsung) as the chip design is tailored to the specific manufacturing processes of a foundry and, in turn, due to long production cycles and orders of large volume, manufacturers depend on, and tailor their process according to particular 'big buyers'.[7] Conversely, demand for AI chips is becoming inundated by application-specific designs, thereby restricting innovation in and availability of generative universal chips.[8] But even when the material infrastructure of an AI system is based on universal chips (i.e. GPUs), the architecture built on top can be impossible to replicate and is usually protected by a plethora of legal constructions.[9] Finally, training an AI system requires agile access to troves of data and knowledge-intensive algorithmic training, which itself renders those MNCs with the respective infrastructural capacity indispensable agents in the value chain of AI development.[10]

As a result, a less generative digital future is on the horizon.[11] For almost a decade now, scholars have been warning against the power and control of MNCs over the modular and (re)configurable digital infrastructures that sustain and mediate our daily lives by leveraging their tremendous data wealth and computational capacity.[12] Being dependent, the argument goes, on few digital infrastructures and normalizing arithmetic logics for all sorts of decision-making in public life generates important questions of power and democracy that shall not be left unchallenged.

Yet, mainstream legal and policy analysis seems largely indifferent to the current production trajectory of market-driven generativity and programmability. In contrast, with geopolitics and the speculative agenda of the AI Safety camp dominating the policy debate for the global governance of AI, the policy and normative question as to what technologies and functionalities are being built, by whom, and for what purpose is only relevant as long as it relates to national security, supply chain management, and the allegedly dooming prospect of 'catastrophic harm'. But as this paper argues, understanding the material roots of this programmability and the role of law in 'guardrailing' its prospects is essential for any attempt to devise and institutionalize

[6] Kevin B Sobel-Read, 'Global Value Chains: A Framework for Analysis' (2014) 5 Transnatl Leg Theory 364, 400.

[7] Jan-Peter Kleinhans and Julia Hess, 'Understanding the Global Chip Shortages: Why and How the Semiconductor Value Chain Was Disrupted' (Stiftung Neue Verantwortung 2021) 7 <https://www.stiftung-nv.de/sites/default/files/understanding_the_global_chip_shortages.pdf> accessed 7 February 2024.

[8] Neil C Thompson and Svenja Spanuth, 'The Decline of Computers as a General Purpose Technology' (2021) 64 Commun ACM 64.

[9] OpenAI, 'GPT-4 Technical Report' (arXiv, 16 March 2023) 2 <http://arxiv.org/abs/2303.08774> accessed 22 March 2023.

[10] Jennifer Cobbe, Michael Veale and Jatinder Singh, 'Understanding Accountability in Algorithmic Supply Chains', *2023 ACM Conference on Fairness, Accountability, and Transparency* (ACM 2023) <https://dl.acm.org/doi/10.1145/3593013.3594073> accessed 24 January 2024.

[11] Jonathan L Zittrain, 'The Generative Internet' (2006) 119 Harv L Rev 1974; Petros Terzis, 'Building Programmable Commons' (2023) 15 Law Innov Technol 583; ITRS 2.0, 'Executive Report: International Technology Roadmap for Semiconductors 2.0' (2015) 8 <https://www.semiconductors.org/wp-content/uploads/2018/06/0_2015-ITRS-2.0-Executive-Report-1.pdf> accessed 24 August 2022.

[12] Martha Poon, 'Corporate Capitalism and the Growing Power of Big Data: Review Essay' (2016) 41 Sci Technol Hum Val 1088; Seda Gürses and Val Joris Hoboken, 'Privacy after the Agile Turn' in Jules Polonetsky, Omer Tene and Evan Selinger (eds), *Cambridge Handbook of Consumer Privacy* (Cambridge University Press 2017); Fenwick McKelvey and others, 'Optimising Our Network Lives' [2020] AoIR Selected Papers of Internet Research; Hal Abelson and others, 'Bugs in Our Pockets: The Risks of Client-Side Scanning (Preprint)' (arXiv, 14 October 2021); Devika Narayan, 'Platform Capitalism and Cloud Infrastructure: Theorizing a Hyper-Scalable Computing Regime - (2022) Environment and Planning A: Economy and Space 54 (5); Carmela Troncoso and others, 'Lessons from a Pandemic: Deploying Decentralized, Privacy-Preserving Proximity Tracing' (2022) 65 Commun ACM; Seda Gürses and Roel Dobbe, 'Programmable Infrastructures' (*TU Delft*) <https://www.tudelft.nl/tbm/programmable-infrastructures> accessed 24 January 2024.

mechanisms for (global) AI governance. Even more so, if our goal is to work towards a transformative legal-political agenda of/for infocomputational programmability.

To do so, this paper challenges the dominant narratives in AI law and policy and attempts to re-ground the debate on the transnational regulation of AI by moving away from existing 'grand plans' towards exploring the material (legal) reality of AI production. Through a theoretical approach to the global value chains (GVCs) of AI, it explores the multifarious techno-legal ways in which MNCs exert power and control over their suppliers and customers by capturing value whilst displacing costs and by engaging in a form techno-legal work that is normatively conducive yet entirely overlooked by the tools and methods of traditional legal analysis. Chapter 2 sets out the 'regulatory object', meaning the two aspects of the GVCs of AI that this paper brings together in an attempt to understand their nature and interactions. Chapter 3 explores the various legal and techno-legal constructions that hold these value chains together and reinforce the uneven distribution of power within it. In the end, Chapter 4 offers a foundational set of policy goals for a global agenda of programmability that reframes the target of policy enquiry by viewing lead firms not as mere market platforms and coordinators of market-enabling functions but as orchestrators of the programmable fabric that sustains our digital world whilst shaping its potentialities in the process.

Finally, this paper would not have been even conceived without the scholarship contributions of others. Seda Gürses's work and that of the 'Programable Infrastructures Project' at TU Delft more broadly, has been foundational of an entire discipline.[13] It did so, by drawing attention on compute and its global infrastructures when mainstream law and policy analysis was merely focussed on data, its governance, and (legal) protection. Since the first seminar on programmable infrastructures, ideas around 'infrastructures', 'computation', and 'programmability' have taken many shapes and forms by various scholars and disciplines without necessarily maintaining the strong theoretical and methodological foundations that have already been put in place by the team at TU Delft. For the legal realm, in particular, analyses that incorporate consideration on computing power and capacity have been scarce.[14] This paper attempts to use preliminary insights from the scholarship on computational infrastructures and frame them within the concept of GVC regulation in order to introduce novel considerations for the field of law and technology. It does so while acknowledging that the scholarship (theoretical and empirical) on computational infrastructures and the production logics that shape them is still in progress by the team to which we owe the discipline, the vocabulary, and the thinking spaces we are now hoping to form.

THE GVCS OF AI—CHIPS AND MACHINE LEARNING (ML)

During the last decade, GVC and global production network (GPN) studies have started gravitating towards platforms studies and the contemporary scholarship on digital technologies. Introducing a special issue on 'Digitalisation and Value Chains', Butollo *et al.* admit

[13] See, indicatively, Gürses and Dobbe (n 12); Gürses and Hoboken (n 12); Agathe Balayn and Seda Gürses, 'Beyond Debiasing: Regulating AI and Its Inequalities' (European Digital Rights (EDRi) 2021) <https://edri.org/wp-content/uploads/2021/09/EDRi_Beyond-Debiasing-Report_Online.pdf> accessed 24 January 2024.; McKelvey and others (n 12); Tobias Fiebig and others, 'Heads in the Clouds: Measuring the Implications of Universities Migrating to Public Clouds' (arXiv, 27 July 2021). See also, Poon (n 12). To follow the work of the team at TU Delft visit 'Programmable Infrastructures Project' (*TU Delft*) <https://www.tudelft.nl/tbm/onze-faculteit/afdelingen/multi-actor-systems/onderzoek/projects/programmable-infrastructures-project/about-the-project> accessed 24 August 2022.

[14] See, indicatively, Michael Veale, 'Rights for Those Who Unwillingly, Unknowingly and Unidentifiably Compute!' (SocArXiv, 31 July 2023); Michael Veale, 'Some Commonly-Held but Shaky Assumptions about Data, Privacy and Power' (SocArXiv, 8 August 2023); Cobbe, Veale and Singh (n 11); Michael Veale, 'Verification Theatre at Borders and in Pockets' (SocArXiv, 9 August 2023); AI Now Institute, 'ChatGPT And More: Large Scale AI Models Entrench Big Tech Power' (*AI Now Institute*, 11 April 2023) <https://ainowinstitute.org/publication/large-scale-ai-models> accessed 11 August 2023.

that '[t]he international discourse on new technologies and their economic and social effects is ubiquitous and inevitably overlaps with key topics in GVC/GPN research'.[15] In this context, scholars have explored the role of digital corporations in GVCs as 'platforms' that coordinate markets (i.e. in the industrial Internet of Things market);[16] or provide the core technology for others to work with and innovate (i.e. the cases of Intel and, more recently, Qualcomm).[17] Therefore, technological platforms have been understood either as types of multi-sided markets or providers of modular technological architectures.[18] From a legal perspective, Salminen *et al*. highlight conceptual and regulatory gaps between traditional value chain regulation and digital platform regulation, offering a more nuanced understanding of platform operators as second-tier lead firms in an attempt to refresh the normative mandates for sustainability and security in value chains.[19]

Within this strand of scholarship, analyses of the value chains of AI systems have so far been scarce and fragmented. Scholars have focussed on the supply chains of the hardware that makes an AI system while others emphasized the data, ML, and computational aspect built on top of existing hardware.[20] Alongside these accounts, a popular branch of scholarship explores the security vulnerabilities caused by the outsourcing of the manufacturing of high-performance chips to third parties across regions and continents.[21] Finally, and more broadly, traditional GVC scholarship has mapped and analysed the GVCs of products and devices (ie smartphones) that could in some form or the other be encompassed by the broad term 'AI'.[22]

This fragmentation is not surprising. As Ferrari argues, delineating the markets in which MNCs such as Google, Amazon, and Microsoft operate is exceptionally hard.[23] By extension, mapping the GVCs of AI is equally hard for—at least—two reasons. The first one is practical. Companies that build AI systems do not always disclose information on their suppliers and when they do, the value chain map is a rather convoluted web of interconnected (sub)contractors that spans across the entire world.[24] The second reason is conceptual. AI is more a *system*

15 Florian Butollo and others, 'Digital Transformation and Value Chains: Introduction' (2022) 22 Glob Netw 585, 587.

16 Florian Butollo and Lea Schneidemesser, 'Who Runs the Show in Digitalized Manufacturing? Data, Digital Platforms and the Restructuring of Global Value Chains' (2022) 22 Glob Netw 595; John Humphrey, 'Value Chain Governance in the Age of Platforms' (Institute of Developing Economies, Japan External Trade Organization (JETRO) 2018) 714 <https://ideas.repec.org/p/jet/dpaper/dpaper714.html> accessed 1 November 2022; Alexander Willner, 'The Industrial Internet of Things' (2018) in Qusay Hassan (ed.) *'Internet of Things A to Z: Technologies and Applications'* (John Wiley & Sons).

17 Annabelle Gawer and Michael A Cusumano, *Platform Leadership: How Intel, Microsoft, and Cisco Drive Industry Innovation* (Illustrated edition, Harvard Business Review Press 2002); Ke Ding and Shiro Hioki, 'Intellectual Property Strategy and the Governance of Technological Platform-Driven Global Value Chains: The Case of Qualcomm' (2024) 28 Competition & Change 165.

18 Annabelle Gawer, 'Bridging Differing Perspectives on Technological Platforms: Toward an Integrative Framework' (2014) 43 Res Policy 1239.

19 Jaakko Salminen and others, 'Digital Platforms as Second-Order Lead Firms: Beyond the Industrial/Digital Divide in Regulating Value Chains' (2022) 6 ERPL 1059.

20 Charlotte Stanton and others, 'What the Machine Learning Value Chain Means for Geopolitics' (Carnegie Endowment for International Peace 2019); Dieter Ernst, 'Competing in Artificial Intelligence Chips: China's Challenge amid Technology War' (Center for International Governance Innovation 2020); Cobbe, Veale and Singh (n 10); Fabian Ferrari, 'Neural Production Networks: AI's Infrastructural Geographies'(2023) 2 Environment and Planning F 459.

21 Samuel T King and others, 'Designing and Implementing Malicious Hardware', *Proceedings of the 1st Usenix Workshop on Large-Scale Exploits and Emergent Threats* (USENIX Association 2008); Vasilios Mavroudis and others, 'A Touch of Evil: High-Assurance Cryptographic Hardware from Untrusted Components', *Proceedings of the 2017 ACM SIGSAC Conference on Computer and Communications Security* (Association for Computing Machinery 2017) <https://doi.org/10.1145/3133956.3133961> accessed 15 November 2022; Wei Hu and others, 'An Overview of Hardware Security and Trust: Threats, Countermeasures, and Design Tools' (2021) 40 IEEE Trans Computer-Aided Des Integr Circuits Systems 1010.

22 Joonkoo Lee and Gary Gereffi, 'Innovation, Upgrading, and Governance in Cross-Sectoral Global Value Chains: The Case of Smartphones' (2021) 30 Ind Corp Change 215; Jason Dedrick and Kenneth L Kraemer, 'Intangible Assets and Value Capture in Global Value Chains: The Smartphone Industry' (World Intellectual Property Organization (Economic Research Working Paper no 41) 2017).

23 Ferrari (n 20) 12.

24 For example, Google does not disclose the identity of the manufacturer(s) for its Tensor Processing Unit whilst Apple's list of suppliers for 2022 includes more than 200 entities across 52 countries.

than it is a *product* as its networked modularity and agile method for development renders its nature highly programmable and contingent.[25] Therefore, when thinking about the production logics of AI systems, distinguishing between the value chains of physical and digital, or material and immaterial may lead to theoretical misconceptions and unconstructive epistemic segmentation.[26]

For this reason, this paper escapes traditional market segmentations (electronics, IT, ICT, etc.) and introduces a more versatile 'infrastructure-based' approach capable of accommodating both the underlying 'structural' aspect of AI production (often represented in semiconductors, hardware, etc.) as well as its 'functional' that is usually built on top of it (software, algorithms, data management software, domain-specific languages, ML models, etc.). This is because the structural part (i.e. hardware) reflects and gives shape to a plethora of value-added activities and processes. In turn, the functional part (i.e. software) and its specific applications drive the demand for more computationally advanced hardware as developers and researchers wishing, for example, to train an AI model for inferencing depend on access to digital platforms and ML tools that enable them to capitalize on the computational capabilities of hardware.[27] Finally, the structural and the functional part of the value chains are brought together in the data centres whose enormous size hosts assemblages of chips and other equipment (cooling systems), carefully architectured to the computational needs of the owner's (or tenant's) suite of applications and functionalities. Therefore, for the purposes of the paper's legal-normative project, the GVCs of AI are defined as the complex web of manufacturing and infocomputational processes whose interweaving enables the (re)programming and (re)configuration of global digital infrastructures.

The structural links in the chain

Since the early days of the computing technologies, hardware has been shaping demand and business models of entire industries. For example, Campbell-Kelly and Garcia-Swartz explain how IBM 1401/1410 and System/360 triggered transformations in the software industry as companies abandoned the software contracting model for the sake of building corporate software products that were compatible with these machines.[28] Similar dynamics are triggered today with other widely used 'computers', namely the smartphone and the cloud, as developers seek to innovate based on the capabilities and functionalities offered by these technologies and their proprietors. In this context, Hwang observes that 'hardware actively shapes the landscape of what can be done with the technology of ML, and plays a significant role in influencing how it will evolve going forwards.'[29]

For the purposes of GVC analysis, although the exact nature of the hardware and semiconductors that comprise a particular AI system may vary and/or remain secret, and regardless of how complex an AI system can be(come), its technological apparatus cannot but involve (directly or indirectly) logic chips and in particular:[30]

[25] Gürses and Hoboken (n 12).
[26] Matthew Hockenberry, 'Redirected Entanglements in the Digital Supply Chain' (2021) 35 Cult Stud 641.
[27] Antone Gonsalves, 'Microsoft Invites Access to Azure OpenAI Service, GPT-3' (*SearchEnterpriseAI*, 25 May 2022) <https://www.techtarget.com/searchenterpriseai/news/252520696/Microsoft-invites-access-to-Azure-OpenAI-Service-GPT-3> accessed 23 November 2022; Jennifer Langston, 'New Azure OpenAI Service Combines Access to Powerful GPT-3 Language Models with Azure's Enterprise Capabilities' (*The AI Blog*, 2 November 2021) <https://blogs.microsoft.com/ai/new-azure-openai-service/> accessed 23 November 2022.
[28] Martin Campbell-Kelly and Daniel D Garcia-Swartz, *From Mainframes to Smartphones: A History of the International Computer Industry* (Harvard University Press 2015) 69–70.
[29] Tim Hwang, 'Computational Power and the Social Impact of Artificial Intelligence (Preprint)' (arXiv, 23 March 2018) 7 <https://arxiv.org/abs/1803.08971>.
[30] Ernst (n 20) 27.

- Central processing units (CPUs);
- and/or graphics processing units (GPUs);
- and/or similar ML-enabling technologies such as field-programmable gate arrays (FPGAs) and application-specific integrated circuits

GPUs are particularly important for training AI systems. Although initially popularized for image and graphics generation and display, GPUs have become pivotal for AI applications due to their ability to run computational tasks in parallel (and as a result much faster than a CPU). Acknowledging their importance, Microsoft's 10K filling for 2022 writes that '[o]ur datacenters depend on the availability of […] networking supplies, and servers, including graphics processing units ("GPUs") and other components'.[31] Understanding their significance for AI development, the US has banned the export of NVIDIA's A100 and H100 GPUs to China whilst the UK Prime Minister has recently announced the allocation of £100 million to the purchase of approximately 5000 GPUs.[32] In terms of supply, NVIDIA is the largest vendor of discrete GPUs (GPUs that are not part of the same die as the CPU) that are largely used for training AI systems and its proprietary CUDA software is the only way developers can leverage the computational power of NVIDIA's GPUs to build AI applications.

With our focus being on the GVCs of AI, it is important to note that manufacturing capacity of <10 nm is entirely allocated to logic chips.[33] US companies produce 74 per cent and 67 per cent of the value added in the semiconductor value chain by intellectual property (IP) ownership and logic chips design, respectively, whilst US-headquartered firms collectively represent more than 90% share in advanced logic products.[34] On the manufacturing side, only TSMC (Taiwan), Intel (US), and Samsung (South Korea) can produce advanced-node logic chips (<10 nm), which are required for computationally intensive data processing in smartphones, PCs, data centres, and AI servers[35]. Besides, only one company in the world can build manufacturing equipment for advanced logic chips, namely the Dutch Advanced Semiconductor Materials Lithography (ASML).

The functional links in the chain

Moving from the structural to the functional part of the GVCs of AI, access to foundational and other ML models and access to data for algorithmic training or labelling services can vary. According to their design and procurement, for example, AI systems can be accessed through APIs (i.e. the DALL-E transformer), proprietary cloud-based platform environments (i.e. the Google Cloud ML Engine), or downloaded and run locally assuming there is the adequate computational capacity. Stanton and others define the value chain of ML as a process involving five value-added activities: data collection, data storage, data preparation, algorithmic training, and application development.[36] Largely dominated by tech companies in the USA, China, and India, data collection reflects the high mobile penetration rates in these countries. Big Tech companies operate large data infrastructures that enable them to collect real-time data on a population level and to administer access to this data according to their ends and priorities. Data preparation is

[31] Microsoft Corporation, 'Annual Report Pursuant to Section 13 or 15(d) of the Securities and Exchange Act of 1934 - Form 10K' (2023) 16 <https://microsoft.gcs-web.com/static-files/e2931fdb-9823-4130-b2a8-f6b8db0b15a9> accessed 23 January 2024.

[32] James Titcomb, 'Sunak to Spend £100m of Taxpayer Cash on AI Chips in Global Race for Computer Power' *The Telegraph* (20 August 2023) <https://www.telegraph.co.uk/business/2023/08/20/sunak-spend-100m-taxpayer-cash-ai-chips-global-race/> accessed 13 November 2023.

[33] Sarah Ravi, 'Strengthening the Global Semiconductor Supply Chain in an Uncertain Era' (*Semiconductor Industry Association*, 1 April 2021) 18 <https://www.semiconductors.org/strengthening-the-global-semiconductor-supply-chain-in-an-uncertain-era/> accessed 17 November 2022.

[34] ibid 31,41.

[35] ibid 35.

[36] Stanton and others (n 20).

delivered by a diverse array of workers across countries and demographics, and it is largely facilitated by popular data labelling platforms such as Amazon's Mechanical Turk.[37] Conversely, US technology companies lead in data storage capacity and algorithmic training (the USA is home to approximately 40 hyperscale data centres).[38] Finally, software development kits and AutoML tools play a crucial role in the expansion and consolidation of value chains in software and ML development.[39]

Recently and under the rapid expansion of foundational models such as the OpenAI's ChatGPT, scholars have been drawing attention to the value chains that support the development and commercialization of these models. Cobbe et al. argued that the problem of algorithmic governance and, by extension, accountability cannot be meaningfully addressed unless we have a robust understanding of the complex AI production networks and the agile algorithmic supply chains that sustain them.[40] At the same time, the scale and modularity of these chains compartmentalize social relations and the division of labour, thereby hindering the process of 'locating' ethical accountability.[41] In parallel, Ferrari moves beyond traditional understandings of global value networks introducing the concept of neural production networks to encompass and empirically assess the role of lead firms such as Google and Amazon in 'computationally enveloped productions arrangements'.[42] Finally, Matus and Veale used the analytical lenses of value chains of ML to demonstrate inherent inequalities and power asymmetries (i.e. in the networks of labour) therein arguing that, just like in the field of sustainability, standardization processes, and certification systems are largely unrealistic—if not unsuitable—solutions for dealing with such social problems.[43] Taking stock of this scholarship, Brown has compiled a set of risk-based policy proposals for the regulation of AI technologies based on the responsibilities and duties of those actors that are better positioned to assess risks and take actions to mitigate them.[44]

These accounts and policy proposals are important for understanding the complex (sub-)systems of AI production and for regulating the means and risks associated with their development and use at scale. Transforming their takeaways to normative tools and legal practice, however, is hard, and as this paper demonstrates, dominant epistemic structures and risk-based approaches are not well-equipped to deal with the complexity of problems posed by the power of (global) infrastructural programmability that a handful of MNCs currently hold.

What question for the law?

For a project aiming at institutionalizing the debate on the regulation of digital-infrastructural programmability, defining its value chains and the entities (lead firms) that exert control over them is necessary but not sufficient. As Salminen and Rajavuori argue: 'any approach to regulating global value chains must focus on conceptualizing global value chains (i.e. the regulatory object), lead firms (i.e. the regulatory subject), and adequate value chain governance (i.e. the

[37] Djellel Difallah, Elena Filatova and Panos Ipeirotis, 'Demographics and Dynamics of Mechanical Turk Workers', *Proceedings of the Eleventh ACM International Conference on Web Search and Data Mining* (Association for Computing Machinery 2018).

[38] Stanton and others (n 20) 3.

[39] Ferrari (n 20) 9–11.

[40] Cobbe, Veale and Singh (n 10). For a foundational understanding of the impact of agile methodologies for software development in the production logics of the sector see Gürses and Hoboken (n 12).

[41] David Gray Widder and Dawn Nafus, 'Dislocated Accountabilities in the AI Supply Chain: Modularity and Developers' Notions of Responsibility' (2023) 10 Big Data Soc 1.

[42] Ferrari (n 20) 2.

[43] Kira JM Matus and Michael Veale, 'Certification Systems for Machine Learning: Lessons from Sustainability' (2022) 16 Regul Gov 177, 178–184.

[44] Ian Brown, 'Allocating Accountability in AI Supply Chains: A UK-Centred Regulatory Perspective' (Ada Lovelace Institute 2023) <https://www.adalovelaceinstitute.org/resource/ai-supply-chains/> accessed 1 August 2023.

ideal that regulation tries to achieve)'.[45] Therefore, to move beyond a merely descriptive analysis of the value chains and its drivers, the intellectual enquiry also has to grapple with the normative goal. In other words, the challenge lies in thinking whether law can (and/or should) do more than safeguarding product safety through compliance or national security through export controls and contribute towards an interventionist, norm-shaping agenda aiming at regulating info-computational production across continents and jurisdictions with an agenda that is founded upon strong theoretical and methodological grounds.

GVC regulation can offer some guidance in this direction. At its core, GVC regulation manifests the institutional possibility of attempting to regulate transnational production based on certain normative commitments and mandates. Transnational sustainability laws, for example, impose sustainability obligations (such as due diligence) on lead firms whose production networks span across continents and jurisdictions. Importantly, in the case of Big Tech, the ability to identify the regulated actors in a value chain can increase the level of legal specificity and extensiveness, thereby strengthening the role of law in value chain governance.[46] At the same time, however, the normative pillars or GVC regulation and its EU-oriented scope may prove insufficient for encompassing the normative goal of regulating the GVCs of AI. This is because traditional GVC regulatory approaches, with their emphasis on regulating externalities based on normative anchors such as sustainability and security, cannot tackle the problem of having a handful of large MNCs acting as norm-shaping orchestrators of production networks that get to define what kind of 'things' will be built (from chips, to computers and sensors) and for what functions. Equally, the normative goal of resilience, albeit well-intended when used in the GVCs context, can be misleading when applied to AI because it may end up legitimizing further consolidation and control over global AI production by those players with the capital and computational capacity to absorb supply chain crises and guarantee 'resilience' of critical infrastructures on their own terms. In other words, apart from a normative goal for GVCs in general, resilience is also the strategy of those who build, maintain, or benefit from infrastructures of/for value creation.

For these reasons, novel normative foundations and legal tools may indeed be necessary.

In this direction, actor-centric (who 'governs' the GVCs?) and network-centric (whose entities' operations make a production network?) approaches may prove methodologically useful but they also require a firm substantial footing if they are to be transferred as analytical and normative tools for regulating the GVCs of AI.[47] In other words, just like we regulate corporations for not exercising sustainability due diligence on their suppliers because we want to save the planet; or just like we want to prevent corporations from sourcing minerals extracted from areas in armed conflict because we promote peace and human rights, regulating the GVCs of AI, needs an underlying normative anchor.

To theorize and develop potential foundations for the transnational regulation of infocomputational production, legal scholars need to first and foremost confront and reflect on the way law constructs, protects, and solidifies the organizational backbone of AI production. By bringing together different links and legal constructions of the value chains that sustain the political economy of AI production, this paper is a first attempt to systematize and delineate the role of law therein. In doing so, it showcases how market-coordination happens in the GVCs of AI and—more importantly—at what cost, and illustrates power-enabling and power-entrenching functions of law that extend beyond its over-emphasized and celebrated market-facilitating role.

[45] Jaakko Salminen and Mikko Rajavuori, 'Transnational Sustainability Laws and the Regulation of Global Value Chains: Comparison and a Framework for Analysis' (2019) 26 Maastricht J Eur Comp Law 602, 604.

[46] ibid 614.

[47] For a description of the various approaches that the EU has taken in regulating Global Value Chains, see Anna Beckers, 'Global Value Chains in EU Law' (2023) YEL 42.

LAW AND POWER IN THE GVCS OF AI

Despite its centrality in undergirding the 'order of things' in GVCs, law is surprisingly absent from mainstream GVC analysis.[48] Against this background, this section attempts to navigate and map the multifaceted impact that law has on the AI industry starting from the way labour relationships are fashioned across the value chains before moving to exploring how IP and contracts shape the distribution and production logics therein. The chapter then discusses the role of geopolitics and its impact on laws that fragment our digital world and divert us from seeing and regulating other power structures. In the end, it illustrates forms of power in the GVCs of AI that—through law or its absence—have been left alone to (re)configure themselves. Throughout this chapter, law is used as a methodological tool to understand the various tenets of governmentality that bind and hold together the GVCs of AI with all its organizational complexities and normative underpinnings. As such, the paper follows Eller's conceptualization of GVCs as constitutive of a normative order rather than independent concepts of/for legal analysis.[49]

Constructing power asymmetries across the value chain

The highly convoluted zig-zag of value chain activities in the GVCs of AI is rooted in legal constructions that operate and facilitate transactions across every stage of the value chain. These activities, the human labour that supports them, and the entities they connect are coordinated not as a common collective enterprise, but rather as agents who abide by an animated production logic that provides transaction opportunities whilst furthering the uneven distribution of gains in the process.[50] Exploring these legal micro-structures in all their complexity, allows us to confront and reflect on the role of law and that of professional legal practise in cementing relationships of value extraction and the unequal distribution of value and power in and across the GVCs of AI.

Extracting labour

When thinking about the labour that makes AI systems people will be excused to picture the stereotypical image of the Ivy League graduate in Silicon Valey with his high salary and self-evident talent in producing innovation that scales. But as Fuchs has demonstrated, underneath this highly valued and socially appreciated work lies a plethora of people and professions, an international division of digital labour, whose work is either exploited or strategically overlooked by law and the production logics of AI development.[51] This section briefly discusses the role of law in three such categories of labour starting from the 'field' of mineral extraction, before moving to data labelling labour and the rights of artists whose work is appropriated by generative AI systems.

Roughly from 2010 onwards, people from the Global North have started waking up to the realization that the working conditions in the mining industry that supplies the materials for the global production of electronics and ICT components might indeed amount to what our laws recognize as 'slavery' and 'forced labour'.[52] To respond to this problem, states have introduced supply chain due diligence schemes aiming at expanding the boundaries of corporate social

[48] Klaas Hendrik Eller, 'Is "Global Value Chain" a Legal Concept?: Situating Contract Law in Discourses Around Global Production' (2020) 16 Eur Rev Contract Law 3, 6; The IGLP Law and Global Production WG, 'The Role of Law in Global Value Chains: A Research Manifesto' (2016) 4 Lond Rev Int Law 57.

[49] Eller (n 48) 23.

[50] ibid 16.

[51] Christian Fuchs, *Digital Labour and Karl Marx* (Routledge 2013); Christian Fuchs, 'Theorising and Analysing Digital Labour: From Global Value Chains to Modes of Production' (2014) 1 The Political Economy of Communication <http://www.polecom.org/index.php/polecom/article/view/19> accessed 31 October 2023.

[52] 'The Congo Report: Slavery in Conflict Minerals' (Free the Slaves 2011).

responsibility beyond the corporate's jurisdiction. For example, the Dodd-Frank Act in the US and the EU Conflict Minerals regulation introduced transparency obligations for US and EU companies, respectively, whose products use tin, tantalum, tungsten, and gold that has been sourced in the Democratic Republic of Congo (DRC). Empirical evidence, however, indicates that the hopes for conflict- and violence-free sourcing of minerals have so far failed to materialize.[53] As computational production intensifies and pressure on the suppliers increases, it is likely that the auditing and compliance-focussed culture of due diligence will keep manifesting its insufficiency. Indicatively, the latest NVIDIA's conflict minerals report admits:[54]

> '[O]ur due diligence measures can provide only reasonable, not absolute, assurance regarding the source and chain of custody of the necessary conflict minerals in the products we contract to have manufactured. [...] we have no direct relationships with smelters, refiners, and therefore possess no independent means of determining the source and origin of conflict mineral ores processed by smelters or refiners. [...] We also rely [...] on information collected and provided by independent third-party audit programs. Such sources of information may yield inaccurate or incomplete information and may be subject to fraud'.

Another category of exploitation that is integral to the modes of global information and computational production involves the various forms of labour that power up the engines of AI training, from data labelling to model calibration and post-deployment support.[55] Introducing the mechanics of this work, Amazon's CEO, Jeff Bezos, referred to it as 'people-as-a-service' thereby capturing the very essence of having a decentralized mass of workers at the service of machines sorting out tasks 'that are not (yet) computable'.[56] The accepted term for this kind of work is 'Reinforcement Learning with Human Feedback', a technical term that masks 'thousands of hours of often traumatic human labour'.[57] Finally, while in its early days, most of this work was undertaken through independent users of the Amazon's Mechanical Turk, today data labelling companies where this work is outsourced are mushrooming raising hundreds of millions in venture capital only to offer an average renumeration of $1.77/hour.[58]

Public law stays largely indifferent to this kind of labour and its conditions whilst transnational law, more broadly, has not really developed a strong track record in standardization of labour practices and rights across jurisdictions. Inevitably, the relationship between the AI company and the AI worker is left to the discretion of the former to define. Unsurprisingly, the widely preferred option for the recruiting company is to consider the worker an 'independent

[53] Elif Härkönen, 'Conflict Minerals in the Corporate Supply Chain: Is Transparency the Solution to Human Rights Violations in the Tantalum, Tin, Tungsten and Gold Supply Chains?' (2018) 29 European Business Law Review 716–718. Dominic P Parker and Bryan Vadheim, 'Resource Cursed or Policy Cursed? US Regulation of Conflict Minerals and Violence in the Congo' (2017) 4 J Assoc Environ Resour Econ 1; Nik Stoop, Marijke Verpoorten and Peter van der Windt, 'More Legislation, More Violence? The Impact of Dodd-Frank in the DRC' (2018) 13 PLOS ONE 8; 'Is Corporate Transparency the Solution to Political Failure on Our Greatest Problems? A Discussion of Darendeli, Fiechter, Hitz, and Lehmann' (2022) 74 J Account Econ. In contrast, see and compare with Bok Baik and others, 'The Real Effects of Supply Chain Transparency Regulation – Evidence from Section 1502 of the Dodd-Frank Act' (19 April 2023) <https://papers.ssrn.com/abstract=3908233> accessed 31 October 2023.

[54] 'NVIDIA Corporation - Conflict Minerals Report as Required by Items 1.01 and 1.02 of This Form - EX-1.01 - April 26, 2023' <https://fintel.io/doc/sec-nvidia-corp-1045810-ex101-2023-april-26-19473-799> accessed 31 October 2023.

[55] David Gray Widder, Sarah West and Meredith Whittaker, 'Open (For Business): Big Tech, Concentrated Power, and the Political Economy of Open AI' (17 August 2023) 10 <https://papers.ssrn.com/abstract=4543807> accessed 18 October 2023.

[56] Moritz Altenried, 'The Platform as Factory: Crowdwork and the Hidden Labour behind Artificial Intelligence' (2020) 44 Capital & Class 145, 146.

[57] Supra note 55

[58] Adrienne Williams, 'The Exploited Labor Behind Artificial Intelligence' <https://www.noemamag.com/the-exploited-labor-behind-artificial-intelligence> accessed 31 October 2023.citing Kotaro Hara and others, 'A Data-Driven Analysis of Workers' Earnings on Amazon Mechanical Turk', *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems* (Association for Computing Machinery 2018) <https://dl.acm.org/doi/10.1145/3173574.3174023> accessed 31 October 2023.

contractor' to be renumerated on the basis of the tasks that s/he will manage to complete. This form of contract, Altenried observes:[59]

> '[I]s not only functional in the sense of providing flexibility for employers and pushing costs for down time, insurance and work equipment onto the workers themselves, but also as a technique to organise the work process in the absence of the physical factory and its foremen'.

In Kenya, 150 employees of Samasource, an AI company that provides content moderation services for major platforms including Facebook (Meta), TikTok, and OpenAI, formed the Content Moderators Union, and four content moderators for ChatGPT employed by the same company filed a petition to the Kenyan government to intervene and legislate for workers' conditions and fair renumeration.[60] The legal reality that led to this mobilization is anything but inevitable. Western jurisdictions choose to hold outsourced workers on different standards than their domestic ones despite the fact that their working conditions can in various ways affect elements of the final products that end-consumers will enjoy. These links are even more apparent in the case of data labelling and content moderation as the tasks undertaken by, say, an employee of a contractor in the Philippines can directly influence the output of a generative AI system in the UK. Despite its centrality to AI production, however, workers' rights have not captured the interest of mainstream legal analysis. Weirdly, lawyers from the Global North seem more comfortable discussing legal responses to speculative futures (i.e. the 'catastrophic' prospects of AI-powered biotechnologies) than confronting the lived reality of exploited workers in the Global South.

Finally, large language models and Diffusion Models are trained on an incalculable number of texts, literary, and art works.[61] For reference, Stable Diffusion, an image-generation AI model, was trained on approximately 2 billion images that were scrapped off of the web through Common Crawl.[62] Although Stable Diffusion's model card does not touch the issue of creators' rights over the images that were used to train the model, OpenAI's DALL-E System Card asks '[i]ndividuals who find that their images have been used without their consent [to] report the violation to the OpenAI Support team'.[63] Copyright law jurisprudence, however, which in the past has been expeditiously mobilized on all fronts (from legislation to digital infrastructure modifications) to confront piracy and illegal streaming, has yet to provide creators with any kinds of legal defences to protect their work from appropriation by AI companies.

If anything, private law has facilitated the exact opposite. Quite ironically, OpenAI recently announced the 'Copyright Shield' to financially support its clients in case of lawsuits for copyright infringements that will result from products generated by OpenAI's tools.[64]

[59] Altenried (n 56).

[60] Dennis Musau, 'Facebook, TikTok and ChatGPT Content Moderators in Kenya Finally Unionise' (*Citizen Digital*, 1 May 2023) <https://www.citizen.digital/tech/facebook-tiktok-and-chatgpt-content-moderators-in-kenya-finally-unionise-n318987> accessed 10 November 2023; Niamh Rowe, '"It's Destroyed Me Completely": Kenyan Moderators Decry Toll of Training of AI Models' *The Guardian* (2 August 2023) <https://www.theguardian.com/technology/2023/aug/02/ai-chatbot-training-human-toll-content-moderator-meta-openai> accessed 10 November 2023.

[61] See, for example, Tomas Mikolov and others, 'Efficient Estimation of Word Representations in Vector Space' (arXiv, 6 September 2013) <http://arxiv.org/abs/1301.3781> accessed 14 November 2023.

[62] 'Stable Diffusion v1 Model Card (Section: Training)' (*GitHub*) <https://github.com/CompVis/stable-diffusion/blob/main/Stable_Diffusion_v1_Model_Card.md#training> accessed 13 November 2023; Robin Rombach and others, 'High-Resolution Image Synthesis with Latent Diffusion Models' (arXiv, 13 April 2022) <http://arxiv.org/abs/2112.10752> accessed 31 October 2023.

[63] 'DALL·E 2 Preview - Risks and Limitations' (*GitHub*) <https://github.com/openai/dalle-2-preview/blob/main/system-card.md> accessed 31 October 2023.

[64] 'New Models and Developer Products Announced at DevDay' (*OpenAI*) <https://openai.com/blog/new-models-and-developer-products-announced-at-devday> accessed 10 November 2023; Bill Rosenblatt, 'OpenAI's Copyright Shield Is Business As Usual For Enterprise IT' *Forbes* (7 November 2023) <https://www.forbes.com/sites/billrosenblatt/2023/11/07/openais-copyright-shield-is-business-as-usual-for-enterprise-it/> accessed 10 November 2023.

This scheme, which essentially refers to the existence of an indemnification clause in its software license agreement, is premised on the assumption that liability for copyright infringement lies with the client (i.e. a chatbot developer) and not OpenAI itself despite pending lawsuits that argue otherwise.[65] Alarmingly, this legal and conceptual trap has become quite popular with providers of generative AI services.[66] The pattern that in the past had solidified data extraction through contractual terms of services and privacy policies is once again at work here, this time for the emerging field of generative AI: in the absence of a sector-specific political mandate and/or a public law determining where value should lie/be directed towards, private law is left alone in reconfiguring relational arrangements that pre-empt and pre-shape the normative and discursive space within which future legal dialogue will happen.

IP and the schism of inequality

A significant turning point in the history of the semiconductor industry was the emergence of the 'fab-less' model in the late 1970s. Born out of the prohibited costs of semiconductor manufacturing, the vertical integration and outsourcing towards Southeast Asia gradually led to the creation of companies whose business model was centred not on manufacturing, but on designing and marketing hardware.[67] The emergence of the fabless firm separated the intangible-intensive design process from the tangible-intensive manufacturing, and, at the same time, it incentivised the creation of a plethora of new elements, business opportunities, and models on both sides of the value chain. On the design side, proprietary digital tools such as electronic design automation (EDA) tools, cell libraries, and design modules (DMs) flourished, whereas, on the manufacturing side, specialization deepened with the optimization of the production processes for packaging, assembly, and testing.[68] Given the knowledge- and capital-intensive nature of the industry, such a transformation would not have been possible without strong IP rights and tightly controlled contractual arrangements.

IP rights underpin all phases of semiconductor development. Chip design is facilitated through proprietary EDA tools. These are tools capable of undertaking computationally intensive and complex tasks throughout the design phase. Instead of developing this capacity in-house, fabless companies usually purchase proprietary EDA tools as well as cell libraries and DMs from companies such as Mentor and Synopsis, or IP blocks from companies such as Cadence Design Systems whose entire business models revolve around monetizing on IP.[69] Coupled with that, fabless companies along with relevant third parties that hold IP blocks want to make sure that their designs will be based on and integrate with the dominant processors' architectural design which, in turn, is licensed to them by ARM or Intel. Once a chip design is finalized and before its ultimate physical attributes are decided, proprietary physical libraries and process design kits (PDKs) need to be incorporated into the final design in order to link it with the particular manufacturing characteristics of the foundry that will manufacture it. In the end, the 'netlists' that are given to foundries for final production are protected by a complex

[65] 'The Authors Guild, John Grisham, Jodi Picoult, David Baldacci, George R.R. Martin, and 13 Other Authors File Class-Action Suit Against OpenAI' (*The Authors Guild*) <https://authorsguild.org/news/ag-and-authors-file-class-action-suit-against-openai/> accessed 10 November 2023.

[66] Kyle Wiggers, 'Some Gen AI Vendors Say They'll Defend Customers from IP Lawsuits. Others, Not so Much.' (*TechCrunch*, 6 October 2023) <https://techcrunch.com/2023/10/06/some-gen-ai-vendors-say-theyll-defend-customers-from-ip-lawsuits-others-not-so-much/> accessed 10 November 2023.

[67] Rakesh Kumar, *Fabless Semiconductor Implementation* (McGraw Hill 2008) 18.

[68] Jeorge S Hurtarte, *Understanding Fabless IC Technology* (Newnes 2007) 47.

[69] Greg Linden and Deepak Somaya, 'System-on-a-chip Integration in the Semiconductor Industry: Industry Structure and Firm Strategies' (2003) 12 Ind Corp Change 545, 569.

blend of copyrights (in software, databases, and text) usually enforced through technical means of encryption and watermarking.[70]

In theory, IP licensing allows firms to make more efficient use of their resources by focussing on what they do best, and at the same time, it benefits the market by creating 'industry-wide economies of specialization' whilst empowering the bargaining power of smaller firms with valuable IP.[71] In AI practice, however, due to the cumulative character of the technology, meaning the ability of an AI system to form the basis for generating further innovation, IP licensing does not represent the traditional 'right to use' purchase that leads to a vertical relationship between buyer and seller. Instead, it serves primarily as a modularity element of the design process, an integrator of production logics, and a'bargaining chip' for 'the orderly division of rights among producers of complementary technologies'.[72] As such, IP licensing locks lead firms and IP vendors into contractual relationships that paralyse the bargaining power of the less powerful parties and prevent them from 'upgrading' their role in the GVCs. Nonetheless, lead firms may wish to synchronize all elements of the design processes and opt for bringing IP capacity in-house either through mergers and acquisitions (M&A) or through building in-house chip design capabilities from scratch, a pattern that seems to have become a strategic priority for Big Tech.[73]

Coupled with that, the increasing centrality of IP rights in the semiconductors industry has led to an uneven distribution of costs across the value chain. Cohen has mapped and analysed the various legal entitlements that reinforce and entrench power asymmetries in every aspect of our digital world;[74] legal entitlements that are not necessarily determinants of optimal resource allocation towards the 'entitled' but serve primarily as the normative fuel for the 'distribution of present and future resources among such actors'.[75]

Today, mainly due to entitlements flowing from IP, the global AI industry is an industry of non-globalized innovation.[76] Despite initial hopes that countries in Southeast Asia would manage to strengthen and 'upgrade' their positions in the GVCs of AI, the industry has been gradually cementing and fragmenting around particular players and regions. Today, the US and other Western countries are dominant in the intangibles, from chip design and IP blocks to marketing and brand name value whilst Southeast Asia has attracted the lion's share of manufacturing, packaging, and assembly. In this direction, Durand and Milberg further demonstrate that the skewed geographical distribution of intangible assets significantly limits the ability of tangible-intensive producers from developing economies to 'upgrade' their position in the

[70] Thomas Hoeren, 'The Semiconductor Chip Industry – The History, Present and Future of Its IP Law Framework' (2016) 47 IIC - International Review of Intellectual Property and Competition Law 763, 792; Moritz Schmid, Daniel Ziener and Jurgen Teich, 'Netlist-Level IP Protection by Watermarking for LUT-Based FPGAs', *2008 International Conference on Field-Programmable Technology* (2008).

[71] Ashish Arora, Andrea Fosfuri and Alfonso Gambardella, 'Markets for Technology and Their Implications for Corporate Strategy' (2001) 10 Ind Corp Change 419, 444; Ashish Arora and Robert P Merges, 'Specialized Supply Firms, Property Rights and Firm Boundaries' (2004) 13 Ind Corp Change 451; Lee Davis, 'Licensing Strategies of the New "Intellectual Property Vendors"' (2008) 50 Calif Manage Rev 6.

[72] Laura Poppo and Todd Zenger, 'Do Formal Contracts and Relational Governance Function as Substitutes or Complements?' (2002) 23 Strateg Manag J 707; Dieter Ernst, 'Limits to Modularity: Reflections on Recent Developments in Chip Design' (2005) 12 Ind Innov 303, 318; Davis (n 71) 15. This process of informal enforcement of contractual and quasi contractual arrangements is not dissimilar to Gilson and others' concept of '*braiding'* in Ronald Gilson, Charles Sabel and Robert Scott, 'Braiding: The Interaction of Formal and Informal Contracting in Theory, Practice, and Doctrine' (2010) 110 Colum L Rev 1377.

[73] Richard Waters, 'Big Tech Raises Its Bets on Chips' *Financial Times* (10 March 2022) <https://www.ft.com/content/4d-b69e3c-c901-4776-970e-c57e99f71aba> accessed 22 November 2022; Sam Shead, 'Tech Giants Are Rushing to Develop Their Own Chips — Here's Why' (*CNBC*, 6 September 2021) <https://www.cnbc.com/2021/09/06/why-tesla-apple-google-and-facebook-are-designing-their-own-chips.html> accessed 22 November 2022.

[74] Julie E Cohen, *Between Truth and Power: The Legal Constructions of Informational Capitalism* (Oxford University Press 2019); Amy Kapczynski, 'The Law of Informational Capitalism' (2020) 129 Yale LJ 1460.

[75] The IGLP Law and Global Production WG (n 48) 68; Robert L Hale, 'Coercion and Distribution in a Supposedly Non-Coercive State' (1923) 38 PSQ 470, 485–486.

[76] Jeffrey T Macher, David C Mowery and Alberto Di Minin, 'The "Non-Globalization" of Innovation in the Semiconductor Industry' (2007) 50 Calif Manag Rev 217.

respective GVCs.[77] As IP costs remain largely unchanged, fixed costs of manufacturing rise, and as a result 'firms controlling the intangible-intensive parts of the chain will receive a disproportionate share of the gains from the network as output expands'.[78]

Contractually prescribed power structures

Inextricably linked with a strong IP protection regime are contractual agreements and novel forms of contracts among original equipment manufacturers, fabless companies, and foundries. The high capital costs of purchasing equipment coupled with long production cycles and the volatile consumer demand inevitably lead to supply chain uncertainties that companies attempt to navigate through *ex ante* contractual governance reflected in, for example, minimum wafer start contracts, quantity flexibility contracts, and capacity reservation contracts.[79] For example, TSMC offers 'tradable capacity options' that allow different buyers to exchange capacity they have purchased but no longer need without TSMC collecting additional profit.[80] Illustrating the industry's degree of cumulative consolidation, TSMC has recently announced the acceptance of 'guarantee deposits' amounting to approximately $4 billion for future manufacturing capacity (most likely by Apple and AMD).[81] Meanwhile, ASML, the only company in the world capable of manufacturing photolithographic tools for chip development at the leading node, has 'preferential agreements' with TSMC and, at the same time, has already agreed with Intel on the future (yet still uncertain) sale of its first machine for 2 nm production.[82] Indicative of the value of contractual and licensing agreements is the fact that in Q2 of 2022 ASML recorded higher profit from net bookings than it did from actual sales of photolithographic tools.[83]

Contractual governance and novel forms of contracts have thus created an extremely complicated, tightly run, and extensively controlled value chain which by—legal—design benefits those lead companies with the operational and logistical capacity to shape, navigate, and sustain it. By exercising their power over value chains, lead firms have gravitated demand towards few manufacturing foundries capable of responding primarily to orders of large volume to amortize production costs. Quite alarmingly, Thomspon and Spanuth predict that by 2026 to 2032 'leading-edge semiconductor manufacturing will only be able to support a single monopolist manufacturer'.[84] Therefore, existing control over the GVCs of AI is gradually transformed into monopsony power over a global manufacturing infrastructure tailored to the needs and priorities of lead firms whose main incentive is to capture value and displace costs.[85]

[77] Cédric Durand and Wiliiam Milberg, 'Intellectual Monopoly in Global Value Chains' (2020) 27 Rev Int Political Econ 404, 422; Yutao Sun and Seamus Grimes, 'China's Increasing Participation in ICT's Global Value Chain: A Firm Level Analysis' (2016) 40 Telecommun Policy 210.

[78] Durand and Milberg (n 77) 418; Elena Baglioni, Liam Campling and Gerard Hanlon, 'Global Value Chains as Entrepreneurial Capture: Insights from Management Theory' (2020) 27 Rev Int Political Econ 903, 914.

[79] Konstanze Knoblich and others, 'Modeling Supply Contracts in Semiconductor Supply Chains', *Proceedings of the 2011 Winter Simulation Conference (WSC)* (2011); R John Milne and others, 'Incorporating Contractual Arrangements in Production Planning' (2015) 53 Comput Oper Res 353.

[80] Neda Khanjari, Izak Duenyas and Seyed MR Iravani, 'Should Suppliers Allow Capacity Transfers?' (2022) 31 Prod Oper Manage 2324; Erica L Plambeck and Terry A Taylor, 'Implications of Breach Remedy and Renegotiation Design for Innovation and Capacity' (2007) 53 Manag Sci 1862.

[81] John Loeffler, 'Intel Locks down All Remaining TSMC 3nm Production Capacity, Boxing out AMD and Apple' (*TechRadar*, 12 August 2021) <https://www.techradar.com/news/intel-locks-down-all-remaining-tsmc-3nm-production-capacity-boxing-out-amd-and-apple> accessed 24 November 2022; Isaiah Mayersen, 'TSMC Has Received $4 Billion from Clients to Reserve Future Manufacturing Capacity' (*TechSpot*, 20 November 2021) <https://www.techspot.com/news/92316-tsmc-has-received-4-billion-clients-reserve-future.html> accessed 24 November 2022.

[82] Lisa Wang, 'Intel Places ASML Order to Step up TSMC Competition - Taipei Times' (20 January 2022) <https://www.taipeitimes.com/News/biz/archives/2022/01/20/2003771688> accessed 24 November 2022.

[83] ASML Holding, 'ASML Announces Q2 2022 Financial Results' (ASML 2022) <https://www.asml.com/en/news/press-releases/2022/q2-2022-financial-results> accessed 22 November 2022.

[84] Thompson and Spanuth (n 5) 35.

[85] Donald A Clelland, 'The Core of the Apple: Degrees of Monopoly and Dark Value in Global Commodity Chains' [2014] JWSR 82, 87; Ronald Gilson, Charles Sabel and Robert Scott, 'Contracting for Innovation: Vertical Disintegration and Interfirm Collaboration' (2009) 109 Colum L Rev 431.

Contracts can enable both such functions.[86] When studying contracts at a transnational level for GVC analysis, Eller invites us to move beyond a mere search for liability ascription based on the black letter of supply contracts, to explore how 'contracts relate to additional and competing normative driving forces of the chain, such as algorithmic, IT-driven or logistical governance'.[87] As a case in point, supply uncertainties in the GVCs of AI along with the mass availability of cloud-based systems for supply chain management, have created 'opportunities' for supply chain surveillance which often come as a contractual pre-condition for the subcontractors' participation in the value chain bearing, in turn, its own—often overlooked—terms and conditions. For example, Durand and Milberg explain how lead firms achieve a 'panopticon' view of their supply chains through data integration and centralization across the GVC. Using IT systems, data-extractive technologies, and data centralization, lead firms strengthen their bargaining power, learn from their partners, and use this captured knowledge to further enhance their innovative capabilities.[88] Therefore, the centralization of information across organizational and geographic boundaries enables value chain modularity thereby 'easing supplier switching and aiding in the coordination of spatially dispersed industries'.[89]

Coupled with that, lead firms reinforce their position in the GVCs to the detriment of their subcontractors by maintaining control over the intangibles while outsourcing manufacturing under strict terms for logistics and delivery. This 'logistic revolution' unlocks novel panopticon possibilities over the GVCs of AI.[90] Drawing attention to the paradox of 'assembler misery' and 'brand wealth' in Apple's business model, Froud *et al*. criticize the outsourcing model of the conglomerate, which squeezes suppliers' margins and directly affects workers' conditions.[91] As contracting with them can 'send a supplier's stock soaring', lead firms capitalize on their bargaining power by squeezing suppliers' profit margins.[92] For instance, when Apple approaches a supplier for a price quote on parts, it demands 'a detailed accounting of how the manufacturer arrived at the quote, including its estimates for material and labour costs, and its own projected profit'.[93] In a similar context, Satariano and Burrows further report that Apple extends credit and financing to some key suppliers in exchange for long-term commitments that ultimately generate strong path dependencies.[94] At the same time, it is almost impossible to obtain and scrutinize such agreements and price deals as lead firms often compel the confidentiality and silence of their suppliers and contractors through trade secrecy provisions and non-disclosure agreements.[95]

Overall, what seems obvious once we look closer to the legal constructions that forge the structural aspect of the value chain of AI, is—unsurprisingly—that creating a computational

[86] Colin Haslam and others, 'Apple's Financial Success: The Precariousness of Power Exercised in Global Value Chains' (2013) 37 Accounting Forum 268, 271.

[87] Klaas Eller, 'Transnational Contract Law' (2021) in Peer Zumbansen (ed.), *The Oxford Handbook of Transnational Law* online edn, Oxford Academic 15.

[88] Durand and Milberg (n 77) 420; Jianfeng Wang, 'Economies of IT Systems at Wal-Mart - an Historical Perspective' (2006) 9 Academy of Information and Management Sciences Journal 45; Richard P Appelbaum, 'Giant Transnational Contractors in East Asia: Emergent Trends in Global Supply Chains' (2008) 12 Competition & Change 69; Nada R Sanders, 'How to Use Big Data to Drive Your Supply Chain' (2016) 58 Calif Manag Rev 26.

[89] Timothy J Sturgeon, 'Upgrading Strategies for the Digital Economy' (2021) 11 GSJ 34, 42.

[90] Florian Butollo, 'Digitalization and the Geographies of Production: Towards Reshoring or Global Fragmentation?' (2021) 25 Competition & Change 259, 268.

[91] Julie Froud and others, 'Financialization across the Pacific: Manufacturing Cost Ratios, Supply Chains and Power' (2014) 25 Crit Perspect Account 46.

[92] Omri Ben-Shahar and James White, 'Boilerplate and Economic Power in Auto Manufacturing Contracts' (2006) 104 Mich. L. Rev. 953; John Boudreau, 'Apple Taps Obscure Asian Suppliers to Bring the iPhone and Other Products to the Masses' (*The Mercury News*, 26 September 2012) <https://www.mercurynews.com/2012/09/26/apple-taps-obscure-asian-suppliers-to-bring-the-iphone-and-other-products-to-the-masses/> accessed 26 November 2022; Clelland (n 85) 93; Kevin B Sobel-Read, 'Global Value Chains: A Framework for Analysis' (2014) 5 Transnatl Leg Theory 364, 370.

[93] Adam Satariano and Peter Burrows, 'Apple's Supply-Chain Secret? Hoard Lasers' *Bloomberg.com* (3 November 2011) <https://www.bloomberg.com/news/articles/2011-11-03/apples-supply-chain-secret-hoard-lasers> accessed 28 November 2022.

[94] ibid.

[95] Dedrick and Kraemer (n 22) 11.

infrastructure is much easier and progressively less burdensome if you are a big player from the Global North. And this dominance in the structural part of the value chain is self-reinforcing in that critical buying power offers opportunities for discounts in orders of large volumes or privileged access to equipment in periods of supply chain crisis whilst, at the same time, by providing extremely powerful technical infrastructure for data and computation, lead firms render investments decisions to capital-intensive equipment by other players rather unappealing.[96] As a result, we are now witnessing a shift from thinking of data and computation equipment as capital expenditure to managing it as operational expenditure.[97] The increasing dependency of global AI production on the lead firms along with the capacity of the latter to extract domain-specific knowledge from their suppliers blurs the boundaries between providers of Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS), and Software-as-a-Service (SaaS) and enables the lead firms/infrastructure providers to capture value across the value chain as well as to build capacity to control future value production across and beyond the structural part of the chain.[98]

This is because the mechanisms for offering these infrastructural services are by design likely to create capture and dependencies. For example, cloud credits, a form of free-trial of cloud services that is widely offered primarily by Big Tech, serve as entry points for entities such as start-ups to the cloud ecosystem of a particular vendor thereby forming technical bonds and learning curves that are then difficult to dislodge or replicate. These support programs can last up to 2 years in some cases and according to the French Competition Authority: '[they] could be the subject of particular attention'.[99] Coupled with that, major cloud providers that offer services across the functional value chain (storage and computing infrastructure, and software, and data management service) design their technology stack to provide maximum optimization and brand homogeneity across their network whilst cultivating a culture of 'certified' education on their platforms (which is often free) to attract professionals and introduce them to their ecosystems. The battle then becomes one of public image and branding with the strategic goal being that whatever innovation will happen in the future, it will be one way or the other financially and culturally associated with this or that cloud ecosystem. As one interviewee for French Competition Authority review put it in a quote worth citing in full:[100]

> '[T]he brand image of hyperscaler has become a sesame for developers, who have pounced on certifications that add value to their profiles […] This situation drains other technologies, which do not enjoy the same level of notoriety and fail to interest Cloud developers and architects due to a lack of value. As a result, customers turn to the skills most present on the market, also fuelling the race for salaries and technological skills. These factors favour hyperscalers'.

Overall, contracts, as the governance mechanism and backbone of transnational social institutions per Eller, aim at exerting governance in a GVC by becoming an *ex ante* 'means of coordination and safeguarding' rather than an *ex post* 'sanctioning in case of breach'.[101] This function of contracts encapsulates the reality in the GVCs of AI quite eloquently. Lead firms in different segments of the value chain (from equipment manufacturing to cloud provision) are engaging in a strange tango of interdependence whose flow and rhythm are predominantly dictated

[96] 'Opinion 23-A-08 on Competition in the Cloud Sector' (Autorité de la concurrence 2023) para 208 <https://www.autoritedelaconcurrence.fr/en/opinion/competition-cloud-sector>.

[97] Lukas Brun, Gary Gereffi and James Zhan, 'The "Lightness" of Industry 4.0 Lead Firms: Implications for Global Value Chains' (2019) 48.

[98] Grzegorz Lechowski and Martin Krzywdzinski, 'Emerging Positions of German Firms in the Industrial Internet of Things: A Global Technological Ecosystem Perspective' (2022) 22 Global Networks 666, 669–674; Butollo and Schneidemesser (n 16) 602–603.

[99] 'Opinion 23-A-08 on Competition in the Cloud Sector' (n 96) para 408.

[100] ibid para 268

[101] Eller (n 87) 11.

by contractual agreements and the relational governance systems they enable. AI systems are thus born out of arrangements among private actors following a path of deeply consolidated market channels. Thanks to the order-enabling function of contracts, private actors' structural power over the value chain is left alone in designing and deciding what chips are to be built, for what (kind of) hardware, and to what (and whose) ends. Contractual governance orchestrated by powerful firms is thus shaping the constitutive fabric of our digital world the same way traditional contracts '[are] shifting control from what was traditionally state-based, constitutionally-backed, and socially embedded production to private hands'.[102]

At some point, it all comes down to land

Connecting, now, the structural (i.e. GPUs) with the functional (cloud services, software, and algorithms) part of the value chain, the legal constructions of the data centre industry are also formative of/for the political economy of AI. Indicatively, hyperscalers, a term used to describe 'very large companies that have built global hosting capabilities and developed dedicated applications used by millions of users' (in other words, Amazon, Google, and Microsoft), apart from owning and investing in data centres, also sign long-term (10–15 years) leasing agreements with data centre operators (such as Equinix) for exclusive use of tailor-made data centre space.[103] These leasing agreements often take the form of Triple Net (NNN) agreements where the tenant (usually a 'hyperscaler') assumes costs for property tax, insurance, and maintenance in exchange for the right to make modifications to the space and customize it to suit their operational needs. From a landlord's perspectives, these tenancies can prove financially more attractive than traditional ones as they reduce maintenance costs, they are low-risk (especially when the tenant is a hyperscaler), and can guarantee a steady flow of income over a long period of time. This reality, coupled with Big Tech's incessant demand for computation, have shaped the dynamics and transformed the business models of an entire industry as data centre operators (such as Stack or Equinix) have been incentivized to pull resources and equity for real estate investments in 'built-to-suit' hyperscale data centres instead of prioritizing, for example, colocation data centres that are more suitable for, and affordable to small and medium enterprises.[104] As a matter of fact, between 2015 and 2021, the number of hyperscale data centres more than doubled, and this trend is projected to keep growing.[105]

Eventually, it all comes down to land acquisition where Big Tech seems—once again—to be investing in good terms. Big Tech's data centres investments are often treated favourably (as 'strategic investments') by the recipient state bearing all sorts of benefits with regards to administrative expediency and energy supply.[106] In practical terms, this means that Google, Microsoft, and Amazon will be able to buy more land (or lease land that others have bought for them in

[102] Claire A Cutler, 'Private Transnational Governance in Global Value Chains: Contract as a Neglected Dimension', *The Politics of Private Transnational Governance by Contract* (Routledge 2017) 89.

[103] Yevgeniy Sverdlik, 'How Cloud Giants (Hyperscalers) Go About Leasing Data Centers' [2021] *Data Center Knowledge* <https://www.datacenterknowledge.com/data-center-podcast/how-cloud-giants-hyperscalers-go-about-leasing-data-centers>; Mark Haranas, 'Microsoft Is Leasing The Most Data Center Capacity In US' *CRN* (20 January 2021) <https://www.crn.com/news/data-center/microsoft-is-leasing-the-most-data-center-capacity-in-us> accessed 13 November 2023.

[104] Indicatively, in Amazon's 10K filling to the Securities and Exchanges Commission (US) we read that '[p]roperty includes buildings and land that we own, along with property we have acquired under build-to-suit lease arrangements when we have control over the building during the construction period and finance lease arrangements'. See here Amazon.com Inc, 'Annual Report Pursuant to Section 13 or 15(d) of the Securities and Exchange Act of 1934 - Form 10K' (2022) 46 <https://d18rn0p25nwr6d.cloudfront.net/CIK-0001018724/d2fde7ee-05f7-419d-9ce8-186de4c96e25.pdf> accessed 13 November 2023.

[105] Synergy Research Group, 'Number of Hyperscale Data Centers Worldwide from 2015 to 2021' (Statista 2021).

[106] James Maguire and Brit Ross Winthereik, 'Digitalizing the State: Data Centres and the Power of Exchange' (2021) 86 Ethnos 530; Vicki Mayer, 'When Do We Go from Here? Data Center Infrastructure Labor, Jobs, and Work in Economic Development Time and Temporalities' (2023) 25 New Media & Society 307; Charis Papaevangelou and Evgenia Siapera, 'Big Tech's Infrastructural Expansion and Digital Colonialism in "Greece 2.0" (Conference Presentation)' (PlatGovNet 2023: Imagining Sustainable, Trustworthy, and Democratic Platform Governance, 4 April 2023).

Joint Ventures) in order to build, either alone or through investment partnerships, their very own hyperscale data centres, tailored and architectured to their specific infrastructural needs and functionalities (meaning data centres operating their application-specific chips and custom system architecture); data centres that, in the unthinkable scenario of their operators going bankrupt, will only be able to be sold for parts.

Weaponising the chips industry

Moving from the microcosm of private law to the global arena of AI policy, the recent activity and interest around chips trade and development worldwide traces its origins to geopolitical tensions and, in particular, the recent attempts by the US government to drag the semiconductor industry in its trade war with China.[107] Chip war is the new war of our globalized world.[108] Despite the industry's voices to the contrary, in 2018 the US imposed tariffs on semiconductors imports from China which were followed by export controls in 2019.[109] Today the US has imposed national and company-specific restrictions on exports of semiconductor-related technologies to China through its Commercial Control Lists.[110] Examples of such restrictions include Nvidia's A100 and H100 accelerators, two GPUs that are widely used in the development of high-performance data centres.[111] International agreements have also played their part in exacerbating the tensions. Recently, under the Wassenaar Arrangement, the Dutch government blocked the Dutch-based ASML from shipping its EUV lithography equipment to China's major foundry, the Semiconductor Manufacturing International Corporation (SMIC), thereby preventing SMIC from advancing and growing to full capacity.[112]

These aggressive trade practices are supplemented by industrial policies and sector-specific legislation. In July 2022, the US Congress passed the CHIPS and Science Act 2022 aiming at strengthening the manufacturing and design capacity of the US semiconductors industry mainly by providing federal subsidies (approx. $53 billion), tax credits, skills development, and research funding. In a similar context, the EU Commission introduced its proposal for a Chips Act to promote enhanced cooperation among stakeholders (R&D institutions, IP owners, design houses, SMEs, start-ups, etc.), investment facility support, as well as development and access to pilot lines in an attempt to ensure EU's competitiveness, innovation capacity, and resilience in the industry.[113]

[107] See, generally, Chris Miller, *Chip War: The Fight for the World's Most Critical Technology* (Scribner 2022); Ernst (n 20); Chad P Bown, 'How the United States Marched the Semiconductor Industry into Its Trade War with China (Working Paper)' (Peterson Institute for International Economics 2020).

[108] Rosa Brooks, *How Everything Became War and the Military Became Everything: Tales from the Pentagon* (Reprint edition, Simon & Schuster 2017).

[109] Bown (n 107) 374.

[110] US Mission China, 'Commerce Implements New Export Controls on Advanced Computing and Semiconductor Manufacturing Items to the People's Republic of China (PRC)' (*U.S. Embassy & Consulates in China*, 11 October 2022) <https://china.usembassy-china.org.cn/commerce-implements-new-export-controls-on-advanced-computing-and-semiconductor-manufacturing-items-to-the-peoples-republic-of-china-prc/> accessed 17 November 2022; Michael Schuman, 'Why Biden's Block on Chips to China Is a Big Deal' (*The Atlantic*, 25 October 2022) <https://www.theatlantic.com/international/archive/2022/10/biden-export-control-microchips-china/671848/> accessed 17 November 2022.

[111] The following recent update is indicative of the nature of the 'techno-legal' work undertaken by MNCs: Nvidia which due US restrictions requires specific licence to export its A100 and H100 chips to China has recently built a modified, China-specific version of its A100 GPU, an accelerator widely used in high-performance data centres. The new version of the accelerator, the A800, runs at a 400GB/sec interconnection speed which is slightly below the performance threshold of the US ban (600 GB/sec). For more details see Rita Liao, 'Nvidia Touts a Slower Chip for China to Avoid US Ban' (*TechCrunch*, 8 November 2022) <https://techcrunch.com/2022/11/07/nvidia-us-china-ban-alternative/> accessed 17 November 2022.

[112] European Commission (SWD), 'European Chips Act: Staff Working Document | Shaping Europe's Digital Future' (2022) 18 <https://digital-strategy.ec.europa.eu/en/library/european-chips-act-staff-working-document> accessed 30 September 2022.

[113] European Commission, 'Proposal by the European Commission for Strengthening Europe's Semiconductor Ecosystem (Chips Act)' (2022) Recital 12 <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:52022PC0046> accessed 17 November 2022.

These legal developments mark a historic shift in the political economy of the semiconductor industry. Led by the US, a policy shift is currently underway as the market-driven, *laisser-faire* strategy is gradually abandoned for the sake of a protectionist agenda that prioritizes self-sufficiency, resiliency, and aspiration for complete control over the value chains' chokepoints.[114] As a result, the liberal vision for a globalized world of chip interdependence collapses, and network structures end up entrenching, rather than diffusing, power over AI production.[115] Defenders of such policies believe them to be necessary preconditions for responding to future supply chain crises. Critics argue that such fears are unsubstantiated and largely inflamed by the suspicions claims against 'whatever includes the word 'China'.[116] Be that as it may, whether chip resiliency is an attainable goal in an industry that spreads all around the world and partitions into a vast complex of knowledge- and capital-intensive segments and processes is entirely unclear. Even more unclear is whether such a goal, if attainable, would indeed be desirable for the political economy of computing.

Geopolitical tensions and the US–China conflict are likely to exacerbate the decoupling of the global digital sphere.[117] As the gradually expanding splinternet phenomenon takes various forms across the internet and infrastructural layers, a trade battle over semiconductors will deepen its impact, widen the schism between digital ecosystems and aggravate the already difficult knowledge exchange among researchers and policymakers.[118] In such a scenario, progress on global protocols and standards will hinder and major players and cloud providers will inevitably come to the rescue.

In other words, a geopolitical race for a 'closed' development of AI systems by specific 'like-minded' countries and private actors may be used as an argument to further justify and intensify the pathway towards AI standardization. Consolidated economic networks will enable coercive efforts led by those states that have jurisdiction over key hubs in the network of AI production.[119] Efforts to deliberate on important legal-political questions on AI standards and the institutional safeguards necessary for properly scrutinizing and deliberating such techno-normative processes may be fended off or derailed.[120] Relatedly, the geopolitical framing of the semiconductor crisis, often eloquently expressed in war-inspired rhetoric, elbows aside other 'battles' and critical questions for our digital future(s) and, at the same time, by vilifying the 'other side' it implicitly legitimizes industrial policies that solidify the unequal and extractive status quo.[121]

Besides, with geopolitics dominating the dialectics and regulatory debate, there is hardly any political and institutional capital left for talking and thinking about power and programmability outside of the nation-state framing. As a result, the ability of private actors to roll out

114 Gregory C Allen, 'Choking Off China's Access to the Future of AI' (Center for Strategic and International Studies 2022).

115 Henry Farrell and Abraham L Newman, 'Weaponized Interdependence: How Global Economic Networks Shape State Coercion' (2019) 44 Int Secur 42, 49.

116 Matthew Glavish, 'Biden Administration's Actions Needlessly Harm Critical US Chip Company' (*American Enterprise Institute - AEI*, 3 October 2022) <https://www.aei.org/technology-and-innovation/biden-administrations-actions-needlessly-harm-critical-us-chip-company/> accessed 17 November 2022; Willy Shih, 'Why Is Biden Restricting More Chip Tech To China? It's Complicated.' (*Forbes*, 14 September 2022) <https://www.forbes.com/sites/willyshih/2022/09/14/export-restrictions-on-sale-of-chips-and-equipment-to-china-will-they-work/> accessed 17 November 2022; Scott Lincicome, 'Does the U.S. Semiconductor Industry Really Need Urgent Taxpayer Support to Stop China? | Cato at Liberty Blog' (*CATO Institute*, 23 July 2020) <https://www.cato.org/blog/does-us-semiconductor-industry-really-need-urgent-taxpayer-support-stop-china> accessed 17 November 2022.

117 Ernst (n 20) 45; Paul Blustein, *Schism: China, America, and the Fracturing of the Global Trading System* (McGill-Queen's University Press 2019).

118 David Shambaugh, 'U.S.-China Decoupling: How Feasible, How Desirable?' (*China-US Focus*, 6 December 2019) <https://www.chinausfocus.com/foreign-policy/us-china-decoupling-how-feasible-how-desirable> accessed 26 November 2022.

119 Farrell and Newman (n 115) 56.

120 Michael Veale and Frederik Zuiderveen Borgesius, 'Demystifying the Draft EU Artificial Intelligence Act' (2021) 22 Comput Law Rev Int 97; Matus and Veale (n 43).

121 AI Now Institute, 'US-China AI Race: AI Policy as Industrial Policy' (*AI Now Institute*, 11 April 2023) <https://ainowinstitute.org/publication/us-china-ai-race> accessed 13 November 2023.

a particular device feature (i.e. scanners of content on users' devices) or to design a chip tailored to a power-enabling functionality (i.e. proximity-tracing) remains outside of the regulatory agenda. Power in AI is thus understood in terms of geographies, sovereignty, localities of production, and borders rather than infrastructural power and affordances.[122] Regulating such power falls outside of our accepted categories of technology regulation.[123] Finally, if the AI standardization process indeed intensifies, it is difficult to see how regions with little or no presence in the GVCs of AI (i.e. the Global South) will manage to engage with such processes; or whether standardization will become a vehicle for the 'concatenation of industrial processes' thereby further entrenching and deepening the power asymmetries between North and South in AI development;[124] or what would happen when standards from the Global North interact with AI systems developed in/from the Global South.[125]

Transnational techno-legal work and the role of standards

Law does not merely permit or prohibit certain activities across a value chain but instead, it can guide corporate power by becoming a guiding compass for 'creative compliance'.[126] In navigating their way out of a complex web of legal constructions, corporations internalize normative mandates and distil them to produce their own reflections and interpretations of the rules. In so doing, they 'produce effects on social welfare similar to the effects resulting from rulemaking and enforcement by governments'.[127] Within global networks of any kind, this norm-producing and standard-setting power moves decision-making and rule-setting away from interstate negotiations and towards networks of private actors and corporate salons.[128] The highly modular nature of AI production further intensifies segmentation and specification across the value chain.[129] At the same time, lowering the degree of platform modularity to allow privileged access for innovation to a selected few MNCs can create relational ties of value exchange that are hard to replicate and penetrate.[130] Understanding how corporate power is exercised at the micro-level allows us to see the transnational legal order in its full complexity.[131]

Uniquely, in the case of the GVCs of AI this techno-legal work (performed by lawyers and/or AI-hardware engineers) fossilizes itself in hardware. AI practitioners and hardware developers design and deploy tools as final products of an internalized legal work that reflects the corporation's private strategy for legal compliance. This order-enabling techno-legal work is normatively significant not only because of the way it enforces and entrenches legal entitlements but

[122] Daniel Lambach and Kai Oppermann, 'Narratives of Digital Sovereignty in German Political Discourse' (2023) 36 Governance 3; Louise Amoore, 'Cloud Geographies: Computing, Data, Sovereignty' (2018) 42 Progress in Human Geography 4; Stephane Couture and Sophie Toupin, 'What Does the Notion of "Sovereignty" Mean When Referring to the Digital?' (2019) 21 New Media & Society 2305; Henning Lahmann, 'On the Politics and Ideologies of the Sovereignty Discourse in Cyberspace' (2021) 32 Duke J Comp & Int'l L 61.

[123] Sobel-Read, 'Reimagining the Unimaginable' (n 4).

[124] Thorstein Veblen, *The Theory of Business Enterprise* (Routledge 1978) 323; Baglioni, Campling and Hanlon (n 78).

[125] Rory Horner and Khalid Nadvi, 'Global Value Chains and the Rise of the Global South: Unpacking Twenty-First Century Polycentric Trade' (2018) 18 Global Networks 207, 231; Sareeta Amrute and Luis Felipe R Murillo, 'Introduction: Computing in/from the South' (2020) 6 Catalyst: Feminism, Theory, Technoscience.

[126] Doreen McBarnet, 'Transnational Transactions: Legal Work, Cross-Border Commerce and Global Regulation' in Antoine Masson and Mary J Shariff (eds), *Legal Strategies: How Corporations Use Law to Improve Performance* (Springer 2009) 385; The IGLP Law and Global Production WG (n 48) 77.

[127] Dan Danielsen, 'How Corporations Govern: Taking Corporate Power Seriously in Transnational Regulation and Governance' (2005) 46 Harv Int l LJ 411, 412. For an excellent account of how this internalization happens in the legal-corporate world of privacy compliance see Ari Ezra Waldman, *Industry Unbound: The Inside Story of Privacy, Data, and Corporate Power* (Cambridge University Press 2021).

[128] Waldman (n 127); Kathryn Judge, 'Intermediary Influence' (2015) 82 U Chi L R.

[129] Butollo (n 90) 272; Eric Thun and Timothy Sturgeon, 'When Global Technology Meets Local Standards: Reassessing China's Communications Policy in the Age of Platform Innovation' in Loren Brandt and Thomas G Rawski (eds), *Policy, Regulation and Innovation in China's Electricity and Telecom Industries* (Cambridge University Press 2019).

[130] To understand modularity as an intentional platform strategy for relational value chain governance see Ding and Hioki (n 17).

[131] Danielsen (n 127) 415, 416.

primarily because it serves as the foundation of an infrastructure that promulgates future ordering(s) in a form of *quasi* legal imperialism.[132] Paraphrasing Bertram Turner: '[i]n enacting the ordering of their constitutive components, [digital infrastructures] develop their own specific [techno-legal] configurations'.[133]

Therefore, looking into hardware configurations and doing the 'infrastructuring work' is as important as thinking about broader policy for global programmability. As such, this endeavour is not dissimilar to McBarnet's research that zooms in to the technical, yet norm-shaping, legal work at the micro-level of individual global business-client relationships while warning that '[e] fforts at global control of business may be set up at a macro level, only to be destroyed by stealth through routine private legal work'.[134]

To illustrate the argument, take the example of modern Digital Rights Management (DRM) technologies. Today, the reason we cannot screen capture a Netflix video with our smartphone is that Google's Widevine and Apple's Fairplay provide a form of copyright protection that is integrated into the hardware of mobile devices (e.g. TVs and mobile phones) thereby protecting against piracy of streaming and video playback across privileged apps and streaming systems. This form of hardware protection is not directly mandated by law but rather it represents the way Google and Apple decide to enforce rights and entitlements through (re)programming their infrastructures.[135] It is them who decide the exact nature of their compliance as well as the conditions based on which functionalities will open up for use by third parties.[136]

Apart from IP protection, hardware support has also been designed and deployed to support security and privacy mostly through Trusted Execution Environments (TEE). A TEE is an execution environment, isolated from the main operating system of a device, which protects its runtime states and stored assets. A TEE, for example, prevents applications (such as bank apps) from accessing facial recognition data when the user has authorized such log-ins (the authorization is thus performed at an operating system level). Unlike specialized and static hardware coprocessors, a TEE can be (re)configured by updating its code and data.[137] Its isolated architecture guarantees the security and confidentiality of the running code without compromising the main system's operations. TEEs (or enclaves) are particularly popular for providing confidentiality and security guarantees in mobile devices and are increasingly marketed as the solution to similar problems in cloud environments.[138]

A pattern that emerges from the use of hardware protections by dominant platforms is related to the way such practices consolidate their power and increase their political leverage. For example, Over-the-Top (OTT) service providers such as Netflix and Disney+ cannot but opt to use FairPlay and Widevine as they offer protection to some of the most popular delivery channels for video and TV content (Android devices, Apple devices, Chrome, Mozilla, and Safari browsers etc) while viewers cannot but use platforms that are compatible with these DRM technologies to access content by OTT providers. In the same spirit, Singh et al. explain how TEEs

[132] McBarnet (n 126) 379.

[133] Bertram Turner, 'Legal Pluralism in Infrastructural Designs: Alternative Supply Chains in the Moroccan Argan Oil Export' (2021) 48 Sci Technol Hum Values , 479.

[134] McBarnet (n 126) 370, 386.

[135] I owe this example—and many of the thoughts underlying this paper—to conversations with my colleague, Dr Michael Veale.

[136] Humphrey (n 16) 10.

[137] Mohamed Sabt, Mohammed Achemlal and Abdelmadjid Bouabdallah, 'Trusted Execution Environment: What It Is, and What It Is Not', *2015 IEEE Trustcom/BigDataSE/ISPA* (2015) 58.

[138] Amit Vasudevan and others, 'Trustworthy Execution on Mobile Devices: What Security Properties Can My Mobile Platform Give Me?' in Stefan Katzenbeisser and others (eds), *Trust and Trustworthy Computing* (Springer 2012); N Asokan and others, 'Mobile Trusted Computing' (2014) 102 Proceedings of the IEEE 1189; Jatinder Singh and others, 'Enclaves in the Clouds' (2021) 64 Commun ACM 42.

can be leveraged to meet some of the GDPR requirements while warning, however, that the deployment of TEEs by the dominant players in the cloud market is likely to further reinforce and entrench their power.[139] In simple terms, whilst a TEE may solve the problem of disclosing sensitive information to third parties, whether its code and purpose remain unaltered by all means and at all costs, rests on the goodwill of the device manufacturer. This form of 'architectural manipulation' per Jacobides *et al*. enables infrastructure operators to become programmable bottlenecks across and beyond industries by creating 'convenient rules of the game' that others abide by.[140]

Linked to that, a claim that is usually taken at face value when it comes to the various technical standards that underpin the development and operations of digital infrastructures, is related to the 'open' nature of a particular standard and/or system. For example, Google's Kubernetes is a container orchestrator (usually likened to the traffic controller of items that run in a computing environment) that is widely offered by all major cloud providers (including Google's competitors) whose open-source nature, however, cannot guarantee interoperability as technical lock-in can and does happen in the layers and services built on top.[141] Similarly, Amazon's Simple Storage Service (S3) is the global standard for global storage in the cloud and despite its extensive public documentation and ability to be accessed via API, 'third-party cloud service providers report difficulties in implementing interoperability in practice'.[142] Warning against corporate narratives on open (-source) AI, Widder *et al*. observe that:[143]

> 'The truth [about 'open' AI] is less comforting […] When we examine the resources required to create and deploy AI from start to finish, and who actually has them, visions of democratic access and a competitive AI market fade'.

Mainstream legal analysis lacks the normative tools necessary for framing, analysing, and regulating power forged through hardware 'protections' and technical standards.[144] But if there is something we can learn from the short history of the Internet, it is that technical architecture and the decision-making mechanisms we institutionalize to create them, have a norm-shaping power that shall not be left unnoticed.[145] Today, similar important decisions on how human-rights relevant devices, chips, and sensors will be designed, deployed, updated, and perform, are taken in the product design tables of few MNCs with civil society being left to challenge and resist them once their functionality has been set in motion.[146] One exception that perhaps can offer some novel imaginaries and trajectories on how to

[139] Singh and others (n 138) 47,50.

[140] Michael G Jacobides, Thorbjørn Knudsen and Mie Augier, 'Benefiting from Innovation: Value Creation, Value Appropriation and the Role of Industry Architectures' (2006) 35 Res Policy 1200, 1208–1209.

[141] 'Opinion 23-A-08 on Competition in the Cloud Sector' (n 96) paras 512–513.

[142] ibid p.142

[143] Widder, West and Whittaker (n 55) 4.

[144] For some exceptions see Joris van Hoboken and RÓ Fathaigh, 'Smartphone Platforms as Privacy Regulators' (2021) 41 Computer Law & Security Review; Veale, 'Rights for Those Who Unwillingly, Unknowingly and Unidentifiably Compute!' (n 14); Singh and others (n 138).

[145] See, generally, Niels ten Oever, *Wired Norms: Inscription, Resistance, and Subversion in the Governance of the Internet Infrastructure* (University of Amsterdam 2020); Roxana Radu, *Negotiating Internet Governance* (Oxford University Press 2019); William Lehr and others, 'Whither the Public Internet?' (2019) 9 Journal of Information Policy 1; Francesca Musiani and others (eds), *The Turn to Infrastructure in Internet Governance* (2015).

[146] See for example the Client-Side Scanning saga that started with Apple's announcement in August 2021 and ended up becoming a legal-political battle at the European Parliament two years later. See, generally, Abelson and others (n 12); Paul Rosenzweig, 'The Apple Client-Side Scanning System' (*Lawfare*, 24 August 2021) <https://www.lawfareblog.com/apple-client-side-scanning-system> accessed 13 October 2022; Paul Rosenzweig, 'The Law and Policy of Client-Side Scanning' (*Lawfare*, 20 August 2020) <https://www.lawfareblog.com/law-and-policy-client-side-scanning> accessed 13 October 2022; Meredith Whittaker, 'President of Signal Foundation Meredith Whittaker's Speech for EDRi's 20th Anniversary' (*EDRi*, April 2023) <https://edri.org/wp-content/uploads/2023/04/EDRi20anniv_Meredith_Whittaker.pdf>.

organize techno-legal work from the ground-up for meaningful intervention and change in a global scale is the DP-3T team that built the decentralized contact-tracing protocol that was eventually adopted by Google and Apple.[147]

Viewed as a legally constructed process that law overlooks despite its normative significance, techno-legal work follows the paradigms of private and public law constructs that cement power asymmetries in the GVCs of AI. The story of this chapter then becomes clear: AI Governance is not a legal *terra nullius* in anticipation of a set of rules that will bring order to an unbalanced universe. Rather, once we zoom in, we can see a world of strategically designed micro-constructs whose interlinkages in the everyday legal practice drives and reinforces an increasingly uneven distribution of value and power. In other words, AI production is—and has been for quite some time now—already on strategically fashioned, market-driven guardrails and for this reason, the success of any grand-scheme or masterplan for principle-based guardrails AI Governance (call it 'Global AI Treaty' or 'Digital Constitutionalism') is seriously diminished if it chooses to ignore them.

Questioning the ends and means of computational production cannot fit the dominant ideology and framework of legal-political analysis. Through this maze of legal micro-constructs, no one can really see the power of infrastructural programmability in its totality. The problem becomes more complicated as governments are abandoning those aspects of global trade that do not fit their geopolitical interests whilst lead companies are seeking total control over their value chains in an attempt to maintain or increase their skyrocketing growth figures. Computing potentialities are thereby constrained as geopolitics and markets, public actors, and private entities, stifle the spectrum of programmability. Those who care about computing technology, how it is built, by whom, and for what, are left with a small playing field centred exclusively on the configurations of the software layer and splintered across separate legal disciplines. Law's critique—almost inevitably—ends up being about data management, content moderation, the auditing of algorithms, and (constitutional) legitimacy, and shifts away from questioning the infrastructural axis upon which our computing technologies are structured and operate. But it does not have to be that way.

A NEW AGENDA AND THE ROLE OF GLOBAL SOUTH

Risk-based legal tools and logics from GVCs regulation may offer some limited help in bringing accountability and transparency in the value chains that sustain and expand modern AI production. For example, banning non-disclosure agreements, limiting the remit of trade secrecy, and strengthening whistleblowers' protections for the development of large AI models can shed light on the present and future trajectories of AI. Similarly imposing transparency obligations for decisions, projects, and investments, across the value chain of AI might also offer an opportunity for further scrutiny, journalistic investigations, and research. However, traditional value chain regulation with its emphasis on regulating externalities and its methods largely driven by the need to allocate liability in case of harm, cannot easily grapple with a norm-shaping project that wishes to institutionalize collective possibilities for AI governance and democratize access to informational and computing resources. The same goes for competition law.

Naturally (and somewhat inevitably), the obvious legal answer to the problem of power concentration in the GVCs of AI that has already been triggered in some jurisdictions in the Global North came from the field of competition law and was narrowly focussed on the cloud

[147] Troncoso and others (n 12); Terzis (n 11) 612–613.

industry.[148] Taking stock of these critiques in an attempt to move beyond a geopolitical agenda for the regulation of compute, a recent report by AI Now calls for a series of antitrust measures including structural separation between chip design and cloud provision; between hardware and software; and between AI-model and cloud infrastructure.[149]

But the theory and methods of competition law are not well-equipped to encompass the problem of power in mandating programable potentialities for the present and future of infocomputational technologies. This is not only because of practical issues such as that of 'market definition'; after all, definitional problems could, one way or the other, be solved through 'more' competition law. Instead, the fundamental concerns between the two projects are different. For what's at stake for the political economy of AI, this paper argues, is not a well-functioning economy where no one abuses its dominant positions or relationships of economic dependence but the risk of relinquishing our ability to question, intervene, and change the power of orchestrating the design, affordances, and functionalities of humanity's largest infrastructure.[150] There lies the conceptual and normative turn that law has to perform. And to do so, the project requires an act of/for political creation along with a vision for a function of law that can be and prove transformative.

New legal tools?

Delineating the fundamental pillars of 'transformative law', Kjaer observes that, in its essence, transformative law is a form of 'future law' which invigorates knowledge-based visions of world-(un)making fuelled by the normative goal of maintaining a sustainable society of intergenerational equality.[151] For law to be(come) transformative of the techno-legal arrangements that underpin the political economy of AI, broader political coalitions need to be nurtured across sectors and regions under a global agenda for programmability. One of the hardest obstacles in this direction is the leap of imagination required to conceive and theorize the normative anchor of/for such a project. Hardcoding these end-goals is neither necessary nor desirable. Rather, following law's transformative potential, the prospect lies in realizing and institutionalizing the possibility of using forms and functions of law as 'acts of recognition' for constituting different world visions, possibilities, and potentialities.[152]

Why do we care about infrastructural programmability? Why shall we mobilize capital resources, institutional structures, and legal mechanisms that address such issues? What factors raise the status of such a problem to a matter of global (infrastructural) significance?

Building on the rich and rapidly emerging scholarship on this subject, this paper argues that, fundamentally, our interest and commitment to visions of an equitable and democratic access and use of the world's infocomputational resources may justifiably derive from the principles of

148 See 'Cloud Services Market Study' (Ofcom 2023) <https://www.ofcom.org.uk/__data/assets/pdf_file/0027/269127/Cloud-services-market-study-final-report.pdf>; 'An Inquiry into Cloud Computing Business Practices: The Federal Trade Commission Is Seeking Public Comments' (*Federal Trade Commission*, 21 March 2023) <https://www.ftc.gov/policy/advocacy-research/tech-at-ftc/2023/03/inquiry-cloud-computing-business-practices-federal-trade-commission-seeking-public-comments> accessed 13 November 2023; 'Report on Fact-Finding Survey on Trade Practices by Digital Platform Operators' (Japan Fair Trade Commission 2022) <https://www.jftc.go.jp/en/pressreleases/yearly-2022/June/221102EN.pdf>; 'Opinion 23-A-08 on Competition in the Cloud Sector' (n 96).

149 Jai Vipra and Sarah Myers West, 'Computational Power and AI' (*AI Now Institute*, 27 September 2023) 44 <https://ainowinstitute.org/publication/policy/compute-and-ai> accessed 13 November 2023.

150 Mario Pansera, Javier Lloveras and Daniel Durrant, 'The Infrastructural Conditions of (de-)Growth: The Case of the Internet' (2024) 215 Ecol Econ 108001.

151 Poul F Kjaer, 'What Is Transformative Law?' (2022) 1 European Law Open 760, 768–778. See also more generally Poul F Kjaer (ed), *The Law of Political Economy: Transformation in the Function of Law* (Cambridge University Press 2020); Poul F Kjaer, 'Constitutionalizing Connectivity: The Constitutional Grid of World Society' (2018) 45 J Law Soc S114; Niels Åkerstrøm Andersen and Justine Grønbæk Pors, 'Transformation and Potentialization: How to Extend the Present and Produce Possibilities?' [2022] Kybernetes <https://research.cbs.dk/en/publications/transformation-and-potentialization-how-to-extend-the-present-and> accessed 14 November 2023.

152 Kjaer, 'What Is Transformative Law?' (n 151) 768–769.

sustainability, emancipation, and intergenerational justice. Sustainability is hereby conceived as environmental, encompassing the now well-documented impact that computational production has on the planet and the need for law to contribute to sustainable modes of living and production;[153] but it also refers to the socio-technical sustainability of the digital infrastructures whose viability currently depends not on criteria of quality and suitability but on logics and methods of/for continuous expansion.[154] Emancipation, on the other hand, reflects the normative mandate of breaking free from the extractive data relationships of the modern, data-hungry digital ecosystems and the legal assumptions and constructions (i.e. the rational consumer) that helped creating them and encapsulates the promise of building technologies for human flourishing rather than control.[155] This promise invites us to imagine forms of rights that create novel intellectual pathways and normative possibilities but are currently left 'unthinkable' due to the way human rights-based approaches have managed to become the 'global standard' of digital regulation.[156] Finally, intergenerational justice emerges from the realization that the material consequences of the legal, political, and institutional decisions we make today for our digital infrastructures, will stick around for generations and for this reason we owe careful considerations on the values we imprint on them.

Whilst political discourse focuses on the ends, regulation and legal mechanisms would also need to account for the means.[157] Given the scarce and finite character of the global manufacturing capacity for chips and the asphyxiating power of IP and lead firms' contracts over it, an agenda that aspires to develop infrastructures, models, and technologies pursuant to a vision for fair and equitable computations shall be accompanied by a realistic plan on how such models and technologies will be produced and/at scale. Such a transformative legal agenda would necessarily entail considerations over the legal constructions that entrench and reinforce these asymmetries. In this direction, legal scholars have a variety of legal tools (and histories) to draw on from a national, regional, and international level. Ideas might involve: arguing for land rights to build (or bring down) a data centre; acknowledging, in (constitutional) law the public value of programmability; abolishing practices of data extraction; establishing robust mechanisms for workers' protection across jurisdictions; creating opportunities for collective and community ownership of data and computing infrastructures; challenging the sacrosanct enforcement of IP against the 'public domain'; introducing forms of international taxation for hyperscalers and chip manufacturers; exploring alternative community-driven legal structures for financing technology development; standardizing contractual governance of scarce manufacturing resources; strengthening environmental obligations for lead firms in the GVCs of AI; steering away from

[153] See, indicatively, Emily M Bender and others, 'On the Dangers of Stochastic Parrots: Can Language Models Be Too Big?', *Proceedings of the 2021 ACM Conference on Fairness, Accountability, and Transparency* (Association for Computing Machinery 2021) <https://dl.acm.org/doi/10.1145/3442188.3445922>; Tamba S Lebbie and others, 'E-Waste in Africa: A Serious Threat to the Health of Children' (2021) 18 Int J Environ Res Public Health 8488; Loïc Lannelongue, Jason Grealey and Michael Inouye, 'Green Algorithms: Quantifying the Carbon Footprint of Computation' (2021) 8 Adv Sci 2100707; 'The Carbon Footprint of Computational Research' (2023) 3 Nat Comput Sci 659.

[154] Vipra and Myers West (n 149); Pansera, Lloveras and Durrant (n 150) 4.

[155] For a critique of the 'liberal self' as the global regulatory standard see Jake Goldenfein and Lee McGuigan, 'Managed Sovereigns: How Inconsistent Accounts of the Human Rationalize Platform Advertising' (2023) 3 Journal of Law and Political Economy; Julie E Cohen, 'What Privacy Is For' (2013) 126 Harv LR 1904.

[156] For a critique of human-rights based approaches in social media regulation see Rachel Griffin, 'Public and Private Power in Social Media Governance: Multistakeholderism, the Rule of Law and Democratic Accountability' (2023) 14 Transnatl Leg Theory 46; Rachel Griffin, 'Rethinking Rights in Social Media Governance: Human Rights, Ideology and Inequality' (2023) 2 ELO 30; Barrie Sander, 'Freedom of Expression in the Age of Online Platforms: The Promise and Pitfalls of a Human Rights-Based Approach to Content Moderation' (2019) 43 Fordham Int Law J 939; Barrie Sander, 'Democratic Disruption in the Age of Social Media: Between Marketized and Structural Conceptions of Human Rights Law' (2021) 32 Eur J Int Law 159. For an overview of the rapid expansion of human rights-based approaches in digital regulation see Anu Bradford and Anu Bradford, *The Brussels Effect: How the European Union Rules the World* (Oxford University Press 2020).

[157] Ingrid Burrington, 'The Infrastructural Power Beneath the Internet as We Know It' (*The Reboot *retrieved from the Internet Archive*, 22 April 2022) <https://web.archive.org/web/20220528232931/https://thereboot.com/the-infrastructural-power-beneath-the-internet-as-we-know-it/> accessed 5 November 2024.

investments in AI due to their carbon footprint; empowering tech workers and establishing mechanisms for (global) collective bargaining.

But general principles and 'big policy' shall not allure us. A global project on the law and politics of programmability requires not only institutional engagement but a parallel enquiry into the micro-world of the transnational legal order along with political movements towards agonistic data/computing practices.[158] It is through studying and engaging with the micro-level, the techno-legal mechanisms for value capture and value inscription, that we start to see the previously unseen and explore alternative possibilities.

Such alternatives are currently hard to ideate. At the very least, they involve some form of involvement in the legal formations and decision-making processes underlying the deployment of a functionality-enabling chip or hardware. In such a scenario, instead of discussing what kind of measures shall be in place for regulating access to data generated by particular sensors, people, governments, and organizations are given the ability to scrutinize hardware procurement and institutionalize the discussion on whether particular features shall be deployed at the first place. Alongside that, people and communities participate, organize, and institutionalize the practice of doing and implementing 'infrastructuring work'. They are given the legal channels to demand positive (re)configurations in the design of digital infrastructures as well as the legal rights and financial resources to tinker with programmable technologies, break them open, play with them, repair them, and reverse engineer them.[159] Open-source hardware and Open ML projects are necessary but not sufficient conditions for a transformative agenda.[160] New forms of computing activism are needed and a new culture of community-driven standardization; a form of techno-legal process that grapples with the politics and affordances of particular technologies and provides the interested and affected parties the institutional channels necessary for shaping their programmable visions.

In a recent workshop on the role of law in value chain resilience, organised by the LEXSCURE project, Kjaer insightfully observed that a common thread that connects colonial law and modern GVCs regulation is the underlying project of having materials flowing one way (from South to North) while norms and rules going the other way around (from North to South). This observation is as accurate for the value chains of traditional materials as it is for the political economy of AI: even if much of the production is found and performed in the Global South, what is built, by whom, how, and for what purpose are all defined by the designs, visions, and projects of people in the Global North. Therefore, to think about different agendas for the transnational regulation of infocomputational production is to imagine ways and strategies to reverse these historical currents of norm-flowing.

Writing for the practice of computing in/from the South, Amrute and Murillo read 'South' as a method of/for computing; a form of enquiry for exploring potentialities for collective work that will challenge the hegemonic and utilitarian modern practice of computing and cultivate practices that are 'entangled, committed, and joyful'.[161] To move beyond the dominant reality of computing as a weaponizing means of waging war and inequality, Amrute and Murillo invite us to think about digital-infrastructural concentration and the neo-colonial extractive model of North-South, not as a monolithic and binary concept but as an epistemic formation and political compass.[162] Their account of a counter-hegemonic 'historic block' attributes the current state of our monopolistic and pervasive digital world to monopolies that arise 'globally

[158] Roderic Crooks and Morgan Currie, 'Numbers Will Not Save Us: Agonistic Data Practices' (2021) 37 Inf Soc 201.

[159] Julie E Cohen, 'Rethinking "Unauthorized Access"', *Configuring the Networked Self* (Yale University Press 2012).

[160] Gagan Gupta and others, 'Open-Source Hardware: Opportunities and Challenges' (arXiv, 11 June 2016) <http://arxiv.org/abs/1606.01980> accessed 1 November 2022; Benjamin J Birkinbine, 'From the Commons to Capital: Red Hat, Inc. and the Incorporation of Free Software', *Incorporating the Digital Commons*, vol 13 (University of Westminster Press 2020); Widder, West and Whittaker (n 55).

[161] Amrute and Murillo (n 125) 2,16.

[162] ibid 2–4.

and infrastructurally' and calls us to experiment, tinker with, and build towards 'technological autonomy' and 'data sovereignty' projects.[163] Viewing 'South' relationally enables us to develop a shared analytical toolkit for computing that extends beyond the mainstream critique of Big Data to involve issues around 'infrastructural control and unchecked political influence at multiple levels and domains of expert knowledge'.[164]

Viewed as such, the 'South' becomes the heart of a radically different political project. Scholars in the Global North do not need to reinvent the wheel. Issues of land, emancipation, community rights, protection of shared knowledge and other ideas that people in the Global North might now find attractive have long been in the mind, practice, and agendas of people in the Global South.[165] Creating spaces for co-learning and co-thinking can thus prove formative of new avenues for shaping visions and priorities for the present and future of AI production. Aiming at dismantling the hegemonic understanding of the GVCs of AI as another terrain of the US-China trade war, such a legal-political project challenges us to construct institutional possibilities for a different political agenda and computing practice capable of questioning the values, ethics, ownership status, and priorities of the entities that 'infrastructure' our digital world. Creating equitable and just computational worlds and futures would not necessarily entail large-scale investments in factories or million-dollar research projects that would merely and uncritically flow expert knowledge from North to South but rather it would be a project centred on developing the organizational, institutional, and infrastructural capacity for supporting computing cultures, practices, and projects in, from, and of the 'South'. Such an agenda would advocate that we do not need national legislation determining, for example, where Apple will build its chips as much as we need a diverse and inclusive legal-political initiative for institutionalizing the debate on what computations the iPhone will be able to perform and under what circumstances; or on whose benefit present and future Amazon's data centres shall occupy land and consume energy; or on whether mandates of sustainability and intergenerational justice oblige Microsoft to refrain from using knowledge and art to create proprietary tools for text- and image- generation; or on whether future generations are entitled to enjoy a sustainable world where Google is not tracking them from birth; and finally, on whether Apple, Amazon, Microsoft or Google, in their corporate form and networks of value generation, are indeed the best vehicles to solve problems and satisfy present and future needs of people and communities in North, South, and beyond.

CONCLUSION

The way we think about law in relation to AI production matters. The hegemonic narrative reinforces the idea that law merely provides 'market-facilitating' institutions and 'rules to correct

[163] ibid 14.
[164] ibid.
[165] The literature here is endless, but some starting points to explore epistemic and normative tensions between legal thinking in the Global North and the lived reality of Global South include B de Sousa Santos, 'Public Sphere and Epistemologies of the South' (2012) 37 Africa Development 43; Boaventura de Sousa Santos, 'Beyond Abyssal Thinking: From Global Lines to Ecologies of Knowledges' (2007) 30 Review (Fernand Braudel Center) 45; Nikita Dhawan, *Decolonizing Enlightenment: Transnational Justice, Human Rights and Democracy in a Postcolonial World* (Verlag Barbara Budrich 2014); Ana Cecilia Dinerstein, *The Politics of Autonomy in Latin America: The Art of Organising Hope* (Palgrave Macmillan UK 2015); Teemu Ruskola, 'Where Is Asia - When Is Asia - Theorizing Comparative Law and International Law Symposium - The Asian Century: The Concept of Asia in International Law' (2010) 44 U.C. Davis Law Rev 879; Leah Temper, 'Blocking Pipelines, Unsettling Environmental Justice: From Rights of Nature to Responsibility to Territory' (2019) 24 Local Environment 94; Daniel Bonilla Maldonado (ed), *Constitutionalism of the Global South: The Activist Tribunals of India, South Africa, and Colombia* (Cambridge University Press 2013); José-Manuel Barreto, 'Epistemologies of the South and Human Rights: Santos and the Quest for Global and Cognitive Justice' (2014) 21 IJGLS 395; Tembeka Ngcukaitobi, *Land Matters: South Africa's Failed Land Reforms and the Road Ahead* (Penguin Random House South Africa 2021). For the field of law and technology in particular see, indicatively, Stephanie Russo Carroll, Desi Rodriguez-Lonebear and Andrew Martinez, 'Indigenous Data Governance: Strategies from United States Native Nations' (2019) 18 Data Sci J 31; Lisa Nakamura, 'Indigenous Circuits: Navajo Women and the Racialization of Early Electronic Manufacture' (2014) 66 Am Q 919; Serena Natile, *The Exclusionary Politics of Digital Financial Inclusion: Mobile Money, Gendered Walls* (Routledge 2020).

information asymmetries' rather than being a 'terrain of struggle' over the terms and conditions under which value is generated and distributed.[166]

Seeing the deeply integrated and ever-evolving GVCs of AI in all their complexities and nuances allows us to see a transnational techno-legal order heading towards consolidation; a form of global ordering that constraints computational potentialities whilst shaping the constitutive fabric of our digital future(s) in the process. Contrary to traditional GVC analysis, the point of enquiry in the GVCs of AI is not only the way an MNC achieves a form of managerial control without ownership across the value chain, but the fact that in doing so it simultaneously exerts infrastructural control over the nature of computations people will undergo or undertake. Law constructs and reinforces power in the GVCs of AI by providing the foundation for a power-enabling form of contractual governmentality and by cementing IP fences that perpetuate the uneven distribution of value across the chain. Meanwhile, law amplifies the geopolitical framing that wants transnational AI development to be shaped based on national interests.

Alternatives to how law operates are hard to imagine but histories and cultures of computing can offer inspiration for doing things differently. Moving beyond the 'trade-war' framing, a counter-hegemonic agenda for global programmability would develop policies that explore, scrutinize, expose, and question the power of lead firms over what is being built, by whom, and how. In such a scenario, law transforms epistemic boundaries and vocabularies and generates the discursive and institutional space for 'fighting' over the foundational principles for value generation and distribution in the digital world of the future. Emerging from critical legal, data, and computing scholarship particularly from/for the Global South, a global agenda of programmability would advocate that computing in/from/of the 'South' is not about entering or upgrading one's role in the modern GVCs of AI but about exposing the inequalities and power asymmetries inherent therein while accepting the ontological possibility of working towards equitable and community-driven computational projects. A global agenda of programmability would be further promoted by legal and normative tools capable of interrogating, challenging, and reshaping power structures and infrastructures; forms of power that mainstream legal analysis has for long time now lacked the incentives and capacity to articulate and confront.

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[166] The IGLP Law and Global Production WG (n 48) 60.